Abstract

This investigation aimed to explore how Ontario secondary school science teachers used culturally relevant teaching strategies. This question was broken-down and addressed with the following sub-questions: how do teachers reportedly relate lessons—directly or indirectly—to students’ personal experiences? How do teachers integrate students’ cultural backgrounds into the classroom and lessons? Can teachers identify anecdotes relating to students who “successfully” entered careers in science, discussing student character and/or personality? Following this, a thorough discussion of the various engagement constructs was conducted. This was concluded with a connection to literature in culturally responsive pedagogy and how it is a viable pedagogical tool to foster engagement in the science class. The interview participants Batman and Superman discussed the importance of fostering a respect for science as a way of knowing, but not the only way, particularly through acknowledging that science is about more than content. The participants discussed thoroughly the need to foster positive views of science through ways of knowing, suggesting that this could be done through cultivating an accommodating classroom environment which takes all cultural perspectives into account. The implications for the broader educational community are significant, particularly in the need for further professional development opportunities to be offered.

**Key words:** engagement, culturally responsive pedagogy, science teachers, Ontario.
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Chapter 1: Introduction

1.0 Introduction: Research Context and Problem

Adolescence is a phase typified by self-discovery. Teens enter into this period having only a limited knowledge of their own personalities and limitations, subsequently engaging on a years-long process of development culminating in adulthood. Of course, the diverse array of personalities and dispositions seen among adults is intricately linked to the diverse contexts each individual develops in during adolescence (Kanwal, Jung, & Zhang, 2015; Thompson, 2011; Zimmerman & Iwanski, 2014).

Disengagement, is often described as a stepwise process wherein students detach, emotionally and psychologically from school (Belfanz, Herzog, & Mac Iver, 2007). In Ontario, teens aged 14-18 spend at minimum 55 hours in each half-course over a semester (Ontario Ministry of Education, 2008). A student’s continued engagement is contingent on in-school context, which some believed is predicated on their sustained attendance. This has been addressed somewhat at the provincial level by the Ministry of Education in Ontario though The Education Amendment Act (Bill 52), otherwise known as the Learning to 18 initiative, which mandates that students are to remain in school until they are legally adults (Education Amendment Act, 2006). However, legislation forcing students to simply remain physically present in schools has had a limited impact, doing little to minimize disengagement (Ungerleider, 2008). Such measures are seen as counterproductive to fostering development as they do not view disengaged students as individuals with their own situated reasons for disengaging.

Student disengagement affects all academic disciplines, especially the sciences. A recent study by the Council of Canadian Academies (2014), however, reports that only 42% of Canadians have a basic scientific literacy, broadly defined as a vocabulary and understanding of
the nature of science. Vast numbers of students are not learning scientific content, or developing an appreciation for scientific inquiry needed to be the scientifically literate citizens demanded by society. It is important that these issues be addressed at the secondary level, as only 18.6% of students obtain post-secondary degrees in a science, technology, engineering or math (STEM) field (Statistics Canada, 2011).

To understand the complex factors that lead to student disengagement in the sciences, one must analyze the Curriculum Documents published by the Ministry of Education in Ontario (Ministry of Education, 2008). Every course in secondary science focuses on the following three goals:

- to relate science to technology, society, and the environment.
- to develop the skills, strategies, and habits of mind required for scientific inquiry; and to
- to understand the basic concepts of science.

It is critically important that every science class addresses these points given the pervasive role that science plays in the lives of all Canadians. Science is present in what most people take for granted, from the places we work, to the food we eat, to the life-saving pharmaceuticals we take (Johnstone, 1991). It cannot be understated—especially in the technologically-focused information age that we are living in—how important it is to produce citizens capable of understanding important, fact-driven data from pseudo-science (Sue, 1999). In short, we want scientifically and technologically literate people who can not only read, but understand how to interpret information around them scientifically as this will lead to healthier people and societies (Hodson, 2007).

While the Ontario Curriculum has goals of the science program, there is an issue in how to foster student interest in the sciences. Clearly, situating science in a social, economic and
environmental context, as directed by the curriculum, is insufficient in affecting student engagement (Council of Canadian Academies, 2014; Ontario Ministry of Education, 2008). In taking a different approach, it is known that student engagement is heavily underpinned and affected by a student’s identity. There is considerable literature to support that overall student engagement in science is closely linked to one’s self-concept and self-efficacy, crucial components to one’s self-identity (Green et al., 2012; Linnenbrink & Pintrich, 2003). Self-concept is a holistic term defined as one’s self-knowledge, schemas and social behaviour (McConnell & Strain, 2007; Markus & Wurf, 1987). In other words, self-concept is one’s belief as to who they are. Self-efficacy, on the other hand, is one’s belief that they can succeed at particular tasks. Self-concept and self-efficacy are tightly linked, are both developed further during adolescence and are high indicators of student scientific success.

If self-concept and self-efficacy are predictors of scientific engagement then it is worthwhile for teachers to adapt their pedagogy appropriately. Turning to the Ontario Curriculum (2008), there is little guidance in how teachers can develop their lessons to target self-concept and self-efficacy. In fact, the Ontario Curriculum (2008) states that teachers “must provide opportunities for students to develop habits of mind for meaningful work in science” (p. 10) but leaves the method up-to the teacher’s own discretion. Fostering self-concept and self-efficacy directly can be extremely difficult, due to their dynamic nature (Linninbrink & Pintrich, 2003; Pajares & Schunk, 2001), a reliable and practical framework is needed which indirectly addresses these constructs. One method which is of critical importance is culturally relevant pedagogy (CRP), which can be broadly defined as rooting instruction in who students are in their everyday life (Ladson-Billings, 1995a; Ladson-Billings, 1995b). Interestingly, early reviews describe student concept of self and others as a vital theoretical underpinning for success of CRP.
This method is particularly powerful as it uses the cultural knowledge, prior experience, frames of reference and performance styles of diverse students to make learning more relevant and effective for students (Gay, 2010). Some research shows a plausible link between CRP and student self-efficacy, strengthening this as an extremely useful framework toward fostering student success (Gonzalez-Espada et al., 2015).

It has been shown that adolescence is a critical developmental phase for students, both personal and academic. It is also known that during this period that students develop their self-concept and self-efficacy. Considering that the research shows that these constructs are linked to cultural context, if the scientific curriculum is not delivered in a matter sensitive to a student’s own cultural context then a student may not be motivated to succeed in their science classes. This perspective is not sufficiently addressed in the Ontario Ministry Documents, as they focus on developing scientific literacy in social and environmental context. This is far too narrow of a scope. In order to motivate students to become life-long scientific learners this context must be expanded to integrate students’ self-concept and self-efficacy through culturally-relevant teaching.

If a teen’s self-concept and self-efficacy is not cultivated in the science curriculum then they will fail to form the required habits of mind set-forth by the Ontario Curriculum. This can have several negative down-stream affects such as low student enrolment in post-secondary science programs, high drop-out rates, high rates of science anxiety, and a general apathy toward science (Council of Canadian Academies, 2014). There is a great risk in producing citizens ill-equipped to evaluate the world around them in a scientific context (Council of Canadian Academies, 2014; Amyot, Benoît, & Schiele, 1994). It is for this reason that in order to address issues related to student engagement in the science then we ask the student to look no further
than themselves. Cultivating an interest in science implies that the student is able to identify with science in the context of their own schemas and self-interests; it is only in doing so that they will be truly engaged and be life-long scientific learners.

On this note, situating the study in the context of secondary schools is of particular importance. Research supports that adolescence is a critical period of self-discovery and development (Marcia, 1980). The window to integrate science into student’s self-concepts and efficacy is beginning to close in adolescence, and teachers must harness a teen’s desire for self-discovery. For that matter we look at secondary students as this is a critical time to begin developing students’ self-concepts by situating their identity in context of science. It is imperative that we develop adolescence to be stewards of science.

Due to the constraints of time, this study will focus on one such method, culturally relevant teaching, as it is proven to be effective in the literature in promoting interest in science. There is, however, an absence in qualitative studies discussing science teachers’ philosophies of CRT and engagement of self-concept and self-efficacy.

1.1 Purpose of the Study

The purpose of this study is to examine Ontario secondary science teachers’ reported philosophies of culturally relevant teaching and engagement. I explored this topic by interviewing a sample of these teachers about: teacher reports of their efforts to relate lessons, directly or indirectly, to students’ personal experiences, teacher understanding of students’ cultural backgrounds in the classroom and how/if these are reportedly integrated into lessons, as well as teacher anecdotes relating to students who “successfully” entered careers in science. It is my hope that these findings will highlight a diverse array of CRT practices that all teachers can
integrate into their lessons to produce adolescents that see the value of science as it relates to their own self-identity.

Producing stewards of science is extremely important, given the increasing globalization of Canadian society. We are experiencing incredible innovation, and it is important that we educate a generation of adults capable of carrying us into the future, regardless of its nature. The daunting task for educators is in how we use every student’s unique perspective to cultivate an inherent interest in science, as progress is dependent on this. Culturally relevant teaching is constantly presented as a viable, practical tool to accomplish this endeavor (Ladson-Billings, 1995a).

1.2 Research Questions

The main question driving this study is: What are Ontario high school science teachers reported philosophies of culturally relevant teaching and engagement? This question was broken-down and addressed with the following sub-questions:

- How do teachers reportedly relate lessons—directly or indirectly—to students’ personal experiences?
- How do teachers integrate students’ cultural backgrounds into the classroom and lessons?
- Can teachers identify anecdotes relating to students who “successfully” entered careers in science, discussing student character and/or personality?

This study ultimately aimed to bring awareness to the importance of the concurrent development of scientific identity with the self in a culturally-sensitive context. In shining a light on practitioners utilizing such methods and their experiences, we hoped to enhance the teaching practice, by way of positively affecting student engagement.
1.3 Background of the Researcher

The concepts of self-concept and self-efficacy are extremely important to me, as I struggled greatly throughout my undergraduate education to find my “identity” as a scientist. To a certain extent, I decided to pursue my Master of Science in Chemistry simply because I was not satisfied with my level of comprehension, and felt that such an advanced qualification would somehow make me “better”. Anecdotally, I did find this to be a theme among some of my more disinterested colleagues. This notion of tying in one’s own worth to their formal education was highly intriguing to me, simply because whenever I would experience difficulties in my education I would enter into periods of intense self-doubt.

This mentality, however, was not new to me. In elementary and high school, I tied-in my identity, self-worth and happiness intimately with my academic success. That, for better or worse, worked for that period in my life. School was, after all, straight-forward and not too difficult for me, and as such I remained relatively happy and stable. For that reason, I decided to enter into post-secondary studies in Chemistry—the hardest of the sciences (in my opinion) as a mission to “conquer” because only at that point would I be completely secure in my scientific abilities. Of course, this was disastrous for me as university is not easy and I lacked the resiliency to be happy and proud of myself even if my academics and grades were suffering. I was, after all, able to graduate with my B.Sc. after working to decouple from academic success. This worked fairly well for me, and I attained a considerable amount of success. I carried on-with this until my M.Sc., where I found that I was working in science not because I loved the subject, or was intrigued by its study, but because I could. Furthermore, I was able to emotionally fund this venture because it wasn’t as intricately tied into my self-worth.
In hindsight, it is clear that science was something I always did because I could. Either it made me feel good about myself, or I was secure enough in the other aspects of my life that I was able to persist in spite of my slight apathy. This was always starkly contrasted by my family and friends, who constantly looked at my studies as something “foreign” and incomprehensible. For better or for worse, science is part of who I am, and I am comfortable with that. However I am intrigued that is not true for others. Those who are too scared to study, or have been turned away from the subject from a few bad experiences have not bothered to incorporate science in any positive way into their identity.

Although I am not yet at that point personally, I want to understand how science can be taught to students so that they incorporate it into their own identity in way that doesn’t evoke apathy, anxiety or depression. Aside from my self-worth, part of my interest in science in high school was because it was taught by males, who were from a similar cultural/socio-economic background as myself and my family. There were thus constant anecdotes and metaphors that endeared science to me. That positive experience helped me persist in science, and only made sense in hindsight. I want to know how I can best apply this to students of all cultural backgrounds, so that students entering into post-secondary can clearly situate themselves in the context of science, regardless if that is their chosen field of study.

1.5 Overview

This research project is organized into five chapters. First, I reviewed the literature in the areas of engagement, self-concept and culturally relevant pedagogy in Chapter 2. In Chapter 3 I elaborated on the research methodology and include information on data collection, limitations and the participants. In Chapter 4 I reported and discusses the research findings. Lastly, in
Chapter 5 I reviewed the implications of the findings, and recommend future directions. A list of appendices and references are found at the end.
Chapter 2: Literature Review

2.1 Chapter Introduction

In this chapter I reviewed literature in the areas of engagement, self-concept and culturally relevant pedagogy. More specifically I reviewed themes related to adolescents. I started by reviewing the literature in the area of engagement and some best practices for its fostering. Next, I reviewed research on adolescent engagement in order to better understand science class-specific constraints. From there, I reviewed research on culturally relevant pedagogy. Finally, I related this literature to engagement through self-concept.

2.2 Student Engagement: Theory and Practice

Engagement is an all-encompassing term and ubiquitous in the education literature. It is commonly used as an end-goal for educational institutions, a benchmark to reach given effective teaching. For that matter, it is used quite frequently and variably both formally and informally. One can then imagine how it can be difficult to unambiguously define what engagement is. Firstly, what is known is that engagement differs based on the context and that effective practices must keep this note in mind. This section will work toward establishing a practical definition of what engagement means, both for the student and for the teacher, and will outline some of the best practices for its implementation. This is important to know as engagement is an excellent indicator for institutional excellence and student success. In order to probe for effective practices that foster self-concept and self-efficacy, one must first address engagement.

2.3 Defining Engagement

Student engagement as a concept has been developed over the past 70 years. In the 1930s, Ralph Tyler, the prominent educational psychologist, indirectly alluded to it in his investigations linking the students’ time spent on their work and its effects on their learning
It was not until the 1980s, however, where a definition that conceptualized student involvement was first offered, defined engagement as the quantity and quality of energy that students invest in their educational experience (Astin, 1999). This work was among the first to suggest that student involvement is proportionally related to student learning. Later work built on the concept of student involvement to include engagement, which was defined as the degree in which students participate in effective educational practices (Kuh, 2001; Kinzie, Gonyeah, Shoup, & Kuh, 2008). It is important to note that these practices are considered to be activities other than studying, such as consultation with instructors (Axelson & Flick, 2010).

It is from this work on student engagement and involvement that the construct of engagement was developed further (Astin, 1999; Kuh, 2001). Contemporarily, engagement is regarded as a practice where students make a psychological investment in learning. Effective engagement can be observed when students participate in an activity of incorporating and internalizing material in their own contexts (Guthrie, 1996). Modern definitions also expand on previous conceptualizations regarding effective practices to include aspects of metacognition; where students are directly tasked with curriculum design, classroom management and building school climate (Bovill, Cook-Sather, & Felten, 2011).

Considering this, it is useful to review engagement in the context of the Ontario Science Curriculum. The clearest definition of engagement offered by the Ministry of Education comes from interpreting it in the context of instructional approaches. According to this document, students are seen as being engaged only when they are able to see connections between scientific concepts and the world around them (Ontario Ministry of Education, 2008). The Ministry’s philosophy, therefore, is quite narrow as it addresses only one particular type of
psychological/cognitive investment in learning—finding relationships between scientific concepts and the external world. Indeed, this view on engagement percolates through to the literature as there are numerous studies outlining various practices that strengthen teenage students’ ability to form these external connections. In truth, engagement can also exist on a behavioural and emotional level and can be reflected in students’ feelings and behaviours (Gettinger, 1995; Luiselli, Putnam, Handler, & Feinberg 2005). In order to thoroughly grasp the best practices for affecting engagement in the science class, a discussion of the factors that affect it is first required.

2.4 Factors that Affect Student Engagement

Given the significant literature precedent linking engagement with learning, the current chapter will highlight several key factors and practices that are known to foster engagement. If engagement is proportional to the amount of time a student spends in educationally effective practices, then one must consider the role of the teacher in this light. This is echoed in the literature, with several studies stressing the decisive importance of teachers in affecting student engagement (Stroet, Opdenakker, & Minnaert, 2015; Taylor et al., 2014). One prominent argument, rooted in self-determination theory, asserts that engagement is best achieved when teachers address a student’s intrinsic-motivation (Taylor et al., 2014). Intrinsic motivation in an educational context can be seen in students who pursue their studies for joy or pure self-interest (Taylor et al., 2014). Teachers who positively influence a student’s intrinsic desire to learn material are said to be effectively engaging their pupils.

As one can imagine, when investigating effective means to engage students one must also ensure that the school context is attuned to the student. Just like the student is in the constant presence of the teacher, they are also constantly physically and emotionally present in the school.
It makes sense that to affect engagement the students’ classroom environment must be considered. One highly investigated and successful practice is in bringing technology into the classroom. Recent research into mobile technology-mediated approaches, for example, found that integrating learning activities with mobile technology-mediated approaches was an effective technique toward increasing student engagement in mathematics classes (Bray & Tangney, 2015). Keeping with this trend, one recent study found significant increases in student engagement specifically in science classes when tablets were integrated into lesson plans (Manuguerra & Petocz, 2011). Clearly, there is precedent to suggest that technologically-enhanced learning environments positively affect learning by means of engaging students (Conole, de Laat, Dillon, & Darby, 2008). These approaches have been found to be more effective than more traditional educational approaches, as they take advantage of students’ already invested interest in these media (Bovill, Cook-Sather, & Felten, 2011).

Ultimately, high levels of engagement are predicated on good overall health. Undoubtedly, engagement is highly dependent on students’ mental health (Bond et al., 2007). A recent report indicates that discrepancies between mental health and educational achievement are closely associated (Freudenberg & Ruglis, 2007). Mental health is an especially important, as symptoms of various disorders such as, but not limited to, anxiety and depression, begin to show during this developmental period (Cummings, Caporino & Kendall, 2014; Starr, Stroud, & Li 2016). This is an extremely crucial factor to keep in mind when addressing student engagement, as issues relating to mental health are associated with low overall school performance, drop-out rates and undoubtedly persist to adulthood (Bond et al., 2007). The challenge, similar to the other factors affecting student engagement, is in finding effective strategies that implement positive mental health and ensure enduring student success (Bond et al., 2007).
An interesting note to consider is that the three factors outlined in this chapter that affect engagement: teacher, environment and mental health, are all inter-related. Engagement, in truth, is a confluence of these factors. Discussion will subsequently shift to effective practices that best integrate the teacher, the environment and mental health to positively affect engagement.

2.5 Practices that Foster Student Engagement

In response to increasing dropout rates, the National Research Council in conjunction with the Institute of Medicine in the United States was tasked with finding the practices to foster engagement (National Academy of Sciences, 2004). The research methodology was largely qualitative, involving a committee of various educational professionals tasked with reviewing, synthesizing and analyzing research on academic engagement and motivation as applied to urban high schools (National Academy of Sciences, 2004). It was concluded that student engagement is optimally represented by the students’ beliefs of “I can” (perceptions of understanding and control), “I want to” (values and goals) and “I belong” (social connectedness to peers and teachers). Engagement, as a construct, was subsequently expanded to include academic and behavioural engagement, which are directly and indirectly observable, and cognitive and psychological engagement, which are internal indicators and best measured through self-reported data (Appleton, Christenson, & Furlong, 2008). Engagement, henceforth, can be conceptualized as a dynamic state highly influenced by a variety of contextual factors, such as those mentioned above (Christenson et al., 2008).

Direct connections between tasks that specifically addressed these constructs and academic success have been found in several studies. Academic engagement, for one, is known to be influenced by instructional quality and delivery, supplemental support and classroom structure (Dotterer & Lowe, 2011; Thompson, Fulk, & Piercy, 2000). As such, providing clear
directions for tasks, offering a variety in learning activities and helping students are ways to foster academic engagement (Gettinger, 1995). Behavioural engagement, in contrast, can be discerned from attendance, obedience of school policy and interest/participations. Implementation of school-wide programs which lower suspensions and office referrals are well-regarded to increase this type of engagement (Luiselli, Putnam, Handler, & Feinberg 2005).

While both academic and behavioural engagement are correlated with student success, there is some agreement in the literature that enduring success is best achieved through cognitive and psychological engagement (Appleton, Christenson, Kim, & Reschly, 2006; Doll & Hess, 2001; Greene, Miller, Crowson, Duke, & Akey, 2004; Greene, 2015). In doing so, we are not only ensuring learning, but also fostering enduring content knowledge and a well-rounded student (National Academy of Sciences, 2004). Cognitive engagement best addresses students’ perceptions and beliefs regarding themselves, the school and other students. Psychological engagement, in contrast, can be indirectly studies by measuring students’ belongingness, expectations of success and perceived value of school (Appleton, Christenson, Kim, & Reschly, 2006). Moreover, when these psychological needs are addressed with cultural enterprises such as family and school, engagement is observed in both behaviour and cognition (Appleton, Christenson, Kim, & Reschly, 2006). That being said, cognitive and psychological engagement are subjective and can be difficult to implement in a classroom setting that is rich in diversity (Burgess, Wilson, & Lupton, 2005; Hollingworth, & Williams, 2010; Kirkham, 2016). Moreover, the literature is scarce in reports that directly address the four engagement constructs together (Fredricks, Blumenfeld, & Paris, 2004).

Interestingly, culturally-responsive teaching has been found to directly affect student engagement (Debnam, Pas, Bottiani, Case, & Bradshaw, 2015; Gray, 2002; Young, 2010).
Moreover, self-concept and self-efficacy are sometimes associated with this construct, making it worthwhile to investigate further (Jimerson, Campos, & Greif, 2014). Subsequent sections will firstly work toward defining the constructs of psychological and cognitive engagement, as a clear definition is required before fitting them into a culturally-responsive framework.

2.6 Fostering Adolescent Engagement in Science

Engagement is often described as the holy grail of learning, and is thus an extremely useful concept to understand. However, teasing-out an effective practice for fostering engagement continues to challenge modern educators (Fredricks, Blumenfeld, & Paris, 2004; Hospel & Galand, 2016; Marsh et al., 2012). The focus of the current chapter will be in outlining and expanding on the recent findings on eliciting high student engagement in adolescents.

2.6.1 Applying the engagement constructs to adolescents

Engagement in school is an antecedent for success, both in school and later in life (Veiga, García, Reeve, Wentzel, & García, 2015). This can be compared to recent literature work relating to self-concept and school achievement, which are known to mutually-influence one-another (Coelho, Sousa, & Figueira, 2014). At this point, what is understood is that success can be both dependent on engagement and self-concept; and the latter can both develop and be developed by a student’s academic achievement.

On that note, one active area of recent research has explored the precise relationship between engagement and self-concept, with an ultimate goal of fostering engagement and academic success indirectly through developing one’s self-concept. Studies have shown that engagement and self-concept are indeed effective in students’ school adjustment (Appleton, Christenson, & Furlong, 2008). That being said, this relationship is rather complex and may be subject to change during adolescence (Veiga, García, Reeve, Wentzel, & García, 2015). One
explanation for this change is the individual school and peer-contexts that each adolescent experiences. For example, if academic success is devalued by peers, then this has the risk of forming a negative school self-concept and lowering engagement (Darr, 2012).

In fact, during adolescence, the impact of peer relationships on engagement cannot be understated. A very recent study found that the relationship between self-concept and engagement was influenced by an adolescent’s age (Veiga et al., 2015). For example self-concept was found as an engagement-fostering asset for early (grades 6-7) and not middle adolescents (grades 9-10) (Veiga et al., 2015). It was found that this was due to cognitive and psychological engagement in school being devalued by peers (Veiga et al., 2015). As a result, peer-influence can be extremely powerful in undermining adolescents’ self-concept, though affecting their willingness to cognitively and psychologically engage, although more work is required to further probe this link.

2.6.2 The difficulty in fostering engagement in science

It is known that engagement and self-concept are indeed linked. Moreover, engagement can be hindered in contexts where a negative self-concept is supported by a middle-adolescent’s peer context. On this note, it is useful to shift discussion toward science-specific constraints to engagement. Science classes are similar in regard to the engagement constructs reviewed in earlier chapters, that *behavioural, emotional, cognitive and psychological* engagement are viewed as key predictors of success in the sciences (Fredricks, 2011). Without a doubt, however, the most work in the literature seems to be in connecting behavioural engagement in the sciences with achievement (Marks, 2000). This is most likely due to the fact that the common forms of assessment in science—attendance and recall-based tests—only probe this type of engagement (Marks, 2000). This is not to indicate that the other forms of engagement play a lesser role in the
context of the science classroom. However, there is a clear need to study the role that these other forms of engagement play in the science class (Pintrich & De Groot, 1990).

In fact, with the exception of emotional engagement, the other forms of engagement were found to be heavily influenced by existing self-regulatory constructs (Sinatra, Heddy, & Lombardi, 2015). Cognitive engagement and psychological investment, for instance, are linked positively to student success in the sciences. Higher levels of self-efficacy have been observed in tasks where students are involved with cognitively-demanding tasks (Schunk, & Mullen, 2012). In that regard, this recent research shows that there are highly domain-specific aspects of engagement in science that needs to be considered, namely how motivational, emotional and cognitive factors interplay. These ultimately influence how a student chooses to engage with the science content. This, in fact, is a crucial understanding regarding science engagement—that a student is ultimately responsible for engaging in content. Effective practices, as a result, must work toward making that content practical to the student in their own terms. Therein lies the power in designing lessons that engage via a student’s self-concept, as it is utilizing existing schemas that the student already has decided are meaningful.

2.6.3 Fostering cognitive and psychological engagement in the sciences

Taking stock of the literature, it is evident that there is a need to address practices in the science classroom that foster cognitive and psychological engagement. Doing so can ensure meaningful encoding of content, and it will form the life-long scientific learners desired by the Ontario Curriculum. Interestingly, several approaches in the literature aim to accomplish this via addressing Vygotsky’s theories of intelligence (Vygotsky, Cole, & John-Steiner, 1980). Additionally, it has been argued that science education would greatly benefit through integrating affect (emotional) and intellect (cognitive/psychological) engagement (Nieswandt, 2005). In
order to do so, some scholars argue that emotional engagement needs to be redefined, taking into account student feelings of equality and power, and to situate them in a culturally-sensitive social learning environment (Matthews, 2015; Matthews, 2005).

One noteworthy investigation that follows this theory used a Directed Activity Related to Text (DART) method (Matthews, 2015). Students were tasked with filling in discussion sheets that asked content-specific and opinion-type questions following a particular science lesson, which focused on cognitive learning. In groups, students were then instructed to share these thoughts with their peers, in an effort to engage in emotional-type learning. It was found that not only were students raising explicit questions and issues relating to content, learning and relationships, but students also learned the invaluable lesson that learning together is a vital component of science practice (Matthews, 2015; Matthews, 2005). On that note, it has been argued that the best science pedagogy engages students with the following questions: (i) what values are included? (II) whose values are included? (III) whose values are excluded? and (IV) what is made explicit and what remains implicit? (Hodson, 2011).

What one can see evolving from the literature is an emphasis on cognitive and psychological engagement, though engaging a student’s emotions (Matthews, 2015; Matthews, 2005). It follows that in order to foster lifelong scientific learning, educators should make use of a student’s basic values and feelings. According to some reports, classroom practices should focus on engaging in student’s emotional views in social settings in order to develop positive personal views of science (Matthews, 2015; Nieswandt, 2005). On that note, the definition of cognitive and psychological engagement becomes clearer, as it involves integrating students beliefs and values about the importance of learning, leading to expended effort above and beyond the required minimum (Greene, 2015). One way to access this highly valuable form of
learning, according to existing literature, is through tapping-into a student’s existing emotions, values and beliefs. These values and schemas are more broadly defined in the educational psychology literature as self-concept and self-efficacy, yet the link between these constructs and engagement theory/practice is underdeveloped. Fostering cognitive engagement, leading to the most effective and durable form of learning, must be done indirectly through a student’s existing theory of self (Greene, 2015).

2.7 Culturally Relevant Pedagogy: A Practical Tool for Engaging Students

It is important to note that there is a scarcity in literature reports that propose utilizing a student’s self-concept to engage their emotionals. This is most likely because one’s emotions, along with their beliefs, attitudes and perceptions fit into the construct of self-concept (McConnell & Strain, 2007; Markus & Wurf, 1987). Studies have explored the efficacy of methods that specifically address components of a student’s emotional base in a culturally-responsive context (Ladson-Billings, 1995). This final section will highlight Culturally Relevant Pedagogy (CRP) in the context of this framework, focusing on their ability to foster self-concept in the sciences.

2.7.1 Culturally relevant pedagogy in the science class

To review, CRP can be broadly defined as rooting instruction in who students are in their everyday life (Ladson-Billings, 1995a; Ladson-Billings, 1995b). In this section, a review of practices aimed at delivering CRP in the science class will be conducted, with an emphasis on self-concept. Once account, for instance, developed three criteria which are argued to constitute an effective framework for CRP: communication styles, culture and learning, and perceptions of knowledge (Howard, 2001). Ladson-Billings, who originally developed CRP, also attempted to disambiguate this practice by expanding it to include aspects of both cultural competence and
sociopolitical consciousness (Ladson-Billings, 2006). Later research uncovered deep issues with the practical implementation of CRP in the classroom, as it was often plagued with issues related to teachers’ cultural bias, existing racism in school, and a lack of support systems for staff to implement practices (Young, 2010).

In reviewing the literature on CRP, one fact becomes increasingly apparent: that there is a lack of literature clearly outlining a framework for implementing CRP into practice. Furthermore, the implementation of CRP in the class is made more difficult by the small amount of educational literature aimed at empirically considering and evaluating the efficacy of these practices (Lee, 2004; Rodriguez, 1998). Most studies focus on critical discussions (Aikenhead & Jegede, 1999; Atwater, 1996a; Atwater, 1996b; Lee, 1999; Lee & Fradd, 1998) and not methodology. This is even more apparent in the sciences; because there is no general framework for teachers to draw from, practices are not clear or difficult to implement.

Drawing from this realization, Patchen & Cox-Petersen (2008) conducted seminal work into using existing constructivist practices to inform and develop CRP to meet the needs of ethnically diverse students. The implications of this study were five-fold: First, diversify strategies, seating arrangements and student responsibilities; have a more flexible understanding of time in the classroom; provide more inquiry-based instruction and student-led instructional initiation, exploration and discovery activities; deepen responses to student contributions and to include student ideas; and to share and recognize students’ lives.

As far as connecting these findings to the existing literature on engagement reviewed above, the findings from Patchen & Cox-Petersen are highly relevant as they provide a firm pedagogical foundation (Patchen & Cox-Petersen, 2008). However, to successfully implement CRP, a student-centered framework is needed that focuses highly on intrapersonal and
interpersonal dialogue (Lee, 2005). This, according to one account, is an effective way of engaging students’ emotions and is relevant to self-concept (Greene, 2015). Although, it should be noted that there is little research exploring the relationship between CRP and self-concept. Going forward, the focus will be on relevant studies that utilize this framework to implement CRP.

2.7.2 Culturally relevant pedagogy in the science class

It follows, based on the above literature, that the most successful examples of culturally relevant science pedagogy utilize multi-faceted and student-centered approaches. One study (Meyer & Crawford, 2015) combined multicultural education strategies and explicit instruction in the nature of science in a “multicultural inquiry” approach. They found that in relating the content of lessons to particular cultural aspects held by students, that they viewed science as more than just a subject at school. Their views subsequently grew to differ from media-based depictions and became in-line with discipline-specific views held by scientists (Meyer & Crawford, 2015). In another investigation, focusing specifically on addressing the difficulty in having practicing teachers inexperienced in CRP, it was found that a successful means of challenging teachers’ existing views and supporting CRP is through collaborative planning time and home visits (Johnson & Bolshakova, 2015).

In a larger study of Puerto Rican students, González-Espada et al. (2015) studied the efficacy of utilizing a collection of multidisciplinary science essays written by Puerto Rican scientists in an effort to bring awareness to science in lieu of traditional textbooks. In using these culturally relevant materials, they found those students’ perceptions of science improved, particularly in boys, and that students highly preferred interactivity (González-Espada et al.,
These findings highlight the importance of adapting textbooks and materials in a direct culturally-sensitive manner, so that students’ experiences are taken into account.

Culturally Relevant Pedagogy has also been shown to be highly effective when specifically attuned certain student’s identity. In interviewing a “problem” student from an underrepresented population, Conlin, Richards, Gupta, and Elby (2015) were able to trace back his love of science to an alignment of his identity—as a lover of challenges—to the epistemology of science. Moving beyond the classroom, but staying within the realm of science the role of librarians in fostering student inquiry and identity via science-infused after school programs was explored (Subramaniam et al., 2015). It was subsequently found that this form of culturally relevant science teaching was highly effective in fostering engagement, through promoting authentic inquiry and engaging science learning in the context of the students’ everyday lives. These investigations therefore expand our understanding of CRP as a student-centred approach, from culturally-sensitive practices to those addressing a student’s self-concept.

In following a variety of CRP practices, it is evident that successful practices address a student’s own identity. Indeed, this is in line with Rodriguez’s (2015) view regarding the next generation of science standards, where he argues that some CRP frameworks fail due to a lack of retrospection, contradictory discourses and a lack of emphasis on student voice (Rodriguez, 2015). On this note, it is more evident than ever to develop CRP practices that emphasize the development of the student’s identity. The implications that such methods would have on affecting student engagement are well-understood, yet the nature of such practices needs to be addressed in the literature.
2.8 Conclusion

In this chapter I reviewed research on engagement theory and practice, ultimately focusing on recent trends in culturally relevant pedagogy in the science class. This review elucidated the extent that research has been conducted in how to foster behavioural engagement. It also raises questions about practices that neglect to foster psychological and cognitive engagement, and fail to look at these constructs as dependent on student self-efficacy and self-concept. The literature pointed to the need for further research in the area of culturally relevant pedagogy in the science classroom, and how this could be used to foster student identity. In light of this, the purpose of my research was to learn how culturally relevant pedagogy was being used by teachers to foster self-concept and self-efficacy by means of engaging students’ psychological and cognitive identities.
Chapter 3: Research Methodology

3.0 Introduction: Chapter Overview

To review, this MTRP investigated Ontario secondary science teachers’ reported philosophies of culturally relevant teaching and engagement. This was anchored by the main question: what are Ontario high school science teachers’ philosophies of engaging, culturally-relevant lessons?

Therefore, in this chapter I identified the methodological decisions that I have made, my reasoning for these choices in the context of my research purpose and questions. I started with a discussion of the research procedure and approach followed by a description of the main instrument of data collection. Next, I identified the participants of the study, listing the sampling criteria and describing the sampling procedures while providing some information on the participants of this study. I continued by describing how I analyzed the data, while considering and addressing some crucial ethical issues. Ultimately, I spoke to the methodological limitations of the study, while recognizing and acknowledging the strengths.

3.1 Research Approach and Procedures

This study was conducted using a qualitative research approach. This involved a review of the existing research related to the research questions and purpose of this study, as well as the use of semi-structured, face-to-face interviews with two-to-three teachers. A clear definition of qualitative research was imperative for this study, in particular, as it provided an important context through which the research problem could be understood. Flick (2007) defined qualitative research by comparing it to its quantitative counterpart. Generally, it can be defined as not being the latter, with the main difference of it not being standardized. Flick (2007) also argues that it can be defined by several features and that it is tasked with understanding the
construction of reality as a function of the perspective of participants in their everyday lives. Flick (2007) also goes on to compare qualitative and quantitative paradigms though drawing the important parallel that the former uses its text as its empirical material.

Stemming from this definition, another important value of qualitative research with respect to quantitative research arose. Walliman (2010) maintained that relativistic approaches espouse that the world around is simply a creation of the mind; that our worldview is our world. Walliman (2010) is also careful in saying that this does not imply that the world is not real, rather it could only be experienced through one’s perceptions, which are inseparable from our preconceptions, beliefs and values. This was notably in direct contrast to the philosophy of positivist philosophy underlying most quantitative studies. One of the qualitative researcher’s main duties, therefore, is to acknowledge that the world has already been interpreted by their subjects, and to then reveal the nature of the meanings created by humans (Walliman, 2010). Instead of focusing on the discovery of universal laws, the ultimate responsibility of the qualitative researcher, is to highlight and provide perspective(s) on the varying interpretations of a phenomenon (Walliman, 2010).

Thus far, discussion has centered upon highlighting the main differences between qualitative and quantitative paradigms, without focusing on the values that the former holds over the latter. On this note, Denzin and Lincoln (2005) provide insight into the value of qualitative research, insisting that it first-and-foremost locates and incorporates an observer in the world. In doing so, Denzin and Lincoln (2005) assert that this research methodology transforms the world, by turning it into a series of representations, in the form of field notes, interviews, photographs, recordings. In contrast to quantitative paradigms, which are concerned with the study of phenomena by separating them from the researcher, qualitative research seeks to make sense of
these phenomena by interpreting them in the context of the meanings that people—including the researcher—bring to them (Denzin and Lincoln, 2005).

In light of this discussion, qualitative research emerges as the optimum methodology to carry out this study. This is because, first-and-foremost, it provided me with an adequate framework from which I inquired into the lived experiences of a small sample of science teachers practicing culturally relevant pedagogy. Moreover, quantitative studies which narrow the scope of metaphysical and epistemological understanding to one, objective reality separate from the investigator. Qualitative methodology encourages work to transcend this belief toward the characterization and understanding of multiple interpretations of a phenomenon (Mertens, 1998). This highlights the crux of this investigation, where I not only looked into a sample of science teachers practicing culturally relevant pedagogy, and how they develop their practice in secondary schools, but also how these educators understand their experiences.

3.2 Instruments of Data Collection

Some typical sources of data in qualitative research are interview transcripts, literary texts, historical records, memos and recollections (Walliman, 2010). Barbour (2008) offers three general approaches in order to generate data: ethnography, interviewing and focus groups. While these techniques do not all generate similar data, and findings they provide the researcher with varying perspectives on particular phenomena. As such, the method of choice needed to be carefully selected to suit the purpose of the study and must generate the subjectively best answers to the investigator’s research questions. In complex cases, Barbour (2008) suggested the use of multiple methods to further verify findings.

According to Barbour (2003), interviews are often considered the standard through which qualitative research is conducted, at it provides an in-depth exchange between the researcher and
subject. On this note the structure of the interview can vary greatly, as the interview must match well with their research method (Barbour, 2008). As this work is most interested with understanding science teachers’ experiences utilizing culturally relevant pedagogy, interviews with a sample of these practitioners would yield the most pertinent data. In interests of satisfying this, the researcher can employ a range of interview styles, varying from highly structured to loosely structured (Barbour, 2003). Structured interview guides utilize identically worded questions being presented in the same order to each interviewee (Barbour, 2008). Open-ended or un-structured interviews are equivalent to guided conversations (DiCicco-Bloom & Crabtree, 2006), and are typically used to elicit insights about observed behaviours or interactions. The semi-structured interview, in contrast is often concerned with the exploration of the subjective world of the interviewee (Wengraf, 2001). The semi-structured interview protocol was the main instrument of data collection used in the present study.

Semi-structured interviews are extremely crucial as they elicit unique perspectives of importance from the interviewee, as opposed to the researcher dictating the direction of the discussion (Barbour, 2008). This is of great importance to the present study, as I was interested in learning about unique and salient experiences in regard to culturally-focused science teaching. Additionally, (Wengraf, 2001) argued that the interviewer, in contrast to structured or unstructured interviews, is involved in a process of model-building and testing, dynamically constructing and validating their theories over the course of the interview sessions through allowing for deviation from a set-protocol of questions. An additional constraint was that semi-structured interviews are often the sole source of data for a qualitative research project (DiCicco-Bloom & Crabtree, 2006), as was true with the current investigation. These provided the optimal conditions for my study, as I was interested in having to revisit and challenge ideas through the
data collection process of the semi-structured interview. The time and location of those interviews was also variable, and called for settings that are separate of every day events (DiCicco-Bloom & Crabtree, 2006). This was also optimal for my study as it removes the interviewee from their educational contexts which may facilitate critical reflection and dialogue necessary for the study.

Although semi-structured interviews allow for group-interviews, the present study was focused on one-on-one, face-to-face interviews (DiCicco-Bloom & Crabtree, 2006). This was advantageous as respondents were more comfortable sharing their experiences in intimate settings. On a final note, Rapley (2001) wrote that interviews are performances, wherein the interviewer worked the interview in a way similar to a normal, everyday conversation. Wengraf (2001) expanded on this by asserting that successful semi-structured interviews required the following: as much preparation beforehand, discipline and creativity in the session, and ample time for analysis and interpretation afterwards. All of these allow for flexibility when it comes to unexpected responses, and will give the best insight into the research topic at hand. I organized my protocol (Appendix B) into four sections: participant background, questions and encounters with culturally relevant pedagogy as a teacher and student, their experiences (expected or unexpected) teaching science in a culturally responsive framework, followed by questions concerning what challenges and supports are available. Examples of questions include:

- How do you relate lessons, directly or indirectly, to students’ personal experiences?
- Can you give me an example of a time that you explicitly integrated culture-specific content in your classroom?
- If integrating cultural content did not go well for you, what do you think you could do instead?
3.3 Participants

In this section, I reviewed the sampling criteria that I set for participant recruitment, and I also presented and reviewed the range of methods for teacher recruitment. Herein, I also included a section where I introduced each of the participants. Due to the impracticality and limitations in studying large populations, purposive sampling was used instead (Barbour, 2008). The sample participants represented well the phenomenon under study (Barbour, 2008); they also related closely to the research question while holding to specific criteria (DiCicco-Bloom & Crabtree, 2006). The following sections will communicate the methodological constraints associated with the participants.

3.3.1 Sampling Criteria

The following criteria were applied to all teacher participants:

1. Participants are OCT-certified secondary school science teachers.
2. Participants have participated in a professional development course or workshop on culturally relevant pedagogy or teaching (or similar).
3. Participants are teaching in the Greater Toronto Area

Unlike quantitative research, which demands a random selection of the sample to get an accurate representation of the whole population, qualitative research calls for a small selected sample (Carr, 1994). This is due to the nature of the study as well as the analysis of the data (Cormack, 1991), which constrains for smaller sample sizes. Therefore, in order to answer my focal research question, the participants that I interviewed have experienced using culturally relevant pedagogy in a secondary school science setting. Additionally, both participants have received exposure through professional development courses, independent research/reading or through collegial interaction with CRP. In the interest of understanding how these science
teachers constructed their own identity, and how this affected their pedagogy I wanted to also learn of their experiences outside of the science context. Due to the diverse cultural setting that is Toronto and its surrounding suburbs, a broad palette of experiences were covered by my geographically constrained sample. Lastly, I interviewed a variety of participants from a variety of age groups in order to have a rich data set.

3.3.2 Sampling Procedures/Recruitment

Carr (1994) argued that sampling procedures, while unique to each methodology, must meet the standards of the strategy used for data collection. Regardless of the sampling procedure, the integrity of the sample depended on its relationship to the population or phenomenon the study was trying to understand (Carr, 1994). Furthermore, Marshall (1996) asserted that the strategy used must accurately reflect the aim of the research and the nature of the questions asked. While random/probabilistic sampling is considered to be the best method to generalize the results to a larger population, it is not the best way of understanding complex relationships between issues and human behaviour (Marshall, 1996). The reasons for this are four-fold (Marshall, 1996): qualitative samples are usually small; true random samples require in-depth knowledge of the entire population; generalizability depends on the phenomenon being normally distributed throughout the population; and, qualitative sampling does not account for inherent bias in both the researcher’s and participants understanding of their own and others’ behaviour. Moreover, as generalizability was not the key aim of the current qualitative investigation, random sampling was not used.

As the goal of the present study was to not produce a sample representative of a larger population, but one that reflected diversity, purposive sampling was be used (Barbour, 2008; Mays & Pope, 1995). For that matter, there are four main sampling strategies utilized:
convenience, judgement, theoretical and snowball sampling (Marshall, 1996). Convenience sampling, the least exhaustive and expensive technique— involves selection of the most accessible participants (Marshall, 1996). In spite of its ease, it typically results in data of poor quality and reliability (Marshall, 1996). Judgement or purposive sampling is the most common technique, and involves the researcher actively selecting the best sample for the study at hand (Marshall, 1996). It is so commonly used as it well represents diversity within a group of people or a phenomenon (Barbour, 2008) leading to greater insight. Additionally, snowball sampling— where respondents own networks are used to find further samples (Barbour, 2008) – is related to purposive sampling (Marshall, 1996). Theoretical sampling, in contrast, is used when samples are driven by theory to any extent, where emerging data generates new theories leading to modification of the sample (Marshall, 1996). It is mostly used for grounded theoretical research, and is used directly or indirectly in most qualitative studies (Marshall, 1996).

Due to the various methodological constraints of the current study, I employed a combination of convenience, purposeful and snowball sampling. The sampling procedure was convenient in the sense that I selected participants that were directly within or associated with my network of educators. Having grown up and done all of my education and training in the Greater Toronto Area, my sample stemmed from my existing network. The sample was also purposeful in that I employed discretion and criteria to skim the sample to include only those most relevant to my research topic and to keep the population size small, this ensured that my interviews are in-depth and exhaustive. Lastly, I employed snowball sampling once I found a small number of educators that met my sampling criteria, this ensured that further participants shared novel yet relevant insight into my research topic.
3.3.3 Participant Bios

As previously alluded to, each participant has had experience teaching in Ontario. It should be noted that, due to the novelty of the research, it was rather difficult accessing participants who met the stringent criteria of the paradigm: being science teachers whom practice CRP. Thusly, both educators teach in publicly-funded educational programs, one at the Toronto District School Board while the other in a popular academic bridging program at a publically-funded university. Both participants were considered experienced science teachers due to their number of years – over ten each – in the teaching profession.

**Batman** is an Associate Professor in a bridging program at a major publically-funded university. They have experience teaching both in an Ontario context, as well as teaching high-school in a private setting in their non-Canadian context of origin. They have a combined total of fifteen years’ teaching experience divided between the two contexts. Their STEM (science, technology, engineering and mathematics) experience was limited to only their undergraduate education, and they specialize in teaching chemistry, biology and geography. Currently, their focus is on facilitating the transition to university for students and adults from marginalized communities who are interested in pursuing higher education.

**Superman** is a science teacher in the Toronto District School Board, currently in their first year of a three-year secondment to the Ministry of Education. They specialize in curriculum assessment policy and science innovation. Specifically, they look after the science and technology curriculum for Grades 1-8, and look after the Grades 9-12 science curriculum. They also review the technology and computer science curriculum. In Ontario, they have taught all permutations of science from grades 9-12, with the exception of grade 12 physics. They also had experience teaching at all three streams—applied, academic and locally developed, and have
been teaching. Combined, they have been teaching for over seven years. In undergraduate, they specialized in biochemistry and did not attend a graduate STEM program.

3.4 Data Analysis

While in quantitative research data analysis follows data collection, this is usually not the case in qualitative research (DiCicco-Bloom & Crabtree, 2006). As such, DiCicco-Bloom & Crabtree (2006) point out that data analysis usually occurs concurrently with data collection. This technique can be advantageous as it facilitates an emergent understanding of research questions, which influence the sampling and questions asked. This repetitive process of complimentary data analysis and sampling reaches a saturation point whereupon no new themes are discovered, concluding data collection (Kuzel, 1999). Walliman (2011) argues that this reciprocal process is an essential part of some qualitative projects, and is what separates it from quantitative research. It follows that the research topics, objects and the phenomenon under investigation are tentative and explorative (Walliman, 2011). A theory therefore becomes more refined throughout the course of the investigation (Walliman, 2011). In spite of qualitative researchers trying to make the data analysis project as scientific as possible, there is nonetheless a subtle art involved in dealing with the data (Walliman, 2011). Justification of findings is dependent on the strength of the argument given (Walliman, 2011), which is developed in the analysis process.

Unlike the various statistical methods used to analyze and justify quantitative data, qualitative data analysis is still being developed (Walliman, 2011). Miles and Huberman (1994) suggested that there should be three concurrent stages in data collection: data reduction, display and conclusion drawing or verification. A large wealth of information is first collected, and, in its raw form, it is difficult to understand and interpret it. As such, the researcher’s first task becomes
to distil and simplify the complex information into simple patterns and easy-to-understand configurations. Data reduction occurs through coding, clustering and summarizing, followed by organization of the data into tables or diagrams in order to enable one to adequately analyze the data. From there the significance of the data, drawing of conclusions and verification can occur (Miles and Huberman, 1994). This approach has been described by DiCicco-Bloom & Crabtree (2006) as a template approach, as it involves applying a framework based on previous experiences and perspectives.

Therefore, during my own data analysis I borrowed from this procedure; meaning I transcribed raw interview data, coded it, as it related to my research purpose and questions. Afterwards, I categorized and organized this data in order to identify themes and to locate inconsistencies in the findings.

3.5 Ethical Review Procedures

Integrity of the data and findings is closely linked to the integrity of the methods used. Research, regardless of the findings, can only be considered of value if it is done honestly and with integrity (Walliman, 2011). First-and-foremost, the researcher is bound to respect the core ethical principles of autonomy, beneficence and justice (Orb, Eisenhauer, and Wynaden, 2000). Respecting the virtues of the participants and of the work in an honest manner is vital, not only to maintain rapport with colleagues and participants, but to ensure the continued trust in and credibility of the work (Walliman, 2011). With specific interest on this work DiCicco-Bloom & Crabtree (2006) highlight four main considerations related to the interview process: reducing the risk of unanticipated harm, protecting the interviewee’s information, effectively informing interviewees about the nature of the study and reducing the risk of exploitation.
Although the topic of culturally relevant pedagogy in the science classroom posed no acute risk with respect to the participants, there were nonetheless considerations that I had to keep in mind. The nature of the questions, as well as the interview process could have elicited emotional responses or memories from the participants that might led them to feel compromised. I aimed to reduce this risk, firstly, by reassuring the interviewees that at any point in the interview, they could choose to pass on a question or cease the interview in order to protect their emotional and mental well-being. Orb, Eisenhauer, & Wynaden (2000) further spoke to the importance of ongoing consent as a vital means to protecting the participant from and reducing the risk of unanticipated harm. Another measure that I took, was to manage the participant-researcher relationship, as most of my participants were not individuals whom I personally knew or had directly worked with. These measures added an additional layer of protection for the participant.

Another ethical issue that I had to keep in mind was with respect to keeping the anonymity of the interviewee, with specific emphasis to the information that they were sharing (DiCicco-Bloom & Crabtree (2006). During the interview process, as is to be expected, the interviewee may have shared information that could have compromised their position, as such this information must remain anonymous and protected (DiCicco-Bloom & Crabtree (2006). Failing to maintain the anonymity of the participants would directly contradict the autonomy and affect the beneficence of the participant (Orb, Eisenhauer, and Wynaden, 2000). The present study respected anonymity by first utilizing creative pseudonyms to refer to the participants that were sufficiently diverse from their usual identifier. Additionally, any other identifying indicators were not utilized or released. Participants were promptly and directly informed of the study in person through written documentation, and any data obtained was held on a private and password protected external hard-drive. The contents of which will be erased after five years.
It is also of vital importance that I maintained a rapport of trustworthiness with the participants of the study (Orb, Eisenhauer, & Wynaden, 2000). Orb, Eisenhauer, & Wynaden (2000) maintained that trust must be continuously renegotiated throughout the investigation, as this not only ensures ongoing participation in the project, but also ensures the best results. Trust can be maintained through a variety of avenues, but is best held by ensuring adequate an ongoing communication of the intent of the investigation (Orb, Eisenhauer, & Wynaden, 2000). This can be difficult for the researcher, as they are continuously collecting data, and uncovering new themes and purposes (DiCicco-Bloom & Crabtree 2006); it is thus recommended that the participants be kept aware that their ongoing participation is necessary and likely. This has the added advantage of improving the quality and richness of the participants’ responses (DiCicco-Bloom & Crabtree 2006). Some risks stemming from this were in how I subjectively interpreted the data, or how these influenced the design of my study (Orb, Eisenhauer, & Wynaden, 2000). To avoid these, I maintained ongoing communication with the participants, and asked to sign a consent letter (Appendix A) giving their consent to be interviewed as well as audio-recorded. This consent letter provided an overview of the study, addressed ethical implications, and specified expectations of participation (one 60-minute semi-structured interview).

DiCicco-Bloom & Crabtree (2006) lastly asserted that interviewees should not be exploited for personal gain. It is thus suggested that a method of acknowledgement be put into place whereby the contributions of the participants to the success of the research process be made explicit and direct. This embodies the principle of justice in qualitative research, and is ultimately shown through recognizing vulnerability in the participants, especially respecting those groups most susceptible to exploitation such as children, the people with active mental illness or the elderly (Orb, Eisenhauer, & Wynaden, 2000). An additional practical consideration
in the implementation of justice (Capron, 1989) is that the protocol must provide no further burden to an already burdened group of individuals. The interview used herein involved the discussion of the participant’s views regarding race, gender and ethnicity; as such it was imperative that I fostered an environment that encouraged the open and healthy discussion of these ideas, while respecting the interviewee’s beliefs.

Lastly, (Orb, Eisenhauer, and Wynaden, 2000) asserted that the relationship between the participant and researcher can affect the integrity of the investigation. This is especially true as I, a preservice teacher, interviewed a variety of established educational professionals. As such, there was the consideration of the role that the power difference plays. This may have affected the way I interpreted the data or the design of the study itself (Orb, Eisenhauer, & Wynaden, 2000), as I may have felt obligated to adhere to particular ideologies. I was continually sensitive to these facts, while I disclosed to the participants any feelings or instances of power imbalance.

3.6 Methodological Limitations and Strengths

One of the main limitations of the current study was in the scope of the research and data. Given the ethical parameters governing the current study, interviews were limited to only teachers, leaving other stakeholders such as students and parents unavailable. The implications of the relatively small number of participants were that it may have affected the integrity of the data in the broader academic community (Griffin, 2004). Griffin asserts that, in order for research to be taken ‘seriously’, the status and ways that the participants are positioned in their respective field is important. That being said, inherent to the small sample size is one of the greatest strengths of the qualitative paradigm. Carr (1994) asserts that it facilitates the gathering of deeper, more interesting data especially compared with more rigid approaches.
Another limitation that I considered was the effect of the individual researcher’s skills, biases and idiosyncrasies on the research quality (Anderson, 2010). In response to this criticism, Anderson (2010) responded by arguing that the validity of the findings relates to the extent to which they are an accurate representation of the phenomenon that they are trying to reflect. In the case of the present study, using ulterior motives of data collection such as surveys and questionnaires may not accurately represent the subtleties and complexities of the research topic (Anderson, 2010). Moreover, in order to attain data of sufficient depth and content that it accurately represents the phenomenon under study was necessary that researchers themselves become immersed in the context or phenomenon (Carr, 1994). The researcher may use their biases, skills or idiosyncrasies as a method through which to effectively conduct the interview (Barbour, 2008) such that the data is sufficient to effectively describe the subject. This is something worth risking (Carr, 1994) by virtue of the high degree of depth offered by qualitative methodology (Duffy, 1985).

It is also important to consider the effect that the researcher’s presence (Anderson, 2010) or relationship (Carr, 1994) with the participants has on the responses. On that note, all qualitative data is based off of qualitative judgement (Atieno, 2009). The relationship between the researcher and the participant may be a vital tool in order to uncover any subtext, or to speak in greater depths to the data (Ateino, 2009). This would not otherwise be possible had the researcher not been familiar with the respondent. Moreover, as the researcher and respondent spend a considerable amount of time together, the latter feels like less of a research object, leading to the data being more likely to be valid and honest (Carr, 1994). There is risk, however, to the respondent and researcher sharing too close of a relationship, as it may result in the former being able to separate their own experiences from that of the subject, conflating the data and
reducing understanding of the phenomenon (Carr, 1994). Referred to as ‘going native’, this is not entirely negative, as it may increase understanding of the subject (Carr, 1994). In the case of the current study, as I conducted short, sixty-minute interviews at pre-determined locations and times separate from the respondent’s native contexts, this risk was reduced.

3.7 Conclusion: Brief Overview and Preview of What is Next

To conclude, in this chapter I presented the methodology that will be used. I began with a general overview of the research approach and procedures that I will be taking. The present study used a qualitative research approach, as it provided an adequate framework from which I could inquire into the lived experiences of a small sample of science teachers practicing culturally relevant pedagogy. Qualitative methodology also lends toward multiple interpretations of a phenomenon. The main instrument of data collection that I used was the interview, as interviews are often considered the standard through which qualitative research is conducted, and they provide an in-depth exchange between the researchers and subject facilitating rich data. I also reviewed the sampling criteria and procedures that I used, which was a combination of convenience, purposeful and snowball sampling. To analyse the data, I will transcribed raw interview data, coding it as it related to my research purpose and questions. Afterwards, I categorized and organized this data in order to identify themes and to locate inconsistencies in the findings, thereby discussing the significance of the findings. I also reviewed several important ethical considerations, such as respecting participant anonymity and maintaining a fair, professional relationship with the interviewees in order to uphold trustworthiness and integrity of the findings. Lastly, I discussed several important methodological limitations and strengths of the qualitative research paradigm. Next, in Chapter Four, I reported the research findings.
Chapter 4: Findings

4.0 Chapter Introduction

In Chapter One I delineated the purpose of the study, which is to investigate and review how Ontario secondary science teacher use culturally relevant teaching in their classrooms. In chapter 2 I reviewed and established literature precedent of culturally responsive pedagogy, establishing the need for focused studies which delineate success criteria for CRP praxis. Herein, I share findings from a thorough analysis of two semi-structured interviews. This will be done to ultimately gain insights into what culturally responsive pedagogy (CRP) in Ontario secondary science classes reportedly looks like. The conducted interviews were audio recorded and then transcribed verbatim to account for the experiences of the educators Batman and Superman who both teach various science courses in the Ontario education system. As indicated in Chapter Three, the participants’ names have been replaced with pseudonyms, as well as any other identifying information related to them, or their students, has been removed in order to preserve confidentiality.

The data collected through the interviews was subsequently parsed, coded and will now be discussed and interpreted heavily via the use of themes. For the sake of context, this chapter will firstly provide some detail regarding the participants, and will then proceed with a discussion of the participants’ responses as they relate to the following list of themes and sub-themes, interpreted across the interviews:

- Fostering positive views of science through ways of knowing
- More than content: a philosophy of Culturally Responsive Pedagogy
  - Hybrid culture
  - Environment
Teacher self-concept

Student self-concept

Engagement

- Defining a praxis of Culturally Relevant Science pedagogy
  - Challenges
  - Efficacy of practice
  - Realizing Culturally Relevant Pedagogy through a Critical Lens

Insights gained from analyzing interviews with both participants suggested that teachers’ perception of effective science pedagogy should accommodate students’ cultural identities.

4.1 Theme 1: Fostering Positive Views of Science through Ways of Knowing

Throughout the interview process, both participants consistently expressed that the goal of their culturally relevant science pedagogy was to foster a positive view of science via an acknowledgment that science is one of many worldviews. This can be viewed as the both the antecedent for and product of CRP. According to Batman, it is important to communicate to that “science is a way of knowing, but not the only way [of knowing]”. When probed further, Superman implied that a paradigm shift in students’ worldviews was a central goal of their pedagogy. This is necessary in order for students to hold science in a positive light. Both participants noted that science is greater than themselves and their experiences, and holding this worldview facilitated favourable views of science within them.

Superman also articulated the belief that their own positionality with respect to science needed to be engaged prior to the students forming their own independent identities. What this implied was that teacher identity was plastic, or constantly evolving, and informed student identity. Teacher and student identities are viewed by Superman to be indiscrete, where at best
the two constructs intersect and co-evolve. Interestingly, both Batman and Superman each expressed that their passion for science teaching came through reflection and consideration of their own experiences—both positive and negative. Batman expressed that their experiences could be described as “ways of knowing,” which are simply the individual experiences which inform their worldview. Superman noted the idea of accommodating worldviews thusly:

And another time we Skyped a school from Kenya and a kid…he was born here and his parents are from Kenya…and he was like ‘are these people gonna have, like wifi in their huts, are they gonna have clothes?’ And when then when they turned on the Skype they were wearing suits, and it blew his mind…so I think you need to have those experiences to kind of shift the kids’ mindset too.

What Superman describes above is an instance of colliding worldviews, where the student’s perception of Kenyan life is at odds with their perception. This brought forth a particularly interesting point of clarity— that positive views of science were effected through the teachers bringing to their pedagogy acknowledgement and respect for such contrasting world views. Batman noted, complementing Superman’s above expressed belief, that teachers should foster “cognitive conflict” within their students, from which positive views of science can be born.

Both participants perceive that their students seem the most engaged with the science content when they are analysing phenomena through the lens of their own worldviews. In doing so, Superman perceives that students subsequently engage in content beyond the expectations of the curriculum.

Work by Nieswandt (2005), discussing the phenomenology of engagement suggested that high student engagement is achieved through integrating affect (emotional) and intellect (cognitive/psychological) by means of instigating cognitive conflict. This converges particularly
with Superman, who discussed that engagement was fostered following instigating cognitive conflict utilising contrasting worldviews. How this can be accomplished in diverse and evolving classroom environments will be the subject of subsequent discussion.

4.2 Theme 2: More than Content— A Philosophy of Culturally Responsive Pedagogy

Superman and Batman held similar philosophies about the role that culture and environment play in their reported enactment of culturally relevant pedagogy. According to Ladson-Billings (1994a) an authentic practice of CRP should effectively balance content, culture and environment (Ladson-Billings, 1994a). This perspective was initially raised in conversation with and supported by Batman when they were prompted to describe ‘ineffective’ CRP practice:

What it is not for me is tokenism or superficial. There is a difference between a multiculturalist approach and anti-racist science education. One is going deeper, and one concerns the ‘three S’s’: saris, samosas and steel bands. As long as we have a ‘cultural day’, or ‘[you] bring your muffins’…you know…then we are doing multiculturalism. But [we] need to go deeper…examining the textbooks and examining their language.

Above, Batman is describing an instance where their practices balances culture, content and environment. In no instance did either participant note that content superseded culture in terms of their view of effective CRP, highlighted above by Batman. Superman held the view that “you start with the curriculum and you gotta know what you have to teach and then from there you find resources and ideas and strategies and ways to teach that.” In other words, for them, content must complement culturally relevant pedagogy, suggesting that it should not be the focus, rather a tool through which student engagement can be produced. Implicit to this thinking, therefore, is that there is an underlying structure which is self-regulatory in nature that informs engagement, in accordance with Sinatra et al. (2015). This suggests that accommodating culture and
environment into CRP is needed to foster positive views of science. This will be discussed in greater detail in the following section.

4.2.1 Hybrid culture

Optimal CRP practice is a hybrid of the differing cultural perspectives in a classroom environment. Both participants emphasized the difficulty in realising this in the classroom, due to the sometimes implicit nature of culture, as well as culture not being an explicit expectation in the Ontario science curriculum’s Big Ideas (which only discuss science, technology, society and the environment). Superman argued for educators to consider hybrid culture, one that exists at the intersection of youth culture, popular culture and teacher culture:

*Superman:* And I think that in terms of like a definition, I don’t think culture necessarily means race… I think it also means youth culture. So I think there’s a very—and I think the hybrid culture of each youth that you have

*Interviewer:* So it’s very holistic?

*Superman:* Yeah, I think that’s where my definition would take it for that.

Here, Superman argues that culturally responsive pedagogy should at best accommodate all permutations of culture, emphasizing that teachers must tune specific cultural artefacts to the individual make-up of their classroom. It was considered by Superman that issues related to equity in the science class are mitigated through hybrid cultural views. This certainly converges with earlier findings by Meyer and Crawford (2015), which, in a study of classrooms consisting of students from multiple cultural groups, suggested that multi-faceted and student-centered approaches was important, consistent with a hybrid approach. This converges with Superman’s feelings that CRP should accommodate all cultures, and their practice of incorporating all
cultural voices into their lesson. Batman recalled a particular instance from their practice where ignorance to the multi-faceted nature of culture was problematic:

if you have a child in your class, you’re talking to the child and they are looking down, you as a teacher would interpret that as ‘this child has a problem’, this child is not up to par, shy, not cognitively very engaged. So you could label that child as inadequate, not because that child is inadequate but because that child is responding to you culturally. You know/she knows that looking at the teacher in the eye is disrespectful because that teacher is the elder. Subtle things that completely affect how we learn…not just science.

Here, Batman described a particular scenario where responding to students in a culturally sensitive manner required a complex cognitive process of uncoupling one’s own biases from a student’s affect. This realization and practice formed the crux in which hybrid culture was defined by Batman, while complementing the previous theme wherein consideration of science as just one way of knowing was thought by teachers to foster positive views of science. Like a chameleon, Batman reported above that they were required to switch between frames of reference in order to accommodate one student’s need for cultural specificity. A significant barrier toward managing the diverse needs of the classroom, according to Superman, is cultural appropriation:

sometimes students would not want to bring their culture in…so it was interesting—because I think that they have been so suppressed to not be themselves, not be proud of who they are, or the clothes that comes from their culture that they do not want to be a part of that.

In other words, at times students can not want to engage in teacher-led CRP at all, possibly due to internalized racism.
Superman then goes on to describe above an instance where practicing cultural appropriation is done under the façade of hybrid culture. Superman notes that a student’s experience a “brainwashing of [their] own culture” which is predicated by a fundamental disrespect for the student’s own lived experiences. Superman elaborates further, claiming that there was no possible content-based remedy for what the student was experiencing:

One example, where things went kind of weird…we were watching a documentary, is [sic] called, ‘Blood in the Mobile’…and the people were from the Congo, talking about mining diamonds…so there was…scientists talking about the problems in the Congo—and the kid whose parents are from the Congo was like ‘look at these idiots, man these Africans don’t know anything, like what are they talking about! Get with the times man, like what the hell [sic] is the guy wearing on his head?’—and he was from there…and it was kind of like…‘what’s up man?’…and he’s like ‘these people are from the old days.’

In instances where a teacher is faced with such blatant examples of internalized racism they must be comfortable exceeding the content-driven restrictions of the curriculum. Batman noted that a sensitivity to multiple perspectives can be best taught through the use of “self-directed learning projects.” This is converges with one of the central tenants of Ladson-Billings’ CRP paradigm; which is to root instruction in who students are in their everyday lives (Ladson-Billings, 1995a; Ladson-Billings, 1995b). This was echoed in Batman’s sentiments that sensitivity to multiple perspectives through use of differentiated instruction engages students. When it comes to how, exactly, the classroom environment can be modulated to accommodate for students’ experiences, this will be the subject of further discussion in the next section.
4.2.2 Environment and learning

Both interviewees believed that certain aspects of their classroom environment are either restrictive or assistive of their CRP practice. Batman noted that their experiences lead them to believe that environments which seem conducive to learning typically integrate student beliefs, philosophies and identity. The nature of how these constructs relate, noted Superman, could be summed up as a dichotomy of “old-school vs. new school” environments. Batman claimed that “success equals marks which equals passing.”, which they believed was old-school. This is done through rigidly adhering to content and strict curriculum guidelines. In those classrooms where those “old school” approaches dominated, according to Batman, engagement was limited. As far as what “new school” environments looked like, Superman argued that

It doesn’t matter what colour some of my students are, I treat them the same! Like, you should be extra receptive to that. And now that you know that, you should be asking for their experiences, you should be bringing those experiences in—different people’s cultures…and making sure that other people are kind of represented in your work.

Here Superman argues that “new school” environments are those where students feel accepted and respected. Furthermore, in a study of the factors that affect student engagement, the National Academy of Sciences (2004) found that students’ beliefs of “I can” (perceptions of understanding and control), “I want to” (values and goals) and “I belong” (social connectedness to peers and teachers) are reliable predictors of engagement and academic success (National Academy of Sciences, 2004). This converges with Superman’s suggestion that students need to feel accepted and respected in order for them to feel engaged. Moreover, Batman argues that effective and engaging environments differed, depending on the institution of study as well as smaller cultural differences, noting that “I would do what I had to do and then the next teacher
would come in. It was a structured environment.”, further converging with the work by the National Academy of Sciences (2004).

In spite of the rigidity and structure of the environment described by Batman, Superman spoke to the need to “make students feel part of the environment,” where “there would not be explicit links to critical pedagogy or culturally relevant pedagogy [in the lessons].” When Batman was asked to offer advice to novice teachers looking into practicing CRP, their advice was quite insightful: “I would say, as long as your heart is in it, 80% of the work is in.” Although this may appear superficial at first glance, it suggests that a teacher’s own self-concept and belief about their ability to engage and effect change is can positively affect student success. In a study of the relationship of self-concept with engagement, Coelho et al. found that self-concept, engagement and student success influence one another (Coelho, Sousa, & Figueira, 2014). This converges with my findings, which suggest that teacher self-concept can influence a student’s engagement. Moreover, work Jimerson et al. (2014) suggests that teacher self-concept can specifically affect student engagement (Jimerson, Campos, & Greif, 2014), also convergent with Batman’s comments that if the teacher lacks passion, this can disengage students. On that note, when Batman was probed about whether or not they thought CRP could be successful, Superman echoed the insights offered by Batman that positive teacher attitude is important for practice. Superman said that:

I think if you do things for a face value, and you concentrate on things like holidays and food only…it’s very superficial…and even if [you’re] a teacher in a school and you say, our PLC for the year is critical pedagogy…there’s gonna be the teachers that go up and say, ‘oh look its Hanukah, so we’re gonna bring in some examples from Hanu[kkah]—
‘….something that’s very surface level…so examples that are surface level…so it can be damaging in a way, like if you’re not doing things…correctly…

On one level, what Superman argues coincides with Batman’s sentiment that cultural appropriation, if not meticulously attended to, can lead to an inauthentic version of CRP. Beyond that, however, Superman suggests that specifically creating a caring culture relies on the teacher taking initiative. In other words, a strong teacher self-concept produces an environment which can foster student self-concept and, thus, engagement:

I think that how you know you get it is…when you see them, their faces are sort of like ‘oh!’…you see them become more advocates and more engaged in class—that’s when you know…so that they feel really welcome, they can speak…and they will bring in their own cultural references, their own identities more once you start making that space a safe space. ‘Cause if you try to do that in a non-safe space then good luck…you can’t…so it’s about that caring culture in the classroom. And if that’s not there then the space is not safe to discuss culturally relevant [pedagogy]…it’s out the window.

Emergent from this excerpt, Superman implicitly advocated for, and reportedly tried to foster a positive science self-concept. When Superman about whether they believed their students held positive views of science after taking their classes, they elaborated further:

Yeah I think that a lot of them do—they say that…this is from my own teachings, they’ll say that I didn’t realize science was fun, or I didn’t realize…a lot of the time, and when I did my Masters research I interviewed boys who stopped taking science in grade 10, and the questions were like ‘why did you stop taking science?’ And the kids were like, ‘the teacher was racist…’, ‘the teacher said that…I could only do worksheets’, they even said…in front of us ‘I don’t trust you with chemicals’.
Here, Superman suggested that students may begin to develop an aversion for science. Green et al. (2012) in an investigation of the relationship between self-concept and self-efficacy engagement, discuss that they are positively related. This is convergent with Superman’s discussion where absence of engagement is reflective of low science self-concept. When asked to expand on this philosophy, Superman shared their experiences:

So you have the grade 9 applied class, who’s supposed to be hands-on, and all these things, were doing worksheets only, never going outside, never doing experiments, never going on field trips...’cause they couldn’t be trusted. Whereas the academic class were doing the dissections, doing all these things and it’s like [with the applied classes] ‘oh I can’t trust them with scalpels, so, let’s not do a dissection’. So they’re almost being robbed of their science experience...and I think that if every kid had an awesome experience in science then I think that they would end up loving science. Because...all the way through grades 3 and 4 you see the kids love science, and then there’s some point [where] they get turned off...and they think that science isn’t for them, or that science is hard, or that science is not what I am, or whatever. So I think that we need to engage them earlier in that.

Superman is suggesting that if students see no place for science in their own self-concept, due to culturally non-responsive or racist behaviour on the part of a teacher, than this can be particularly dangerous. Specifically, positive experience can positively foster science identity. Superman suggests that teachers need to be hyper-cognisant of this relationship.

Patchen & Cox-Petersen (2008) conducted a study on using existing constructivist practices to inform and develop CRP to meet the needs of ethnically diverse students. The findings of this study were five-fold: First, diversify strategies, seating arrangements and student responsibilities; have a more flexible understanding of time in the classroom; provide more
inquiry-based instruction and student-led instructional initiation, exploration and discovery activities; deepen responses to student contributions and to include student ideas; and to share and recognize students’ lives. These findings converge with Superman and Batman’s pedagogical philosophy: that creating an environment in which students feel welcomed and validated can be vital for students to accommodate science into their self-concept. In order to accommodate these worldviews, both Superman and Batman discussed their shared philosophy that CRP expands beyond content; integrating different cultures, environments, as well as the self-perception of all stakeholders. From conversations with the participants, that their philosophy of CRP has multiple manifestations. First among these, was that it involves teachers expanding their conceptions of culture to accommodate differentiating cultural viewpoints, which were defined as hybrid culture. In doing this effectively, it requires teachers balancing environmental factors with their own self-concept, as well as the students’ identity. This was found to coincide well with the engagement literature

4.3 Conclusion

Through following both interview transcripts, a consistent and through pattern emerged. Firstly, the participants emphasized that fostering positive views of science in their students is what originally brought them to adopt CRP into their practice. In this light, Batman’s view was that this can be affected through showing to students the importance of considering “science as a way of knowing, but not the only way”. This diverged slightly from Superman’s insights in that, yes, science is a way of knowing, but it must also be taught in context of their own identity in order to effectively engage students. This implied a symbiotic process, whereby teacher identity informs student identity, and vice-versa. Fostering positive views of science, therefore,
stems from realization that science instruction must be placed in the context of other ways of knowing, which includes academic content, as well as personal interests and experiences.

In order to accommodate these worldviews, both Superman and Batman discussed their shared philosophy that CRP expands beyond content; integrating different cultures, environments, as well as the self-perception of all stakeholders. From conversations with the participants, that their philosophy of CRP has multiple manifestations. First among these, was that it involves teachers expanding their conceptions of culture to accommodate differentiating cultural viewpoints, which were defined as hybrid culture. In doing this effectively, it requires teachers balancing environmental factors with their own self-concept, as well as the students’ identity. This was found to coincide well with the engagement literature.

These findings led to several conclusions and implications for teachers who look to implement CRP into their practice as a means of fostering engagement in the science class. The nature of these findings and the extent to which they have on a CRP praxis in the science class which will be discussed in depth in the subsequent chapter.
Chapter 5: Conclusion

5.0 Chapter Introduction

In this chapter I will discuss the implication of the findings in Chapter Four. These will be presented in context of the central research question presented in Chapter One: what are Ontario secondary science teachers’ reported philosophies of culturally relevant teaching and engagement? Next, a brief review of existing literature – originally presented in Chapter Two will be presented – and my findings will be discussed in terms of their impact on future research into CRP in the secondary science classrooms. Based on the research question, in addition to literature discussion, implications for these data on both my own professional identity and practice as well as the broader educational community will be discussed. These implications will be formulated into recommendations for future practice, focusing on few areas of further research identified as key in Chapter Four.

5.1 Overview of Key Findings and their Significance

The key findings emerging from interviews with science teachers reportedly practicing CRP were three-fold: that pedagogy should acknowledge students’ individual knowledge and experience-bases, while empowering them to discover a way in which science can be accommodated into their own knowledge schema, that educators can achieve this difficult task through fostering an environment fostering hybrid cultures that accommodate and acknowledge these ways of knowing, and that teacher and student identity are symbiotic and evolving together.

The nature of these findings and the impact on CRP and the educational literature are profound. I argued in Chapter Two that the literature needed examples which both define what CRP in the science class looks like, outline reliable criteria to measure efficacy of practice, and
present these in a reliable algorithm for the everyday science teacher to implement in their class. While my findings address these concerns at a preliminary level, they suggest that future qualitative studies be conducted into assessing the degree of efficacy that acknowledging worldviews and critical pedagogy have on fostering high student engagement in the science class. Additionally, these data suggest that qualitative investigations should be complimented by quantitative data in order for teachers to adequately gauge the degree to which worldviews and critical pedagogy can be used to foster engagement in their specific classroom context.

5.2 Implications

In this section I will be discussing the implications of my findings in both a broad and narrow scope. In the first sub-section, I will review the implications of my findings for the broader educational community and its various stakeholders. Next, I will present the significance of these findings in the context of my own professional identity, and growing practice as a teacher.

5.2.1 Broad: The educational community

The implications of this study on the broader educational community and its various stakeholders were vast. One major discussion point, for both participants, was that the Ontario College of Teachers views on professionalism are too rigid and explicit. Within the realm of reason and professional responsibility, participants noted that a major hallmark of effective CRP practice is in building an excellent rapport with students. This is presupposed by building close working relationships with students. Participants noted, however, that due to fear of professional reprimand, they feel apprehensive toward building such rapport due to misinterpretation of their practice as professional misconduct. As far as the broader community is concerned, this implies that there may be a general tendency among staff in schools to limit their availability to help
students outside of school hours—purely for fear of professional reprimand. This may increase the divide between students and teachers, impeding the building of rapport and reducing student engagement overall.

Both educators noted the significant restrictions that class sizes have on their practice. Larger class sizes means less time spent with each student, which restricts a teacher’s ability to foster relationships and build rapport. Additionally, teachers noted that there is simply not enough time in a typical school day to devote the amount of attention that is required to adequately develop their CRP practice. Finally, both teachers note that resources are difficult to attain and, in some cases, teachers are apprehensive to sharing for fear of their work going uncredited. In cases where resources are available, they may be underdeveloped, unclear, or, due to the dogma of CRP practice, limited to specific cultural groups. In the context of the broader community, if there is a general attitude among teachers toward hoarding resources then this could result in less collaboration. This may impede the modification and enhancement of resources to better fit the needs of the students.

Parents are also implicitly mentioned to have a vital role in fostering effective CRP practice and engagement in the science class. Due to the nature of class sizes as well as the diverse cultural mosaic that describes most southern-Ontario secondary school classrooms, there is a sense that it is likely that some students can be neglected. In this case, participants state that parents have a crucial role in reinforcing practice assisting the teacher in their role. This implies that those parents or guardians who are, for whichever reason, may be unavailable to assist their child only negatively impacts the experience of their child in the classroom.

Teachers also note that the diverse cultural backgrounds of all staff can and will make it difficult to implement culturally-sensitive materials, or to engage in culturally sensitive practices.
To a certain extent, the participants noted that the responsibility falls on the shoulders of administrators. Administrative staff, in particular, who are not supportive could make it all the more difficult to foster a caring culture among all stakeholders.

One significant implication deals with the nature of engagement and student success. Meaning, it can be difficult to gauge success as there are no cut-and-dry indicators for its measurement—it is as subjective and diverse in nature as the students themselves! As such, CRP practices and related research may not define success in clear terms.

5.2.2 Narrow: My professional identity and practice

If there is one notion that I entered this profession with, it was that the diverse nature of classrooms makes it all the more difficult to develop targeted resources; this study confirmed my impression. As far as my evolving practice is concerned, this study has only reinforced to me the need to be steadfast, optimistic and passionate about developing resources which accommodate the cultural identity of all students. Professionally, I hope to be involved with lunch-and-learn type sessions which address CRP practice in discipline specific areas. It is extremely important in this regard to foster a sense of rapport and community within the department and school in order to facilitate sharing and adaptation of resources. [say more about how you want to work with students / how these things can effect how you relate to them]

In a broader sense, this study has expanded my philosophy as to teachers’ fundamental role. Whereas I previously thought of teaching as a nine-to-five job, this work suggests that teachers’ role extends beyond the day-to-day operation of the school, and requires educators to be open to all opinions and sensitive to other viewpoints, within reason. Teacher need to view science, as more than just the dissemination of knowledge. Clearly, students’ perceptions of science are heavily informed by both what and how teachers decide present it to them. Educators
need to be cognisant of this at all times. My ideas as to the purpose of schooling were also changed. Whereas I previously viewed the school and home to be separate places, I’ve come to believe that the school needs to mirror students’ home life to the best of its abilities. To this end, there need to be a greater focus on the principles of 21st century learning: that success in a knowledge-driven society means flexibility, particularly when it comes to one’s worldviews. I can best adopt this through a commitment to professional development, and a flexibility to accommodate all worldviews into my philosophy of science. Additionally, equity needs to be more heavily emphasized in the science classrooms while, being careful to avoid superficial infusions of culture.

5.3 Recommendations

In light of the implications discussed in the previous section, herein several recommendations will be presented and discussed. The first recommendation is concerning the degree to which schools support teachers in implementing their practice. In particular, more professional development opportunities need to be offered for teachers which introduce and assist educators in developing their CRP practice. Going beyond this, more support staff need to be hired and trained to be sensitive to the cultural background and needs of the students.

Concerning policy, there are several areas of improvement that can be suggested at both the board, Ministry-level and professional regulatory level. Boards, for instance, should incorporate into their individual board improvement plans (or make it clearer) directives and statements which delineate to teachers the importance of cultural sensitivity and integration into lessons and the classroom environment. At the Ministry-level, culture needs to be made a specific recommendation in the Ontario Science curriculum in order to legitimize and communicate to teachers its importance. At the regulatory level, the Ontario College of Teachers
should publish memoranda and professional advisory-type materials which address cultural sensitivity and equity.

Concerning teacher education, there is a clear lack of courses in teacher induction programs which specifically address CRP. It is heavily recommended that such courses or curricula be offered. Additionally, beyond teacher education, there needs to be more professional development opportunities offered regarding CRP, specifically AQ courses.

Concerning the school community as a whole, it is important to foster a community of teachers, administrators and parents founded on trust and respect cannot be understated. This can be addressed through simple means such as maintaining open lines of communication, through e-mail, phone calls or take-home letters to parents which establish clarity, accountability and care. Beyond that, incorporated into existing administrator-qualification courses, there needs to be training on cultural sensitivity, equity and anti-bias practices.

5.4 Areas for Further Research

As it stands, there exist few studies which discuss success criteria, practices and methods of gauging effective CRP practice in the science classroom. The recommendations for areas of further research, then, are straightforward in concept, but of high importance in terms of the CRP literature. Above all, there needs to be a unified message in the literature as to the incorporation of culturally responsive pedagogy to include science. This should be presented through discussions of cultural constructions of science as well as the nature of science, and how these can positively or negatively affect student engagement in the science class.

Stemming from these discussions, there is a clear need to define success criteria for culturally responsive pedagogy in the science class. As it stands, it is difficult to measure efficacy of practice with no clear description of what effective practice should look like and how...
it can be measured. Most research into CRP is qualitative in nature, and it would be helpful to expand the scope of future study design to include quantitative methods, this should assist with the development of concrete success criteria.

Lastly, studies which investigate the relationship between critical pedagogy in the science class, CRP and student engagement should be conducted. It was suggested by Superman that CRP should always adopt a *critical lens*, focused on action(s) that students can take to resolve the issues they see in the world, and further qualitative and quantitative studies characterising this relationship need to be conducted. As it stands, CRP does not bridge practice and action, and empowering science students to act on their own perceptions of science should foster engagement.

5.5 Concluding Comments

The purpose of this study was to speak to practicing science teachers about their experiences integrating culturally responsive pedagogy in their classroom. While several vital implications and recommendation stemmed from these discussions, quite possibly the most important finding was that the nature of science and science pedagogy are not that different after all. Both are ever-evolving, deeply informed by culture, and traditionally lend themselves to the loudest, most outspoken voices in the room. I hope that, in context of the current study, I have added credence to the notion that there is value to nurturing and paying attention to the subtleties of the everyday science class. If this is not done we run the risk of silencing important cultural voices, diluting the pool of future science students.
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Appendices

Appendix A: Letter of Consent for Interview

Date:

Dear ________________________________,

My name is Daniel Dalessandro and I am a student in the Master of Teaching (MT) program at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). A component of this degree program involves conducting a small-scale qualitative research study. My research will focus on Ontario secondary science teachers’ philosophies of using culturally relevant pedagogy and engagement. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one roughly 60-75 minute interview, which will be transcribed and audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient for you, outside of school time. The contents of this interview will be used for my research project, which will include a final paper and informal presentations to my classmates. I may also present my research findings via conference presentations and/or through publication. You will be assigned a pseudonym to maintain your anonymity and I will not use your name or any other content that might identify you in my written work, oral presentations, or publications. This information will remain confidential. Any information that identifies your school or students will also be excluded.

The interview data will be stored on my password-protected computer and the only person who will have access to the research data will be my course instructor. You are free to change your mind about your participation at any time, and to withdraw even after you have consented to participate. You may also choose to decline to answer any specific question during the interview. I will destroy the audio recording after the paper has been presented and/or published, which may take up to a maximum of five years after the data has been collected. There are no known risks to participation.

Please sign this consent form, if you agree to be interviewed. The second copy is for your records. I am very grateful for your participation.

Sincerely,

Daniel Dalessandro
Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw from this research study at any time without penalty.

I have read the letter provided to me by Daniel Dalessandro and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ______________________________________

Name: (printed) ______________________________________

Date: ______________________________________
Appendix B: Interview Protocol

Thank you for participating in my research study. My name is Daniel Dalessandro and I am a first-year student in the Master of Teaching program at OISE. The aim of this research is to learn how a sample of science teachers practicing culturally responsive pedagogy is learning about and experiencing student engagement. This interview should take approximately 45-60 minutes, and is comprised of approximately 23 questions. The interview protocol has been divided into four sections, beginning with the interviewee’s background information, followed by questions regarding their own experience(s) as science students in secondary school, transitioning to how this influenced their decision to practice culturally responsive pedagogy, and concluding with their experiences, challenges and supports that they provide to their own students. I want to remind you that you can choose to not answer any question, or remove yourself from participation at any time. Do you have any questions before we begin?

To begin can you state your name for the recording?

**Section A—Background Information**

1. Can you start by describing your current job title and responsibilities in your current position? (Official title and responsibilities)
   - What science classes do/did you teach? (topic grade and stream).

2. How long have you been a teacher?

3. Where did you do your undergraduate education?
   - Did you attend graduate school in a STEM field?

4. Where did you attend teachers college?
- How long ago was this?
- Have you taken any additional qualification OR professional development courses?

5. Can you tell me a little bit more as to why you decided to become a science teacher?

6. I am also interested in learning about how you situate science in relation to your own identity. Do you consider yourself a scientist?
   - To what extent would you say you utilize scientific reasoning in your daily life?

7. Which school do you teach at currently?
   - Could you describe from me the demographics of your school?

8. What other things, besides teaching, are you involved with at your school?

Section B—Experience as a Science Student in Secondary School

9. (If possible) Could you tell me about your experiences as a student in the Ontario public school system?

   **Possible Prompts**
   - Where these experiences positive/negative?
   - Did you enjoy science classes in high school?

10. What does a “good” science student look like to you?
    - Can you tell me about experiences from when you were a student where you *felt* like you were a “good” science student?
    - In contrast, can you tell me about your experiences from when you *felt* like you were not a “good” science student?

**Follow-up Questions**
(a) (If applicable) In those negative experiences, what do you think the teacher could have done differently?

(b) (If at all) Did these experiences (positive OR negative) affect your decision to study science in university? To become a science teacher?

11. Do you bring these experiences into the classroom?
   - (If yes) How? How did students respond to this?
   - (If not) Would you consider integrating them? How would you do this?

12. How do you think your own science experiences in high school compare to your students’ science experiences?
   - What are the similarities/differences?

Section C—Exploring Practice: Culturally Relevant Pedagogy

Script: As you know, one of the reasons why I would like to hear from you is because you have self-reported that you practice culturally relevant pedagogy (CRP). In this vein, I would like to hear more about your practice.

13. How long would you say that you have been practicing CRP?

14. What does culturally relevant OR responsive pedagogy (CRP) mean to you?
   - When did you first hear about it?
   - Have you attended any professional development workshops on culturally relevant pedagogy or teaching with students’ culture in mind?

15. What do you think culturally responsive pedagogy ‘looks like’ in the classroom?
   - What does it NOT look like?

16. Do you think your experience(s) as a science student influence your choice to practice CRP? (if yes) How so?
17. Can you walk me through a typical period in your science class?
   - How do you begin each class?
   - How do you structure your lessons?
   - How often do you encounter ‘problems’ (with students/content acquisition) and how do you overcome them?

18. Can you give me an example of a time that you explicitly invited your students to bring their heritage or community cultures into their science learning?
   - Can you describe this lesson?
   - Was cultural-content the main focus of the lesson, or an additional feature?
   - Was this successful?
   - (If ‘NO’) How did you know?

19. Now, can you walk me through how you typically prepare lessons?

   **Prompts**
   - Do you use resources provided by other teachers?
   - Would you say you are comfortable inviting and discussing your students’ cultures in the science classroom?
     - Why? Why not?
     - (if no) What might make you feel more comfortable?
     - (if yes) Do you think your colleagues feel the same way?
   - How do you usually “hook” students OR get students to buy into your lesson? Are these “hooks” culture-related?

20. What are some challenges that you have experienced in implementing CRP in science?
Do you think that science is easier or harder than other subjects in terms of CRP implementation? Why/not?

Section D—Exploring Efficacy of Practice

21. Have you remained in contact with any students after you have taught them?
   - While they are still in the same school, but not taking any courses where you are the teacher?
   - After they have moved on from OR graduated?

22. (If possible) I want to get a sense of where students “go” after having taken your classes.
   - Have you had students who have gone onto careers in science?
   - Of those students who chose to not study science in their academic careers with whom you are still in contact, what are their feelings toward science in retrospect?

23. What advice do you have for new science teachers looking to practice CRP?

24. Do you have any final thoughts?

Thank you very much for your time and thoughtful responses!