Discourse and the Construction of the Science-Teacher-Subject:
An Examination of why we say the Science Teacher is Elite

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Abstract

Science education has found itself in a paradoxical state of stagnant flux. Despite numerous calls for reform and a near consensus amongst science educators on the teaching techniques that hold the most promise, new pedagogical approaches have hardly been implemented. Scholarship advocating for pedagogical change tends to focus on examining teachers’ beliefs, instructional methods and student engagement. These approaches are limited as they often fail to account for the political, social and historical groundings of these practices. This study explores the relations of power, discipline and domination implicated in the construction of the science-teacher-subject. It employs a poststructural conceptualization of the subject of lack to invert the science teacher identity, shifting the focus from ontological questions of self towards an epistemological understanding of the process of subjectification. This epistemological query does not seek the “truth” of what the science teacher is, but rather recognizes that the science teacher is a genealogical formation integrally connected with social power.

Using a discursive analytic, this study focuses on the production of science teachers’ identity by thirteen secondary school teachers and draws upon Foucaultian genealogy to demonstrate the implementation and performances of these “historical” discourses in the classroom. The science teacher is subjectified in the data as: 1) a passionate subject that holds a natural affinity for science and teaching science; 2) a gatekeeper to personal and societal advancement, opportunity and financial stability; 3) a modern subject charged with maintaining the narratives of enlightenment; and 4) a postpositivist subject that is responsible for promoting the interconnectedness of science, society and politics.

Within this cacophony of diverse subjectifying calls, the science teacher is consistently given social status while being disciplined to maintain the hegemony of
Western science. The epistemological supremacy of Western ways of knowing remains foundational in the field of secondary science education, and this framework continues to present the science teacher as objective, rational and blameless for the domination that secures its privileged position. While the science teacher is nearly powerless to change the direction of Western science, the teacher is rewarded with elite status for its reproduction.
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CHAPTER ONE: The Top Left Hand Corner

The bell rings and I look out over my Grade 12 chemistry class. It is the last period of the day, and I can tell that my class is exhausted. I open with a common idiom, “Well class, we have a lot of stuff to get through today”, and turn to write the day’s lesson in the top left hand corner of the whiteboard. I write a few definitions, and the students open their books and begin to copy the notes.

As I am reaching for the upper left corner of the board, I am overwhelmed with a sense of hypocrisy. I am well read on the benefits of inquiry learning; I have participated in science education research groups. I wrote my master’s thesis on students’ experiences of inquiry learning. So why do I find it so difficult not to reach for that top left hand corner? All these thoughts race through my mind as I begin to write. Despite my emotional reaction, I continue to add points to the top left hand corner. Despite my knowledge and experience, I regularly revert to direct instruction. I know better than this, but I feel caught and conflicted.

At the end of the period the students pack up their belongings, and I pack up my lesson notes. They walk out of the classroom talking about the weekend. Their performance is over. They have listened, taken notes, answered questions, and worked on their assignments. They have performed the role of good science students, and I have performed as the good science teacher. I have embodied what my students and colleagues expect. We covered the curriculum for the day, I have effectively managed my classroom, I am on track with my long range plans, and my students will be ready for their exams. I am competent. I am a professional. I am a good science teacher. I have performed my role well.
I ask myself how I have arrived here. How what is seen as science teaching has been so engrained in me that I struggle to break from it. I enter my classroom with contradictory subjectivities; my intellectual and my professional seem to be at odds. I want to believe that I have the power to enact agency and resist dominant pedagogical discourses, but my continued performances show the inefficacy of this belief.

It is clear to me that my pedagogy is still a reiteration of dominant discursive norms. Despite my academic knowledge, my performances as the good science teacher remain largely unchanged. I do exhibit discursive agency with regard to my teaching but I feel a pressure to maintain the status quo. I have often attempted to define exactly who, or what, is disciplining me, but have been unable to do so. Like water running through cupped hands, articulation eludes.

**A Point of Entry**

I began my doctoral studies from a place of inner tension, a space of disaccord and dissonance, a place where I was beginning to experience the complicated curriculum (Phelan, 2011) and a pedagogy of discomfort (Boler, 1999). A positivist epistemology fails to rectify my continual drive for the top left hand corner. The lack of implementation of these ‘best practices’ represents for me a crack in the positivist foundation of science education reform. I have the desire, and the academic and pedagogical knowledge to resist these archaic approaches but fail to act accordingly. This tension represents a starting point. It marks a need to construct new knowledge about the definition and roles of the “good” science-teacher-subject. It marks a need to begin to approach questions of identity from a new perspective which actualizes the problem of the current regime of truth (Foucault, 1977). To see my dilemma as an
intersection of competing discourses, instead of merely a personal crisis, I contemplate adopting a poststructural gaze. My professional experience has shown me that the positivist notion of the identification of best practice culminating in better learning is an over simplification of science education. It is the inefficacy of positivism that provides me with my point of entry.

The Stagnancy of Science Education

My experiences of pedagogical stagnancy in the science classroom have been echoed in the literature of the last four decades. Science education worldwide has paradoxically found itself in a state of stagnant flux. Over the last two decades there have been numerous calls for substantial reform, but implementation has remained elusive. During the 1980s and 1990s alone Hurd (1994) found that over 400 national reports were published in the US calling for science reform. These calls for change have continued in both the US and Canada where the National Research Council, the Canadian Council of Ministers, the American Association of the Advance of Science and the National Association for Research in Science Teacher have advocated for a movement away from rote learning and the transmission of conical science content towards a deeper understanding of inquiry learning and the processes of science.

Despite these calls for reform in the secondary sciences and a seeming consensus among the science educational community on the teaching techniques that hold the most promise, very little actual implementation of new pedagogical approaches has occurred in the field (Anderson 2007; NRC, 1996). Regardless of the calls for change, a persistent stability in science education exists. Basic teaching techniques and pedagogical approaches have not changed, students still carry out recipe-type activities that are
supposed to reflect the processes of science and teach science knowledge, but generally fail on both (Hofstein & Kind, 2012). “The evidence suggests that, despite these widespread calls for reform, traditional practices have been remarkably robust and resilient to the forces for change” (Tobin & McRobbie 1996, p.224). A new vision of science education is far from becoming a reality in the classroom.

A gap in the knowledges of science education exists; a gap that manifests in the contradiction between the dynamic nature of science and the stagnancy of what is occurring in the classroom. Science education has been inundated with positivist research aimed at quantitative data, measurable results and accountability. Tobin (2012) writes:

> It must be clear to all that the tried and tested methods have failed, and will continue to do so for as long as scholars and policy makers consider individuals in isolation from associated collectives… it is difficult if not impossible to reform science education without examining the socio-cultural aspects of science education. (p.15)

Faced with the continual failure of reform efforts, one might conclude that a better understanding of reform cannot be found in the proliferation of reform documents, more calls for change, or an increase in professional development no matter how robust or sustained. As Tobin reminds us, we must turn our query towards power, dominance and the socio-cultural aspects of science education.

My study proposes turning a poststructural gaze towards power and the discourses which constitute the science-teacher-subject. My study is an exploration of how teachers are encouraged, coerced, disciplined and even seduced into maintaining a pedagogical status quo. Such an examination will provide insight into the dynamics at play at the intersection of teachers’ subjectivities, discourses and calls for reform,
leading us to a better understanding of why reform has proven to be so elusive in the field of science education.

**Rationale - Towards a Deeper Understanding**

Science teachers’ beliefs and identities can run in marked contrast to the vision put forth by reform efforts (Tobin & McRobbie, 1996). When dominant discourses frame these visions as true, and teachers’ identities are aligned with these “truths”, it presents a significant obstacle to science education reform. These commonly held beliefs of science teachers are referred to in the literature as dominant discourses (Moore, 2004), myths (Tobin & McRobbie, 1996), and nested epistemologies (Tsai, 2002). However, regardless of the semantics used, these enacted beliefs are integrally associated with power relations and the identities of science teachers. “These different patterns of actions congeal over time into discursive norms that naturalize an individual as a science teacher” (Sharma & Muzaffar, 2012). As Bryan and Fraser (2012) suggest, it is surprising how few studies address the social and cultural dimension of science teachers’ pedagogical beliefs.

There is a need to examine the power dynamics involved in the subjectification of the science teacher. As Zembylas (2003) explains, an understanding of the processes of discipline and domination is crucial to exploring subjectification. The dominant pedagogical discourses of science teaching need “unpacking and critiquing… precisely because they [discourses] have a nasty habit, if we let them of getting in the way of teacher development” (Moore, 2004, p.10). The examination of discourse as a formative vehicle of power is important because it reveals the fluidity and contingency of identity. Identity is not merely attached to one’s body, but it is something that is produced,
performed, and disciplined through relations of power. For Ball (2006, p.256), “theory is a vehicle for thinking otherwise it is a platform for outrageous hypotheses and for unleashing criticism, it provides the possibility of identification, to work on or against prevailing practices of subjectification”. An analysis and exposure of the formative nature of discourses provides an understanding of what constitutes a pedagogical regime of truth, thereby opening the space for pedagogies that are not aimed at continuing the status quo and that open new possibilities for student learning.

**Research Questions and Aims**

The overarching goal of this research is to explore the subjectification of the science teacher. As suggested in my opening vignette and supported by current literature, research into the identity and subsequent performances of science teachers requires a theoretical shift away from positivist approaches and humanistic conceptualizations of self. This study adopts a poststructural conceptualization of identity: Shifting the concept of identity as something that lies uniquely inside the individual, towards identity as a process of subjectification.

Poststructuralism allows us to see that who we are is politically, socially and culturally contingent. What was traditionally seen as personal, is also the political and social (Boler, 1999). With this shift in theoretical framework, questions of pedagogical stagnancy are deferred towards the political, cultural and societal forces that construct the subject. Issues of curricular and pedagogical stagnancy shift away from the individual, towards sociocultural relations of power and the manner by which discourses and power produce the science-teacher-subject.
The purpose of this study is to explore discourses themselves as (per)formative entities with regard to the subjectivity of the science teacher. Drawing on Laclau and Mouffe’s (2001) conceptualization of the field of discursivity, my study begins by identifying the ways by which science teachers are subjectified in the data. This aim is articulated by the research question: What are the discourses that subjectify the high school science teacher? Responses to this question are found in various descriptions and versions of science teacher identity as described by thirteen secondary teachers. Following this initial inquiry, the study poses the epistemological question that draws on Foucaultian genealogy: Why do we say the science teacher is subjectified in these particular ways? The latter question illuminates what is accomplished and enacted by these subjectifying discourses, situating them in their larger historical and social contexts. The epistemological question is not an analysis of the “truth” of what the science teacher is but a recognition of the science teacher as a genealogical formation integrally connected with social power.

Following from these two overarching lines of inquiry, secondary questions to help further investigate the subjectification of the science teacher include: How have the dominant discursive constructs of high school science been “historically” constructed? What are the discourses that subjectify the science-teacher-subject? In what ways do disciplinary relations of power constrain the performativity of the science-teacher-subject? And, how do science-teacher-subjects enact agency in the discursive field? These explorations contribute to a deeper understanding of the main purpose of the research: an inquiry into why we say the science teacher is subjectified in these particular ways.
The Research Process: A Bricolage of Theorizations

The central aim of the study is to understand the subjectification of the science teacher. However, the use of the term “understanding” is problematic and positivist, as it suggests the uncovering of a graspable reality. My study progresses with a narrower focus. For my research, I have endeavored to focus on the analysis of discourses amongst secondary school teachers. I believe that the school is a space where a great deal of professional identity formation occurs for teachers and that an important medium of these subjectifying discourses is the verbal utterances among colleagues. This limit considered, my work demonstrates one spatial and temporal context where subjectification occurs.

Science and the science teacher are two important concepts that require definition. For the purpose of this dissertation, I will define science as both a body of knowledge and a systematic process by which people create and organize knowledge of the natural world based on observation, evidence and reproducibility of experimental results. In a similar vein, I will define the science teacher as a formally trained educator who instructs youth and young adults in a school setting about science as defined above.

Bloome et al. (2005) suggest, there is not a given set of traditions that define the boundaries of what counts as discourse analysis but that the prior experiences, endeavors, and arguments of researchers must be claimed, argued, and labored for in the present. Due to the multiple theorizations of discourse analysis, I drew on Jorgensen and Phillips’ (2002) theorization of multiperspectivism as a methodological framework for this study. Multiperspectivism asserts that different theorizations provide different forms of knowledge about a phenomenon. Combined, they complement each other to produce a
broader understanding of the phenomenon of study. My aim was to build a framework that combines, integrates, and takes advantage of the strengths of multiple theorizations. Many of the authors that I drew upon do not offer concrete methods of discourse analysis, but do offer theorizations that provide a range of analytical focus points.

As previously discussed, this study proceeds from a poststructural theorization of the subject: The subject is no longer understood to be defined by a fundamental core or essence but by lack (Lacan, 1977). In the absence of a true center (Derrida, 1967), the subject of lack is driven to continually perform discursive norms (Butler, 1995), to fill a primordial void based on misrecognition (Lacan, 1977). It is in this space, this absence of a center, that the process of subjectification continually takes place on the body (Grosz, 1994).

A study that conceptualizes a subject of lack and the continual substitution for center would be remiss without a discussion of the discursive constructs that are drawn upon to create the illusory essentialized self, which is of utmost significance when considering subjectivities that exist in a space where hegemony and established regimes of truth are present. It is precisely these hegemonic constructs, based on the discourses of Western science, which this study aims at deconstructing as they are largely responsible for the production of the science-teacher-subject.

Poststructuralism offers great explanatory potential with regard to understanding the subjectification of the science teacher. Poststructuralism provides the foundational notion of the subject of lack, while problematizing metanarratives and claims to truth and universality. The questioning of metanarratives is key to any examination of the discourses of Western science. Recognizing Western science as a metanarrative with
well-established regimes of truth (Foucault, 1977), the researcher can question its hegemonic constructs (Gramsci, 1971; Laclau & Mouffe, 2001; Cherryholmes, 1988). Poststructuralism positions the researcher in a space to question hegemony and power.

Foucault (1980) conceptualizes power as the medium in which discourse circulates and thus, subjectification is ridden with relations of power. A study that examines the subjectification of the science teacher through discourse would be remiss without considering the sociocultural relations of power and the manner in which power has produced the subject position of the science teacher. Ball explains that the process of analyzing and identifying discourses is “to engage in struggle, to reveal and undermine what is most invisible and insidious in prevailing practices” (1995, p. 267). In the context of this study this means to expose what is seen and spoken as truth as a discursive formation.

Poststructural research into identity (Butler, 1990; Davies, 2007; Dunn, 1997; Zembylas, 2003) has yielded powerful data, and provided influential new theories of the subject. My study combines these poststructural notions of identity with previous work that investigates the marginalizing effects of Western science (Adas, 1990; Aikenhead, 2006; Carlone, 2003; Feyerabend, 1996; Harding, 2008; Pennycook, 2002). My dissertation melds these two approaches while employing the overarching political theory of hegemony (Gramsci, 1971; Laclau & Mouffe, 2001; Zizek, 1989). Studies that address the marginalization and hegemony of Western science provide a perspective of understanding, but do not necessarily address how these discourses actualize the bodies of the science-teacher-subject. Said differently, it is well established that Western science has marginalizing effects and that violence takes effect through the subject’s
embodiment and performances of its powerful discourses. It is through a bricolage of theorizations that a deeper understanding can be reached about how the science teacher both constructs and reproduces the social constructions and institutions associated with Western science. It is with this powerful new understanding of the subject that this study progresses.

**Overview of Dissertation**

My dissertation is organized into eight chapters. Although a strong foundation in literature permeates all chapters of my study, the second chapter consists of what is typically understood as the literature review. Chapter two establishes a poststructural theoretical and conceptual framework for the study. A key aim of this chapter is to establish a framework that turns questions of identity away from the personal, and towards the social, historical and political discourses that constitute the science teacher. I refer to this process as turning our constitutive gaze outwards, towards the past and towards the field. The use of the term “gaze” is used deliberately as it communicates a critical examination of power, knowledge and the subjectivity of the science teacher. As Sturken and Cartwright (2009) describe “The gaze is integral to [understanding] systems of power and ideas about knowledge” (p. 94). The use of the term is not to establish a hierarchical positioning of myself with regards to my participants, as described by Kaplan’s (1997) imperial or male gaze, but rather to deconstruct the discourses of Western science education.

In chapter two, I establish the theorization of the subject of lack (Lacan, 1977), and decenter the subject (Derrida, 1967) by exploring how the subject relies on discourses to produce an illusory core. Once the subject’s dependence on discourse for
identification is established, the focus shifts towards power itself. I then examine the disciplinary apparatus that compels the subject to function in these discursive systems.

Chapter three is a “historical” examination of the past discourses of Western science and science education. Hall (1988) explains that our perceptions of ourselves and others are always described in terms provided by history. As such, drawing on Foucaultian genealogy, this chapter shifts questions of identity away from introspective reflection towards a retrospective examination of the historical discourses of Western science and science curricula. In the third chapter, I aim to historically contextualize the discourses that currently dominate the field of secondary science education.

In chapter three, I employ a Foucaultian genealogy to discursively link the present field of science education with its past influences. The query takes on an epistemological orientation as I ask, why do we say the science teacher has been subjectified in particular ways? To accomplish this, I explore the discourses of colonization and advancements in Western science as a measurement of cultural worth. The focus then moves towards the beginnings of Western science as an institution and the new-found subjectivity of the scientist. In the latter half of the chapter, I examine curricular change against a backdrop of political change, focusing on ideologies of science education for national development and prosperity as well as calls for a humanistic curricula integrally linked with society, technology and the environment.

Chapter three considers how the dominant discursive constructs of high school science have been “historically” constituted.

After establishing the historicity of Western science and science education, my study proceeds by gaining entry into the “world of practical effects… [where] the focus
is very much on the implementations of those [historical] discourses in actual settings” (Wetherell and Potter 1992, p.90). To accomplish this, chapter four and five explore the field of secondary science education itself. These chapters illustrate the construction of the science-teacher-subjectivity by exploring the ways the participants spoke about science and science teachers.

Chapter four begins by examining the methodology and method for the study, establishing a multiperspectival approach and exploring supplementary theorization for the discursive analytic. Chapter five focuses on the interview data from 13 participants to identify the discourses that subjectify the science-teacher-subject. The overarching aim for chapter five is one of revelation and is strongly aligned with the identification of the discourses in the field of secondary science education that subjectify the science-teacher-subject.

Informed by Foucault (1980) and Wetherell, Taylor and Yates, (2001), chapter six focuses on identifying spoken patterns within the current field of science education (chapter five) and demonstrating the historicity of these discourses (chapter three). Chapter six shifts the questioning of subjectifying discourses from asking how science teachers are subjectified in particular ways, towards asking, “why do we say science teachers are subjectified in particular ways?” Chapter six culminates by exploring the disciplinary apparatus and acknowledging that the mechanisms of power and discipline as both repressive and productive of the science-teacher-subject. These data were used to respond to the question: In what ways do disciplinary relations of power constrain the performativity of the science-teacher-subject?
Chapter seven explores the research question: How do science-teacher-subjects enact agency in a discursive field? The focus of this chapter shifts from the prescriptive and disciplinary nature of discourse, towards the participants’ described agency as they navigated the discursive field of secondary science education. It explores the intersections and contradictions present in the discursive field, framing these “in between” spaces as opportunities where agency and resistance can be enacted.

In the final chapter, I conclude the work by commenting on the implications of the knowledge constructed in this study and theorize about how this knowledge might inform further research agendas. Lastly, I touch on the limitations of the study and share a number concluding thoughts.

The questions addressed in this work come from my own journey as a secondary science teacher, a curriculum writer, and working with pre-service teachers. Through a multitude of experiences in the field of secondary science education, I began to experience an inner tension between my academic knowledge and my traditional pedagogical performances in the classroom. Through a process of autobiographical reflection a “dissonance of selves” arose, a dissonance that required querying self and pedagogy in a new way. A poststructural theorization of the subject provided the explanatory tools to address these questions.
CHAPTER TWO:
The Subjectification of the Science Teacher - Our Constitutive Gaze Turns outwards

Identity and the Poststructural Turn

Our lifelong nostalgia, our longing to be reunited with something in the universe from which we feel cut off, to be on the inside of some door which we have always seen from the outside is no mere neurotic fantasy, but the truest index of our situation.
C.S. Lewis (1949)

Questions of identity, who we see ourselves to be, often provide a starting point for introspective reflection. What is this ‘identity’ that we so often question? Gee explains that “people tend to reserve the term ‘identity’ for a sense of self that is relatively continuous and fixed over time” (2005, p.39). Though identity is a useful term, since it is the common word for people’s sense of who they are, Ivanic refers to it as a “misleadingly singular” (1998, p.11). Am I a teacher, a father, a son, a brother, an athlete, a man? Or am I heterosexual, or am I white? Answers to these questions are nebulous, evade articulation, and often evoke more challenging questions. Am I the sum of these identities? Is who I am an essence found deep inside that transcends these identities? To what degree do my social relations affect who I am? Am I free to choose among different identities? Which identities are accepted in a particular social context?

These questions provide an entry into the poststructural field of subjectivity.

Identity has been described in literature in many different ways. Identity has been described as an understanding of who we are, and who we think other people are (Danielewicz, 2001), as a lived relation in a community (Wenger, 1998), a sense of self (Helms, 1998), as a recognition by self or others as a certain “kind of person” (Gee,
2005), and as a “repository of particular experiences, the site of thoughts, attitudes, emotions, beliefs, and values” (Zembylas & Avraamidou, 2008, p.991).

Poststructuralism questions the view that every person possesses a stable and unified identity: Identity is no longer a permanent essence or core that is “coherent, bounded, individualized, intentional” and “the locus of thought, action, and belief” (Rose, 1998, p. 3). Poststructuralists conceptualize identity as socially constructed and contextually contingent. Laclau and Mouffe (2001) explain that individuals are transformed by discourse into subjects: “They live the relation with their real conditions of existence as if they themselves were the autonomous principle for determination of that relation” (p.100). From a poststructural perspective, the subject is understood as constituted by discourse; they are understood and recognized by their occupation of certain subject positions (Davies, 2007).

Through a poststructural lens, what we are left with is not a bounded, stable identity comprised a single unitary construct, but a fluid, malleable, dynamic sense of self that is never fully realized. What the science teacher uses for identification is not an essence but a social construction, a construction that is both constituted and disciplined by power and the status it provides. Poststructural research into the identity of the science teacher queries the way that historical, social and political practices shape, mold, entice, and coerce people to perform (teach) in particular ways. As questions of the identity of the science teacher move away from the personal toward the political and the social, the focus shifts: Questions of pedagogy move from education, professional development and competency toward the performativity of particular discourses. This poststructural turn allows us to problematize the discourses that have and continue to
create the science-teacher-subject, a process of construction that is prescriptive, disciplinary, and hegemonic.

**The Subject of Lack and the Fantasy of Full Identification**

A conversation with a first year teacher

Teacher: Beginning science teachers do what their colleagues are doing because they have the experience, they have the job, they want to emulate that, because they want to become a full-fledged teacher.

Myself: You mentioned the “full-fledged teacher”, could you tell me what that entails?

Teacher: The full-fledged teacher is someone that’s experienced, they have a full life, they have a family. I think that if you’re balancing school, family, and extracurricular, that’s the full-fledged teacher. You’re doing everything, you’re there for the students, you’re there for the extracurricular, you’re very visible in the school…you know what you’re doing and you feel much more confident about it, you don’t feel like you’re surviving anymore. They [beginning teachers] want to become that, no one wants to be surviving, everyone wants to have an idea of what they’re doing and feel really confident with their plans.

As we make the ontological leap toward a discursively constituted self, where we once saw an essence we are left with lack.

If we subtract all the richness of the different modes of subjectivation, all the fullness of experience present in the way the individuals are ‘living’ the subject-positions, what remains is an empty place which was filled out with this richness; this original void, this lack of the symbolic structure, is the subject. Zizek, 1989, p. 175)

Science-teacher-subjects are in an incessant state of disaccord due to the disconnect between what they perceive to be a bounded identity and their continual failure to fill the void to which Zizek speaks. Torfing (1999) elaborates, suggesting that the subject of lack can only hope to establish itself through acts of identification fueled by the unfulfilled drive to become a fully achieved identity.

The science-teacher-subject is driven to perform an endless series of identifications, discursive performances that often rely on hegemonic discourses to
provide stability in the face of lack. The subject might seek to establish itself as a particular subjectivity by identifying with various discourses, in the field of science education these stabilizing discourses are deeply engrained in the narratives of modernity and enlightenment and the relative epistemological certainty they promise. However, Lacan (1977) explains that identifications cannot give rise to the formation of complete identities. The performances of particular discourses, even those reliant on hegemony, can only produce fragile, unfinished, and permanently vulnerable identity effects.

Subjectification is the active process of attempting to mentally construct and physically embody subjectivity and achieve full identification. In the case of science teachers, the desire for full identification is dependent on the promised certainties of Western science and the status and power they receive as being subjectified as knowers. Although the science-teacher-subject imagines fulfillment and contentment as they strive to fully embody and perform a subject position, these idealized positions’ unattainability leads to fragmentation where the subject imagines perfection, full identification is an ontological illusion. The conversation with the beginning science teacher (above) captures the longing we feel for full identification. The attainment of the subjectivity of the “full-fledged teacher” becomes associated with happiness, contentment, and balance. However, full identification is an illusion as the embodiment of particular subjectivities is strived for but never attained (Butler, 1997); every subjectivity fails in its promise of order and total identity (Laclau & Mouffe, 2001).

The attainment of the ideal subjectivity is an illusion, a fantasy that Lacan refers to as the “Idea-I” (1977, p.2). The Ideal-I is the fantasy that is strived for; it represents a form of self that is without disaccord, a primal unity or “jouissance” (Lacan, 1977). The
desire to obtain the ideal reinforces and reminds the subject of their fragmented self, provoking feelings of loss and lack. Lacan refers to this misrecognition as “meconnaissance” (1977, p.6). Feelings of discord arising from this partiality lead the subject to incessantly perform prescribed roles and leave the subject vulnerable to the disciplinary effect of hegemony which promises this vary certainty and stability. As Butler (1997) explains, the impossible lure of a return to jouissance re-stimulates profound longings in the interpellated subject, and it is therefore the key to the power of given political signifiers.

Althusser’s (1971) notion of interpellation, to which Butler refers, describes the creation of the subject as he/she is named, hailed or addressed. Such a naming is a call to align oneself with discourse and power, to subjectify oneself as a recognizable identity. When the science-teacher-subject turns around and is recognized, he/she accepts recognition as the subject being hailed. Through interpellation, the subject submits to power and what discourses have to say about who he or she is. The interpellation of the science-teacher-subject requires an aligning of oneself with the dominant discourse of Western science. Through this alignment, the science-teacher-subject receives recognition and status but at the cost of performing in particular ways. The interpellation of the science teacher is an entering into a contract with the social body, a contract with condoned and disciplined performances.

The subject is recognized by the standards of various subject positions and as such, is socially defined by language through power and discourse. Identity is not stable, unified, or an essence inside an individual. It is nebulous, fluidic and dynamic. It is often easier for the subject to imagine oneself as a bounded, coherent individual, particularly if
there is power and recognition associated with the discourses that are used for identification. However, identity is not a stable construct but an ongoing process, identities are social representations of the self.

**Performativity**

Viewing identity as subjectivity causes our notion of identity to change from completeness to instability and lack. This shift in conceptual framework affirms the science-teacher-subject as a product of a particular cultural and political milieu. As Smith (1998) explains, the science-teacher-subject can no longer exist as a fully self-conscious actor who can stand back from historical embeddedness and can obtain total clarity about one’s condition. Being recognized as a particular type of person, however, is not a singular event but must be continually performed to sustain identity and intelligibility. Nietzsche claims that there is no doer behind the deed: “For Nietzsche, there is no agent left after its activity has been abstracted from it” (Grimm, 1977, p.82). Deleuze echoes Nietzsche’s view claiming that “there is no subject, but a production of subjectivity (1996, p. 113), the ‘doer’ is variably constructed in and through the deed (Butler, 1990). The subject is both produced and actively produces what the subject sees as the self.

Recognition by self and others by others by specific subjectivities is not a passive process, subjectivities take effect through actions: Subjectivity is expressed through one’s actions, gestures, words and even silences. Butler (1997) refers to these actions as performativity. Simply put, “what we do is what we become” (Sharma & Muzaffar, 2012, p.185). People perform as they attempt to embody particular norms enacting particular gestures that have particular meanings (Vick & Martinez, 2011). Performances
are not a negative exertion of power, but rather induce contentment as one is recognized as being a particular type of person.

Science teaching is a performative act. Science teachers enact particular norms and gestures that are discursive and recognized in that context as the performativity of the science teacher-subject. Wenger (1998) explains we know who we are, and are recognized by others by what is familiar, understandable, usable and negotiable. We do not know who we are by what is foreign, opaque, and unpredictable, except through their negative performance. In the context of science education, these familiar and understandable performances to which Wenger refers involve reproducing accepted pedagogies and often proliferating the epistemological discourses of Western science. The reproduction of dominant discourses through these performances are not inherently negative, as the science teacher is recognized by students as a subject of Western science and such recognition brings with it status, authority and identity. Brass (2010) refers to this process as the “sweet tyranyzing influence”. Power induces a degree of stability as the science-teacher-subject is recognized by a positionality that has “congeal[ed] over time into discursive norms that naturalize an individual as a science teacher” (Sharma & Muzaffar 2012). These recognizable roles are not always sought or desired but it is through these performances that science teachers condone and reinforce (often subconsciously) the discourses that have constructed these roles.

The performances involved in the subjectification of the science teacher have an external and internal duality. The enactment of subject positions results in an internalization of discourses into the sense of self while simultaneously reinforcing the discursive structure. In science education, we see a discursive structure that is highly
sedimented resulting in a narrow understanding of what constitutes “acceptable” performances and the pedagogical stagnancy discussed in chapter one. The performativity of the dominant discourses of science teaching provide recognisability, intelligibility and status for the science-teacher-subject while simultaneously require a submission to be a conduit for the continued propagation of these discourses.

Taking the conceptualization of performativity deeper into poststructural thought, even the articulation of the science teacher essentializes the subject position. It brings about the illusion that there exists a core or essence that defines this subjectivity. The science teacher is a discursively constituted subject position, and as such, this subjectivity is dynamic, dislocated, and ultimately contextually contingent. A contextual contingency that, when queried, requires a critical examination of the social, cultural and political contexts in which science and science teaching have emerged.

**Our Gaze Turns Outwards - Concluding Thoughts**

The self is infinitely more malleable, more open to change than has previously imagined. Given one’s motivation, of course, this dimension of selfhood can be mobilized for great benefit or manipulated for great harm. (Kincheloe, 2004, p.133)

The primary aim of this study is the examination of the subjectification of the science teacher. Poststructural theorization of subjectivity, although challenging in the required ontological and epistemological shift, offers a great deal of explanatory potential with regard to the pedagogical stagnancy of science education: poststructuralism permits a researcher to turn the gaze towards the historical, social, and political and discursive structuration of identity. Problematizing the ‘science teacher identity’ shifts from questioning essential beliefs, views, and philosophies of science
teachers, toward how these components of self have come to be constructed, performed and disciplined.

Traditional views of identity overstate individual’s freedom of action as they view self and action as self-determined. In a modernist sense, one’s essential identity is understood to be both the source and locus of thought and action. Following this thinking, conceptualizing the science teacher’s essentialized identity continues to permit a separation of the science-teacher’s self from politics and power. Viewing self and action as distinct from social and political power masks hegemony, as problematizing what is “true” and “natural” is a futile endeavor. However, seeing the self as constructed, controlled, and disciplined by power, through discourse, provides us with the potential to explore the enduring and persistent subjectivity of the science-teacher-subject and the ensuing stagnancy of science education. It opens the possibility of problematizing what is accepted as natural and universal, both in terms of self and action, and seeing it as social and hegemonic.

Through a poststructural lens, examining the subjectivity of the science teacher becomes an analysis of the discursive structure itself. Research that theorizes the science teacher as a subject of lack with no naturalized or essential core involves examining the discourses that have been supplemented into this primordial void and constructed as a sense of self. Returning to Derrida (1967) there is no center but instead an absence of center for which infinite substitutions is made. The process of subjectification can be thought of as a series of continued substitutions of center driven by acts of becoming. Parts of discourse, originally seen as external, are internalized, naturalized and embodied by discursive performances. When science teachers perceive aspects of their professional
identity as essential, the question arises: what is being substituted or drawn on to create this illusory center? Simply asked, what discourses demarcate the “normal”, “true” and “commonsensical” science-teacher-subject?

The science-teacher-subject is recognizable through the performativity of particular discourses; it is through actions and inactions of the subject that discourse becomes corporeal and known. Pedagogy is integrally connected with teachers’ belief systems and identities. However, when viewed poststructurally, belief systems and identities are no longer seen as essential and individual but as socially and discursively constructed. Teaching becomes a political act; what occurs in the classroom does not escape power and politics but is driven by these forces. Poststructuralism posits Western science, self and pedagogy as social constructs, and as such, it allows for the critical examination of the relations of power involved in these constructions. Such a view is crucial if growth and evolution of the discipline of science education is sought.

Conceptualizing the identity of the science teacher not as a core or essence but as discursively constituted subject allows us the tools to move beyond introspection and toward an extrospective analysis of discourses. Adopting this mindset, issues of identity and pedagogy evolve beyond matters of individual choice or competency and towards politics and power relations. As Zembylas (2003) suggests, questions of identity must move away from who we are and toward how, why, and when we are. With this poststructural conceptualization of the subject in mind, the overarching questions of the study comes into focus: *How* is the subjectivity of the science teacher constituted by the field of discourse and *why* do we say the science teacher is subjectified in these particular ways. What is accomplished in these identifications?
The Coercive Field of Power and Discourse

Power

Power provides the network and the impetus for the circulation of discourses. Power is both the source and the effect of discourse (Youdell, 2006). Foucault’s conceptualization of power as pervasive is important to my study. “Power is everywhere; not because it embraces everything, but because it comes from everywhere, and “power”, insofar as it is permanent, repetitious, inert, and self-producing, is simply the over-all effect that emerges from all these mobilities” (Foucault, 1980, p.93). Power can go “right down into the depths of society” (Foucault, 1977, p.27), “down to the finest grain of the social body” (1977, p.80). “Power reaches into the very grain of individuals, touches their bodies and inserts itself into their actions and attitudes, their discourses and learning processes and everyday life” (Foucault, 1980, p.39). Power is everywhere, it is exercised from and through enumerable points, in every interaction in every relationship, just as subjects are subjected to discourses, so too are they always in power.

Traditionally power was seen as a concrete entity, a commodity, something that could be exchanged and transferred. Foucault’s view of power differs in that power is no longer defined as a force that can be possessed but one that exists through inaction. Power exists through relations of power. Power is pervasive; it is “a machine in which everyone is caught” (Foucault, 1980, p.156). What makes power’s hold on us so strong is that power is not only repressive but it is also productive. The machinery of power, through discourses, produces subjectivities and expected or habitual performances. Foucault (1980) explains that the productive nature of power’s prime effect is the identification of individuals by a prescribed set of gestures, bodies, discourses, and
desires. It is through these prescribed performances that subjects are recognized and are produced as particular types of people. Power produces discourses, knowledge, and subjectivities – the subject depends, often unknowingly, on power for identification.

We are used to thinking of power as what presses on the subject from outside... But if, following Foucault, we understand power as forming the subjects as well, as providing the very conditions of its existence and the trajectory of its desire, then power is not simply what we oppose but also, in a strong sense, what we depend on for our existence and what we harbour and preserve in the beings that we are. (Butler, 1997, p. 2)

Ultimately, the circulation of power and discourses construct the subjectivity of the science teacher. It is through the desire to be socially and culturally recognizable, as well as achieve the status associated with this subjectivity, that science teachers embrace the roles that the social body constructs. This is the prime effect of power that Foucault describes, as power is productive and controls not only by fear or punishment but predominately by desire and the pursuit of comfort. In the context of teaching, the effects of this desire can be observed as subjects strive to be recognized as the good science teacher and continue to operate within acceptable pedagogical modes. As the subjects perform the role of “the good science teacher” they are subjectified because they perform in ways that confirm their internalization of discourses, a subject is created through identifications with a particular subject position. Power produces but it also constrains; what is produced is dictated, a dictation that I propose is responsible for the stagnancy of science education. As Foucault (1980) states: the subject “pursues subordination as a promise of existence” (p. 29).

The construction of identities within a field of discourse is a dialectic process. A field of discourse provides tentatively stable or acceptable identities (subject positions) as individuals continue to contribute and support the stability of the field though
discursively sanctioned identities and actions. In the context of science teaching, the epistemological and pedagogical field of discourse is highly stable and sedimented. As such, the science-teacher-subject receives an illusory stable identity while contributing to the stability of the field itself. It is through this theorization that the disciplining effect of power emerges. To maintain identification and recognisability within the field, the science-teacher-subject must perform in particular ways or risk losing meaning and identification. In the context of the science-teacher-subject, these meanings and identifications carry a great deal of status and prestige. Relations of power are observable; subjects are simultaneously dependent on the discursive structure for meaning while contributing to the structure by reinforcing or failing to reinforce its established meanings.

**Discipline**

Chinese slang, “Chu Tou De Chuan Zi Xian Lan” - the rafters that jut out rot first (Wang, 2004 p. 103).

Power’s constitutive effect made visible in the process subjectification are continually reinforced and strengthened through disciplinary apparatuses. Foucault (1977) explains that disciplinary practices or technologies of power persistently constrain and discipline individuals to remain in and perform their discursively constructed roles. Disciplinary practices are sets of norms and routines proliferated by discourses. Through continued discursive repetition, disciplinary practices form what is considered to be best practice and acceptable identities. According to Foucault (1977, p.135), the goal of these disciplinary apparatuses is the production of “docile bodies”, bodies that can be shaped, trained, and manipulated.
Science teachers are not free from power simply because they are not pedagogically subjected to legal or monetary penalties. Power is exercised “not by law, by normalization, not by punishment but by control” (Foucault, 1980, p.89). According to Foucault (1977), the creation and maintenance of the subject by discipline is not obtained through violence, terror, or weapons. Rather, Foucault suggests that discipline is exercised through technologies of power such as hierarchical observation, supervision, and normalizing judgement.

Boler (1999) refers to normative disciplinary methods as often insidious, subtle, frequently invisible, and used to maintain discipline and control. Science teachers are inundated with images of the socially constructed norm; intelligent, rigorous, objective and rational. These norms can be observed in all types of media, educational policy, and educational institutions. Although these norms are initially formed outside of teachers they are internalized by teachers and become what they strive for.

The judges of normality are present everywhere. We are in the society of the teacher-judge, the doctor-judge, the educator-judge, the ‘social worker’-judge; it is on them that the universal reign of the normative is based; and each individual, wherever he may find himself, subjects to it his body, his gestures, his behaviour, his aptitudes, his achievements. (Foucault, 1977, p. 304)

As Zembylas (2003) explains, even the notion that there is an authentic and true self to which every teacher should aspire (i.e. the Lacanian Ideal-I science-teacher-subject) depends on systems of emotional management, regulation and discipline. The dominant discourses of Western science and science education provide the structure for appropriate and acceptable actions and identities, thus providing meaning and intelligibility. Science teachers are disciplined by these structures, not through any type of overt threat but through their internalized desire to be recognize and imbued with the
status of being associated with these hegemonic discourses. Recognition, however, can only occur if science teachers conduct themselves in particular ways. The power of disciplinary apparatuses is that the failure to act appropriately and normatively can result in the loss of identity, intelligibility and status.

The discursive field establishes the rules by which all actors (subjectivities) must perform. “Practices do not exist without rules, nor rules without practices. Knowing rules means knowing how to proceed” (Cherryholmes, 1988, p.4). The internalized rules are referred to by Foucault (2003) as technologies of self, practices that individuals set themselves as they seek to align themselves with a particular subjectivity. Foucault goes on to explain that in modern societies individuals are encouraged to focus their attention on themselves and their identities to discover the truth of their being (not absolute truth, but rather the truth of their subjection).

Technologies of self, permit individuals to effect by their own means, or with the help of others, a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being, so as to transform themselves in order to attain a certain state of happiness, purity, wisdom, perfection, or immortality. (Foucault, 2003, p. 146)

These promised states of contentment can only by attained if we are recognisable and intelligible and submit to the norms proliferated by discourse. Reminiscent of Lacan’s (1977) méconnaissance and jouissance, the self-manipulation individuals undergo by technologies of self, promise to end lack and misrecognition but, in actuality, they only serve to continue it.

Discipline not only encourages conformity, but is essential in defining the norm itself. As subjects of lack, the science-teacher-subject is always in flux and normative discourses affirm the desirable and the normal subject while simultaneously comprising statements of deficit that demarcate the abnormal subject (Graham & Slee, 2008).
Subjects continually perform and discipline themselves as to not be seen as the other. However, it is that very other that defines the norm. What is normal without the abnormal? What is the subject without the abject? The privileged center can only exist with an underprivileged or marginalized other. Therefore, we must ask what is the norm for science? Traditionally, the norm was white, male, Western, rational and objective and the science-teacher-subject’s normal performances continues to propagate these discourses. The disciplinary function of observation, supervision, and normalizing judgment continues to prevail because it is through these technologies of power that the subject finds identification by distinguishing between the normal and the abnormal. Put simply, as the science-teacher-subjects define what they are not, they establish a ghostly center (Graham & Slee, 2008, p.284), and an illusion of a core.

Poststructurally, we move away from the essentialization of self and towards a fluid, contextual, and dynamic subjectivity. However, with such conceptualization it would seem that science teachers are free to act and choose a subjectivity, that there exists an infinite number of possibilities for self-constitution. The structure of discourse, particularly in science education, limits these choices and limits who subjects can be and how they can act. If a person wants to be recognized as a science-teacher-subject they must submit themselves to discipline of the dominant discourses as they internalize, adopt, and act how these discourses prescribe. These processes, however, often go on without consciousness, thought or choice. “We have internalized appropriate rules and ideologies, have accomplished ourselves to dominant power relationships, and are more concerned with performing expected actions than with analyzing them” (Cherryholmes, 1988, p.6). These practices are no longer seen as controlling and limiting but simply as a
component of the discursive structure in which the subject functions. With the acceptance and naturalization of discipline, subjects internalize disciplinary strategies and they no longer can see them as an external force.

**Hegemony in the Field of Science Education**

Hegemony is the cultural domination by a particular worldview. When hegemony achieves a consensus among the population, it provides people with the illusion of fixed meanings and acceptable subjectivities; it provides ontological and epistemological stability. In the context of the subjectivity of the science teacher, the hegemony of Western science promises a structuration of reality filled with certainty, clarity, status and power for those who continue to uphold its narratives. Hegemony provides a ‘reality’ in which to operate, and “if people consent to a direction imposed on social life, the coercion does not need to be brought in from the outside, it is already there” (Hoffman, 1984, p.75). The science-teacher-subject holds a privileged position within the hegemony of Western science, and as such, coercion and discipline’s locus is internal. The science teacher-subject is both produced by and actively produces the hegemony of Western science. The fluidity and fragility of subjectivity is what makes the hegemonic fixation of identity possible. Hegemony gives the illusion of permanence and a unified reality. As hegemonic discourses gain authority, they become the framework to which subjectivities are constructed with reference to its logic. Subjects are fragmented, contested and defined by lack and hegemonic discourses striving to present themselves as the only possibility to total chaos. In the context of the subjectification of the science teacher, the crisis or threat of chaos is the recognition of self as lack and the loss of certainty that the metanarrative of Western science provides.
As an interpolated subject, hegemony temporarily fills the lack and provides stability to the subject, but in doing so the subject submits to hegemonic discourses for identification and the marginalizing dichotomies that are responsible for their stability. Dichotomies that, in the case of the subjectivities of science, are gendered, raced and epistemologically monopolizing.

Gramsci (1971) describes hegemony as the politics of consent. Consent is not freedom, but an admission to play within discursive rules. Consent and coercion simultaneously exist as people choose to operate within acceptable subjectivities and realities. The science-teacher-subject consents to hegemonic discourses of Western science for stability and yet this temporary stability comes at a cost. “The powerful reactionary forces that are constitutive of oppressive and exploitative structures strive to promote the interpretative subject positions that legitimate those structures, and to exclude the rival interpretative frameworks that threaten to incite subversive practices” (Smith, 1998, p.159). In the field of science education, what results from these concepts are highly prescribed science-teacher-subjectivities and an exceedingly prescribed view of what are acceptable performances.

**Relational Meaning and the Creation of the Other**

The modernist notion that the subject holds a unique bounded identity requires a subject’s essence to transcend the social, its core to exist in interiority with respect to a social exterior. A centered, bounded, essentialized self finds its roots in modernity, these discourses remain dominant in today’s narratives of self. A poststructural view of identity counters such a view by decentring the subject, rejecting the idea of a transcendental subject, instead focusing on constructed subject positions within a
discursive structure (Torfing, 1999). Not only does the subject not hold a fundamental identity; rather, identity is a social artefact; identity is a product of a discursive structure and a reflection of the social body. The subject has become dislocated; the subject’s self is driven from its locus and core.

In a field of discourse, the science-teacher-subject’s identity is established through relations to other discursive formations, as Laclau and Mouffe state “all identity is relational” (2001, p.106). Derrida elaborates explaining that “no element can function as a sign without referring to another element which itself is not simply present” (1981, p.26). Meaning and identity can only be temporarily established by referring to other discursive constructs, however, these referential points are themselves unfixed and the play continues indefinitely. What results is that the subjectivity of the science teacher is constructed not through a common essence but “through its differential relations with the other subject position that are found in a given discursive formation” (Laclau, 1985, p.113). However, these relations are not only with subject positions, as described by Laclau, but also with curriculum, policy, and other historical-political constructs.

Drawing on Derrida’s différance (1967), for meaning (centeredness) to be temporarily established it must both differ and defer meaning. Meaning is deferred as definition is only established by appealing to other words; it is the putting off, or displacement of meaning. Simultaneously, meaning is also produced through differment; meaning is dependent on referencing the other, what the object or subject is not. Subjects define themselves by simultaneously aligning their subjectivities with analogous discursive constructs as well as positioning themselves in opposition to others, what is normal is not based on essential qualities but is entirely and purely comparative. Every
social formation, including the formation of the science-teacher-subject, is constituted through a relation with a constitutive outside. Identity depends on the other for meaning, while simultaneously denying the constitutive outside.

In the field of education, the science-teacher-subject is created by associations of equivalence and difference. For example, the definition of the science teacher is dependent on the conceptualizations and valuations of Western science, which is dependent on the discursive constructs of objectivity, reality and fact. The meaning of objective cannot stand alone; it must be connected with the other signs, this is “playing off” of meaning that Derrida conceptualizes. The duality of différance comes into play as the signs in the chain of equivalence can only by defined through oppositions and differing. The science-teacher-subject substitutes their centers for these equivalent signs (Western science-objectivity-masculine-hard-reality-truth) but this definition is dependent on the antagonistic (subjective-feminine-soft-fiction-myth) for meaning.

Within a poststructural framework, the identities associated with Western science are not neutral but are inherently violent through dichotomies that they depend on for definition and intelligibility. Stoler writes that “becoming adult and bourgeois meant distinguishing oneself from that which was uncivilized, lower-class, and non European” (1995, p.151). In the same way, there is no middle ground with the subjectivities of science. What was once used to define the science-subject (civil, rational, male, white) also defines the other. Race, gender and class form the “grid of intelligibility” (Foucault, 1980, p.93) that constitutes the science-teacher-subject.
Race and the Science-Teacher-Subject

The subjectification of the science teacher can be characterized as a series of continued substitutions of center driven by acts of becoming (performances). In the context of the science-teacher-subject, the external discourses of Western science, science teaching and science curriculum are internalized and naturalized by discursive performances. Recognition that these discourses reflect a particular social reality that defines subjects in particular ways is central to this study. The fact discourses of race in science are rarely spoken does not indicate that Western science transcends race; rather it speaks to the masking of structural racism and white dominance within the hegemony of science.

The believed epistemological superiority of the Western Europeans’ science was integrally connected to the believed superiority of the White race. As Leonardo explains, the discourses of enlightenment and race were used to stratify the world: “Whites created race in order to divide the world. To carve it up into enlightened and endarkened continents” (2009, p.244). The management of who would access and understand scientific knowledge was a class, race and gender specific project. It defined a white European identity while creating an abject other. “This [epistemological] discourse no longer lays claim to a neutral subject. The one who speaks is necessarily someone else’s adversary” (Stoler, 1995, p. 65). The adversary about which Stoler speaks is the non-European, also defined through difference as ignorant, savage and non-white. The discourses of Western science and white racial supremacy co-evolved and as such, an examination of science-teacher-subject would be remiss without addressing race.
Race and the Discourses of Western Science

The examination of race is not the primary aim of this research, however, following Stoler’s (1995) theorization, it is important to acknowledge that the discourses that subjectify the science-teacher-subject articulate and incorporate a racist logic. Bonilla-Silva (2003) writes that when race emerged in human history it formed a social structure that privileged Europeans over non-Europeans. These racialized social systems affected all societies in contact with Europeans. Discourses of race did not simply run parallel with the discourses of modernity, enlightenment and Western science but were integrally part of it. Derrida’s “playing off” of meaning recognizes that the relationship between these discourses is not a passive association; they inherently depend on each other for meaning. The discourses of enlightenment and Western science are integrally tied to the definition of the white race.

Social scientists rarely disagree that race is a socially constructed category (Bonilla-Silva, 2003). Notions of racial differences are human creations, not eternal, essential categories. This theorization will be explored further in chapter three. Although race is socially constructed, it is important to acknowledge that it produces real effects on subjects, as Leonardo explains “Race is completely socially constructed, but we have invested it with material institutions…it define[s] group similarities or differences... and skin colour stratification[s] (2009, p.244). Race is a discourse: “we all create race, and race creates us all” (Leonardo, 2013, p.609). Although race is a social construction it is embodied when discourses demarcate the “normal” science-teacher-subject. These discourses both prescribe particular types of behavior and construct particular types of
people in particular ways. In the case of the science teacher, the norm is a white, middle or upper class male subject.

Racism is an integral component of the structuration of our reality. It was and continues to be used to define “us” and “them,” the normal and the abnormal, and in the field of Western science, the knower and the unknower. Stoler (1995) explains that racism is interwoven into the social body and threaded through its fabric, it does not merely arise in crisis. Just as power and knowledge form an indissoluble couplet, so too are discourses of race interwoven with Western scientific knowledge. Following Foucaultian theorizations in *The History of Sexuality*, the language of modernity, enlightenment and science grew out of the language of race. The belief that science and technology brought about a utopian era for mankind resonates with modernist discourse. However, the “mankind” defined by these discourses is that of the white male.

As the colonialists voyaged and spread their Western knowledge they proliferated a structuration of a reality that privileged Western Europeans and marginalized the *other* races. These racial divisions were hierarchically organized; they defined the white race as true, advanced and civilized, and constructed the *other* as the antithesis of all the was good and natural. The stratification of the world’s races relied heavily on Western epistemologies; claims to better, more accurate, more truthful knowledge allowed white Western men to claim their privileged positions.

Saussure (1916) writes that meaning is produced through differences without positive presence. According to this theorization, the construction of race both secured a global hegemony and stratified race and class within Western Europe. Race defined the essential European with Europe and became an organizing factor for colonialists outside
Europe. As Stoler explains, “State racisms are intimately linked with colonial forms of racialized and classed rule, invested in defining ‘authentic’ European citizens and forming a unified and homogenized ‘body politic’ (1995, p.69). Foucault takes us further. He suggests that racial discourses produce a social tension that threatens the very identity of the one “true” race, in addition to defining the normal and the abnormal.

It will become the discourse of a combat to be carried out not between two races, but between a race placed as the true and only one (that holds power and defines the norm) and one which constitutes various dangers for the biological patrimony. At this point, all those institutions which function internal to the social body as principles of segregation, elimination and normalization of society….we must defend society against all the biological dangers of that other race, of that sub-race, of that counter-race that despite ourselves we are constituting. (Foucault, 1961, p.55)

The discourses of hierarchical race operate violently on multiple levels. As discussed, they define the norm and thereby elevate the status of those who qualify and marginalize those who do not. However, as Foucault describes, they also actively produce a division and incessant tension within the social body. It is more than “us” and “them”, because “they” (the other) pose a threat to the identity and society of those holding privileged positions.

If science continues to be discursively constructed as apolitical, acultural and aracial, the masking of racial discourses will continue to marginalize those defined as other. The resulting continuation of privilege such invisibility bestows on the knowers is particularly insidious. According to Knowles and Peng (2005), those in privileged positions continue to make assumptions concerning the “invisibility” or “transparency” of membership in a hegemonic group. As Bonilla-Silva explains “That contemporary racial inequality is reproduced through ‘new racism’ practices that are subtle, institutional, and apparently non-racial (2003, p.3). Science subjects continue to
propagate the hegemony that bestows a racial advantage because they receive privilege from the system.

**Science and the Privilege of Race**

Leonardo (2013) writes of a racial contract between white people and the social system that elevates their status. He suggests that white people enter into an unspoken contract with the social system, receiving privilege in exchange for upholding its marginalizing structures. By participating, white people remain colour blind (Bonilla-Silva, 2003) to the racial effects of the contract. “It is a state of affair that functions statistically as if they had entered into contract with one another. In this political system, all Whites are beneficiaries even if they are not all signatories... it is an apprehension of an arrangement that amounts to a lived reality” (Leonardo, 2013, p.606).

White people’s ignorance toward the racial contract is an essential component to the theorization of the contract. Wise (2007) writes that white people are not insensitive or hardhearted but that they have the luxury of not knowing black and brown truth. “They don’t know because they don’t have to know… [they have the] privilege of not having to think about it, that privilege of not having to know someone else’s reality, that privilege of being able to ignore it, and that privilege of benefiting from the inequality (Wise, p.235) Whites are born into a world that is racially harmonious with their sense of self” (Leonardo, 2009, p.235). White people are able to accept the “white system” as the system because they have entered into a social contract with it.

In a similar vein, the hegemony of Western science provides a social contract for those who support the system. Science teachers benefit from the epistemic discourses of modernity and enlightenment and therefore they continue to promote it, albeit often in
ignorance. These continued performances reproduce both the hegemony of Western science and the subjectivity of the normalized science-teacher-subject. Just as Leonardo’s racial contract can only exist with an underprivileged other, the hegemonic discourse of Western science must elevate the knower and devalue the unknower. Leonardo refers to this as “White epistemology” and states that “it is based in the elevation of the veracity of scientific claims while suggesting that alternative ways are knowing are incorrect or somehow less correct” (2009, p.232). Discourses of modernity and enlightenment contribute to “an epistemology of the oppressor to the extent that it suppresses knowledge of its own conditions of existence” (Leonardo, 2009, p.232).

In line with Tim Wise and Bonilla-Silva’s conceptualisation of colour blindness and white denial, science is often presented as transcending race. However, through retrospective analysis, we can see that discourses of science are integrally connected to the discourses of enlightened, modernity and colonialism (discursive connections that will be explored in chapter three). Just as colour blindness allows society to continue to exhibit white supremacy, claims of neutral science curricula form an impregnable wall, one cannot level a non-scientific argument against science. As Charles Mills (1997) reminds us, these counter histories are judged by a value system against which they speak, making the situation ripe for a catch-22.

Gramsci (1971) explains that the state works towards propagating consent through education. In science education, Gramsci’s consent requires the acceptance of a race-free epistemological norm. Colour blindness and white denial in science remains rampant because science teachers and students are not required to directly and critically engage with discourses of race. The fact that science is presented as being not about
people, culture, and society does not mean that discourses of race do not need to be examined. These very claims secure positions of power and status for science-subjects. In science, racial discourses are checked at the door: one puts on a white lab coat and a white epistemic ideology.

**Agency and Resistance**

When reflecting on the productive, marginalizing and disciplinary effects of power and hegemony it is not uncommon to feel ensnared in one’s own subjectivity. However, although the subject is always “in” power, where there is power there is also resistance to power. “Resistance is never in a position of exteriority in relation to power” (Foucault, 1980, p.94). The disciplinary apparatus produces the subject, but as a consequence of that production, the subject obtains discursive agency for subverting that apparatus itself.

Although the subjectification of the science teacher by power and discourses may seem to be a paralyzing force, hegemonic discourses are not completely deterministic; being in power does not strip the subject of agency. Dunn (1997) states “to be constituted in discourse is not to be determined by discourse, if determination is taken to mean the impossibility of agency” (p. 695). The science-teacher-subject and the field of discourse exist in a dialectical relationship. The subject is dependent of the field for identification while simultaneously constructing and reinforcing the field through normative performances. This is of particular importance to the field of science education as normative performances do not only constitute the science-teacher-subject but also effect the developing epistemological perspectives of students.
Resistance and agency do not come from a prediscursive realm (Dunn, 1997), but arise from the instability of the field itself. To exhibit discursive agency is not to step outside of discourse or refuse to engage in power. It is to act, to do something different, something outside the normalizing effects of dominant discourses, to identify the discourse, disrupt it, or refuse to repeat it. Foucault writes “Refusal is not revolt nor rebellion, rather there is a plurality of resistance possible, plural, necessary, improbably, spontaneous, violent, solitary, they can only exist in a field of power relations (Foucault, 1980, p.95-96). Ball explains “We do not speak the discourse. The discourse speaks us” (1990, p. 18). Ball’s description highlights the formative nature of discourse, but it omits to make reference to the subject’s discursive agency. Although the discourse does “speak” the subject into existence, the subject can also, through agency, speak the discourse. Even with a sedimented discursive regime, of which Western science is an example, the science-teacher-subject can speak new discourses and new identities as they embrace their discursive agency. As Sharma and Muzaffar (2012, p. 186) explain “no articulation of a subject position can be so hegemonic such that it completely excludes competing articulations completely from the frame”.

As discussed, subjectivity is by nature more or less unstable because it must always be reconstituted. The instability of subjectivity opens tremendous opportunities for change. Butler (1990) explains that subjectification is not a founding act but rather a regulated process of repetition. She sees agency then as located within the possibility of a variation on that repetition, reconstituting differently at any given moment. According to Butler (1990), “reiterations are never simply replicas of the same” (p. 226). Thus, when science teachers reiterate a discursive norm, they do not just plainly repeat it, but
also in the act of doing so dialogize it with their own voice, intentions and interpretations, and thus re-signify it, reconstitute it as uniquely their own. Dominant discourses discipline through normalization, but subjectification is never complete nor is it completely encompassing of all subjects. Therefore when discourses are resisted, subjectivity is not fully embodied; it represents a “failure of any particular articulation to describe the population it represents’’ (Butler, 2000, p.12). When discourses no longer accurately represents subjects, they fail, and make room for new discourses. Teacher identity is both the effect of prior power as well as the condition of possibility for a radically conditioned form of agency” (Zembylas, 2003, p. 225). The subjectification of the science teacher results from a complex interplay of dominant discourse, discipline and agency.

Concluding Thoughts

The science-teacher-subject is continually disciplined to perform particular roles, while achieving status and prestige as they are recognized by these prestigious subject positions. The constitution of the science-teacher-subject is both voluntary and disciplinary as the very structure which provides status simultaneously constrains. The achieved status is not bounded only along school lines but is also a product of many ‘past’ discourses. The science-teacher-subject is based on a powerful and prestigious social positioning, a positioning that finds its origins in the discourses of enlightenment, modernity, and colonialism. Within a conceptualization of a decentered subject, it is vital to turn our gaze towards the past, to examine the “historical” discourses which provide meaning to the science-teacher-subject. With a retrospective gaze, our query shifts from
questions of **how** a science teacher is subjectified to why we *say* the science teacher is subjectified in particular ways.
CHAPTER THREE:  
The subjectivity of the Science Teacher:  
Our Constitutive Gaze Turns towards the Past

There exist many powerful discourses in science and science education, discourses that have and continue to subjectify science teachers. Historical changes in science education are often considered to be a linear evolution, characterized by steady progress and improvement. Such a view, however, is problematic in its ignorance of the relations of power and the political forces that have shaped the science-teacher-subject. As Edward Said explains, “histories cannot seriously be understood or studied without their force, or more precisely their configurations of power, also being studied” (2008, p. 26).

Science curriculum development and the constitution of the science-teacher-subject play out against a historical background of political changes, relations of power, dominance and marginalization. The aims of science education are derived from past and current society; as a society changes so do the goals of science education and the subjectivities of its agents. As Atkin and Black describe, “it is a truism that schools are expected by the public to reflect and transmit the values, wisdom and views of history that prevail in any nation at a given time” (2003, p.1). The reflection and transmission to which Atkin and Black refer manifest through the performances of teachers. The teacher becomes a conduit for the political discourses of a given time, and as such, they are regulated to transmit particular types of knowledge. The following section is an unearthing of the technologies of power which have and continue to constitute and discipline the science-teacher-subject. It is an “historical” analysis that sheds light on why we currently say the science teacher is a particular type of subject.
Conceptualizing the subject as defined by lack requires an outward gaze when questions of identity arise. The outward gaze necessitates a critical examination of the present and past social, political and cultural forces that have constituted the subject. Baker and Heyning explain that as one moves to decenter the subject “the givens of the present are contested and re-presented in new light through the import of historical analysis” (2014, p.30). In the vein of Baker and Heyning’s vision, the aim of the following section is to break down the linearity of time and see how these “past” discourses are ever subjectifying the science teacher, thereby “recogniz[ing] that the normalization of bodies is never done once and forever but is the object of a permanent struggle” (Dussel, 2014, p.87). It is for these reasons that my analysis of the subjectivity of the teacher involves not only turning our gaze outwards toward current discourses that subjectify but also backwards, towards the historical, political and cultural contexts of these discourses. It is a history of the present (Foucault, 1977). It is the examination of Western science as a regime of truth and the way it functions to produce discourses that produce the subjectivity: science teacher.

**The Formation of the Western Subject’s Supremacy**

Western science began its dominance during the enlightenment period in the late 17th century. Hamilton (1992) suggests that for the intellectuals during this period, science was the epitome of enlightened reason. Science was viewed as the vehicle by which society would improve and progress. “Through the application of reason and empirically based knowledge, social institutions could be created that would make men happier and free from cruelty, injustice, and despotism” (Hamilton, 1992, p.37). In the 16th century, Bacon claimed that science would lead to a better society and utopian
future. Science would “let the human race recover that right over nature which belongs to it by divine bequest, and let power be given it, the exercise therefore will be governed by sound reason and true religion…discoveries carry blessings with them and confer benefits without causing harm or sorrow to any” (Dick, 1955, p.539). Plattes in 1641 promised that England could “maintain double the number of people, which it doth now, and in more plenty and prosperity than now they enjoy” (1979, p.2). Western European society shared the view that scientific advancements and the advancement of learning would create a society of plenty. Western science became more than just a dominant epistemology; it became associated with development, industrialization and advancement. In keeping with its Latin origin, *scire* “to know”, Western science became synonymous with knowledge itself. As eloquently expressed by Asok Sen “No knowledge is true knowledge unless it has passed through the sieve of European criticism. All coin is false coin unless it bears the stamp of a Western mint” (Chukwudi, 1997).

While the colonizers were “discovering” new worlds, they were acculturating the colonized into an epistemology of modernity. The epistemology was dominated by the belief that the world was a wholly knowable system, governed by a finite number of universal laws which humans could comprehend by rigorous analysis (Havel, 1992). As Western Europeans held exclusive rights to the knowledge system they had developed, the notion of the civilized, educated human became defined as European. As Pratt states, “Scientific exploration was to become... a source of some of the most powerful ideational and ideological apparatus through which European citizens related themselves to other parts of the world” (1992, p.23). The relationship between the Europeans and the
“other” to which Pratt speaks was not one of equals but one of violence and subjugation, a relationship that was both implicated in and contributed to the constructed supremacy of the white race.

During the 18th and 19th centuries, “with the authority of the natural sciences” (Wieseltier, 1995, p.156), Western knowledge was used to establish and justify the colonial violence of white Western Europeans. The work of the phrenologists (Linnaeus, Blumenbach, Morton and Lapouge) provided a scientific foundation for the subjugation of non-white peoples and elevated white Europeans to positions of prestige and power. While revering and claiming to embrace modernist ideals of objectivity, rationality and neutrality, Western science formed and stratified the concept of a racialized world.

**Epistemological Supremacy and the Measurement of Worth**

In 1503 Christopher Columbus was marooned on Santa Gloria Bay in Jamaica. Columbus wrote:

Today, may Heaven have mercy on me, may the earth cry for me, as I wait for death alone, sick and racked with pain…I am so far away from the Holy Sacraments that if my soul should here leave my body, not even God would remember it”. Columbus ordered his crewman to stay on-board, and handpicked a team of sailors led by Diego Mendez to negotiate with the indigenous chiefs of the nearby villages for food and water. The indigenous villagers eventually grew tired of supplying the Columbus’ men with food and there were signs that they were preparing to attack Columbus’ ships. Columbus had an almanac that he had received from Regiomontanus (a German mathematician and astronomer) containing the dates of lunar eclipses. On February 29th, 1504, Columbus invited all the chiefs from the nearby villages to his ships and warned them that the Christian god would punish them if any harm was to come to the sailors. As proof of this, the moon would disappear and it did. Before the moon emerge from the shadow of the sun all of the village chiefs had pledged to help the sailors in any way that they could. According to Ferdinand Columbus, the indigenous people observed the eclipse and were so astonished and frightened that with great cries and lamentations they came running from all directions to the ships, carrying provisions and begging and promising they would diligently supply all their needs in the future.
Although the encounter between Columbus and the indigenous peoples may seem trivial, it speaks to an early version of constructed Western superiority. Columbus was able to intimidate and ‘outsmart’ the indigenous populations using Western technology and science in violent ways.

During colonial times, scientific and technological advancement became one of the dominant standards by which other cultures were judged. Edward Tylor (1871) identified scientific knowledge and technological development as two of the main gauges by which all human societies could be ranked on a continuum ranging from savagery to civilization, according to European typology. European observers came to view science and specifically technology as the most objective and unassailable measure of their own civilization’s past achievements and present worth (Adas, 1990), a superiority that was easily “scientifically” demonstrated and explained in their favour.

Discourses of epistemologically-based Western supremacy became increasingly prevalent during colonial times. Adas (1990) explains that the scientific and technological achievements were contrastingly cited as evidence of racial abilities or racial ineptitude. Frederic Farrar proposed that the Europeans were the only race that was capable of creating ‘true’ civilization and that the Europeans were responsible for “every noble discovery, every thought and influence that has enabled and purified the white race” (1867, p.125), even if these thoughts and influences were first discovered among the people considered less civilized. Pierre Mille (1905) observed that his countrymen generally accepted the notion that the indisputable superiority of European mental
capacity had been clearly demonstrated by European scientific discoveries and their application to war and communications.

The colonizers felt that their epistemological superiority justified the act of colonization as they needed to bring enlightenment to the “primitive” and “savage” peoples and reap the natural resources of their lands. In North America, the “prominent politicians, writers, and artists of the day caricatured the Indians as slothful, technologically poor, and unprogressive vestiges of savage societies that must either adopt the white man’s ways or perish” (Adas, 1990, p.405). Galaisiere (1779) concluded that the genius of discovery belonged to the Europeans only, and this explained why they had made more rapid progress than any other people in understanding what they saw to be the natural world. George Anson (1748) reflected that like all servile people, the colonized peoples lacked innovative genius and the sense of truth, accuracy and precision required to develop technologically and scientifically. The colonizers believed that it was their duty to bring enlightenment, technology and Western science to the backward, superstitious, and primitive indigenous populations, a belief that rationalized their violent acts.

The Europeans believed that their advancements in science and technology were evidence of their racial evolution towards civility and enlightenment. They believed that their scientific understanding of nature coupled with their religious beliefs brought them closer to a transcendent reality than other populations who held different beliefs and lacked their scientific ways of knowing. The perceived dearth in scientific knowledge produced a hierarchical relationship that favoured the colonizer over the colonized. It was believed that if the indigenous populations did not understand the world as Western
civilization understood it, then they did not understand the world at all. Although these logics are grounded within the context of a presumed Western epistemic supremacy, this rationalization is problematic as it ignores the sophisticated technologies and ways of knowing that were held by these “uncivilised” peoples. Pratt (2004) suggests that Europe’s claims to development included a great ingestion of knowledge from elsewhere: The West “extracted all the things of the world and redeployed them into a new knowledge formation” (Pratt, 1992, p.33). What is noteworthy is this theft and redeployment was yet another unacknowledged tool that enabled the West to subjectify the other as ignorant and themselves as superior. It was within these hierarchical positionings that the epistemic violence of modernity was rationalized.

The West was unable to see the technologies, epistemologies or intelligence of colonized peoples because the Western gaze was incapable of understanding worlds beyond its own rationality. Therefore, the knowledge of the “other” was judged as not measuring up to the rationality and objectivity of a Western knowledge system. Colonizers believed that the expansion of the West was a natural and rational evolution based on their superiority, a belief that rationalized the violence of these acts. Indeed, the modernist discourse of objectivity and rationality of science transcending politics and power is illusory, as Foucault explains: “The idea… that if we live in the world of reason, we can get rid of violence…is quite wrong” (Foucault, 1996, p.299). Following Foucault, it was these very claims to reason, rationality and transcendental truth that elevated the knowers and subjugated the abject other.

The perceived ontological and epistemological superiority of the Western Europeans led a dichotomous and marginalizing construction of the world. Harding
(2008) explains that the term “modern” refers only to societies governed by the rationality for which Western science provides the model. When science is viewed as the modern way of understanding the world, other ways of knowing are devalued as other cultures have only local or primitive beliefs about nature, while modern societies gain universal knowledge about them through their sciences (Latour, 2004). Thus “modern” is always an oppositional term; it relies on the constructed dichotomy between the modern and the traditional. “To become attractive it must locate an ‘other’ worthy of its unfamiliar moral, political, social, and material demands. Yet at the same time as it defines itself against the purportedly familiar, and so depends upon the connecting presence of the traditional as other” (Harding, 2008, p.179). What is culturally-based and traditional becomes inferior as the dichotomy represents science as a new, better and modern way of knowing.

**Biological Supremacy and the Formation of Race**

During the enlightenment period, Western Europe’s advancements in science and technology were used as evidence of white Western supremacy. Science also provided the means with which to measure this supremacy. As Foucault explains “Racism is a state affair, confirmed by a set of scientific discourses that bear witness to it” (1980, p.147). Western Europeans’ claim to a transcendental knowledge system that grasped “reality” promoted the knower (white upper-class men) with the ability to study and pass judgement on the advancement of other races. This claim to universal and objective knowledge paradoxically reflected the social and political landscapes of the period. As such, Western supremacy was not strictly epistemically-based but was intrinsically racial.
Colonialism and enlightenment brought about the social philosophy of biological determinism, the “scientific” theory that colonized people were innately and naturally inferior to their white colonizers. The social body accepted that a greater power of reasoning and rational scientific thought belonged to Western Europeans and that this indicated an evolutionary supremacy. Galaisiere, in *Vogages dans les mers de l’inde* (1779), concluded that the genius of discovery belonged to the Europeans alone, which is why they made more rapid progress understanding the natural world than any other people.

The basis for the belief in Western supremacy was not limited to the evidence gathered from the technological advancements but also included an examination of the physiological characteristics of different races. “European writers frequently assumed a causal relationship between skull shape or brain sized and the past achievements of non-Western peoples in science and invention” (Adas, p.297). During the 18th and 19th centuries, numerous “scientific” and anthropological studies aimed at understanding and classifying race were conducted. In 1758, Carl Linnaeus published *Systema naturae* which proposed a polygenist four-race system. In his publication, Linnaeus proposed a hierarchical classification of race which reflected the superiority of Western Europeans, due to their evolution from a primitive agrarian society to an industrial civilized society. Although some authors suggest that Linnaeus’ classification was largely based upon geographical distribution (Quintyn, 2010), his work was often used to “scientifically” demonstrate the supremacy of Western Europeans as the pinnacle of evolutionary development.
Blumenbach (1865) continued the work of Linnaeus by producing a taxonomy that divided all humans into five groupings: the Caucasian (light skinned Europeans), Magnolian (Eastern Asians), Ethiopian (dark skinned), American (First Nations) and Malay (Polynesians and Melanesians). Blumenbach’s work was based on craniometry, a pseudoscientific examination of human skulls. By measuring the size and shape of sixty human skulls, Blumenbach suggested the degenerative hypothesis of race: He wrote that Caucasians were the original race and the other races (Mongolian, Ethiopian, American, and Malay) had degraded from the White ideal due to diet, geographical location and the environment. Blumenbach’s theory reflected Jean Baptiste de Lamarck’s doctrine that physiological changes were a result of environmental pressure that was inherited from generation to generation. Blumenbach’s work drew heavily on Buffon’s ethnocentric notion that the pale skin of Europeans represented the real and natural color of the human race. Gould (2006) claims that Blumenbach’s addition of the Malay to Linnaeus’ original four race system was significant as it radically changed the geometry of human order from a geographically base model, without explicit ranking, to a hierarchy of worth based on a Caucasian ideal. Blumenbach’s stratification of races reflected the ideologies of the enlightenment period and Europeans’ belief in white Western superiority.

Studies involving the “scientific” supremacy of the white race were not isolated to Europe, but were also practiced in North America during the 19th century. Following Linnaeus and Blumenbach’s work, Samuel George Morton collected skulls and attempted to produce a scientific classification based on their interior cranial volumes. His book *Crania Americana* (1839) was based on a scientific study of the cranial capacity of Caucasian, First Nations, and black people. He concluded that the cranial capacity of
Caucasians was the greatest, which he stated reflected a superior intelligence. The blacks’ were the smallest, which resulted in diminished cognitive capacity, thus justifying their subservience as slaves.

The classification of people based on physiological characteristic continued into the 20th century. The work of Vacher de Lapouge (1854-1936) established the cephalic index, an index which was used to divide the European population into different races based on the shape of their heads. Lapouge claimed that the size of the head not only reflected intelligence but was also tied to a range of other socially desirable characteristics. Lapouge’s unwavering commitment to science and direct observation, he repeatedly claimed that that science spoke for itself, is unique. Lapouge firmly believed that his science reported "the facts" about human inequities, and any objection to these “facts" on sentimental grounds was foolish.

At the turn of the 20th century the “science” of phrenology began to be discredited, but it was replaced by another iteration of scientific racial classification and subsequent social stratification. Binet’s test for intelligence in 1904 was originally developed as a tool to identify areas of need in children. Binet proposed that intelligence was not based solely on genetics and could be largely influenced by the environment (Siegler, 1992). The original Binet test underwent standardization with a large American sample of children and was modified as the Stanford-Binet test. Contrary to Binet’s original aims, the Stanford-Binet test was subsequently used to classify children in static categories of intelligence.

The use of science to demonstrate racial supremacy reemerged with the publication of the *Bell Curve* by Herrnstein and Murray in 1994. Using Binet’s test for
intelligence, Herrnstein and Murray argued that some people are measurable smarter than others and that this intelligence could be quantified through IQ tests. Herrnstein and Murray embraced the discourses of biological determinism of the 18th and 19th century by suggesting that intelligence (defined by IQ) was biologically determined and that particular races (namely blacks) have lower IQs and cognitive ability.

The classification and stratification of race based on physiological characteristics (Linnaeus, Blumenbach, Morton and Lapouge) is generally believed to archaic, unfounded and used to “scientifically” justify a belief in an innate biological superiority of the white race. Although more subtle, the discourse of racially determined IQ is remarkably similar to that of the phrenologists. Intelligence testing measures, categorizes and consistently elevates those who constructed the knowledge over those who did not. As Gould explains, “The crudities of the cranial index have given way of the complexity of intelligence testing” (2006, p.173).

History is fraught with the subjugation of people based on physiology, intelligence and skin colour. However, it is the use of science to justify this supremacy that is significant to this study. The work of Linnaeus, Blumenbach, and more recently Herrnstein and Murray depend on race-based biological determinism. The resulting “natural” social stratification is legitimized by the fact it presents itself as unassailable scientific knowledge. Once a study receives the stamp of science, its methods and data are rarely questioned by the general public and the knowledge is validated regardless of its efficacy. As Wieseltier (1995) explains, one can hide the hardness of politics behind the hardness of science. The use of science and quantifiable data can obscure society’s ability to critically examine findings and gives an illusory transcendence from bias.
Problematic bio-determinism does not deny hereditary aspects of what is culturally interpreted as race, nor does it deny the construct of race as a real cultural entity. “Race may not be "real" in a biological sense, but it surely is "real" socially, politically, economically, and psychologically” (Mukhopadhyayp & Henze, 2003, p. 674). However, the use of science to “prove” the validity of these constructions and avoid conversations about the marginalization (and elevation) of people based on race is noteworthy to this research. As Cartmill explains:

Throughout Western history, the wealthy and powerful have found it comfortable and expedient to overestimate the importance of heredity in explaining the differences between people, in order to try to reassure themselves and persuade others that the prevailing social inequalities are just and natural….Such practices and assumptions have never been more broadly applied, more widely accepted, more strongly upheld by mistaken scientific expertise, and more productive of misery, injustice, and evil than in the case of the concept of biological race. (Cartmill, 1998, p.656)

**Power, Knowledge and the Securing of Western Supremacy**

Western science and technology were used to define and stratify the world’s races during colonial times. This hierarchical stratification, with the aid of “scientific” backing, constructed white Western Europeans as the pinnacle of racial supremacy. Notions of epistemological, racial and religious supremacy combined to create a more generalized belief in Western European superiority. This elevated cultural status was used to justify acts of colonization and establish a social system in which white Western men could continue to occupy a privileged position in the ‘new’ world. As Stoler (1995) explains, a fundamental link exists between relations of force and relations of truth.

The production of scientific knowledge and the formation of race did not escape the power/knowledge constellation (Foucault, 1980). The production of Western scientific knowledge was the production of power. Foucault explains that not only is
discourse always indicated in power, discourse is one of the systems through which power circulates. “Power produces knowledge and power and knowledge directly imply one another” (Foucault, 1977, p.27). The creation of the identity and knowledge of the West was dependent on the creation of the colonized and racialized, (un)knowing other. Omi and Winnant (2005) explain that racial formation refers to the process by which social, economic and political forces determine a central axis of one’s identity. As such, it was within the historical, social, economic and political forces of modernity, enlightenment and colonialism that the central axis of the Western subject’s identity was formed.

The discourses of modernity created the dominant position of the science knower but this subjectivity was “already gendered, raced, and sexed (Weems, 2014, p.228) and exclusively based on Western ways of knowing. Science promoted the white Western man as a powerful and progressive agent of knowledge, masking the constructed domination as natural. Furthermore, science and technology became evidence for and a marker of the self-proclaimed superior rationality of white Western European males. As the acts of colonization demonstrate, the constructed supremacy of modernity is not isolated to ways of knowing but takes effect on the bodies of those holding these beliefs. The “other” is not simply an epistemic characteristic but the constitution of the outside “other” on which the identity of the dominant subject depends.

The organization of the world into the West and the rest resulted in the production of a Western ontology ridden with marginalizing dichotomies. The relationship between the West and the other was always a relationship of power, of domination, and of varying degrees of hegemony (Said, 2008). The concept of Western
became white, urban, developed, rational, and the other became non-white, rural, underdeveloped and irrational. Said (2008) goes on to explain that in a consistent way, the very concept of the occident (West) depends on a positionality of superiority, which puts the Westerner in a whole series of possible relationships with the other without ever losing him the relative upper hand. The only way to create superiority was through the creation of inferiority and the dichotomizing drive for superiority remains. This privilging and marginalizing effect of colonial dichotomies is eloquently expressed by Alastair Pennycook.

If one of the central aspects of colonial discourse has been to construct the native Other as backward, dirty, primitive, depraved, childlike, feminine, and so forth, the other side of this discourse has been the construction of the colonizers, their language, culture and political structures as advanced, superior, modern, civilized, masculine, mature and so on….for every construction of colonized people as indolent, native, feminized children, for example, there was a parallel construction of the colonizer as the severe schoolmaster, the knowledgeable and adult disciplinarian….with every primitive savage there must be a civilized gentleman, for every despotic regime there must be a model of democratic government, every childlike, irrational, heathen native must have a mature, rational [counterpart]. To describe oneself as ‘enlightened’ meant that someone else had to be shown as ‘savage’ or ‘vicious’. To describe oneself as ‘modern’, or as ‘progressive’, meant that those who were not included in that definition had to be described as ‘primitive’ or ‘backward’. (2002, p. 6)

Western knowledge produced the privileged European colonizer and the disadvantaged colonized, by subjectifying the colonizers as the holders of truth through science, and the colonized as deficient in knowledge, ability, and even human identity. Notions of cultural superiority were justified by a belief in both the superiority of Western European knowledge systems (science) and, as seen by the work of Linnaeus, Blumenbach, Morton and Lapouge, in biologically-determined racial supremacy. As Hall (1992)
explains, the knowledge of the West, epitomized by science, became both the organizing factor in a system of global power relations and the organizing concept that still informs an entire way of thinking and speaking. The colonial knowledge/power constellation not only secured the prestige of the colonizers, but also prescribed an ontological and racial framework that remains a defining epistemological framework of “us” and “them” today. A framework that presents the science-subject as objective, rational and innocent in the domination that secured its privileged position.

**Our Gaze Turns towards the Discipline of Science and Curricular Change**

**The Subjectivity of the Scientist**

Formal Western science education began during the 16th and 17th centuries in England with the establishment of the natural philosophies. The study of natural philosophies ushered in an epistemology based on the authority of empirical evidence and imbued with the value of gaining power and domination over nature (Mendelsohn & Elkana, 1981). The practice of the natural philosophies was institutionalized through the acceptance of the British Natural Philosophies into the Royal Society and the formation of L’Academie des Sciences in Paris (Aikenhead, 1994). The formation of L’Academie and the acceptance of the Natural Philosophers into the Royal Society speaks to the establishment of a level of elitism and prestige towards the scientific endeavor and those that practiced its methods. The prestige of science was founded on the idea that science and technology were the means to usher in the Empire’s authority and dominion over nature through logical, objective thought. Science (natural philosophies) became a powerful political institution.
Early on, a tension arose between the natural philosophers and technologists. The natural philosophers embraced the ancient Greek ideology that pure science is superior to technology and wanted to separate themselves from the applied sciences. The natural philosophers created the identity of the scientist to maintain the distinction between those who practiced pure science (scientists) and those who applied this knowledge (technologists). Aikenhead (1994) explains that they did this “by creating a public face of ‘pure science’ by isolating themselves from the ‘vulgarities of practical knowledge’, and by establishing a tight rein over who would have access to becoming a scientist and what standards would apply. Natural philosophies had evolved into a profession” (p.15). Mendelsohn (1976) suggests that purposefully and politically, the name “science” was chosen to replace natural philosophy. Natural philosophers sought to professionalise their work, so the British Academy for the Advancement of Science (BAAS) was established in 1831, and the term “scientist” was limited to only members of the BAAS (Aikenhead, 2006). The BAAS and its members (white, upper class, male academics) produced the new subjectivity of scientist and reserved it only for themselves. In this way the subjectivity of the scientist became raced, classed, and gendered.

Aikenhead (2006) explains that in addition to providing the BAAS members with a professional identity as scientists, the organization issued its members the authority to decide who would be included and excluded. University admission into the sciences was used to control and limit admission into the BAAS. “By ensconcing Western science within the cloisters of university academia where it could control access to the various disciplines, and by defining what those disciplines would entail, the professionalization
of natural philosophy into science was essentially complete in England by 1850” (Aikenhead, 2006, p.12).

In 1867, the BAAS published its Scientific Education in Schools report (Layton, 1981) and began promoting the teaching of what they referred to as pure science and the mental training to develop a scientific habit of the mind. The BAAS’ goal in promoting secondary science learning was twofold. They promoted the study of pure sciences to gain members into the BAAS as well as obtain funding for its members (Aikenhead, 2006). As Seddon (1991) explains, the BAAS’ newly achieved curriculum furthered the divide between science and technology while reinforcing social-class ideologies that favored the elite and white, upper class males.

**Politics and Curricular Change in the US and Canada**

A primary objective in founding the discipline of science by the BAAS was to separate pure science and applied science. The World Wars of the twentieth century produced the opposite effect: science and technology were brought back together. The colonial discourses which used science knowledge as a measure of worth re-emerged as countries began once again to use technological advancements to gauge superiority.

The World Wars and subsequent Cold War in the United States brought about an era of federal interest in science education. The federal US government prioritized science education and new institutions were established to advance national science education. After the Second World War, the US established the Physical Science Study Committee (PSSC), a committee that included many research scientists from MIT and Harvard who had worked on projects during WWII such as the atomic bomb and radar. Atkin and Black (2003) explain that the PSSC was given the task of rewriting the science
curricula to reflect the views of academic scientists rather than educators. The involvement of research scientists in producing science policy had a profound effect on curricular focus.

In Canada, federal involvement in science education after the World Wars was similar to the US, but differed in that it was highly influenced by British interests. After WWI, Canada’s renewed focus on science education for a scientifically literate and technologically advanced population was compounded by its membership in the British Commonwealth. After WWII there was a growing public concern in the British Commonwealth that there existed a technological lag compared to other industrialized countries in the world. Not only was scientific literacy and technological proficiency seen to be integral to Canada’s future but also that of Britain and the Commonwealth. Berg and MacKeracher explain that “until World War I, science in Canada served to explore and exploit the country’s natural resources and to develop an agrarian economy. In contrast, Germany was perceived to have an educational system that prepared chemists and skilled technicians for industry” (1985, p.79). Driven by national interests and pressure from the British government, in 1916 national science education policy shifted its focus to industry. Similar to the establishment of the PSSC in the US, Canada established a special Senate committee on science education policy in 1919. The committee was subsequently charged with overseeing and revamping science curricula in Canada.

The national push for science education in Canada was intensified by the adoption of mass education after WWII. Comparative and capitalistic discourses intersected as the Canadian government emphasized that more science schooling and
knowledge equalled progress: the nation’s “economy, security, global status, is believed to depend on successful science education” (Berg, 1985, p.56). Science education benefitted from improved facilities, more skilled teachers, and higher funding. The new national agenda for mass education coupled with a renewed focus on producing scientifically literate citizens resulted in an increase in training and the specialization of science teachers. Drawing on Foucault’s technologies of productivity, the science teacher was tasked with producing scientifically literate and technologically adept bodies who would approve of the vast expenditures North America would put towards space exploration and national defence.

The comparative discourses of science for development and national defence interests were strengthened by the Cold War and the launching of Sputnik. The launching of the first earth orbiting satellite in 1951 was seen by the United States as a failure of the US education system in general and a failure of science education in particular. Again, we see the re-emergence of comparative discourses as the public perceived this event as evidence that despite the efforts made by the PSSC since WWII, there still existed a technological lag between the US and Russia. Shortly after Sputnik was launched, the US federal government began funding science education and created the National Science Foundation. The funding for the NSF was allocated through the new National Defensive Act. The launching of Sputnik and resulting national funding brought about a renewed focus on science education as an element of national defense.

Although Canada did not play an overt role in the space race and curricular responses to the launching of Sputnik, the curricular changes in the US had a significant effect on science education in Canada. Connelly, Croker and Kass (1985) suggest that
although Canada only played a spectator role, many of the American science programs and curricula gained acceptance in Canada. Three notable examples of curricula were a new physics program developed by the Physics Science Study Committee (PSSC), the CHEMstudy Program, and the Biological Science Curriculum Study (BSCS). All three of these programs were subsequently adopted by Saskatchewan in the 1960s.

The upper level biology and chemistry courses in Saskatchewan still retain many influences from the BSCS and CHEMstudy curricula. Berg writes that “the new science methodologies (of the US) in the 1960s, entered Canada through the Canadian West” (1985, p.23). These curricula, BSCS and CHEMstudy in particular, influenced the biology and chemistry curricula taught today. “By 1969 more than half the grade 12 chemistry students [in Saskatchewan] were taking the CHEMstudy course” (Connelly, Crocker & Kass, 1985, p.331) Physics (PSSC) was authorized in 1963, but proved too topically extensive, so a committee was formed to modify it for Saskatchewan. This process took place in 1969 but in 1971 the PSSC course still outnumbered the modified version three to two. In 1961, all chemistry exams were administered by the Saskatchewan Department of Education, the sole teachers that were exempt from departmental exams were those accredited in using the CHEMstudy Curricula. To this day, a textbook of choice used in senior level biology classrooms is the *Biological Science An Ecological Approach 7ed.*—a BCS text published in Colorado Springs.

Senior science curricula in Saskatchewan still show the influences of the US post-Sputnik science programs.
Effect on the subjectivity and pedagogy of the science teacher

The narratives of science education for national prosperity and security have had, and continue to have profound effects on the subjectivity of the science teacher. The science-teacher-subject is constructed as a political agent tasked with producing a scientifically innovative and advanced population and to maintain economic prosperity for its citizens.

If the economic take-off of the West began with the techniques that made possible the accumulation of capital, it might perhaps be said that the methods for administering the accumulation of men made possible a political take-off in relation to the traditional, ritual, costly, violent forms of power, which soon fell into disuse and were superseded by a subtle, calculated technology of subjection. In fact, the two processes – the accumulation of men and the accumulation of capital – cannot be separated. (Foucault, 1977, p.220)

In the past, the discourses of science-for-development implied that science educators were vital to the war effort; in the present, science education is seen as crucial for the creation of “good society”. However, what is defined as “good” is now defined by a country’s national narratives and economic prosperity. The science-teacher-identity is produced by these discourses and imbued with pride, prestige, power and the sense of being vital for the advancement of what is constructed as “society”. However, as Foucault (1977) warns us, the accumulation of capital and the accumulation of the populace cannot be separated.

At a cursory glance, the subjectivity of the science teacher benefits from the powerful association with the discourses of enlightenment and capitalism: The science-teacher-subject provides access to truth, certainty and objectivity in the teaching of science in particular ways. The science teacher is simultaneously disciplined and
rewarded for maintaining the acceptance of this narrative that promises continued growth and prosperity. The disciplinary apparatus

is intended to make it [education] more economic and more effective, it does so not for power itself, nor for the immediate salvation of a threatened society: its aim is to strengthen the social forces – to increase production, to develop the economy [and] spread education. (Foucault, 1977, p.208)

Accompanying these subjectifying discourses is a rigid disciplinary apparatus. Foucault explains that power is productive at the level of desire and pleasure. As McWilliam describes, discipline and desire are not oppositional ideas; “we maximize our pedagogical pleasures by working within the discursive rules of proper teaching” (2014, p.146). Continuing to produce the discourses of modernity, certainty, truth and rationality is a result of a disciplinary power but this discipline is exerted by the science-teacher-subject’s desire to continue to function in this privileging “reality”.

Weems (2014) explains that the disciplinary apparatus both creates and maintains the privileged place of the “expert” in education. When the science teacher is pushed to embody the role of the “expert”, the science-teacher-subject is disciplined to perform a pedagogy that continues to bolster modern and capitalistic discourses. It is within this understanding that the stagnancy of science education can be better understood when alternative approaches and conceptualizations of what science is, do not translate pedagogically. Due to the performativity of the “expert”, science teachers maintain their privileged positions while simultaneously supporting the disciplinary apparatus on which their own identifications depend. The result, science education remains primarily about productivity and economic success rather than scientific literacy and social awareness.
Science, technology, society and the environment (STSE)

As political landscapes have changed over the years, the foci of science education and the subjectivity of the science teacher has co-evolved. What results is a dynamic reflection of socio-political priorities in science curricula and the subjectivity of the science teacher. Postmodern discourses emerging from the World Wars and the increase in social awareness of the 1970s, left an imprint on science curricula worldwide. Solomon (1994) writes that “all belief in the moral neutrality of science should have vaporized in the searing heat of the Hiroshima explosion” (p.10). Bacon and Plattes’ promises of science bringing about utopian societies of plenty needed to be reconsidered in the face of the atrocities of the World Wars.

One of the effects of these societal changes was the introduction of the STSE (science, technology, society and the environment) approach to science education. STSE is an approach that shifts the focus and broadens the goals of science education; however, it is a diverse and complex narrative. Ziman writes “the fundamental purposes of STS[E] education are genuinely and properly diverse and incoherent” (1994, p22). STSE is an umbrella term which “by its very nature…defies definition. There is not a single, widely accepted road” (Pedretti, 2005, p.116). Despite the complexity, Solomon and Aikenhead (1994) do describe two-features that unite the field: the need to bring contemporary relevance to the science classroom and a commitment to changing the status quo. Pedretti (2005) refers to STSE as a post-positivist approach to science education as it is far removed from the modernist notions of scientific knowledge as irrefutable. It serves to fill an identified lack in traditional science education to ameliorate “the fundamental weakness of ‘valid’ science” qualified not by “what it says
about the world, but what it leaves unsaid” (Ziman, 1994, p.22). The fundamental aim of STSE education is to equip students with the ability to understand and situate scientific and technological developments in their cultural, environmental, economic, political and social contexts. Science education that embraces STSE seeks to examine both the impact of science and technology on society, as well as the impact of culture, society and politics on science as an endeavor (Solomon, 1994). STSE aims not to solely explore one particular viewpoint or promote a valorization of particular values over others, but rather to show science itself as an enterprise connected with social values, thus becoming an examination of how societal values influence the scientific endeavor.

Official calls for a genre of science education that highlighted the interconnectedness of scientific knowledge with the social world is far from a new concept. Gallagher in his seminal article written in 1971 *A broader base for science teaching* called for the examination of the connections of science, technology, and society, stating that “understanding the interrelationships of science, technology and society may be as important as understanding the concepts and processes of science” (p.337). He goes on to explain that for the coming generations of learners, who will live in a world deeply affected by science, the knowledge of the interrelations with technology and society will be a prerequisite for functioning in the culture in which they will be living.

Gallagher’s (1971) call for socially connected curricula that recognizes science as a human endeavor integrally connected to society and culture has been made for nearly half a century. However, as Pedretti (2005) explains, “in spite of widespread rhetoric in support of STSE perspectives, surprisingly little translates into classroom practice, [this]
often leads to its marginalization in the curriculum” (p.117), while content-based pedagogies remain prevalent. What is enacted in the classroom is not often what is put forth in the official curricula when official documents intersect with the dominant discourses of science education. The actual curriculum, what occurs in the classroom, speaks volumes to the strengths of the disciplinary apparatuses in science education. A disciplinary apparatus that continue to circumvent humanistic approaches to science education while promoting content-driven pedagogies deeply intertwined with modernist discourses.

**Content standards, humanistic approaches and the stagnant flux paradox**

During the early 1980s the focus of science curriculum in North America shifted away from content standards to focus on scientific literacy and the connections between science, technology, society and the environment. In Canada, this shift took the form of the Science for Every Citizen program that was produced by the Science Council of Canada. Aikenhead (2006) explains that the SCC used inquiry to produce a national curriculum policy that embraced the humanistic approach to science education. Focusing on developing scientifically literate individuals who understood how science, technology and society influenced each other.

The push for a humanistic approach to science education in Canada and the US was short lived as economic priorities shifted and the science-for-development narrative began to dominate the discursive field. In Canada, an economic downturn resulted in the conservative elements of society demanding a more disciplined school environment, more accountability and a return to the basics (Connelly, Croker & Kass, 1985). In the US, *A Nation at Risk* was published in 1983. The report called for a renewed focus on
higher and more measurable standards, more rigorous objectives, and higher expectations of academic performance. A *Nation at Risk* was published for students as a response to the view that the erosion of the educational foundations of the US was threatening the US future and its people (National Commission on Excellence in Education, 1983). The economic downturn in Canada and the US sparked a resurgence of the colonial discourses of science and technology as a tool to measure superiority between countries.

The narratives behind the motivation for content-based curriculum change were remarkably similar to those after Sputnik in the US—the importance of science education for national defense and prosperity. “If an unfriendly foreign power had attempted to impose on America the mediocre education performance that exists today, we might well have viewed it as act of war” (National Commission on Excellence in Education, 1983, p.1). To insure higher standards, the US moved towards standardized exams. In Canada, the narrative was not as ominous as in the US, however, the result was similar: a renewed focus on preprofessional training and content standards. “The simple ideology of pre-professional training of scientists and engineers seems to be political advantageous over more complex ideologies that inspire humanistic approaches to school science” (Aikenhead, 2006, p.53). The pipeline ideology and a focus on the measurability of content standards triggered a return to the basics in both the US and Canada.

During the next two decades, policy changes calling for accountability and measurable standards continued. In 1996, the US National Academy of Science and the US National Academies produced the National Science Education Standards also known
as the NSES. Atkin and Black (2003) explain that “The power given to the NRC in 1996 marked teachers as the weak link in education, provided a highly prescribed curriculum, and high stakes examinations” (p.156). In 2001, the US educational policy continued to highlight accountability and a focus on the yearly progress of students and teachers with the publication of No Child Left Behind. Similar to the post-Sputnik era, curriculum development was taken out of the hands of the teachers.

Currently in Saskatchewan, a similar constricting of the curricula with a renewed focus on accountability, measurability and standardized examinations has occurred. This reality echoes a movement that began in Alberta over a decade ago. The result is a highly prescribed curricula based on testable objectives. The focus of science schooling shifts, objective results become valued whereas contextual, humanistic approaches based on a philosophy of STSE become secondary. Harding (2008) takes us further explaining that the separation of science from the human delinks nature from culture, resulting in a world of broken networks, leaving nature’s constituents with no voice. What results is a stagnant curriculum that is far removed from the lives of learners and tremendously difficult to change.

The continual re-emergence of the discourses of heavy content, measurable standards, and accountability in the field of science education remain a fundamental element of secondary school science. The persistence of traditional content-focused science education is much more complex than science teachers’ resistance to change, speaking as it does to the disciplinary aspects of these discourses. Curricula manifest political agendas and politics are found in official knowledge (Apple, 2000). As such, the science-teacher-subject’s performances are regulated and disciplined. As such, the
stagnancy found in the field of science education can be attributed to the disciplinary apparatuses present in the discourses of Western Science.

**Concluding Thoughts**

When science education is examined through a postructural lens, we see science as integrally connected to political influence: “When power relations change in society and in the community of education, then what counts as science education would or should shift” (Ostman, quoted in Fenshém, 1996, p.110). The inseparability of science and politics can be clearly seen in the 20th century as major curricular changes were directly influenced by changes in political agendas. Apple (2000) describes “it is naive to think of the school curriculum as neutral knowledge. Rather, what counts as legitimate knowledge is the result of complex power relations and struggles among identifiable class, race, gender, and religious groups. Thus, education and power are terms of an indissoluble couplet” (p.181). What is key in connection to this research is that the subjectivity of the science teacher is integrally produced and disciplined by these relations of power.

An historical analysis of the subject of science reveals numerous recurrent themes. One of the most powerful is the connection between science-technology and economic development and the subsequent pervasiveness of a neoliberal narrative in science education. Since colonialism, science has been seen as the means to achieve modern technological superiority and progress. Just as Bacon and Platæs claimed in the 16th and 17th century that science would usher in an utopian future for all of England, so too has science, technology and science education become an indissoluble cluster in what we see as our current “society”.
The second recurrent theme is accountability and the association of science education with the discourses of innovation and prosperity. National prosperity and economic growth naturally ebbs and flows. In times of economic uncertainty, the public questions the benefits of their investments in education. Within a capitalist paradigm, investment in education must directly result in prosperity. Educational goals are inherently difficult to measure, but politicians must provide evidence of learning to their constituents. As Russ Marchuk the former Ministry of Education in a conservative government of Saskatchewan expressed “You cannot improve what you don't measure, and we intend to measure” (Graney, 2013). What results is political policy that seeks to produce ‘hard’ educational data. The drive for hard data often results in the standardization of a constricted curriculum, standardized testing, and the de-professionalization of teachers, all of which lead to greater control of more docile bodies.

Since the science curriculum’s formal commencement in England, we see “that it is essentially a 19th century curriculum in its educational intent and organization” (Aikenhead, 2006, p.14). There have always been educators who promote school science as a subject that connects with everyday life, and yet traditional science teaching with traditional aims continues to discipline classroom practice. “The evolution of the science curriculum over our 60 years in the field has reflected a tension between advances in our understanding of how students learn and political initiatives that seek to serve policy ends but with scant attention to these advances” (Atkin & Black, 2003, p.172). During the 20th and 21st century, science education has oscillated between content standards/teacher student accountability and more humanistic approaches such as STSE that favor the processes of science. What is crucially important to note, however, is that
these tensions between discourses do not take place in a realm outside of the science teacher, but are performed and continually inscribed on their bodies.

**Our Gaze Shifts**

The science-teacher-subject is subjected by a complex array of discourses, many of which reflect political agendas and relations of power. Even though these discourses are described as being “in the past”, the historicizing of these discourses breaks down the linearity of time: Science-teacher-subjects are revealed as *presently* being subjectified and disciplined by colonial and capitalistic discourses.

The subjectification of the science teacher is a process riddled with relations of power. Poststructural thought allows us to turn questions of identity outwards revealing the relations of power involved in the formation of “self”. We move away from personal questions of self to political questions of self, examining the disciplinary forces involved in subjective construction. Likewise, our backwards gaze reveals the historicity of the subjectivity of the science teacher. Science education can be seen as an exertion of disciplinary power as it shapes the thoughts of students in particular ways. It is the process of “schooling bodies” (Kirk, 2014) in Western epistemology. It is corporeal regulation. We see that since enlightenment and the commencement of the discipline of science, science knowledge and subjectivities associated with the “truth” of Western knowledge system have co-evolved. The science-teacher-subject is a product of many historical discourses, discourses that are deeply rooted in colonialism and neoliberalism. The aim of genealogical analysis, however, is not solely to reveal the historical underpinnings of discourse but also to begin to ask why we currently *say* the science teacher is subjectified in particular ways, as found in the next chapters.
A genealogical gaze yields depth of understanding to the subjectification of the science teacher, however, to understand the current influence of these “past” discourses we must direct our gaze toward the field. In order to ask why we say the science teacher has been subjectified in particular ways, these “particular ways” themselves need to be identified and analyzed. The following three chapters take up these question in the form of a discursive analytic. These three chapters turn our constitutive gaze to the field of secondary science education with the aim of identifying and analyzing the discourses in secondary schools that constitute the science-teacher-subject.
CHAPTER FOUR: Methodology

Discourse Analysis

Discourse Analysis: An Ontological and Epistemological Perspective

If language rests upon the metaphorical translation of actual experiences into radically dissimilar media (images and words), then language can tell us nothing about the way things really are in themselves…our entire intellectual, verbal, rational scheme rests upon, metaphors…the truths of language, logic science, and philosophy are therefore simply analytical…they tell us nothing more than what we originally built into them. (Grimm, 1977, p.94)

Discourse analysis is not only a qualitative method, but also a methodological choice, one based on a poststructural onto-epistemic framework and the contextual contingency of knowledge. Discourse analysis aims to explore the relationship between what is uttered or written and what is accepted as reality, it aims to examine the construction of meaning. Tanner (1982) describes discourse analysis as the process of seeking out the mysterious moving force that creeps in between the words and between the lines, sparking the ideas, images and emotions that are not contained in the words one at a time, it is the force that makes words into discourse. Language is formative: it builds, shapes, constructs and creates meaning. In that language is performative, it can be said to accomplish things.

Within a poststructural framework, language is not transparent. As Lacan (1977) explains we are forever separated from ‘the real’ through our introduction into language. The analysis of language and discourse brings us not to reality, but to an awareness of the inner workings of knowledge and power, and how discourses and power have shaped what is considered as truth and reality. My study is not an attempt to move beyond language to find a truth or essence, nor is it to make claims about the validity, or partiality of utterances. It focuses on discourse itself. As Hall explains, “Nothing
meaningful exists outside of discourse” (Hall et al. 1997). My method follows Hall’s theorization in that it solely focuses on the discourses that subjectify the science teacher.

Wetherell, Taylor and Yates (2001) explain that when we analyze discourse there is no secondary level, discourse should not be treated as information about something but rather as demonstrative of the effects of language. Discourses constitute and construct particular subject positions, and they express a “truth” of being. Following this theorization, the central aim of the study is to reveal what is seen by the participants as the true and natural science-teacher-subject, to expose the taken-for-granted assumptions, commonsensical knowledge and normative pedagogies, and to situate the discourses socially and historically.

The focus on discourse itself is an exploration of what discourses accomplish. In the context of my study, discourse analysis is the examination of what discourses do to science teachers. Specifically, my examination focuses on the discourses that constitute acceptable subjectivities and permissible actions. It will look at how discourses determine what is conducted in an “appropriate way at appropriate times in the appropriate places” (Gee, 2005, p.26). Anderson (2003) explains that as discursive system becomes more integrated and dominant, power becomes less visible and tractable in research. Although challenging, the revelation of the constructs of hegemonic discourses is crucial to understanding the subjectification of the science teacher.

Avoiding a Prescriptive Methodology

In conducting a poststructural analysis of discourse, we encounter the difficulty of attempting to outline a research method which by its very nature cannot be prescriptive, and cannot have specific set of rules to follow. As Foucault states, “I take
care not to dictate how things should be” (1994, p.288). Torfing explains that “discourse theorists must remain methodological bricoleurs and refrain from developing an all-purpose technique for discourse analysis” (1999, p.292). Anderson suggests that one’s research should not be guided by prescribed method because,

A definition of methodological rules leads to an ontologization of the social phenomena, when the aim is precisely to de-ontologize…the world is not asking to be observed in any particular way, we must observe the world as poly-contextual, as dependent on the distinction shaped by observation…we must choose a way of seeing and accounting for its implications regarding the way the world appears and does not appear…data is contingent in relations to the chosen way of seeing. It is always possible to observe in a different way. (Anderson, 2003, p.153)

From a poststructural perspective, knowledge is contextual and can be interpreted in different ways, therefore a methodology evolving from a poststructural framework needs to avoid an essentialized research method. A prescriptive method disregards the social situatedness of the researcher and the research, and assumes a transcendental positivist philosophy. Laclau and Mouffe (2001) explain that a prescriptive or scientific approach that attempts to determine the essence of the social “would be in actual fact the height of utopianism” (p.143). There is no universal approach to research, no analysis that is more methodologically sound for reaching reality, because “different approaches will therefore conceive the same field of study differently, emphasising some aspects and ignoring others” (Jorgensen & Phillips, 2002, p.94). “Research can never free itself from values as it is always situated in a specific cultural and historical context” (Jorgensen & Phillips, 2002, p.180). It was my goal to analyse the data using a multiperspectival approach, an approach that I believe is best suited to both acknowledge the contextual situatedness of discourses and to meet the aims of my research.
Towards a Multiperspectival Approach

Avoiding a prescriptive or essentialized research method does not give one license to “do whatever one wants” or to adopt “anything goes” approach. One must include an explicit explanation and justification for using multiple analysis techniques. “Multiperspectivism requires that one weighs the approaches up against each other with respect to philosophical premises, theoretical claims, methodology and method, identifying what kind of contingent knowledge each approach can supply and modifying approaches in the light of these considerations” (Jorgensen & Phillips, 2002, p.155).

When conducting a discursive analytic Bloome et al. (2005) suggest that there is not a given set of traditions that define the boundaries of what counts as discourse analysis but that the prior experiences, endeavors, and arguments of researchers must be claimed, argued, and labored for in the present. For this study, I drew on Jorgessen and Phillips’ (2002) multiperspectivism. It asserts that different perspectives provide different forms of knowledge about a phenomenon. Combined, they complement each other to produce a broader understanding of the phenomenon of study. The complexity of the social world merits approaching questions from multiple perspectives. My aim was to build a framework that combines, integrates, and takes advantage of the strengths of multiple theorizations.

My multiperspectival approach takes on the form of an analytical bricolage, drawing from various conceptualizations and theorizations that I believe to be important to my study. Many of the authors that I drew upon do not offer concrete methods of discourse analysis, but their theorizations do provide a range of analytical focus points. Firstly, I will establish a working definition of discourse, and will explore Laclau and
Mouffe’s discourse theory (a central theorization for my analysis). In the following sections, I supplement discourse theory with several fundamental theorizations of Gee, Fairclough, Foucault and Butler and Derrida.

**Discourse Theory**

**Conceptualization of Discourse**

Beginning a discursive analytic it is important to clearly conceptualize what discourse is. The field of discourse analysis is inundated with differing techniques and multiple foci. In order to articulate the method of discourse analysis, one must first describe the theory of discourse from which one is drawing, and then outline its relevance to the study.

Discourse has been described in many ways in literature. For my research, I define discourse as the temporal and spatial context where utterances are infused with meaning. Discourse analysis examines the intersection between the utterance and the intended meaning in a particular context. Discourse communicates a meaning in a context; it determines meaning as it works in the space between the utterance and interpretation, “a discourse is a differential ensemble of signifying sequences in which meaning is constantly renegotiated” (Torfing, 1999, p.85). “Our cognition and speech-acts only become meaningful within certain pre-established discourses, which have different structuration that change over time” (Torfing, 1999, p.84). Discourse is a framework for meaning.

Discourse provides the framework that produces a communal understanding of meaning. When there is shared meaning among individuals in a specific social context, the illusion of a shared reality emerges. The dominance of particular discourses create a
structure that is often believed to represent the modernist notion of a transcendental reality, but as Lacan (1977) describes, we do not have access to the real. All we have access to is discourse, and discourse is only representational. Following Hall (1997) our “reality” requires discourses to achieve meaning and “our discursive attempts to distinguish between the discursive and the extra-discursive become impossible, for we inevitably resort to discursively constituted concepts to refer to the extra-discursive” (Smith, 1998, p.88). The ‘real’ is inaccessible because we are always bound to discourses to mediate our experience.

Just as discourses produce meaning, so too can we use the analysis of discourse as an entry point into the relations of power present in the fabrication of identity. My study does not attempt to understand a participant’s understanding, or interpretation of “reality” but focus on how this reality is constructed and the relations of powers that are involved. My aim is to analyse the “relational totality of signifying sequences that together constitute a more or less coherent framework for what can be said and done (Torfing, 1999, p.147), to reveal the discursive field that constructs the science-teacher-subject.

The Discursive Field

Laclau and Mouffe’s (2001) discourse theory is central to my research methodology as it highlights the dynamics of multiple discourses in social contexts. Dunn (1997) explains that the gaps and absences inherent in language leave the possibility of ongoing contested meanings, which result in chronic discursive instability. A discourse can never be so fully hegemonic that other discourses cannot enter the social field. Multiple discourses intersect, resulting in an incessant struggle for meaning for
both subjects (subjectivities) and objects. Consequently, meanings and subjectivities are never completely fixed, nor completely fluid and open (Laclau & Mouffe, 2001). Within this conceptualization, subjectivity is fluid, contextually contingent and under continual tension. Laclau and Mouffe refer to the temporal and spatial context of the discursive struggle as a field of discourse. The field of discourse can be thought of as the social context where dominant and secondary discourses intersect, compete and draw on each other for meaning. It is within these dynamic discursive power struggles that subjectification occurs.

Returning to the subject of lack, identity is always in flux as we do not possess a true center or essence. Dominant discourses invoke a mythical norm by creating both a centre and a margin by defining and universalising. As Derrida (1967) suggests, “there is no center but an absence of center for which infinite substitutions are made” (p.353). The field of discourse represents the dynamic space where meaning construction and subjectification occur, it represents what is drawn on and substituted for, in the absence of a center.

**Relevance to the Study**

Discourse theory is central to this study because it complements a poststructural view of identity as subjectivity. Within a field of discourse, subjects are inundated with competing meanings and contradictory subjectivities. However, subjects are not free to choose from multiple subjectivities as the field of discourse is not a level playing field, but one in which power relations determine which subjectivities are acceptable, meaningful, and intelligible. In science education, the dominance and hegemony of
particular discourses sediment particular subjectivities and condone permissible performances.

Examining the subjectivity of the science teacher using Laclau and Mouffe’s discourse theory requires an examination of how the field of discourse operates in schools. By applying discourse theory, I examine how the “science-teacher-identity” is established in the discursive field. As Cherryholmes says "we should try to discover how it is that subjects are gradually, progressively, really and materially constituted through a multiplicity of organisms, forces, energies, materials, desires” (1988, p.115). In essence, my analysis maps the conflicted field of discourse, to see how dominant and weaker discourses intersect, interact, and produce the science-teacher-subject. Said differently, it explores how the participants in the discursive field both contest and reproduce the dominant subjectivity of the science teacher.

Subjectification involves the subject’s attempt to arrest the flow of meaning by inscribing an illusory internal centeredness from discourses. Inscriptions of centeredness are produced when signifying chains that partially fix meaning expand to include the identity of the subject. These privileged referential points are referred to by Laclau and Mouffe (2001) as nodal points, they create a sustained identity by constructing a knot of definite meanings, unifying the given field (Torfing, 1999). Nodal points are objects or subjects in a discursive structure that have relatively uncontested meanings. These privileged signifieds are relationally drawn upon to fix other meanings and the discursive structure congeals. As Cherryholmes (1988) explains, a transcendental signified acquires its status because it is ideologically favored, and its establishment further exacerbates the system. My analysis examines the field of discourse for these privileged or
transcendental signifieds that have been substituted for the science teacher’s center, creating the illusion of a core or essence associated with this subject position.

Discursive constructs that are held as true and essential are in fact empty signifiers. However, these empty signifiers are capable of temporarily fixing a range of floating signifiers by articulating them within chains of equivalence and difference, the former establishing meaning through mutual differences and the latter establishing meaning through similarity. My analysis of discourse is not solely an analysis of the presence of discourses in schools but also an examination of how particular meanings are relationally established to arrest the flow of meaning. In the context of the subjectivity of the science teacher, the science-teacher-subject is constructed by drawing upon other established meanings found in the discursive field of school science. In the absence of essential subject, meaning is always relational, and these discursive relations occur through alignment with analogous constructs (chains of equivalence) or through contrast (chains of difference). Meaning and subjectivity are established through continual deferral of meaning along these chains.

Lastly, discourse theory is relevant to my study because it permits us to see relations of power within a field of discourse. The field of discourse is always contested, and an examination of competing discourses gives us insight into the relations of power that define hegemonic systems. If we examine the field though Foucault’s conceptualization of knowledge as power, we see that the conflict over meaning (knowledge) is a power conflict. “Popular discourse must be valued as weathervanes or signposts that allow the organic intellectual leaders to map out the configuration of
power relations and cultural struggles that obtain in a given formation” (Smith, 1998, p.74). The goal is not just to “see” the exertion of power, but also the effects of power.

**The Examination of the Dynamic Field of Discourse**

**Interdiscursivity and Discursive Assumptions**

A central component of my discourse analysis is the examination of interdiscursivity (Gee, 2005). The discourses found in a social context are not isolated or entirely self-forming but draw on other discursive formations to universalize meaning and identity. The referencing or deferral of meaning occurs along Laclau and Mouffian chains of equivalence and difference. The deferral of meaning is often used as a tool to give validity to assumptions.

People make referential assumptions when speaking. These referential assumptions are often used to secure the “truth” or “validity” of an utterance, and are often drawn upon to produce contextual truths. The process of referencing outside texts or making referential assumptions often frames what is spoken or written as being true and universal, which can serve as precursor to establishing hegemony. When what is uttered is meant to be accepted as truth, particulars become universals and hegemony comes into existence (Gramsci, 1971). The fixation of meaning and universalization of identities is best achieved in reference to hegemonic discourses. These hegemonic references are by nature interdiscursive and can bring about a transposition of hegemony into the field of discourse.

Fairclough (2003) explains that the ability and capacity to exercise social power, domination, and hegemony includes the capacity to shape the nature and content of common ground. My analysis of discourse with its questions of power and hegemony
focused on these naturalized and universalized meanings and identities. “Seeking hegemony is a matter of seeking to universalize particular meanings in the service of achieving and maintaining dominance” (Fairclough, 2003, p.58). Drawing on Laclau and Mouffe, in a contested field of discourse, meanings and identities are never fully fixed, therefore “the hegemonic struggle between political forces can be seen as partly a contention over the claims of their particular visions and representations of the world to having a universal status” (Butler, 2000, cited in Fairclough, 2003, p. 45). Hegemony depends on achieving consent, and textual assumptions and interdiscursive references can be tools used to assure particular discourses continue to dominate the field of discursivity. Analysing discourse considering assumptions and interdiscursivity is important, as questioning what is used to achieve consent is essential to problematize hegemonic regimes.

Supplementing Laclau and Mouffe’s discourse theory with Fairclough’s interdiscursivity, we see that drawing chains of equivalence and difference are integrally interdiscursive. The analyses of these signifying chains address how individual discursive formations always exist in relation to other discursive formations. In the context of the subjectivity of the science teacher, there exist numerous interdiscursive relationships between the subjectivity of the science teacher and other discursive constructs associated with science. My analysis was focused on the discourses in schools, and yet, it was also integral to examine the presence of these “outside” discourses in the field. My aim was not only to analyze the discourses, but also to examine the discursive field to see how these elements gain meaning relationally. Following Anderson (2003), my analysis emphasizes the ambiguity, and the incessant
floating of meaning, and the attempts to arrest this flow. In Laclau and Mouffian terms, I focused on the logics of equivalence and difference that are used to establish the meaning of an utterance. Supplemented by Derrida (1967), I asked how the meaning of an utterance is both deferred and differed, and what the power relations involved are.

**Deconstruction**

Deconstruction is an important component of a poststructural analysis of hegemony. Where there is hegemony, there is universalization of meaning, and deconstruction works at destabilizing these universalizations (Derrida, 1976).

“Deconstruction in a certain sense implies a theory of hegemony and the theory of hegemony implies deconstruction” (Torfing, 1999, p.103). Hegemony provides an illusion of universality, but can only exist within a competing field of discourse. Ambiguities and undecidables in language always exist; therefore, one can never determine the essence of something. Dunn (1997) suggests that a deconstructionist needs to trace the ways in which the boundaries between seemingly discrete categories become blurred, underscoring the aporia or contradictions inherent in the discursive construction of meaning. In the context of the study, deconstructive analysis destabilizes and reveals the contradictions present in the subjectification of the science teacher. Deconstruction shows the conflicting meanings in text, each reading is an attempt to simply examine the play of meaning, and how the field of discourse is a fragmented reality. Hegemony produces the illusion of fixed meanings, and deconstruction questions and problematizes these constructions.

My research assumes that discourses construct and structure our reality. Deconstructive analysis is not about stepping outside of discourse, nor revealing an
underlying truth. Deconstruction does not refute or deny the dominant structuration of discourse, because deconstructive analyses cannot “take accurate aim, except by inhabiting those structures” (Derrida, 1976, p. 24). In my research, my analysis of discourse examined the meaning and identities (subjectivities) created by the discourses in schools. The analysis of discourse includes, in an overarching manner, the deconstruction of these constructions. Dunn (1997) explains that the idea that both society and culture are constructed by discourses, and therefore can also be deconstructed, is at the core of poststructuralist thought. Analyzing the social reality created by the field of discourse must involve the de-structuring of the “reality” present in the field.

Deconstruction is an important component of the study as it focuses on the field of discourse and the differing and deferring that occurs within the field. Deconstruction can enhance an understanding of subjectification as “it can be used to explore and celebrate difference, accentuate difference, resolve or overcome difference, bracketing of difference, or reaching a consensus which suppresses difference” (Fairclough, 1995, p.55). Melding discourse theory with Derridian deconstruction, the examination of the field of discourse is a deconstruction; I deconstructed the chains of equivalence and difference to show how teachers’ identities are not essential but constructed by différence. Derrida (1967) argued, that signs operate by means of a continual deferral to other signs which leads to a perpetual absence in language and therefore a recurring tendency for language to undermine itself through its own gaps. My deconstruction traced the deferral of meaning of the science-teacher-subject through logics of
equivalence and difference, framing how established meanings are in fact a product of play between signs.

**Method**

**Context of the Study**

Contextual awareness is foundational to qualitative research. Acknowledging context is of particular importance when involved in a poststructural analysis because discourses and knowledge are contextually contingent. As Patton (2002) suggests, taking something out of context is to distort it, to change its meaning by omitting consideration of how a gesture, a conversation, or even a word occurs in a context that locates it in its time, space, and circumstance. Different discourses are spoken and enacted differently depending on the social and cultural context; therefore, the data gathered in my study do not lie outside of the context in which they were gathered. In qualitative research examining the context of the study involves an awareness of the personal, social, political, and cultural fields all of which are produced and maintained by discourses. On a secondary level, articulating the context of the research aids in the reflection process itself, as acknowledging context enables the researcher to become more sensitive and insightful towards the participants and the data. While describing context, it is important to note that context itself is fluid, dynamic and continually evolving and contextual descriptions are not comprehensive, generalizable or transferable.

**The Setting and the Participants**

The setting for the study took place in a suburban school division. The school division has four comprehensive high schools with populations ranging from approximately 600-1000 students. All four high schools offer a range of programming
including advanced placement courses, practical and applied arts, fine arts, and modified programming. Two of the four high school also offer French immersion programming. The teaching staffs of the four high schools range from 41 to 58 full time teachers plus support staff. Although there exists a variance between the socio-economic and racial composition of the schools, the participants all have experience working with diverse student populations as the four high schools draw from all areas of the city. The thirteen participants were recruited from all four high schools.

The recruitment process was facilitated by my employment with the same school division for the last 12 years. Although my intention was not to solely recruit colleagues that I had a previous professional relationship with, once the consent process was complete there existed some degree of collegial relationships between myself and all thirteen participants. Our professional relationship varied from teaching together for two to twelve years, collaborating on division led projects, or being members of the same professional learning community.

In the attempt to construct a rich representation of the field of discourses, I chose to work with thirteen participants for the study. During the planning phase of the study, I originally anticipated working with 8-10 participants. The number of participants were selected following Tranter’s (2010) theorization that the quality of a qualitative discursive analytic is “likely to increase by analyzing a smaller number of interviews thoroughly than larger number but with less attention to detail” (p.141). My initial vision of working with 8-10 participants was altered because at the planning stage I was uncertain as to the number and depth of discourses that would emerge during data gathering. In addition, it became clear to me from our initial conversations that these
thirteen participants were enthusiastic about the project, and I felt that they could all make valuable contributions to the research.

It is important to note that there exist many discourses which subjectify and discipline teachers outside of the classroom and the school; however, my fieldwork only focused on the spoken utterances in schools. Participants from a variety of subject areas and schools were chosen, not to find a representational sample, but rather because the science-teacher-subject is not solely constructed from discourses amongst science teachers. Furthermore, when examining discourse as a vessel for the circulation of power, perspectives that come from ‘outside’ science teachers’ perspectives provide crucial insight into the privileging and marginalization of subjectivities.

The participants had a variety of teaching assignments and were at various stages in their careers. The participants in this study, presented by their pseudonyms that maintain only gender, included:

- John, who is in this 20th year of teaching with teachable majors of psychology, business and history. John also taught for 2 years at a First Nations School (middle years and high school) before moving to his current division where he has 4 years of experience at elementary level, and 14 years of experience in two high schools. Lately, his course load is currently heavily geared toward psychology classes.
- Stephen, who is in his third year of teaching. He is educated as a middle years specialist and has worked teaching a variety of areas in Grade 9 and 10 classes. He also has experience at the elementary level, teaching Grade 8.
- Cassandra is a senior level math teacher. She holds a bachelor’s degree in education with a double major in Math and French. She has worked as a French immersion teacher at the elementary and high school level at 6 schools over her 17 year career.
- Susan is a senior secondary English teacher. In addition to her bachelor’s degree in education, she also holds a master’s degree in education. She has worked exclusively at the secondary level, at two different high schools in the division.
- Samantha is in her 8th year of teaching. She is the EAL (English as an additional language) specialist at her current school. Samantha also has overseas experience teaching one year in China, and one in Korea. She holds a bachelor’s degree in
education with a major in cross cultural studies and a minor in English, as well as a bachelor’s of Arts degree majoring in indigenous studies and minoring in psychology.

- Michael is currently in his first year of teaching, he holds bachelor’s degrees in mathematics and education, majoring in mathematics and chemistry. Currently, Michael teaches Grade 9 and 10 science, Grade 11 environmental science and Grade 11 physical science.
- Ben is currently in his 19th year of teaching. He holds a biology major and junior science minor. His teaching load includes: senior biology, Grade 11 health science and Grade 10 science. He has taught at two schools in the division.
- Maureen has taught for 23 years and is in her second year in a position of added responsibility. She holds a bachelor’s and master’s degree in education, with a mathematics major and a chemistry minor. She has taught at two different division and three high schools in her career.
- Eric is in his 24th year of teaching. He has a mathematics major and a double minor in physics and social studies. He currently teaches calculus, senior level physics, and grade 11 physical science. He has worked at two schools at his current division.
- Geneva is currently in her 7th year of teaching. She holds two bachelor’s degrees, one in French and one in education. She currently teaches French immersion with a French major and a minor in religious studies. Geneva also has six years of experience working as a learning resource teacher.
- Michelle is currently in her 11th year of teaching. She is the senior level chemistry teacher at her current school. She holds a bachelor’s degree in education and a bachelor’s of science degree with a chemistry major. Her teaching assignment includes, Grade 12 chemistry, Grade 9 and 10 science and Grade 11 physical science.
- Jennifer is in her 11th years of teaching. She holds a bachelor’s degree in education and a bachelor’s of science degree in chemistry. She is currently at her third school placement teaching chemistry and physics.
- Joanne has more than 25 years of teaching experience and has taught at four different high schools during that time. She teaches regular and advanced placement English at the Grade 9 and 12 levels.

Consent Procedures

The study was approved by the Research Ethics Board at the University of Regina prior to data collection. Once approval was granted by the REB (See Appendix B for approval Letter), an application process was undertaken to achieve permission at the division level to work with their teachers (See Appendix C for approval letter). When the divisional application process was complete, I met with the senior administrators of the
division to explain the project. The application process was successful and consent was granted by the division, the schools, and site specific administrators.

Participant recruitment began with an initial email (See appendix D) being sent out to all the secondary teachers in the school division. The initial recruitment email briefly described the research, required involvement, and asked for initial expression of interest. Once initial expressions of interest were received, I made contact via email, phone, or in person to discuss the project further. At this point, the potential participants numbered twenty-eight, and they were provided with a consent form which further described the project. The consent form explained confidentially, the expected requirements, and format for the data collection process. The potential participants were asked to return the signed form if they still wished to participate.

Twenty-five of the twenty-eight teachers that initially expressed interest in participating returned the consent forms. Of the twenty-five teachers that expressed a willingness to participate, I chose thirteen participants for the research. The participants were chosen based on a desire to have a manageable amount of data while maintaining a degree of diversity with regards to areas of subject specialization and the number of schools involved. The motivation for subject area diversity was to increase the depth of discourse and did not evolve from a desire for representational data. Prior to entering into data collection, I met with each participant to discuss the study, reiterate the anonymity of the research and to convey that they were free to leave the study at any time if they should so chose. At this point, the participants provided informed consent and the data collection process began.
Data Collection

The research process began with the completion of three pilot interviews. Although the data from these interviews do not appear in the dissertation, the process allowed me to become familiar with my planned line of questioning and the semi-structured interview format. During the piloting process, interview questions were added, removed and amended with the goal of encouraging depth of conversation and reflection. The pilot interviews were also beneficial as they provided me with a higher level of confidence with the emergence of unstructured and unanticipated discussion that would likely arise during the data gathering process.

The data for the study was generated from two sets of conversation-based, semi-structured interviews. My focus was on depth and richness. As Travers (2010) explains, the key issue in a qualitative project is not the number of interviews, but what one does with the interview material collected. The initial interviews ran from 45 to 75 minutes. I conceptualized the interview as an opportunity to be taken into the world of the participants and to listen to the discourses being spoken. I generated specific questions by identifying broad topics that I thought would begin the conversation about science education but was open to pursuing other avenues as they arose during the interviews. I asked opening questions and then requested elaboration, attempting to experience depth with regard to the participants’ perspectives, and to capture the discourses in their responses.

My goal was to approach each interview as a conversation, knowing that subjectifying discourses would emerge. Travers (2010), explains that in-depth interview is more like an “open-ended conversation between the interviewee and the
interviewer…it seeks to answer social questions through the subjective meanings and understandings people bring to their interpretations of the social world” (p. 294).

Questions were not explicitly asked about the identity of the science teacher, rather I analyzed the participants’ descriptions of their experiences in and with science education to reveal these discourses. The data generated were co-constructed as the discourses that arose were the result of a bidirectional discussion. The goal of the interviews were simply to see the way science teachers and science teaching were discussed. The interviews were not an inquiry into a specific program but a gathering of discourses amongst secondary teachers about science and science education. The interviews were designed to explore the following areas:

- The first phase of the interviews involved the participants reflecting on their own experiences in science education as a student. This line of questioning then shifted toward the participants’ current experiences with science education and science educators in the workplace. The final genre of questions for the first phase involved a discussion about how the participants’ perspective of science education and science educators has changed or remained constant throughout their professional careers.

- The second phase of the interviews focused on the participants’ perspectives and conceptualizations of science teachers and science teaching. This line of questioning explored the participants’ descriptions of pedagogy, “typical” science lessons, and the characteristics and personalities of science teachers.
• The third phase of the interviews explored the relationship between school subjects in high school. Within this phase, the non-science teacher participants were asked to explore what they thought to be the similarities and difference between their subject areas and science classes; and, the science teacher participants were asked to differentiate between science and other subjects.

• The fourth phase of the interviews focused on the participants’ perspectives of the goals of science education and their understanding of the nature of science and science knowledge.

• The final phase was only explored with the science teacher participants. The science teachers were asked to discuss their own development as science teachers. This phase specifically focused on who they saw themselves to be and their growth throughout their careers.

I transcribed each interview in its entirety to allow for first-hand detailed analysis. The thirteen initial interviews produced just over 165 pages of single spaced transcribed data. The transcription process itself was of utmost importance as it permitted me to immerse myself in the data and the indicators of discourses found in the data. After the first set of interviews were completed and initial cursory analysis was conducted many rich discourses emerged. The secondary interviews were essential because during the transcription of the first interviews I identified the need to further explore emergent discourses, or explore particular discourses in greater depth. Due to the fluidity of the interview structure, there were continual additions and modifications of particular questions as the study evolved. The second interviews were crucial as they
allowed the study to explore these emergent questions with all of these participants. Once the second set of interviews were transcribed, a total of over two hundred pages of qualitative data were obtained. At this point, I estimated that the conversations were rich enough to allow connections to certain discourses.

A final layer of depth was added through a member checking process. Once the two sets of interviews were transcribed and an initial identification and analysis of discourses was complete, I returned the draft to the participants. Eleven of the thirteen participants returned the draft with no changes. One participant requested a follow-up conversation to clarify the transcription of a question response. Once the conversation was had, no changes were requested. The final participant asked for a change of two words in a response to insure anonymity. These changes were incorporated into the data.

**Data Analysis**

My analysis began by examining the data for repetitions and patterns. My approach was not solely a content or micro analysis of discourse; it also sought to get a deeper understanding for the data and reveal particular themes, categories and representations from the interviews and transcripts. The examination of the data for patterns amounted to a focus on the commonalities and “connections between consecutive utterances” (Wetherall, Taylor & Yates, 2001, p. 15) between participants. Edley (2001) writes of interpretative reservoirs or resources that are frequently drawn on to describe subjects. My analysis began with a search for these common ways or patterns that are “part and parcel of any community’s common sense… when people talk about things they do so in terms already provided to them by history” (p.198). Through continued readings of the transcribed data, these subjectifying patterns emerged and a
deeper understanding of the current discursive terrain and their historic influences came into focus.

The discourse analysis occurred at multiple levels. On an initial level, it examined language patterns associated with science, science teaching and science teachers and then proceeded to examine what these patterns accomplished in a larger societal and cultural context. It both sought to identify discourses in the field and to “show how these [discourses] constitute aspects of society and the people within it, [to demonstrate how] language available to people enables and constrains not only their expression of certain ideas but also what they do” (Taylor, 2001, p.9). The study focused on the local deployment of particular discourses and their broader social implications.

The discourses of science teaching interact with and traverse other discourses (such discourses of Western science, science education, pedagogy, curriculum and capitalism) and in doing so are influenced by them. As such, the subjectifying discourses identified in the study were not bounded to a single category of discourse, so analysis necessitated examining the grid of intelligibility that subjectifies the science-teacher-subject. This unbounded analysis is necessary because “discourses are also fluid and often opportunistic, at one and the same time, drawing upon existing discourses about an issue whilst utilizing, interacting with, and being mediated by, other dominant discourses” (Carabine, 2001, p.269). As Derrida conceptualizes with his “playing off of meaning”, the discourses that subjectify the science-teacher-subject traverse many areas, including curriculum, pedagogy and history.

Phases of Analysis
The research process was a dialectic process where recursive relationships existed between the theoretical framework, the research questions and analysis of data. Data analysis took place in two phases and is presented as three separate chapters.

*Phase one (Chapter five)*

To explore my first research question: What are the discourses that subjectify the high school science teacher? I was interested in identifying discourses that my participants used to construct the subjectivity of the science teacher. The first phase of data analysis involved the identification of discourses and was accomplished through multiple readings of the transcribed data. Discourses where highlighted and noted as they appeared in the transcribed text or spoken in the interviews. To organize the data, I chose to construct categories of description, each category representing my interpretation of one aspect of the subjectivity of the science teacher. I chose to construct these categories because I believe that they capture the way that the subject position is embodied, quite literally who the subject is seen to be. The categories of description did not encompass all the identified discourses, but served as primary referential points for further discursive subgroupings encountered in the data. After several readings of the transcripts, I felt that a saturation point had been reached, and I had ample data for phase two of analysis.

*Phase two (Chapter six)*

The second phase of data analysis returns to the historical data (chapter three), and data from the field (chapter five). Chapter six adds an additional layer of depth to as it inverts question of subjectivity away from ontological questions of self and towards epistemological understandings of the process of subjectification. Phase two employs a
Foucaultian genealogical method to explore why do we say the science teacher is subjectified in these particular ways? The chapter concludes by examining disciplinary apparatus and resulting pedagogical constraints in line with the research question: In what ways do disciplinary relations of power constrain the performativity of the science-teacher-subject?
CHAPTER FIVE:
The subjectivity of the Science Teacher - Our Constitutive Gaze Turns towards the Field

Introduction

Fairclough (1995) explains that any piece of discourse (texts or verbal) will have a major point or theme, or small set of them, and that no piece of work can or should ask all possible questions, cover all the data under analysis, or seek to deal with every linguistic detail. There is never a complete or definitive analysis of text. My analysis of discourse is of a particular type. Following Fairclough, the analysis is neither definitive nor comprehensive. Nor is it an encyclopedic account of all the discourses present. The study does not categorize discourses as strictly curricular, scientific or pedagogical but assumes that these discourses based on their prevalence in the data form a grid of intelligibility that subjectifies the science-teacher-subject. In an overarching way, the analysis aims to reveal a deeper understanding of the field of discursivity in the secondary sciences. My aim was not to exhaust the text, but rather to increase the understanding of the discursive system that subjectifies the science teacher.

Chapter five provides an examination and analysis of the discourses identified from the interview data. The data and analysis is presented in terms of four categories of description that have stood out prominently in the text regarding the science teacher subject: 1) The passionate science teacher, 2) the modern science teacher, 3) the postpositivist science teacher and 4) the science teacher as gatekeeper to opportunity. I draw attention to these categories of discourse as found throughout the interviews, and show the context in which the discourses are set. Then I take the discourses up again and explore them in greater depth in chapter six.
The Passionate Science Teacher

The science-teacher-subject is dominantly constructed by the discourses as having an innate passion for the sciences. Not only was a passion for the subject area expressed as an essential characteristic of “good” science teachers but it was also described as leading to effective pedagogy. Said differently, in order to be “good” at science teaching, one must be passionate about science. In my conversation with Samantha, she described teacher passion as a key characteristic.

They have to be good at their subject, when I say good I mean proficient. They understand the subject really well. Someone who’s cut out to teach science would be someone who is motivated and excited about the subject, you know, really passionate about it. Usually when you’re passionate about it, things just fall into place. Your explanation falls into place when you’re passionate about it. And your students also can totally tell if you enjoy the subject, which will motivate them, to keep going, there’s gotta be passion there, otherwise why would you do it?

This passage exemplifies the notion that a passion for the sciences is an essential component of the authentic science-teacher-subject. Samantha describes the passion of science teachers as a key characteristic that allows everything else “to fall into place”. Her statement indicates that if the science teacher is “motivated” and “excited”, they will be “cut out” to be an effective teacher. From Samantha’s perspective, the passion of the science teacher is a motivating factor for students to “keep going” in the sciences, as well as the primary reason people teach science. The latter point is evident in her question: “Why would you do it [teach science]” if you were not passionate about it?

As our conversation continued, Samantha positions her past science teacher Miss House as an example of the passionate science teacher. She describes Miss House’s passion, and then characterizes her passion as the reason Samantha found science to be fun.
I remember the teacher, Miss House. She was short, she had dark hair to about her chin, and just had this passion. She was fun and she made it [science] fun. Although Samantha’s description of Miss House is quite brief, the description provides an interesting corporality to the discourse of the passionate science teacher. Samantha describes numerous physical characteristics, referring to her hair and height, and then refers to her passion. Her statement constructs Miss House’s passion as a corporeal characteristic of the science-teacher-subject. What is notable here is that Samantha’s description of Miss House’s physical characteristics make no reference to race. She recalls her height, her hair colour, even her hair style but avoids any description that would allude to Samantha’s interpretation of her race. There is no need to mention her race because the lack of racial reference defaults to a white norm that can be taken for granted: Samantha does not feel the need to articulate the race or racial characteristic of Miss House as her whiteness exists as an unspoken assumption in our conversation. Implicated in this absent presence, one finds the emergence of a colour-blind (Bonilla-Silva, 2003) discourse in the science classroom.

Continuing my interview with Geneva, she was quick to identify passion as quality or trait of science teachers.

I would definitely use passionate. I have never met a science teacher that is not passionate about science. And I think that, that’s crucial to them sharing their knowledge with their students. Even as a student, I knew my [science] teachers loved doing it. That was evident.

Geneva positions the science teacher with the universal quality of passion for the subject area. The dominance of the passionate science teacher subjectivity is evident in the fact Geneva bases her statement on her experiences as a student and as a teacher: she states “I have never met a science teacher that is not passionate about science”. Geneva’s explanation also suggests passion is “crucial” to the sharing of knowledge, and is
therefore an essential characteristic of the science-teacher-subject. This discourse re-emerged during my conversation with Geneva as she contrasted science teachers with “other” teachers.

I think there is a fascination with science teachers, a fascination with a complexity and the content. I think they want their students to see how amazing these things are that they’re discussing and exploring, like the concepts of gravity, or the concept of the atom. I think that the science teacher can see the bigger picture and just the appreciation of the work that went into discovering that concept. I have an interest and a love for something, but I’m not sure that I’ve seen the same passion from a group of other subject teachers. Yes, there’s the odd ones here or there, but as a whole I would consider the science department to be the most passionate.

Geneva sees her lack of passion for the sciences as a reason she self-defines as a non-science teacher. Interestingly, Geneva feels that science teachers as “a whole” are “more passionate” than other teachers. Her statement constructs science teachers as a distinct group from other teachers, and positions the science teacher group in a privileged position, atop the hierarchy of knowledge. This distinction between the science-teacher-subject and the other is also apparent in Geneva’s comparison between her deficit in love and passion for her subject area to that of science teachers.

At a cursory glance, the construction of the science-teacher-subject as passionate indicates passion as a fundamental and essential trait. Reminiscent of the modernist discourses of biological determinism, passion for science is not constructed as something that is acquired, learned or developed, but as a trait that is depicted as not occurring naturally. These essentialized characteristics are perpetuated and further entrenched by the equally dominant discourses that suggest success in science is due to a natural affinity towards the sciences. The discourse of the passionate science teacher essentializes the identity of the science teacher: the authentic, passionate science teacher is natural, not made, and belongs to a particular type of person.
The Natural Affinity for Science

Non-science teacher participants

During analysis, it became clear that participants who were non-science teachers often attributed their struggles in science class to their own lack of ability. This discourse emerged during my conversation with Stephen.

I think that your average science teacher is, they’re of that mind. In chemistry and physics I was under the impression that I wasn’t [of that mind], I didn’t have what it took to be a success. Science was always something that I felt I didn’t get. Stephen self-identifies as being somebody who “didn’t have what it took”, rather than the successful who were “of that mind”. His statement implies that he was not of that mind and therefore did not have what it took to “be a success” in the sciences: “science was always something that I felt I didn’t get”. As my conversation with Stephen continued, he contrasted his own lack of interest in science with what he perceived to be my affinity towards science.

Obviously, you are interested in it, and I think your brain works in a certain way in order for you to understand. I feel like in order to get it [science], you need to have a really procedural mind and a little more than a teacher would need to have. Stephen’s statement that “obviously, you are interested in it [science]”, and that my brain “works in a certain way in order for me to understand” is telling. He sees the science teacher, myself, as requiring the essential characteristic of an interest (similar to the passionate science teacher discourse), and a way of thinking based on an innate, physiological aspect. He constructs the affinity for science as biologically determined and implies that science teachers are born with a type of brain different than that of non-science teachers. His perspective also constructs the science teacher by drawing a distinction between science teachers and non-science teacher, describing science teachers as having a more procedural mind than other teachers.
Geneva reinforces the natural affinity discourse as she describes her memory of her experience in Physics 20.

Physics was interesting. [I] just took the first level 20 class. Although I found science interesting in a general sense, it was never something that I felt I was very knowledgeable in or strong in. So I never pursued it further than the base minimum.

Geneva’s statement adds complexity to the natural affinity for science discourse as she self-identifies as having an interest in science but lacking in knowledge. On the surface her statement seems simplistic, however, there appears to be an ingrained assumption that somehow her science knowledge should have existed prior to her science learning. She felt that she did not have the knowledge to be successful in physics, even before she took the physics class. Her quotation indicates that not only is the affinity for science natural but that science knowledge itself should somehow exist as part of self, prior to learning.

When asked to explore her experience further, Geneva reinforced the dominant discourse of the natural affinity for science. She shared stories of her struggle in science class to reconcile her curiosity with a perceived naïveté and lack of innate knowledge which trivialized her curiosity and questioning.

I felt that I didn’t have the knowledge or the skill base to become a good scientist. It didn’t mean that I wasn’t curious, or that I’m not still curious. Lots of times my questions, the things I was curious about, would be what I consider to be more naïve. Like I felt that I should have already known what was a silly question to ask, or wouldn’t contribute to where we needed to go in the classroom. Sometimes I felt that my questions were more of an interruption than a contribution, people laughed or maybe it was the way I asked it, or my own uncertainty in my interpretation of the response I was getting, perhaps that it wasn’t a valuable question.

Although Geneva’s description reflects several discourses that will be examined later in this chapter, her experiences provide insight into the notion that scientific competency is
innate. Geneva justifies her negative experience with science by claiming that she lacked the knowledge to be a “good scientist”. Her curiosity and questions were considered “naïve” and an “interruption” because she did not have the science knowledge or the ability to “contribute”. Geneva describes success in the sciences as something that you had or did not have; it was not something that could be learned or developed. Her description continues to stratify those who can practice science and those that cannot. Said differently, it is not only an affinity for science that is true and natural for the authentic science-identity, but that somehow science knowledge (content) should be naturally endowed as well. Geneva’s description frames the science classroom as a place she does not belong. Whether it be because of gender, race, class or perceived intelligence, she does not see herself as a natural science-subject. The science teacher is an increasingly rarified subject in possession some of the most laudable personal qualities.

Science teacher participants

The science teacher participants also contributed to the dominant discourse of the natural affinity for science as an innate characteristic; however, their contribution to the discourse differed from the non-science teacher participants: The science teacher participants did not believe their group possessed the innate scientific ability that non-science teachers believed they had, nor did they believe non-science teachers lacked this innate scientific ability. The science teacher participants contributed to the natural affinity discourse by primarily using students as examples. As Michelle and my discussions moved towards graduation requirements for students in high school, her remarks were particularly telling.
Thirty level sciences are so hard, [particularly] if you have no intention of anything, anything post-secondary, or anything that requires science. Those are pretty hard for kids who aren’t science inclined. Chem[isty] 30 and Physics 30 are so math related and even Bio 30 is just a crap ton of stuff and there’s a lot of numbers. They’re very hard concepts if that’s not your area. I mean we’ve streamed math that way, why not stream science that way.

A similar view was expressed by Jennifer.

There are some students who are better at math and science, those kids getting that [single] senior science credit is tough and is a pretty big deal. So to make them [non-science students] take more [science] classes would be doing them a disservice. The kids who are drawn towards science are going to take as many or as few sciences as they feel that they need to. For those kids who just need to graduate, I think that one science is probably enough for them, and it’s probably hard enough for them to just get through that one.

In both the Michelle’s and Jennifer’s responses the ingrained ability to do science was expressed in terms of the ability to cope with the difficulty of the subject area. Jennifer and Michelle express their view that one senior science was “enough” for students who were not scientifically “inclined” but not enough for those who were “drawn towards science”. What is conspicuously absent in both their descriptions is any reference to other goals or indicators of success in the sciences. Students are constructed as scientifically inclined or not. The natural affinity discourse again emerged as Ben spoke about his daughter in high school.

I’m biased as a science teacher, I’ll be recommending my daughter loads up on her sciences. And for those [students] that are capable I’d do the same thing. I say, ‘you should, you’re capable of taking these and handling these classes’.

Ben recognizes his own bias as a science teacher and then comments that those students who are “capable” of “taking and handling” science courses should take them. His statement reinforces a boundary between those that can “handle the classes” and those who are not “capable”. His statement also indirectly suggests limiting access for those deemed incapable in that it implies only those who are capable (have a natural affinity)
will be encouraged to take all of their science classes. Ben’s statement exemplifies another dominant affinity discourse: The notion that a student’s capability is established prior to him or her taking secondary science, not something that is developed while taking the courses. I then asked Ben to expand on what he meant by being “capable”.

In general terms, having the intelligence, academic intelligence, school smarts to handle the content. For lack of a better word: are you a smart enough person and a hard enough worker to get it done? You don’t have to be a rocket scientist to do well in high school science, but at the very least you have to be quite bright or very conscientious to care about your mark. Be studious and get it done. But there are students who we teach, in my opinion anyways, who just really don’t quite have it, [the] cognitive ability to handle some of the senior level sciences. They might scrape by with a 50, or maybe not.

The characteristics of “capable” offered by Ben restate the natural affinity discourse. The description, however, provides a deeper insight into what was meant by “capable”. He qualifies capability as having “intelligence” not developing intelligence, being “smart enough”, “organized’, “bright”, “conscientious”, “studious”, “bright” and being a “hard enough worker”. The way that capability is described as being an innate personality trait frames it as a trait that either present or absent, not developing. This discussion also exemplifies the discourse of meritocracy: if you have talent and work hard, you will be successful. Those who are successful are deserving of their success. This concept reinforces the social hierarchy amongst subjects and prescribes who will be (or has already become) successful in science. These are the ones who will become (have already become) dominant as a product of their success, in a way, the students are stratified as knowers and un-knowers. There is also a hint of a hostile attitude towards the un-knowers as the knowers are described positively (smart, bright, studious and organized) which implies that un-knowers embody the opposite (unintelligent, dim, lazy and disorganized). The absence of this trait in the un-knowers is then reinforced: Ben
explains that there are students “who don’t quite have it”. He also mentions the passing grade of 50%, indicating that a student that does not “have it” is unlikely to even pass the course. Reminiscent of discourses of biological determinism, *the natural affinity* discourse is reinforced by the lack of any mention of the potential for growth and learning among those who are already considered undeserving.

It is clear from the data that a natural affinity for science was a discourse that demarcated the “good” or “normal” science-subject. When the participants described people who excelled in science as being “of that mind” (Ben), or having “[their] brain work[ing] in a certain way” (Stephen), and contrasted this affinity with “[those] who aren’t science inclined” (Michelle) and who “just really don’t get it” (Ben), a biologically determined and divisive discourse is operating that justifies the status quo.

Racial discourses have traditionally been tied to biological determinism, and as such, the absence of the concept of race in the data is crucial to note. Biological determinism allows those in power to attribute intelligence to wholly biological factors, while ignoring contributing social factors. Said differently, if success in the sciences is natural and biological, then the current social order is to be expected. Systems of privilege and marginalization can be disregarded.

*The natural affinity* discourse brings up an important critical question: If ability and affinity in science are natural (hence inherited), who are most likely to have it or not have it? The *other* is constructed as “*those* kids who just need [one science class] to graduate” (Ben), “*those*…kids who are aren’t science inclined” (Michelle), “and *those* students…who just really don’t have it” (Samantha) *emphasis added*. Although racial
discourses were not explicitly spoken in the data, the use of “those” is a semantic move (Bonilla-Silva, 2003) to avoid discussing race, class and gender.

The natural affinity discourse constructs success in science to be biologically determined and “naturally” part of the science-subject. According to Wetherell and Potter (1992) the “naturalness” of characteristics forms the crux of a racial discourse, and “there is an inevitability about race summed up in the notions of instincts and inheritance” (p.122). Miles (1989) takes us further and suggests that the categorization of social groups, making assumptions about natural divisions between people, and the assignment of traits and group differences are central to racist discourses. According to Mills’ theorization, if a discourse imbues one group a natural trait (i.e. an affinity for science), racial foundations always underlie such divisions. Although the study’s participants would likely argue that race has nothing to do with one’s affinity for science, the pedigree of the discourses that support natural and biological affinities is largely racist and is integrally connected to modernity and enlightenment. Since discourses of enlightenment and modernity figure so prominently in the data, a grid of intelligibility which includes race, class, intelligence and success must be considered. What is most natural is the coded language (Bonilla-Silva, 2003) that gestures toward the social discourses of race, class and intelligence without having to mention them.

The Modern Science Teacher

Science Knowledge as Objective Universal Truth

Discourses based in modernity and enlightenment—discourses characterized by the belief that the world is a wholly knowable system and is governed by a finite number of universal laws which humans can comprehend through rigorous analysis and rationality (Havel, 1992)—were prevalent in the data. These discourses were particularly
evident when questions of ontology and epistemology arose. The notion of the superiority of science permeates these discourses of modernity. Returning to chapter three (Cartmille, 1998; Pratt, 2004; Stoler, 2004), the binaries of modernity continue to exist in these discourses. Descriptions of science knowledge as objective, certain and fact-based are not neutral; they are set within a dichotomy of superiority and inferiority. The discourses, however, were not restricted to onto-epistemic perspectives but were also drawn to describe the science teacher and articulate what the students’ gained from their formal science education.

**Goals of science education**

During the interview process, I asked the participants what they saw to be the goals of science education. The responses were diverse and often encompassed generalized descriptions of the day-in-day-out teaching of science as well as what the participants believed the students should “take away” from their formal science education. However, a noteworthy discourse emerged that framed the goal of science education as providing students the right answers or universal knowledge. This discourse was particularity apparent during Geneva’s interview.

My general answer [to the question of “What are the goals of science education?”] would be to have a better understanding of the world around us. Somebody has studied them [phenomena] and there is an explanation why everything happens. I think science is definitely more than common knowledge, there are many things that you should just know, and the only way to know is through science.

The modern epistemological orientation of this discourse is evident throughout Geneva’s description: she claims that there is “an explanation why everything happens” and that “the only way to know is through science”. Western epistemic superiority, discussed in
chapter three, is clearly evident as Geneva states that “science is definitely more than common knowledge”.

A similar view on the goals of science education emerged as Jennifer discussed her own affinity towards science.

I think that’s what I like about it [science]. It was challenging and there was always a right answer. When I took my arts classes I always felt like they were always so wishy-washy…I’m very particular, anal retentive, type A. I like that there’s a right answer to things and that if you have a problem and you work hard enough at it you can solve it. I like that there’s an answer to be found at the end. It’s [science is] not philosophical, out there [or] ambiguous, ‘there’s no right answer’. I like that if you work hard, you can get somewhere, I tell kids that all the time. I’m like ‘isn’t it awesome when you get the right answer, and you do a challenging problem and you get the answer at the end’ and they sometimes look at me like I’m a little bit crazy I think it’s super rewarding.

Jennifer opens by stating that there is “always a right answer” in science, and closes by describing the attainment of the answer as “super rewarding” and “awesome”. Further analysis of the exchange with Jennifer reveals that the meaning of the “right answer” is created through the construction of a dichotomy between science and what she constructs as “wishy-washy” arts classes. The difference is reiterated when she refers to science as “not philosophical” nor “ambiguous”. Jennifer’s description contains an additionally strong modernist discourse: that if you work hard enough at a problem you can solve it and reality will be understood. Jennifer’s description frames certainty as desirable and superior to “ambiguous” knowledge. Her description demonstrates a social assumption of the superiority of Western science.

Samantha and I discussed what she saw to be the goal of science education. I asked her why she thought students should be taught science in high school.

Because it’s how things work, it’s how life works, it’s how everything works, it’s how everything works together. It [science] answers the why. We should [be] teaching it because [pause] it’s important. It’s hard for me to answer this because it’s like [laugh] because the question is ridiculous. Why? Because it’s necessary,
Why is it necessary? That’s what I’m having trouble answering. Just because, I don’t know, it’s crucial, it’s necessary, it’s crucial, it’s important.

Samantha’s struggle to identify why science is important is telling, particularly her statement that even asking “why” it is important “is ridiculous”. She opens by referring to the modernist discourses previously discussed and states that science knowledge reflects the way the world works and answers the “why” questions. The later part of her statement, however, is particularly illuminating: she explains that it is hard for her to answer the question of why we should teach science. She continually repeats the same discourse - that science is crucial and necessary – but without providing reasons.

Samantha merely relies on the dominant discourse that science is important because it provides the right answer for meaning. It is a belief system that is right, true and superior, and therefore questioning the epistemology of science is “ridiculous”.

*Modern epistemic discourses*

The discourse of science providing the “right answer” dominated the discussions about the goals of science education. These modern discourses, however, were not limited to ontological statements but were also evident when the participant discussed the nature of science knowledge. These discussions were not neutral; they consistently drew on other subject areas and epistemological orientations to demarcate a superiority based on the certainty, rationality and objectivity of science. The participants often described science knowledge and science learning as black and white, objective, and unchanging. These epistemic discourses contributed to the discourses of reality being found through science, but they were exclusively discussed in terms of the superiority science knowledge itself. Although brief, Stephen’s statement reflected this view.
I may be wrong but science is pretty black and white. It’s yes you do, or no you don’t, or this is correct or this is incorrect. But [science is] very factual which is what I like, versus English or history that are more subjective.

Stephen’s description of other subjects as being “more subjective” was a common effect of the discourse used by the participants to construct the black and white nature of science and elevate its status above other ways of knowing. Both Stephen’s and John’s descriptions contained this same comparison.

Stephen:

I think social sciences [pause] there’s structure, there’s rules, but I would say [social sciences] are more malleable and less rigid. Maybe I’m misinterpreting this, but the black and whiteness of science and how science is yes or no. In English it comes down to interpretation, and interpretation can be different and everything is subjective. I would say science is far less subjective.

John:

You know it’s just science, it’s factual. Coming back to psychology again, just because it’s my area. [In psychology] a lot of it is unknown and you’re dealing with different cases every single time. Whereas science is factual, its black or white, it’s a or b. I think a lot of times science people, in terms of gray areas, they’re uncomfortable with it. It brings a lot more morality and ethics perhaps in discussing a socials science. I think it’s maybe the factual base of the natural sciences.

Within these exchanges, John differentiates science from social science and psychology and Stephen creates a similar binary between science and English. Stephen describes science as “far less subjective” and John defines science as “factual”, “black or white”, and “a or b”. Stephen describes English class as coming down to “interpretation” and being “subjective”, whereas he constructs science as less subjective and not open to interpretation. Noteworthy, is that that binaries that John constructs are not neutral but reinforce the superiority of science. The descriptions of science as “factual”, “black or white”, and “a or b” are not neutral because they construct science on the privileged side of the dichotomy. John again reinforces this dichotomy while discussing morality and
ethics in the social science, stating that science teachers are “uncomfortable” in the “gray areas”.

My conversation with Stephen turned to reasons why traditional science pedagogy has remained resistant to change.

Maybe because [pause] formulas are formulas, and that doesn’t change right? Carbon dioxide is always carbon dioxide. That kind of stuff doesn’t change, so people may feel ‘why the need to change it [pedagogy]’. I can think of an example: If you walked up to a piece of art, an abstract piece of art and you’re standing next to it. I could see something else and pull out a completely different experience than you would. Or, if you read a book or listened to a piece of music, a varying opinion seems to be more encouraged or expected. Whereas in science, it seems that everybody is on board with certain ways of thinking. You might contribute, but I think it’s in support of that one line of thinking.

Stephen hypothesizes that the lack of pedagogical change is due to the epistemology of science itself; he draws connections between static science knowledge and static science education. Stephen illustrates his point by contrasting the way art and science value divergent thinking. He explains that differing interpretations are valued in art, but differing opinion is not encouraged or expected in science. He expresses that “everybody is on board with certain [scientific] ways of thinking”. Upon further reflection, not only does Stephen’s description support the discourse of unchanging science knowledge but it also unifies and positions the practitioners of science in a homogenous group. Implicit in Stephen’s description is the notion that convergent thinking is acceptable, normative and superior whereas the other (those who think differently) are dismissed as outsiders. Stephen’s statement that “everybody is on board with a certain way of thinking” speaks to the social contract between science teachers and a system of privilege. Those who are “on board” benefit from the established hegemonic structures, whereas those who are not “on board” and “think differently” cannot be part of the system. Privilege cannot exist
without the underprivileged (Wise, 2007), and therefore an epistemological violence against “others” is ingrained in this discourse.

The description of science as linear, black and white and unchanging was not limited to knowledge itself but was used to subjectify the science-teacher-subject. Both the science teacher and non-science teacher participants actively constructed the science teacher as one with essentialized personal qualities that reflect their epistemological views. Jennifer, a chemistry teacher, referred to herself and other science teachers as people that feel an affinity towards science because of a “type of personality” characterized by linearity and structure.

I like science because it’s so linear, because there’s a right answer and because it’s not wishy-washy. I think it’s the structure of it, it’s something that we’re comfortable with, that type of personality. In a lot of ways we [science teachers] are linear thinkers. Science is very logical, just in terms of ensuring that kids think in methodical ways.

The constitutive power of this discourse is evident in Jennifer’s description. Science is “linear”, there is “a right answer”, and it is not “wishy-washy”. Therefore, those with those types of personality gravitate (naturally move) towards science. She offers a description of science teachers’ personalities whilst defining them as desirable and superior. During my exchange with Jennifer she also uses the pronoun “we”, which is telling in that she assumes I share the same characteristics because I am recognized as a science-teacher-subject. Her description of methodical thinking is not limited to science teachers as it expands to science students: she states that science and logic ensures that kids think in “methodical ways”.

The discourse of logical and linear thinking was used to construct the ideal performativity of the science-teacher-subject. This discourse is seen in Ben’s description of one of his most influential teachers.
His teaching had lots of structure and order to the flow. And everything sort of builds, one upon the other and that happens in chemistry and math classes. When I think back, my other two favorite teachers were math teachers and they were also very sequential, everything flowed nicely. I don’t like chaos and randomness ‘where did this come from, where are we going, where did these questions come from’. I like things to flow in order.

Ben constructs the ideal science teacher as he recalls his most influential teacher whose pedagogy was characterized by structure and flow. His contrast between sequence and flow with chaos and randomness takes us further into the discourse. Ben creates a binary between epistemological clarity, achieved through scientific sequence, and chaos where this sequencing does not exist. Ben’s statement both constructs the science teacher in a particular way and frames an appropriate and idealized pedagogy. Through this contrast, certainty, linearity and clarity are constructed as desirable and superior traits.

Furthermore, the desirability of these traits is founded on the Western idea that certainty and linearity are superior to other ways of knowing. We can begin to see elements of the hegemony of Western science emerge in the universality and certainty it provides the participants. Descriptions of science as “black and white” (Stephen), “factual” (John) and not in the gray areas (Stephen) firmly ensconces and elevates a modernist conceptualization of science. Western science is constructed in the data as a solution to the crises of ‘unknowing’ and the ungraspable complexity of the world, and as such, it is highly valued by a social body craving certainty.

Modernist epistemologies that characterize science as the pursuit of certainty, “facts’ (John), and “the right answers” (Jennifer) rely heavily on colonial discourses for meaning. Epistemologies of modernity, which were strikingly dominant in the data, have been traditionally grounded in racial discourses. During the Enlightenment, white, Western European men emerged as the rational, objective, common-sensical and logical
subject. This directly contrasted with the colonized other who was constructed as primitive, savage, illogical, and ruled by superstition—not by facts (Adas, 1990).

Although incessantly constructed as transcending class, race, gender, politics and culture, the epistemic discourses of modernity and enlightenment depend on these contradictions for meaning. Although race was not explicitly mentioned in conjunction with these modernist epistemological discourses, they remain divisive. As seen in the data, white Western knowledge is largely assumed to be a ‘true’ and universal knowledge. This implies that, if whites hold true knowledge, other races must hold false knowledge. Indeed, one of the stated purposes of colonization was to “convince” people who are deemed non-white either to acculturate into the white way of knowing or be dismissed as non-knowers, abject, uncivilized, or as far as knowledge is concerned: “in the dark”.

Emotion, Morality, Opinions, and Philosophy not belonging in Science

The platonic conceptualization of the separation between mind, body and spirit was a prevalent discourse during enlightenment and modernity. These divisive discourses remain widespread in the data. Jennifer spoke of these separation discourses as she discussed what she saw to be the goal of science education.

I think that [science education] gives them [students] a logical way of looking at the world and looking at the things that are happening. Instead of looking at it from a feelings or a thoughts standpoint, but looking at it [the world] from a more [pause]. I don’t want to use the word scientific but a more logical perspective as well.

Jennifer creates a binary between science and feelings, associating science with logic and feelings with thoughts. The strength of the association of science with logic is clear in that Jennifer nearly uses the words as synonyms in the latter part of her description. Such separation discourses were also constructed during my interview with Michael when I
asked him about the inclusion of ethical and philosophical debates in the science classroom.

You’ve actually opened a can of worms here. When you’re talking about topics like contraception in science 9, it’s a bit odd to break into a philosophical discussion. I don’t think it [a philosophical discussion] belongs in a science class, that’s why we have ethics. In science class you’re more or less learning about observation, what people have observed and the education theories made from that. It [science] is completely unbiased of everything, because of unbiased observation and deduction. So I don’t think it [a philosophical discussion] belongs in the science class. At the end of the day I’m not a philosopher, I’m not particularity qualified to talk about things in philosophy. The only thing I can talk about is the science behind particular things that we observe. If you’re going to talk about stem cell research, should you talk about the ethics behind it? Well, you’ve just made the cross over to philosophy, you’re no longer talking about science. To make the distinction with your students is important.

Michael identifies contraception as a philosophically contentious topic and clearly suggests philosophical debates do not belong in science class: “I don’t think it [philosophical discussions] belongs in a science class”. He explains further that science is “completely unbiased” and should only be based on observation and related theories. This is reminiscent of Ornstein’s (1938) claim that scientists should not meddle with morality, divinity and politics. Michael relates the separation discourses as he describes himself as “not particularity qualified” for philosophical discussions. Michael’s response separates science from areas of study that are uncertain (namely ethics and philosophy), and relies on what he sees as science’s “unbiased observation and deduction” as the characteristics that are used to define this difference. The discourse of the separation of science from ethics is also clear in Michael’s use of the phrase “made the cross over to”, which highlights a disciplined boundary between philosophy and science.

Michael continued to speak the separation discourse when I asked him what he saw to be the role of the science teacher in drawing connections between science technology, society and the environment in the classroom.
It’s difficult because of the problems that will come up with it [STSE]. You won’t be able you say things definitively, which is what science aims to do. It’s to talk about things objectively. If you’re talking about abortion for instance, in science class you can talk about how it works, but with that [STSE] philosophy you could talk about how it impacted society, how it impacts technology. Those two things could be definitely discussed. But when it comes to talking about how science impacts society, you get into a fuzzy set, something where it really comes down to opinions, tricky, I don’t know. It’s tricky because it opens up the door for a lot of abuse in the classroom. Because if the opinion of the teacher is ‘out there’, it opens the door to these things, which does kinda undermines science. It’s a tricky question, I’m not really sure of my thoughts.

Michael describes science as aiming to provide definitive answers. He illustrates using abortion as an example, stating that he would be comfortable discussing the science involved in the classroom but touching on abortion’s impact on society would bring him to a “fuzzy set” area that “comes down to opinions” and possibly opens “the door for a lot of abuse”. Michael discursively constructs the science classroom as a place of definitive answers which further entrenches the separation discourse as he states that opinions “undermine science”. Michael’s description reiterates the purity of science, and its separation from society.

The data reveals the strong theme of science being an endeavor separate from the “humanitarian” (Joanne) and the “philosophical” (Michael), as well as not dealing with knowledge that is “on an emotional level” (Ben). These tropes buffer a view of pure science that transcends society, culture and politics. What is striking here is that the separation discourse is more about the elevation of objective and rational thinking than differentiating science from other disciplines. Harding (2008) cautions against such a view, as the separation of science from the human delinks nature from culture, resulting in a world of broken networks, leaving nature’s constituents with no voice. What results is that all other social, cultural and political values and interests become secondary
quantities that are devalued in society (Harding, 1998). The elitism of Western science is consistently on the surface of the *separation discourse*.

**Science as Difficult and Rigorous**

A scientific epistemology characterized by stasis, linearity, and separation from emotionality was accompanied by discourse of difficulty and rigour. As with many of the descriptive discourses in this study, comparative statements were used to construct meaning: Science class was often constructed as more difficult than other courses. Michael opens with the previously discussed discourse that procedures and logical thought will bring the science practitioner to truth. I asked Michael how his impression of science teaching has changed during his first year of teaching.

This going to sound really bad, [I’ve realized] that students are bad at chemistry; that chemistry is tougher than I thought it was. I’m a pretty procedural person, procedures are like ‘if you follow them they work’. So I didn’t realise how much you have to push them [students] to do stuff, or spoon feed them content. My view of chemistry and my respect for chemistry has actually increased a bit because it’s actually harder than I thought it was for most people. It’s more difficult, they [the students] are not used to being so procedural or technical.

Michael speaks of his new appreciation for chemistry based on the difficulty of the subject. Upon further analysis, Michael’s use of the phrase “spoon feed content” is telling. His utterance refers to the discourse of *curricula as content* and his use of the term “spoon feed” implies infancy, ignorance and the nourishment of this content. Michael’s statement constructs content as required and frames this same content as difficult to obtain and not accessible to all. Furthermore, the description of “spoon feeding content” speaks to the discipline of both the science teacher and science student.

The student is disciplined to passively receive knowledge while the science teacher is expected to deliver specific “nourishing” content.
The rigour and difficulty of science were often justified by the participants through comparison with other subject areas. Michael provided evidence of this discourse.

In English, [pause] there are marks that are going to get you stuff. You can write an essay in English, you could miss the point quite substantially in high school but if you can write sentences well, grammar is good, sentence structure is good, and you’re going to get a substantial amount of marks. Now that’s a way of cheating the system, so you can get a 70, you can like progress and still do ok, even though you’re missing so much. In chemistry, or actually in many science there’s no freebees. It’s like if you can’t follow procedures there are no partially marks. For example, naming, if you can’t name there’s not much you can do. So I think the students don’t realize there’s not as many partial marks as in social studies. You can’t like half ass it [in science] basically.

Michael refers to the availability of free marks and partial marks in English class and states that lackluster students can do “ok” and get by with 70 in that subject. He contributes to the discourse of the rigour of science by contrasting English with science, a subject where students cannot “half ass it” and where there are “no freebees”. Eric also constructs the rigour discourse as he described his experiences taking courses in the humanities and science.

They [science classes] are difficult, rigorous classes. I look at the courses that I took. I took science courses, and math course and the science and math courses were harder than the humanities courses. I’m not belittling people in the humanities, but I spent a lot of time in those science courses. Did I spend a lot of time in the humanities courses? Yes, but it wasn’t the same type.

Eric fluidly moves from describing courses in the humanities and sciences to describing those who teach and take these courses. The discourse simultaneously constructs the subject (the discipline) and subjectivities (identities) of science in a privileged way. He states “I’m not belittling people in the humanities, but…” science is more difficult, rigorous and requires more time. The hierarchical positioning of those who practice science is clear in this statement. Eric further stratifies the disciplines by distinguishing
their time requirements: He explains that science and math classes are more difficult than humanities and states that he “spent a lot of time in those science courses”. His distinction loses some weight as he admits that he did “spend a lot of time in the humanities courses” but it is then reinforced, as is the dominant discourses, by his statement that the time he spent was “not the same”.

During my conversation with Ben, he indicated that the rigours of science lead to a higher level of intelligence or specialization for science teachers.

I just think that [scientific] concepts require a much higher level of thought, to teach, to learn. I think generally, they’re way more rigorous courses. I think that anybody, quite literally, who’s somewhat athletic or has somewhat of a sports background can go and teach phys. ed. I did it. It was easy. I didn’t really have to prep too much. I mean you have to be organized and there’s challenges, but conceptually I didn’t really have to think long and hard about badminton or basketball, games or sports. It’s tough if you’re not a science teacher and you don’t have the content to walk into a chem. 30 class. You’re stuck in something really difficult, you’re teaching molarity or moles or stoichiometry or dimensional analysis, and if my wife was in one of those classes she would be like ‘what am I going to do’. Whereas some subjects, I just think the content is a lot easier. There are some teachers who do a really bang up job, but I’ve just seen too many [classes] in my career that lack rigour and seem to be a lot of filler and babysitting activities going on.

Similar to Eric, Ben uses another subject area to provide evidence of the discourse: He contrasts science teachers with physical education teachers by referring to the lack of thought and skills required to teach physical education. Ben also elevates the status of science by describing the hypothetical difficulties that his wife would encounter if she were to teach science. This is further evidence of the elevated status of the science-teacher-subject. The authentic science-teacher-subject represents the epitome of knowledge and understanding. Science is more difficult and its knowledge is more complex than other disciplines, and therefore those who are able to practice and teach science have achieved this status through their own abilities and hard work. They are
entitled to and rewarded with an elite social positioning. The notion of meritocracy that justifies the present social order remains.

**Curriculum as Content**

Many participants described the goal of science education as the accumulation of science knowledge, thereby defining science curricula as science content. This discourse, which is integrally connected to the discourse of science providing the “right answers” and being epistemologically static, often arose while participants described the difficulties they experienced incorporating alternative pedagogies in the classroom. Ben described the quantity of content in science curricula as the reason he is unable to draw connections between science, technology, and society and the environment in his science classes.

I hate to say it, but content becomes too much of an emphasis. I’m going to cover the digestive system, and maybe [I] won’t spend as much time talking about some of the technologies that could be used to diagnose problems that [the students] may have heard of. I think [teaching] is about finding that balance. If I tried spending more time there, maybe I’ll have a little less time to do some of the labs that I wanted to do, which I think are awesome and valuable.

Ben describes his labs as “awesome and valuable” but feels time limits his ability to pursue these activities further. On the surface, we see the discourse of time constraints, which is present in a number of assumptions. The first assumption is the prioritization and hierarchization of types of knowledge: Ben clearly believes that time limitations require he only “spends” a limited amount of time on labs and STSE connections. This exchange demonstrates an assumption that curriculum is content, and that the most important goal of science education is the accumulation of this science content knowledge. This concept of time as currency is important to note. The view that one must spend time on particular learning goals produces a hierarchy of importance which
constructs content as the most valuable. The same tension is seen as Ben and I discussed planning a new course.

I’m at a point now where I’m teaching a new course. When I look at that new course, I find that I am more content driven than I want to be. I hope to move away from that as I teach [the new course] more often, and start to build in some more activities and labs. I think the content is interesting, but I don’t want to be overly content driven. My very first few years of teaching, I think it was sort of that way as well. Then as time went on we start to build in more activities or labs, or assignments, and it became less of me teaching and more of me being sort of that facilitator.

Ben states that “I find that I am more content driven than I want to be”. His statement demonstrates the power of the discourse driving curriculum as content. As an experienced teacher he sees value in activities and labs but feels forced/disciplined to continue to perform in line with the curriculum as content discourse.

The discourse of curriculum as content was evident as Michelle described how she interacts with her students in order to facilitate learning.

What’s a way you can get them [the students] to understand and learn and enjoy, rather than just standing up there ‘oh this is what you need to know [if] you don’t know it, too bad, you fail’. I think that’s a university mentality. Whereas, I’m really moving more in high school to, learning for all, that kinda of thing. I do it more so in the lower grades. I do expect more out of a grade 12 chemistry class, but I do still do a lot of things for those kids to help them learn. It’s not the standing up ‘here it is, if you don’t get it too bad’.

Michelle alludes to the presence of the “university mentality” in high schools, a pedagogical approach that constructs science learning as something that students “know, or do not know”. She then self-constructs her own pedagogy based on a responsibility for her students’ learning: she references a pedagogic orientation of “learning for all”. Her statement contrasts her approach with the perceived university mentality that “[if] you don’t know it, too bad, you fail”. At the end of her statement, however, she states “I do expect more out of a grade 12 chemistry class”. This statement contradicts her earlier
sentiments that suggest high school science should be a space for “learning for all”. She therefore constructs a boundary between junior sciences and senior level sciences, the implication of which is that senior level sciences operate on a “university mentality” which junior level sciences leave space for “learning for all”. The hierarchy of those who are able to practice science is very clear. She constructs a particular group, those who only take junior science, as deficient. They lack ability and are therefore excluded from being knowers of science.

I followed up by asking Michelle why she felt that so many teachers relied heavily on notes and direct instruction.

I think it’s more efficient to give it that way, but I don’t think they learn better that way [by direct instruction]. I could just give them everything in a whole less time, but they’re not going to remember it.

Michelle describes giving notes as ‘more efficient” but concedes that “I don’t think they learn better that way”. Upon further analysis, we can see a subtle appearance of the discourse of curricula as content which emphasizes the requirement to cover content and ultimately frames science learning as synonymous with students’ accumulation of science content. The consequence of this discourse is that individual learning (learning for all) becomes of secondary importance to covering content. Michelle’s statement that efficiency is a positive characteristic of direct instruction is only possible when science education is seen as content accumulation.

The curriculum as content discourse treats content goals as paramount and constructs non-content learning as additional or enriching but secondary. Resultantly, teachers examine inquiry, critical thinking, STSE and science skills only if content is covered and time permits. In other words, the science-teacher-subject is constructed and disciplined by political, societal and social discourses to ‘teach’ the curriculum and
therefore, the construction of the curricula itself has significant effects on the subjectivity of the science teacher. When curricula are constructed as content, the science teacher’s primary expected performativity of this discourse is the delivery of this content.

The discourse of science curricula as content and the earlier-discussed discourse of static modernist discourses reflect modernist desires for certainty, clarity and objectivity. Science education therefore becomes about the delivery of truth (content) because it is in the sacredness of this canonical knowledge that the supremacy of Western ways of knowing exists.

**The Postpositivist Science Teacher**

**STSE: An Interconnected Approach**

Modernist discourses that subjectified the science teacher were not the only discourses in the field of secondary science education. Postpositivist discourses of science education that encouraged critical thinking, making scientifically informed decisions, and examined the connections between science and society were also present. During the interviews process, I asked the participants if they were familiar with the philosophy of science education that encompassed integrating STSE (science, technology, society and the environment) in the science classroom. Although the specific terminology of STSE was rarely spoken during the interviews, the aims of an STSE approach none-the-less contributed to the subjectivity of the science teacher. Joanne articulated the importance of making informed and responsible choices based on science knowledge.

You want students to be knowledgeable and informed citizens of the world but I also think there would be relational goals. You want them [students] to be responsible. Whether it’s in respect to an environmental decision that they make, whether they drive across the street to go get something, or walk or bike or
whether they have the air conditioning turned on. I hope that the goals of science educators would have students not just understand facts but to think about the implications of the choices that they make. To see how the choices that they make, will either lead to more choices in the future or diminished choices.

Joanne alludes to connections between science and the environment as she suggests that science knowledge can lead to environmentally conscious decisions. Joanne closes by articulating her view that the goals of science education need to move beyond “understand[ing] facts” (curriculum as content) toward understanding the “implications” of students’ “choices”. As our conversation continued, I asked Joanne about the inclusion of political topics in the science classroom.

Ironically, it has to be [included] if you want to have informed and responsible citizens who are going to engage in a meaningful way with their environment. Then yes, there needs to be.

Joanne’s utterance of the word “ironically’ is telling. She states that it is ironic that political topics should be included in the science classroom. Her description speaks to the divisive structuration of the discursive field wherein learning about power and politics in science is seen as atypical. Reminiscent of the separation discourse, it is only ironic because science and power are rarely constructed as being related. This statement also demonstrates the assumption that science and science knowledge (i.e. “truth”) are value free.

The value of contextualizing science education was commonly referenced during my conversations with the participants. However, these references were often followed by discussions of the appropriateness of STSE inclusion in only certain science classes. Eric spoke of the challenges he faced trying to incorporate these connections into his physics courses.

In our science courses we should we talk about the impact of technology on the environment especially. I try to talk about that all the time, even though it’s not
related to what I’m teaching. I talk about the impact of us cutting down trees, the impact of us heating the oceans, the impact of melting ice. However in physics, it doesn’t always fit. And I think we have to do it even more so now, then we’ve ever had to do it.

Upon analysis, it became apparent that although Eric identifies the need to teach about the connections between the environment, technology and science, he feels that this connection “doesn’t always fit” with physics or is “not related to what I’m teaching”.

Eric reiterates the importance of making these connections in science but assumes that these connections should be made outside of physics. He ultimately acknowledges the importance of STSE connections but subordinates them to standard physics instruction, which demonstrates the dominance of traditional and modernist views of science education.

A similar curriculum-based dichotomy was constructed as Michelle described her familiarity with STSE.

I vaguely remember it [STSE]. I don’t even remember what it stands for. Is the subjective side belong in the science classroom? I think if done properly, yes. A lot of times I just don’t know how, or I’m so busy covering the curriculum that I don’t have/make the time to make those connections. I like making those applications, I think it helps with kids’ [learning] but I’m not fantastic at it. I’m the first one to admit that. Especially the technology aspect of it.

Michelle aligns STSE with the subjective/objective binary, constructing STSE as subjective and science content as objective. She reiterates the discourse of curriculum as content. She claims “a lot of times I just don’t know how, or I’m so busy covering the curriculum”, implying that STSE connections are outside of the curriculum. Michelle’s response continues to create the discursive divide between science content learning and an STSE or humanistic approach to science education. The data reveals that the discursive field presents these two approaches as mutually exclusive: The science teacher participants see either content-based pedagogy or connection-based pedagogy
and the approaches cannot be melded. Content cannot be “covered” humanistically and
STSE cannot be explored simultaneously with content knowledge.

When I initially asked Ben about the STSE approach he, similar to Michelle,
recalled the acronym but was unfamiliar with its meaning.

I can’t remember what it stands for. I think it’s a great concept but not on the
front of my radar. Never has been for whatever reason, probably should be, but it
isn’t. But I think it’s a great opportunity, and I know there are areas in biology
where I’m already doing that but I haven’t really labelled it in my mind as STSE.
I think it’s [STSE] is a good opportunity to talk about things or an angle that’s
relevant. Anytime you’re going to make things more relevant to the kids, they’re
more engaged in the discussion because they say ‘oh that’s interesting and
relevant were talking about this or that’. I think that’s good. So I think it’s great,
but it’s not in the forefront of my mind at all when I think about lessons and
planning and so forth. I probably just think of the world relevance or interesting
more than I think for that particular acronym [STSE].

Ben identifies STSE as “a great concept" and a “great opportunity” that leads to “more
engaged” students. However, Ben defines STSE as science relevance, not an exploration
of connections between science, technology, society and the environment. Although Ben
illustrates the value of this approach, he again frames it as secondary: he states the
approach is “not on the front of my radar” and “not in the forefront of my mind at all”.

Ben’s association of STSE with topic relevance was common among science teacher
participants. The science teacher participants often described STSE as an application of
science knowledge through technology or the effects of canonical science knowledge on
the environment. However, the bidirectional intentions of the STSE approach were rarely
part of the discourse. Reminiscent of the separation of the scientists and the
technologists, the discourses of curriculum as content and STSE interact in a way that
ensconces “pure” content science in a privileged position.

The discourse of STSE is notable for its absence or the weak impression it has
made on participants. In the interviews, connections between science, technology and
society and the environment were rarely brought up unless participants were specifically asked about them. Furthermore, STSE was only recognized as an acronym by only one of the science teacher participants. The importance of a pedagogy that highlights STSE connections was present in the data but it was consistently constructed as outside or in addition to the curricula, not as part of the curricula itself.

**The Encouragement of Critical Thinking**

The need for pedagogy that promotes critical thinking and the questioning of science knowledge was a common postpositivist discourse that arose during my conversations with participants. During Ben’s interview, he often returned to the need to teach students critical thinking skills.

The point of science education is to give them a basic tool, one that they would need to have discussions about biology, about chemistry, about physics. Not the details, but just some of the concepts, but also to create critical thinkers that understand the concept of what is a scientific study. So content is a small part of it, but most people put that into short term memory and they’ll forget most of it anyways, that’s totally fine. But learning how to be a critical thinker and to challenge, but not ridiculously challenge, but be willing to accept the way things are, whether you’re right or wrong. I think those things are really important as a science teacher.

Ben opens by highlighting the importance of content knowledge: he defines it as a “basic tool”. He also states that these basic tools are to be “given”, which suggests adopting a pedagogy based on knowledge transmission and reinforces the *curriculum as content* discourse. In the latter half of Ben’s description, however, the importance of science knowledge diminishes as he explains that most people forget science content in high school and states that this is “totally fine”. His statement concerning the value of science knowledge therefore contradicts his opening description wherein he describes content as a “basic tool”. He then characterizes critical thinking and questioning skills as important, a notion that again emerged as Ben and I began to discuss scientific literacy.
They [students] need enough scientific literacy to see through the bullshit and ask questions and not just believe everything you see and read. It’s [scientific literacy is about] being able to function and not to be led around by your nose without really having a clue and believing everything you see and read.

Ben clearly constructs critical thinking as an essential component of scientific literacy.

His statement values the skills of “see[ing] through the bullshit, “ask[ing] questions” and “not believing everything you see and read”. A similar critical thinking discourse arose while Ben and I discussed the number of compulsory science courses that should be taken.

They could take Computer Science 20 and that’s it, that’s all they need. I just don’t think that gives them enough scientific literacy. They haven’t been exposed enough to the concept of being a critical thinker from a scientific point of view. The scientific literacy goes up, which is more informed citizens and I just don’t think they get enough in science 9 and 10. It’s a little bit and I’m not even talking about the students who are going off to post-secondary, those students would obviously need more if they were going into any health science field. The more [science] they have the better.

Upon further analysis, Ben constructs a difference in learning goals for junior and senior level sciences (Michelle and Eric made a similar distinction when discussing STSE and content goals). Ben suggests that those students who are going to postsecondary need “more”, although what “more” entails remains undefined. I asked Ben to clarify, specifically asking him if he believed that more science classes led to a greater level of scientific literacy and critical thinking.

You could take all of your sciences and really not have learned anything about critical thinking and questioning authority, or being a bit of a doubter and being willing to admit ‘oh yeah, I guess I was wrong’. If I was a curriculum writer, I’d probably look at that and try to get students to understand that in this day and age information is out there, you can’t believe it all blindly. It’s okay to say. ‘hmmm, that doesn’t really fly, I’m going to dig a little deeper’, and what’s the difference between Joe Blow who’s making a statement versus a guy or a group whose research is coming from a university. They’ve got good credentials, they don’t have an obvious conflict of interest.
Ben’s description of critical thinking and the questioning of knowledge and authority represent a postpositivist shift in the discourse. It offers a differing epistemological orientation to that of the modern discourse previously discussed. In lieu of scientific knowledge as unchanging truth, Ben highlights the importance of questioning knowledge, the origins of that knowledge and scientific claims to truth. Ben spoke earlier of STSE as simply representing the relevance of science knowledge but his view of the goal of critical thinking and scientific literacy introduces a postpositivist philosophy.

**Science Teacher as Gatekeeper to Opportunity**

The discourses of science education as opening doors and providing future opportunities for students dominated the conversation with the participants. These discourses emerged during my discussions with Ben and Eric.

Ben: I took my sciences to keep all the doors open. I had some relatives that were older than us, cousins that had gone through the system and were already in university. I remember lots of conversations with them. Because my parents didn’t really know either way, but they [cousins] were like ‘yeah take all your maths, take all your sciences keep your doors open’. I’ve always liked science right but it [taking science] was just to make sure to keep your doors open.

Eric: I think that expectation is out there, and I’ve heard it from parents in interviews that they want their child to take all the courses, all the major elective in math and science because they want to leave their doors open.

My conversation with Ben and Eric frames science education as the gateway/the doorway to future opportunities, future opportunities that are lost if science classes are not taken.

Stephen used the discourse of *opening doors* on four different occasions. First, as he expressed why he did not take all his sciences in high school. Second, as he reflected on why he never felt an affinity towards science. Third, when I asked about his
perspective on the number of sciences required to graduate, and lastly as he hypothesized on why students take all their sciences.

I guess I felt less supported in the challenges and the doors were never necessarily open for me.

I had a poor misconception of myself as a broader learner, so I think I shut lots of doors for myself as far as what I could do in science.

There’s a lot out there that needs to be understood and learned and only taking one science [class] closes a lot doors to that learning.

I don’t want to close any doors. So I’m going to make sure that I’ve got the credits that I need.

Susan made a similar reference when asked about science graduation requirements and her own experience in high school.

You know as educators we often say ‘don’t close any doors’. I had no intention of going into a science field per say, but I wanted to make sure that I had the courses to get into university, just to keep as many options open as possible. It’s not that I had a really fond interest in it, I loved biology, but I can’t say I was thrilled over chemistry and physics. It was just something you did because it gave you more opportunities.

Susan opens by directly referring to the discourse of opening doors claiming that “we [teachers] often say don’t close any doors”. She then states that she “had no intention of going into a science field” but still took the courses in order to have “more opportunities”. Susan’s statement reveals the dominance of the opening doors discourse that prescribes the necessity of taking science even in the face of her own disinterest in science.

The opening doors discourse constructs science teachers as the gatekeepers to upward mobility and future economic success. This discourse adds an additional dimension to the epistemological superiority of science: Not only is holding science knowledge and being acknowledged as an authentic science knower privileging but the
achievement of this positionality also contain a promise of a heightened social class. The 

*opening doors* discourse constructs the science class as the beginning of a pathway that

leads to future status and power, thereby reinforcing and naturalizing the elite

positioning of the science-teacher-subject.

*University preparation*

The *opening doors* discourse was integrally connected to the discourse of

science for university preparation. This connection emerged when I asked the

participants who spoke the *opening doors* discourse and what these hypothetical doors

opened up to. The participants indicated that science education was the door to further

education (university entrance) and future career opportunities. The participants again

differentiated between the goals of junior level science, which they viewed providing a

well-rounded education, and senior level science, which was constructed as preparation

for university. Jennifer discussed the discourse of senior level science as postsecondary

preparation in our conversation.

I don’t like to stereotype kids [pause], there are a lot of kids who are going to go

into trades or go to work right away after school who just need one science class

to graduate. So for kids who are not going further in education, hopefully they get

what they need out of that one science. For students who are going on in

postsecondary, they need to take more sciences, to not miss out in terms of

knowledge.

Jennifer opens by claiming that she does not like to stereotype kids but proceeds to

categorize students into two groups: Those students for whom one science class is

adequate, those “not going further in education”, and those who are planning on

attending postsecondary institutions. She explains that those pursuing “further

education” should take more sciences in order to not be “missing out in terms of

knowledge”.

Michelle continued to create a binary between those students who take senior level science classes and those who do not, as we discussed science education and university preparation.

I mean, as much as they say ‘high school is not to prepare you for post-secondary’. I think those 30 level course are. Students do need some sort of preparation for the post-secondary level. You got kids who need their chem. 30 to go on to welding at SIAST, you’ve got kids that just want to do whatever at university and they need some sort of preparation and lab skills, and that’s how I teach my 30 level course. You want to cover your bases, so I’m going to teach you to prepare you [for postsecondary]. And that’s how I present my 30 level courses, which is very different than how I would teach a grade 10.

Similar to Jennifer, Michelle creates a distinction between the goals of senior and junior level science: Senior level sciences are constructed as a door to postsecondary education, as Michelle states “I’m going to teach you to prepare you [for postsecondary]” and “how I present my 30 level courses which is very different than how I would teach a grade 10”. Upon further analysis, Michelle’s assumption that students take senior level sciences because of their goal of postsecondary studies or to “cover their bases” is telling. Michelle’s assumption places the value of these courses solely on the accumulation of prerequisite knowledge. The alternative goals of critical thinking, scientific literacy and STSE are not even considered. There are two noteworthy implications to this discourse: The first is that only students with postsecondary pursuits in mind should be taking senior level science courses. The second is that senior level science classes hold little value to those who are not focused on further education. The described positionalities are implicit in the continued stratification of those who will/can continue to pursue science and those who are unable to. The university preparation discourse does more than separate science-subjects and non-science-subjects; it also creates and maintains a boundary between social classes: Science subjects are educated and professional and
non-science subjects are uneducated and unprofessional. Through the power and knowledge of the science teacher, science education is the door to the privileged side of the dichotomy. Science teachers therefore hold the metaphorical keys to privilege.

Foucault would argue that the opportunity discourse is about more than a goal of science education - it is really about how power operates through this discourse. Strikingly, here we see evidence of the continued privilege of those in positions of power. Those parents who come from particular classes and races are accustomed to the system, thereby being more likely to influence their students to enter senior science and university. In contrast, those parents who are not privileged by the system pass this very marginalization on to their children. It is noteworthy that Michelle expressed no objection or criticism of this system – one could interpret this as evidence of the racial/social contract discussed in chapter two as well as the discourse of meritocracy above. With further consideration, the opportunity discourse reveals the pervasiveness of deservingness that reinforces hierarchies of power in the knowledge of science. Foucault’s power/knowledge constellation comes into focus as the purpose of science education (science knowledge) becomes the means of status, privilege and upward class mobility. The colonial/colonizing narrative remains.

Science as Responsible for Innovation and Societal Improvement

The participants often spoke of science as responsible for innovation and societal improvement. The link between the performativity of science and innovation was present in Susan’s explanation of why she felt that science was held in higher esteem in high school.

I think that in society, science is a matter of fact. So it’s maybe more respected more than the humanities because it’s cutting edge, there is always research being
done in it. [Science] is what’s going to solve things in the world. Whereas English isn’t seen like that or social studies: ‘No big deal, you’re just teaching about history, it’s not going to change anything in the present tense’. I dunno, I dunno.

Susan frames science as having the potential to solve problems in the world, defining it as “cutting edge”. Her statement indicates a discursively constructed need for science education to push innovation. Although Susan’s explanation is ridden with her own uncertainty, closing with “I dunno, I dunno”, it appears that she believes that scientific innovation is essential for the development of the world, claiming that we need science “to solve things in the world”. The triumphal discourse that science is responsible for societal improvement is remarkably similar to the separation of science discourse.

Science is described as transcendental and as a tool that can be applied to solve any global issue. Problematic global issues that have been caused by advances in science and technology are always missing from this discourse.

Susan’s statement establishes the importance of science through comparison with other disciplines. She states that “the humanities” and “history” [are], “no big deal [because] you’re just talking about history, you’re not going to change anything in the present tense”. Susan’s description depicts science in a triumphal state wherein the progress, innovation, and scientific advancement of science are measures of society’s well-being. Such notions of the triumphalism of science allow the social body to ignore the past and present marginalizing structures associated with the hegemony of science. Through descriptions of being “cutting edge” (Susan) and “essential for the word to continue to grow” (Cassandra), science is constructed as a faith system that is universally good and unproblematic. By positioning the push for innovation as paramount and
reliable, this discourse allows the violence done in the name of science and progress to be ignored.

In response to a question concerning the necessity for students to graduate with more than one science, Michael identified the importance of science for society.

I mean science is getting, is becoming more important going forward. I think the reason that science is important is because the stuff that our society produces now is not as simple to make as it was before. In most fields you must have some kind of basic understanding of science to do things. Going forward society is actually getting more sophisticated because of our understanding of science. It really does come down to the push in our society for innovation, really boils down to maths and sciences for innovation. That doesn’t mean English and all the other stuff is useless, of course, you have to be able to do those other things as well.

Michael constructs the advancement of society as causally linked with advancements in science. His use of the word “sophisticated” is telling, as sophistication is often dichotomized with crudeness or simplicity. Implicated in this argument is the modernist assumption, indeed, the belief, that science and science education are responsible for the deliverance from societal ignorance, crudeness and simplicity. His statement that the fact science is important “doesn’t mean English and all the other stuff is useless” broadens the scope of Western science’s supremacy. Michael may not see “English and all the other stuff” as “useless”, but it is clear from his statement that it is far less important and does not hold the exclusive (or elite) position of science. As Michael continued with his description he began to naturalize and internalize these discourses.

It’s natural for society to fall into that mentality, let’s keep going, let’s keep pushing. I would say I support innovation, of course, and I like the idea of a more educated population.

Michael describes the push for innovation as “natural”, and qualifies the need to continue to innovate by stating “let’s keep going, let’s keep pushing”. Michael’s use of the term “natural” is indicative of the pervasiveness of the innovation discourse. His description
has an overarching sentiment of a common-sense connection between societal advancement and science education. Such a view is further bolstered as he uses the words innovation and education synonymously.

Eric also positioned the science teacher within the discourse of innovation and science education when asked why teaching science was important.

This is a great question, super deep question. I would say the goal of the human being, of humanity, is really to know more about our environment, is to know more about everything, to understand. The world is ridiculously complex, and that’s why it’s important [to teach science]. If we don’t teach them [students] science, then they’ll be an unfortunate drop off in the human time period. They’ll stop learning science, they stop understanding the world about them to a deeper extent. So things would just stop.

Eric indicates that he sees the goal of humanity as the pursuit of an understanding of the world around them. He then aligns this goal of humanity with the teaching of science; he constructs science education and the science-teacher-subject as the vessel by which this understanding is achieved. Michael then takes us further as he describes science as required for the advancement of humanity. He does this in the negative by stating that if we do not teach students science “an unfortunate drop off in the human time period” will occur, and “things would just stop”. Michael’s response constructs the unquestioned importance of science as the taken-for-granted vehicle for the advancement of humanity.

Hegemony is established by promising stability and universality as an alternative to chaos. According to Gramsci (1971), hegemony relies on the threat of chaos to maintain its hold. In Michael’s statement we see the threat of the alternative to Western epistemology hegemony - the threat is that “things would just drop off” and there would be a “drop off in the human time period”. His statement exemplifies a protectionism of Western domination. Just as the colonial narratives promised that science would deliver
society from ignorance and savagery, so too is the loss of this potential salvation used as a warning for not maintaining Western dominance, such is the saving power of science.

Gramsci (1971) suggests that wherever hegemony exists one can find coercion mixed with consent. Capitalistic discourses present a narrative of society as homogenously moving toward a common goal (advancement, innovation, prosperity) through science. The continued improvement of society through science is a romantic picture fueled by enlightenment discourses. This picture, however, results in those considered to not be in solidarity with this view (due to race and/or gender) and those who speak against systemic marginalization being seen as standing in the way of the common good. They are depicted as being resistant to what is good and right. As Wetherell and Potter explain, “the continuous view of history and the golden future are powerful argumentative resources not least because it becomes irrational from this perspective to question the current form of society” (1992, p.184). The discourse of a utopian future through scientific innovation draws attention away from racism, marginalization and social reform efforts. Within a capitalist politic, issues of social justice become subordinate to progress. Implicit in the triumphalism of science is a triumphalism of Western ways of being and living. Superiority is not strictly epistemological but ontological as well.

**Discipline and the Field of Discursivity**

It is clear from the data that the science teacher is subjectified by a “cacophony of calls” (Britzman, 2003, p.223). The science teacher is called to embody and perform multiple and at times contradictory discourses. The categories of description articulated in this chapter cannot be deconstructed as isolated components of self, nor do they fully
represent a subject or a particular discourse. The field, however, does illustrate how the
science teacher is expected to simultaneously embody and perform many roles to be seen
as a “good” science teacher. As Foucault (1972) suggests, the discourse that constitutes
the object also construes the knowledge and practices by which that object is disciplined
and controlled. As the subject learns the discourses of proper or acceptable ways of
acting (performing), they work to acquire these roles. This propagates the discursive
norms through their performances. Subject position are known by their specific
performances that further normalise these actions and establish disciplinary discursive
regimes. Although there may not be detrimental consequences resulting from all
abnormal performances, the abnormal is to be avoided. Power and dominant discourse
creates the good science teacher, what Foucault would refer to as a truth-object, or in the
case of the science teacher, a truth-subject. Carlone (2003) explains, however, that
contemporary discourses socialize teachers into a very narrow definition of what “good”
science education looks like.

Recognition as a science teacher brings status. The very existence of the
subjectivity of the science teacher is dependent on the performances of expected norms,
norms that are integrally connected with the discourses of modernity, enlightenment and
capitalistic ideologies. The continued propagation of these discourses do not occur one-
dimensionally. Science-teachers are both the subjects and objects of these narratives;
they both act and are acted upon, produce and are produced. When the subjects set goals
for themselves to be a science-teacher-subject, they begin to discipline themselves to fit
into a discursive norm. From that point, forward they are disciplined by technologies of
power, both intrinsically and extrinsically to conform to this ideal. When they accept and
internalize this identity, they attain a recognizable position, and see themselves confidently as the good teacher or the good professional.

**Power, the Field of Discourse and the Illusory Self**

Lacan writes of the Ideal-I, a forever unattainable fantasy that represents a unified self that is without disaccord. Upon analysis, the ideal science-teacher-subject is fundamentally a contested and contradictory subject position, ridden with discursive opposition and tension. Two further questions arise from this presupposition: How can a complex, differing and often contradictory field be used to construct the concept of an ideal science-teacher-subject? And, how can conflicting discourses *both* be incorporated into the fantasy of an ideal self?

I propose that the dichotomies presented in discourses are not mutually exclusive when incorporated into the self. Every subject position is full of contradictions, and discourses used to construct a “self” are not an exception to this. Taking this further into poststructural thought, the contradictory discourses that are used to define the subject are in fact required to create meaning, as meaning is created through difference and not positive essence (Saussure, 1916). A sense of a unified self does not draw on one discourse for meaning but is created by the discursive field itself. Every categorized subjectivity (the modern science teacher, the postpositivist science teacher, the passionate science teacher, the science teacher as gatekeeper to opportunity) is a component of being an ideal science teacher. The ideal is not a tangible concrete conceptualizing but a nebulous, fluid, unattainable, imagined sense of self (subject position) created by the field. The essential science-teacher-subject is created by the dynamic field of discourse, however, this idealised self is illusory and does not exist as
something separate from the always-in-production performativity of the science teacher subject.

I propose that power is both the driving force in the field of discourse as well as being responsible for the field itself. Power drives subjectification, while facilitating the continued performativity of contradictory discourses. For example, the science-teacher-subject provides learning for all while simultaneously keeping science elite. Science teachers must be passionate about science and yet the science classroom is not a place for emotion. Science knowledge is black and white truth and yet science knowledge is uncertain and requires critical thinking. When examined from the perspective of power, the reasoning behind our multiple substitutions for center becomes clearer - the science teacher performs the discourses that maintain the elevated status of the subjectivity.

Poststructuralism shifts questions of identity. What was traditionally seen as personal, is now considered to be politically and socially influenced. This inverted gaze progressed by taking the form of a genealogical analysis (chapter three) and a discourse analysis of thirteen semi-structured interviews (chapters five). The intersection of the data from these two sources provides a leitmotif: science subjects in general and science teachers in particular are and continue to be constructed as elite subjects: science-teacher-subjects are passionate about their craft, they provide future opportunities for their students, they provide knowledge and truth, they have the control and discipline to bracket emotion, they are critical thinkers, they are specialized, and they understand and appreciate the role of STSE. The identification of the elite-science-teacher provides an ontological understanding of the subjectification of the science teacher, however, the
study unfolds by now asking the epistemic question: why do we say the science teacher is elite?
CHAPTER SIX:  
The Elite Science-Teacher-Subject

Foucault in *The History of Sexuality* (1980) suggests that the analysis of discourse moves beyond ontological queries and towards epistemological questions of self. In the context of this research, the question is not to ask why the science-teacher-subject is elite but rather to ask *why we say* the science-teacher-subject is elite (Foucault, 1980, p.8). The “we” is not an introspective question from science subjects themselves, rather, “we” represents the social body represented through talk and text, in this case, the discourses of the interview participants. Posed in a different way: why does the social body say, therefore subjectify, the science-teacher-subject as elite. The question is illusory in its simplicity. It is a question of what is gained, what is lost, what is produced and what is repressed? It is a question of constitutive discourses, not limited to simply describing the science teacher as elite but understanding that this elitism is a product of the all the past and present discourses that subjectify the science teacher.

The study of the subjectification of the science teacher is not an analysis of the “truth” of what a science teacher is, according to science and non-science teacher participants. The guiding query stated in chapter one of the discourses that subjectify the high school science teacher, is not a search for a type of anthropological or ethnographic study about the “reality” of who a science teacher is. That is why the question of “why do we say the science teacher is elite?” needs to be addressed. Subjectification is no longer an ontological question of being and essential identities, rather it addresses the science-teacher-subject as a genealogical formation integrally connected to knowledge and power.
To address the science-teacher-subject as a genealogical formation, chapter six further explores the discourses of chapter three (Our constitutive gaze turns towards the past) and chapter five (Our constitutive gaze turns towards the field). It focusing on “the way in which knowledge [and power] circulates and functions” thereby producing a “regime of savoir” (Foucault, 1982, p.781) that constructs the science teacher as a powerful and prestigious subject. I do not aim at positivistically “answering” the query of why we say the science teacher is elite, rather, through revisiting the discourses previously explored, I attempt to come to a deeper understanding of the relations of power involved in the subjectification of the science teacher. Central to chapter six is a return to the field and the interview data, establishing the discursive construction of the science teacher as an elite subject – a normalizing discourse that is not simply a neutral commentary but historically and culturally reinforces a knowledge system known collectively as Western science.

**The Elite Science Teacher and the Other**

During the interviews it became increasingly clear that the science-teacher-subject was constructed by discourse as an elite subject. The hierarchical status given to science teachers was achieved through comparative discourses in which the science teacher was most definitely not the other. These promotive discourses were comprised of science teachers requiring more specialized knowledge and being more intelligent and academic than teachers of other subject areas. Although the participants’ conceptualized the other as those teachers who did not teach science, it must be noted (as seen in chapter three) that the other also signifies the non-science knower. Said differently, the elevation of science teachers over non-science teachers is not limited to the school setting but
secures the status of those that hold science knowledge in the social body. It is through this continued social stratification, based on Western knowledge, that the hegemony of Western science is maintained.

*The specialized science teacher*

The discourse of the science teacher requiring more specialized knowledge and training compared to *other* teachers became evident throughout the research process. It was common for the participants to differentiate between science teachers and other teachers, while discussing non-subject area specialists teaching science class. My conversations with Eric and Michael illustrated this comparative discourse. These two science teacher participants all used English as an example of quasi-specialization. In these two instances, the participants initially presented teaching English class as requiring specialized knowledge, but then described how science teachers could still do an adequate job teaching English.

Eric:

Certainly in English you have to be a specialist in certain areas but you [a science teacher] certainly could go in there. Could I go in there and talk about a poem, certainly I could talk about a poem. I might not even be close to what the actual poem [is about] but I can go in there and talk about it with them. Could I go and talk about a novel? Certainly. Could I do that in a science class, and actually have a clue to what’s happening in there? Well, unless I’m a science major or understand the science, that’s just not going to happen. So are those two different, yeah. And I subbed for a couple of years, before my contract and I know they’re different. You walk into a humanities course, and this is not to belittle the humanities, but you walk into a science class you have to know what you’re doing. You walk into a humanities class, and [I] didn’t know what I was doing but I survived. You cannot survive in a science class, it’s not like the students are going to eat you alive, what I mean by survive is that you’re not going to be teaching them anything. Whereas in the English or humanities, I could probably teach them something.
Eric speaks of his ability to teach poems, novels and carry on classroom discussions, he then contrasts this to science class by stating that only science majors could teach science courses. He further emphasizes the difference between science specialist and non-science specialists as he states that non-science teachers’ ability to effectively teach science is “just not going to happen”. From the data, Eric clearly draws a distinction between English class and science class stating that “so are those two different, yeah”. He then proceeds to further construct the difference between the humanities and science classes through his experiences as a substitute teacher, referring to his ability to “survive” the English courses but not understanding how an outside person could teach science students anything.

Upon further analysis of Eric’s statement, the specialized science teacher discourse differentiates between the required knowledge to teach science when compared to English and the humanities. It must be noted that this differentiation is not epistemically neutral but is founded on the superiority of science knowledge over those of English class and the humanities. Eric opens by asserting that he “doesn’t want to belittle the humanities” but then constructs a hierarchy that does just that. Eric reinforces the discourse of needing a higher degree of specialization through a major assumption: He refers to his own experiences teaching English as being effective; he was able to “teach [the students] something” and “survive” but assumes non-science teachers “would not survive”, “wouldn’t have a clue” and are “not going to teach them [the students] anything” in science class. His experience of teaching non-sciences classes is based on his own experiences but his view that non-science teachers “wouldn’t survive” or
“wouldn’t teach the students anything” is assumed as it is not based on any described experience.

Similar discourses were prevalent in my conversation with Michael who used the telling metaphor of learning a musical instrument to describe learning and teaching science. Similar to Eric, Michael used English as a comparative example.

Science is like a musical instrument, it’s not something you can pick up quickly, it’s something you have to work at for a long time. It would be like me, trying to teach someone how to play flute, I don’t know how to play flute, I’ve never taken flute, but we’ve all taken English, we all know how to write. Science is unique, not everyone knows how to do basic arithmetic, most people don’t know chemistry very well. You can kinda get through English classes just like the teacher can get through it as well. Whereas in science you just can’t. If you’re lecturing and you go into an English class and you’ve read this book “Lord of the Flies”. You like the book, and you know it. I’m not an English person but I’ve read that book I can talk about it for a really long time. I can talk about the symbolism because the whole thing is symbolism. Say you had no idea about types of chemicals reactions, you’d just have nothing to say. Because you need too much background knowledge to talk about it.

Michael’s metaphor captures a unique perspective on the specialization discourse. Not only is science framed as more specialized, described as “not something you can pick up quickly” and “unique”, but it also provides evidence of the discourse of the difficulty and inaccessible of science as a topic. Michael’s metaphor constructs both science and a new musical instrument as not something that one can just do, pick up and play. Both take years of hard work and practice. Paralleling Eric description, Michael refers to English class and draws a distinction: English is constructed as common or everyday knowledge, whereas science is more specialized and much less accessible. Michael’s analogy reflects the discourse that science knowledge is incommensurable with other knowledge systems, while simultaneously defining science as exclusive and superior in its level of specialization and inaccessibility.
The construction of the science teacher as requiring more specialized knowledge was not limited to my discussions with the science teacher participants but was also spoken by non-science teachers. During our discussion about typical science classes, Geneva described what she saw to be the difference between science and English class.

I think for me the difference is that with English [pause], I think that if they speak it they have some sort of knowledge of it, but nobody speaks science language, that’s a speciality. So you have to understand the science terminology, and the language of science which isn’t an everyday. It’s a special skill. If somebody [non science teacher] was coming in they might lack or not have those skill sets, I don’t think that your average teacher could roll in.

Similar to the science teacher participants (Eric and Michael), Geneva constructs the knowledge learned in English class as common knowledge because it is spoken. She contrasts science as having a language “that’s a speciality” and not “everyday”. Her description implies a higher degree of specialization for science teachers and a higher degree of understanding in order to practice it. Her use of the term “average teacher” exemplifies the construction of the elite science-teacher-subject. The use of the term “average” is telling as it signifies a quantifiability of subject positions, it defines other teachers as the mean, whereas the science teacher is defined as exceptional. The meaning of the specialised-science-teacher-subject is constructed not through positive essence of what it means to be a science teacher but through a hierarchical power relations with the other, the “average” teacher.

*The intelligent and academic science teacher*

The dominant discourse of the science teacher requiring more specialized knowledge to teach was perpetuated by the discourses of science teachers as holding superior intelligence and academic prowess. Geneva spoke these discourses as she described a typical science teacher.
I think that good science teachers have really good memories. That’s what I think they would have because they can remember things and there as a lot of terms to remember in science. I think you have to have a good memory and I would consider them to be the minds, or the brains of a faculty even… I would consider that my peers [who] teach science, and I would consider them to be, I dunno smarter than others.

Geneva opens by describing what she sees to be a common trait of science teachers. She describes science teachers as smart and having “good memories”, due to the volume of content in science. Her final statement is comparative as she considers science teachers the “minds or the brains of the faculty” and “smarter than others”, explicitly elevating the status of the science-teacher-subject in the field of discourse.

A similar discourse arose during my conversation with Susan concerning the traits of science teachers.

I don’t want make blanket statements, but this is kinda what it is isn’t it. Well positive qualities that I always respect so much about science teachers: that they are always super intelligent, they’re critical thinkers, they are usually quiet assertive and they’re problem solvers, I respect science teachers so much for those qualities, personal traits that can sometimes, you know, amalgamate with those qualities, is that that can come across to other people as a sense of like, pretentiousness, or an attitude that science is superior to other subject areas, and they’re not afraid to stand up for what they say they need or want way more than other teachers, and a sense of entitlement even with the younger ones.

Susan opens by self-validating the stereotype she is about to use by stating “but this is kinda what it is, isn’t it”. Through this statement she is rhetorically asking for my agreement with the discourse. Similar to Geneva, Susan identifies science teachers as “always super intelligent”, illustrating a blanketing assumption from her experience. In studying Susan’s statement, it became apparent that she felt that the high cognitive ability of science teachers defined by critical thinking, problem solving and assertiveness, garnished both her respect and angst. She illustrates how these characteristics lead to an elitist attitude, stating that science teachers (even the young
ones) are pretentious and feel that they are superior and have a sense of entitlement. Susan’s statement contributes to the dominant discourse of the science-teacher as elite through both her positive statement concerning the intelligence of science teachers as well the resulting arrogance she associates with the subject.

Foucault’s power/knowledge constellation is integrally connected to the discourses of science teachers being more specialized and intelligent than the other. Foucault explains that “Power produces knowledge and power and knowledge directly imply one another” (Foucault, 1977, p.27). As such, science knowledge produces powerful and prestigious subjectivities. Foucault (1994) describes identity formation as the product of discourse and power relations that provide knowledge for establishment of hierarchical order. It is clear from the data that the discursive field produces a hierarchical establishment of subjectivities based on the specialized knowledge and perceived intelligence of the science teacher. Why do we say the science teacher is elite—because of their ability to comprehend Western scientific knowledge. Said differently, the science-teacher-subject obtains its institutional recognition and hierarchical status by the ability to comprehend what was described in the data as a knowledge that is “a speciality” (Geneva), “unique” (Ben), and “superior” (Susan). What is seen is a cyclical reinforcement of power, knowledge and status. The fact that science knowledge was constructed as highly specialized and accessible to only a few renders it beyond examination and critique, thereby elevating those who are able to comprehend its knowledge.

Examining the discourse of the academic and intelligent science teacher genealogically, the status given to science knowledge through comparative discourses is
integrally connected to the discourses of enlightenment and modernity. Scientific knowledge was used by Western Europeans to establish their supremacy and this epistemic superiority was clearly evident in the current discursive field of secondary education. The privileging of science subjects stretches back to colonialization where Western Europeans gained their status from the epistemic divide between themselves and the colonized. The gaining of privileged status for the science-teacher-subject can only occur through the creation of an *other* of lesser status.

The data illustrate that the status of the elite science-teacher-subject is constructed through the distinction between themselves and other teachers. In the data the *other* was qualified as teachers of different subjects but as seen in chapter three, the *other* has historical undercurrents as non-white and non-European subject. Therefore the question of the science teachers’ elite status is also a question of the stratification of subjects. The fact that there exists *the elite science teacher* is dependent on the distinction between the science teacher/the science knower and the ignorant unknower. Not only does the distinction, which comes with naming, create the difference, it also continually enforces the difference every time it is spoken. This distinction was continually spoken in the data: “Science is unique” (Michael), “Nobody speaks science language, that’s a speciality” (Geneva), I don’t think that your average teacher could role in [and teach science] (Stephen), “I would consider them to be, I dunno smarter than others” (Geneva), “there’s more to science” (Samantha), and “there’s not as many people on the planet, who are good at it” (Samantha). The status of the elite-science-teacher-subject is dependent on an epistemological and ontological divide founded on hegemonic assumptions about the supremacy of Western science.
The Elite Science Teacher and the Discourses of Capitalism

From the beginning of colonialism, science and technology have been used to measure the advancement and even the humanity of people. As discussed in chapter three, science and technology were seen as the “true lever of power for man” (Virey, 1826, p.vii), “which remind us every hour of our immense superiority” (Wallace, 1899, p.1). The data from this study reveal that many of these same comparative discourses are present in the field of science education. The capitalistic discourses explored in chapter five of science opening doors for future opportunities and science as being essential for the advancement of our society are deeply grounded in these colonial discourses. We say that the science teacher is elite because they are charged with maintaining the metanarrative of capitalism while simultaneously receiving status and recognition through their performances.

The data from this study reveal exceedingly similar discourses to Bacon and Plattes’ claims in the 16th and 17th century that science would usher in a utopian future. As mentioned in Chapter three, in 1641, Plattes promised that England could “maintain double the number of people, which it doth now, and in more plenty and prosperity than now they enjoy” (1979, p.2). Similar discourse arose as Susan expressed that we need science to “solve things so we can grow”, Cassandra stated that “I think that a good understanding of science is essential for the world to continue to function and to grow” and Michael explained that “society is actual getting more sophisticated because of our understanding of science…. and if we don’t teach them science, then they’ll be an unfortunate drop off in the human time period and this stage”. Reminiscent of colonial discourses discussed in chapter three, a nation’s advancement on the world stage is still
largely associated with their advances in science and technology. This is exemplified by the following statements from the National Science Foundation claims that “leadership in the economy requires world class scientist and engineers, and a national workforce that is scientifically, technically and mathematically strong” (NSF, 2003 p.10), and that the purpose of these scientifically related activities is to have the quality of life of all citizens and the health, prosperity, welfare and security of the nation (NSF, 2009). It is evident from the data that the discourses of national prosperity and advancement through science that began during colonial times continue to dominate the present discursive field.

It is clear from the data that science education and societal advancement is still an indissoluble couplet in our current societal narratives, and scientific advancement has become synonymous with societal improvement. Drori (1998) writes of the narrative of the “science-for-development” (SFD) model. Where “economy, security, global status, is believed to depend on successful science education” (Berg, 1985, p.56). As MacKeracher says, the sciences “more than any other subject within the school curriculum, are tied directly to the economic system and the labour market” (1985, p.107). The coupling of science education and development is not neutral, but strengthens the hegemony of not only capitalism, but also Western science as it promotes an unproblematic and triumphal view of science. There has been little change over the five hundred years since the beginning of colonization; the promise of economic growth is still founded on the belief in and possibility of superior technology and scientific understanding, and science-teacher-subject plays an integral part in the continuance of these narratives.
The dominant societal narratives place great value on the accumulation of wealth and financial security. These socio-economic goals, within the narratives of meritocracy and neoliberalism, are framed as solely reliant on hard work (as stated by the interview participants) and seizing the opportunities provided by society. The desires to achieve opportunity, wealth, and financial freedom in our society are constructed as life goals to which everyone should aspire. Capitalistic ideologies and associated discourses are rarely questioned, and the dominance of these views permeated the discursive field in the data. Through capitalistic ideologies and associated discourses, the intrinsic value of science knowledge itself shifts towards what this knowledge can bring us (wealth, security, progress), the illusory promises of capitalism.

The perversion of education by capitalistic ideologies occurs within all subject areas, although the data speaks to the presence of these discourses in science education in a particularly insidious way. When the discourses of opportunity are accompanied by the discourses that cement the relationship between technological innovation and societal advancement, the power of capitalistic discourses increments exponentially. Within these discourses, the subjectivity of the science teacher takes on the duty of maintaining a capitalistic ideology by being a subject responsible for the continuation of incessant growth through scientific and technological advancements.

The dominance of capitalism can only be maintained through societal control and discipline. What we see in the data is that the science-teacher-subject upholds the norms of Western capitalism through science education. The maintenance and reinforcing of capitalistic discourses is an element of the disciplinary apparatus that constrains the pedagogy of the science teacher. What is noteworthy, and a central finding of this
research, is that the disciplinary function of capitalistic discourses is so powerful—not solely because it restricts and constrains—but following Foucault’s productive nature of power, it produces respectable and positive identities of its adherents and messengers; in this case, the identity of the elite-science-teacher-subject. Through the performances of these capitalistic discourses, the science-teacher-subject is interpellated as a powerful, prestigious and elite subject. It is precisely through the status that capitalistic discourse bestow to science teachers that discipline takes effect.

The colonial narratives of science for prosperity and advancement remain: Knowledge _in_ and _of_ Western science continues to be tied to wealth and the promises of an elevated social class. The science-teacher-subject is given great power and responsibility within this ideology, while simultaneously submitting to and being disciplined by its ideological “truths”. These social pressures/goals are politics of power that greatly influence the elite status of science teachers within school discourses. A result of these capitalistic discourses is that science-subjects gain status as gatekeepers of science knowledge. We say science teachers are elite because, as teachers, they perform the discourses that science promises: truth, certainty and prosperous futures based on science knowledge.

**The Elite Science and the Epistemologies of Modernity**

The status of the science teacher is integrally connected with the discourses of enlightenment and modernity. The genealogical analysis of these discourses (chapter three) illustrated how the notion of white Western Europeans’ supremacy was achieved though their science knowledge. Throughout history, from the phrenologists (Linnaeus, Blumenbach, Morton and Lapouge) to the acceptance of the natural philosophies into the
Royal Society in 17\textsuperscript{th} century England and the creation of l’Academie des sciences in 1666 in France, the elite standard of the subjectivities of science were established. It is clear from the data that the same status and privilege is prevalent today in science education, as Carlone (2003) writes “social-class privilege, not consensus, buttress the traditional science curriculum today” (p.23). What must be noted is that the notion of epistemological supremacy of Western knowledge (science) is not limited to knowledge itself but is integrally part of a power/knowledge constellation that maintains the hegemony and supremacy of those holding these knowledges.

It is evident from the data that the science classroom remains dominated by what Barlosky (1999) refers to as encyclopedic strand of moral discourse: A discourse where the modernist notions that empirical knowledge will clarify all moral questions and will bring about certainty, objectivity, and generalizable knowledge. Modern discourses provide those who accept, perform and are subjectified by them with power, privilege, and the alluring possibility of obtaining truth about the world around them. The science-teacher-subject continues to accept and promote modern epistemological discourses because they provide a concrete, albeit illusory, way of understanding the world and the status and power that comes with this Eurocentric understanding of the world.

Slattery writes that modern discourses promise “an underlying and unifying truth and certainty that can render itself, the cosmos, subjective experience, and historical events as coherent and meaningful” (2013, p.22). Modern claims of underlying truth and epistemic certainty were clearly evident in the data as science was constructed as providing the “right answer” through methodical and rational thought. The dominance of a modern scientific epistemology was clearly seen as the participants often constructed a
reality that was “out there and unchanged by human study of it” (Harding, 1992, p.99). The social body craves certainty and the science-teacher-subject’s status is bolstered by being a modern agent that provides epistemological and ontological clarity and truth.

Foucault (1972) explains that society has mechanisms for transmitting various discourses and establishing truth and consensus. The prevalence of modern discourses in the data indicates science teachers as a mechanism for establishing truth and consensus in our society. The science-teacher-subject is constructed as a hegemonic agent of modernity, a highly disciplined yet prestigious subjectivity. The modern-science-teacher-subject depends on modern discourses for their elite status and identification, and as such, they strive to project their constraints as normative, rational, universal, and ultimately as unquestionable truth. As Gramsci (1971) explains: coercion is combined with consent; even those disciplined and marginalized by these discourses continue to represent them in this elite way.

The science-teacher-subject is a part of the complex constellation of purity, truth and hegemony of modernity. The continued performativity of the science-teacher-subject reaﬃrms and validates the metanarratives of Western science. When teachers perform the modern science teacher subjectivity, they are re-inscribing the epistemological dominance of Western science: “What is done in a prototypical [science class] reproduces its status and secures the prestige and power of science” (Ziman, 1994, p.66). Through teachers’ performances they become the messengers of scientiﬁc knowledge, imparting scientiﬁc fact to their students. Through the routine performance of these discourses, subjects internalize and naturalize the discourses into a sense of self. However, when teachers project a discursively prescribed subjectivity as their true
selves, they also present the discourse in which it was formed as true and natural. The continued inscription of the science teacher’s elite status is integrally linked to the colonial, hegemonic discourses of modern Western science.

Foucault writes of the rules of discourse (1980), rules that govern what is said, what remains unsaid, who can speak with authority and who must listen: The rules of discourse determine who can speak “truth” and what this “truth” is. The identity and status for the science-teacher-subject becomes the ability to speak truth. In a global, Western sense, the science-teacher-subject continues to perform the modern discourses of certainty and rationality; indeed, these are reassuring discourses that are set up as an alternative to nothing less than chaos. An epistemological chaos is characterized in the data as a “reality” without certainty, without objectivity, and existing in gray areas. Curricula that are no longer seen as solely content but take on the “messiness” (Ben), “wishy-washy[ness]” (Jennifer), or the “fuzzy[ness]” (Michael) of a human endeavor. The science-teacher-subject lectures and continues to see science as a compilation of truth that must be transmitted (curricula as content) because the science-teacher-subject depends on these modern, hegemonic discourses for their elite status and identification. Foucault’s rules of discourse have endowed science teachers with the ability to both speak and teach “truth”, and as such, they are given great privilege and status within the social body.

**Western Epistemologies and Continue Colonization**

The physical colonization during European expansion was accompanied by an epistemological colonization. Alatas (1977) explains that colonialism was not only an extension of sovereignty and control by one nation and its government over another, but
was also a control of the mind of the conquered and subordinated. The West’s conquest was not only of land, but continues to dominate and construct a social reality. Barker (2009) writes of contemporary colonialisms and Hardt and Negri (2000) of the contemporary empire, but regardless of the semantic distinctions used, colonial discourse is rooted in the very foundations of our Western culture, and education is one of the technologies that allows it to maintain this hold.

Scientific understanding has become synonymous with truth, with “the way it is”. In the modern and postmodern West, science is positioned as the way of knowing. The science-subject does not only deal in higher status knowledge systems, but when combined with the discourses of modernity and enlightenment, these subjects have the skills (intelligence) to fully understand the world. A scientific understanding of the world is the true understanding of how the world works. Science is positioned as the most important knowledge, as the sine quo non, as the prerequisite of knowledge and all that is worth knowing in the modern and postmodern West.

It was evident from the data that the science-teacher-subjectivity gains much of its status from Western epistemic discourses. Therefore, we say the science-teacher-subject is elite because of its positioning on the dominant side of the dichotomies of colonialism. The performances of science teachers are privileged, as science teachers become the teachers of truths “I like science because…there is always a right answer” (Jennifer), the accessors of reality “We [science teachers] have a better understanding of the world around us” (Geneva), and the promoters of rational thought and objective reasoning ‘Science is factual, its black or white, it’s a or b…and if we work hard enough we will always get to the right answer” (John). However, the more entrenched a
hegemonic regime becomes, the greater degree of marginalization for the other. When the science-teacher-subject is constructed as masculine, as white, as civilized, as straight, as religious and as upper middle class, what results are immense consequences for those who are not recognized by these hegemonically privileged identities. The antagonistic subject of the science teacher (the abject other) becomes non-white, feminine, subjective, rejector of truths, heathen, savage, uncivilized, uninformed and lower class. It is not that women or non-whites are banished from science, but that they always embody the exception. They are interlopers; they have journeyed towards the “ghostly center” (Graham & Slee, 2008, p.284) from the boundary, but the center is not their natural place.

Singh (1996) asks why colonialism still exists today, and why it continues to hold contemporary validity despite having broad ramifications that marginalize and subordinate other cultures, races, economic groups and sexualities. Modern epistemologies provide the illusion of a concrete way of understanding the world, and science-subjects actively perform these discourses because they are privileged by this taste for certainty. As Joanne described in her interview:

I think it’s a human tendency that we want things to be concrete. We like things to be measurable, we are more comfortable when things are not open to interpretation. I think people are less willing to put trust in things that they perceive to be subjective. It’s that idea of being able to have things that are concrete.

We must, however, be cautious of claims to universality and objectivity because as Haraway (1991) explains, “only partial perspectives promise objective vision” (p.190). The social body craves certainty, access to truth and methodical processes for arriving there. The discourses of modernity and enlightenment remain dominant in science education because this is the promise they provide. These epistemic discourses
accomplish a comfortable and familiar structuration of “reality”. Science teachers continue to perform these discourses, often because they do not want to face the reality of science—that science is a messy and uncertain endeavor, integrally connected to politics and society—because such a view would wreck the phantasy of science. It would also destabilize the world as a knowable system to which science teachers provide some exclusionary access. So why do we say the science teacher is elite? Because they continue, through colonial curricula, to structure a Western reality in which they are granted a privileged place.

**The Elite Science Teacher and the Natural Affinity Discourses**

The subject of lack’s continual struggle for full identification drives them to identify with discourses that promise fulfillment. As Lacan (1977) explains, the subject performs and repeats discourses that mask a primordial disaccord. The construction of the science teacher as holding a natural affinity for science plays a particularly powerful role in the masking of lack. Any subject position can only promise fragile, unfinished, and permanently vulnerable identity effects; however, this fragility is not embraced as it reflects an uncertainty and lack. Therefore, the subject strives to project the opposite effect, one of certainty, one reflective of “jouissance” (Lacan, 1977, p. 6). Hegemony takes hold and the science-teacher-subject that performs the natural affinity discourse is recognized as having an illusory essential self.

The subjectivity of the science teacher is dependent on a system of emotional management and coercion. When emotional responses such as affinities for, or passion towards, science are constructed as something that an individual has or lacks, a boundary is created. Those who have membership in this group are seen on the inside, they are
spoken about as a group that share similar characteristics, even described in the collected
data as “having a brain” (Stephen) that is good for science. The focus is almost entirely
on solidarity and commonality for those who are recognized as science-teacher-subjects.
However, as seen in chapter three and five, this group of science-subjects enjoys a
position of prestige and power while being tasked with the maintenance of the hegemony
of Western science.

Gramscian (1971) hegemony can only exist in a discursive field where competing
discourses are present, as hegemony promises universality and certainty in lieu of chaos
and uncertainty. Conceptualizing the science teacher as holding a natural affinity for
science must ask what is it competing against? To what does this discourse promise a
resolution? Two noteworthy dichotomies are created. Firstly, if as the data illustrated, the
natural science teacher holds a fundamental passion for the science, a dichotomy is
created with the apathetic science teacher, a subject who does not love teaching. On the
surface, the passionate-science-teacher may seem to transcend power as this is easily
interpreted as a positive characteristic; however, it prescribes a way of being, a way of
feeling, a component of subjectivity that must be embraced, or the subject risks being
seen as the other. The implication here is that the development of an affinity for science,
rather than science affinity as a natural quality, is a weaker discourse in the field, but
why is this discourse avoided by science teachers? I propose that the discourse that an
affinity for science can developed poses a threat to the elite status of the science-teacher-
subject. Science would be become accessible to all, a discourse that was avoided by
BAAS when they coined the term scientist in the 19th century. The direct implication of
the affinity discourse is that the science-teacher-subject who performs these discourses benefits from the exclusivity and status of its membership.

At a cursory glance the subjectification of the science teacher as holding a natural affinity for science has very little to do with power in the non-poststructural sense of the word. However, the construction of an affinity towards science as a necessary trait of the good science teacher is embedded in relations of power. The subject has expected characteristics that must be inscribed on their person in order for him/her to be accepted and recognized as good. The natural affinity discourse is so compelling because it is a component of what is used to define the good and therefore elite science teacher. The affinity discourse privileges those that claim and perform a lifelong connectivity with science and disciplines those that do not. If a subject wishes to be seen as good science teacher, he/she must self-identify with the dominant discourses. Self-identification, however, must be continually performed to a degree where the subject is accepted as being born with this essential characteristic. The natural affinity discourse is disciplinary, as those who do not have the expected passion, or no longer perform with this passion, no longer qualify as a good science teacher. The subjectivity becomes unattainable.

Western Hegemony and the Lack of Race in the Data

Chapter three provided insight into the grid of intelligibility that has historically subjectified science-subjects. Whether it was the British Association for the Advancement of Science limiting its cloisters to white upper-class men, the phrenologist stratifying the races of the world based on their pseudoscience, or the use of science and technology to justify the acts of colonization, it is clear that race has had a long relationship with science. The lack of explicit racial discourses in the interview data is
hardly surprising given the continued dominance of modernism in the field of
discursivity. However, this lack does not make the subjectification of the science teacher
a raceless endeavor nor does it indicate science’s transcendence from race, rather, it
indicates the continued dominance of Western hegemony and whiteness as the norm in
science.

Stoler writes of a bricolage whereby “an older discourse of race is ‘recovered’,
‘modified’, ‘encased’ and ‘encrusted’ in new forms” (1995, p.61). The racial bricolage of
which Stoler speaks is visible in the discursive field of secondary science education. The
“older” explicit forms of scientific racism exemplified by the work of Linnaeus,
Blumenbach, Morton, Lapouge, have been repackaged in a subtle, systematic and
colour-blind (Wise, 2003; Bonilla-Silva, 2003) way. The whiteness of science does not
need to be named because, as seen in chapter three, it permeates all the discourses of
Western science.

The repackaging or racial discourse to which Stoler speaks is evident in the lack
of explicit racial references in the data. Even within postpositivist discourses, the
participants avoided discussing race: Eric and Ben openly criticised the negative impacts
of science “on the world” (Eric), and “on society” (Ben) but made no reference to race.
Furthermore, Jennifer stated that students need to learn science to “make informed
decisions”, and Ben claimed that students needed science to be “critical thinkers” and to
“see through all the bullshit”. Such criticism, however, was exclusively levelled at
corporations or “society” as a whole and their impacts on the environment. Never were
these negative scientific impacts discussed in terms of the marginalized and racialized
other. Science was described in a polarized way, it was either good for all or harmful for all, but never was it uttered that science elevated some and marginalized others.

The data from this study constructs three dominant discourses that continue to propagate a default to whiteness as the dominant norm in the science classroom. Foremost of these discourses is the modernist philosophy that separates the world of science from the world of human beings, typified by the view that science deals in phenomena and scientific knowledge and not the subjective. As the modernist philosophy of pure science underscores race, privilege and marginalization, an ideology of colour blindness is further sedimented in the science classroom. A second problematic discourse is that of people holding a “natural affinity” for science. Within this discourse, one’s ability in science is assumed to be biologically determined and immutable within the hegemony of white supremacy. Stated differently, an affinity for science has everything to do with systemic privilege for those who are deserving and under-privilege for those who are not deserving. Lastly, we have the triumphal and neoliberal discourses of societal prosperity though science. When viewed through such a neoliberal and capitalistic lens, science is a neutral and non-racial tool for the continued prosperity and dominance of Western society.

Bonilla-Silva writes that at the heart of colour blindness lies the myth “that race has all but disappeared as a factor shaping the life choices of all” (2003, p.178). It is clear from the data that the disappearance or race, or the belief that race was never part of science, continues to dominate the field. The lack of participants all but naming race indicates that science’s racialization is not so much well hidden within the hegemony of Western science, but rather present by default.
It has been suggested that Whites do not grow up with a race discourse, do not think of their choices in racial ways, and do not consider themselves as belonging to a racial group...ignorance showcases precisely how they do perpetuate the racial order by turning the other cheek to it or pretending it does not exist. (Bonilla-Silva, 2003, p.231)

The hegemonic structures of Western science are very much a white Western system that continues to benefit the science-teacher-subject. In the same vein as Leonardo’s (2013) racial contract, the elite status of the science-teacher-subject enters into a symbiotic relationship with the hegemony of Western science. Said differently, the hegemony of science continues to be upheld by those - namely science teachers - who benefit from the system by receiving status and authority. Leonardo (2013) reminds us that it is only white knowledge which claims that race does not matter or that it is not a factor. Whiteness continues to be favoured in the system, race does not need to be named as it is both the default and the norm. The rather muscular descriptions of science on the part of the participants are what could be called “abstract and decontextualized notions of liberalism”. These are precisely the discourses that they are accessing. Within present neoliberal and capitalist discourses, scientific knowledge is now seen as being explicitly for the good of society in its present social order.

Discipline and the Discursive Conflict: Modernity and Postpositivist Science Education

Foucault in *The History of Sexuality* (1980) writes that discourses that appear to be critical of sexual repression, actually work towards the continued repression of sexuality and control of populations. It is the elaborate display of sexuality and its discourses that serves as a repressive control of sexuality among contemporary populations. If we say we are repressed, following Foucault, the discursive display turns to that which is being repressed. Such a view is important when asking the question of why we say the science
teacher is elite. The data from the study illustrate that even the critical discourses that address the modernist-based elitism of science and scientists do not work against the elite discourses but are in fact part of it. The hegemony of Western science is so firmly ensconced that a departure from its expected norms provides little threat to the overall system. In fact, as seen with the postpositivist discourses, such departures are instead likely to be considered evidence that science is as open to alternative thought and ways of knowing as it claims to be. Returning to the pedagogical stagnancy in science education, I propose that the calls for reform and movement towards postpositivist approaches in science education continue to strengthen modernist and subsequent elitist discourses.

Pedretti (2005) refers to a postpositivist approach to science education as an approach far removed from the modernist notions of irrefutable scientific knowledge. Ziman claims that such a vision is far from coming to fruition as “this whole dimension is missing from conventional science education, where the sciences are presented as if they had no social context, no social influence and were of no social concern” (1994, p.28). The data revealed far more complexity than Ziman’s simple dismissal of postpositivist approaches in the science classroom. Throughout the interviews, postpositivist discourses appeared to subjectify and drive performativity. The participants often discussed the importance of a pedagogy that included exploring science as a contextualized human endeavor, critically examining science knowledge and presenting science knowledge as fluid and changing. These postpositivist approaches were described as “really important” (Michael) “integral” (Jennifer) and leading to “genuine learning” (Ben). However, these discourse were often overshadowed by, or re-
integrated into, modern discourses. Calls for the transmission of static content knowledge remained dominant, and as discussed, the subjectivity of the science teacher remained largely constructed by these modernist discourses.

The presence of these postpositivist discourses strengthens the dominance of modernist discourses as they pose a threat to the certainty and truth that they promise. The discourses that one would typically interpret as critical of elitist discourses are in fact part of them. According to Gramsci (1971), hegemonic discourses present themselves as a universal solution to a crisis, the only alternative to chaos. Hegemony relies on its antithesis for meaning and strength. Through a Gramscian lens, we see that the strength and hegemony of modernist discourses rely on the threat of unknowing and epistemological uncertainty for meaning. In the context of this study, modern hegemonic discourses of certainty are presented as a solution to epistemological chaos, a chaos defined by postpositive approaches to science education characterized by epistemic uncertainty. Postpositivist approaches to science education thereby strengthen the hold of modernist and elitist discourses.

One intersection of these two competing discourses occurs at the level of the science teacher subjectivity. The modern-science-teacher-subject is constructed from these hegemonic discourses as a solution to the unknowing and uncertainty of non-science. The subjectivity of the science teacher is a powerful and elite construct because it provides “true” understanding and avoids the epistemological chaos of not understanding scientifically. Performing pedagogies that carry uncertainty (i.e. postpostivist discourses) is not only a matter of losing a concrete understanding of the world but when science knowledge is synonymous with truth, it means simply not
understanding the world, especially when the world is defined through the lens of Western knowledge. If one believes in the absolute knowledge of science, then the science teacher becomes the teacher of absolute objective truth, the agent of avoiding uncertainty and the messiness of uncertain ways of knowing. This is where the alluring power of the discourses of modernity lie. Acknowledging the uncertainty of scientific knowledge and the integral role power plays in scientific knowledge is anathema to hegemony because such acknowledgement must admit that scientific knowledge is not universal. Hegemonic claims to certainty are undermined by postpositive discourses but are paradoxically strengthened by their opposition.

Returning to the data, I suggest that the resiliency of pedagogies associated with modernist science has much to do with the threat of the subject’s loss of status. This loss of recognition was shared with me while Cassandra shared an experience between herself and her administrator.

I’ve had discussions with administrators where they have asked me outright, why I am not doing a specific method. I certainly felt that there was a little bit of heat, not a real consequence per say, but I felt our relationship changed a little bit in terms of how I viewed that person and potentially how they viewed me as an educator. The disciplinary effects of the loss of recognition become clear from Cassandra’s experience. She states “our relations changed a little in in terms of how I viewed that person and potentially how they viewed me as an educator”. The questioning of her pedagogy by the administrator resulted in a change in how Cassandra was seen and saw herself as an educator. Cassandra expresses a loss of recognition, resulting in the loss of a powerful component of her professional self in the administrator’s eyes. Despite Cassandra’s claim that she did not suffer any consequences for her non-conformity, she experienced a loss of recognition. Foucault (1980) explains that the productive nature of
power’s prime effect is the identification of individuals by a prescribed set of gestures, bodies, discourses, and desires. As was observed from Cassandra’s experience, the disciplinary apparatus was powerful as her abnormal actions resulted in the loss of part of what she used for identification. When contextualized within the findings of this study and the elite-science-teacher-subject, this loss of recognition translated into the loss of status.

The elitist tendencies remain in the science classroom because they continue to play a substantial role in the prestigious subjectivities of Western science. Reminiscent of colonialism, science remains elite because of the power it imparts on its members and those striving to be part of its ranks. If the elitist discourses of Western science remain based on modernist narratives then postpositivist science education finds itself on the opposite side of the binary. Traditionalist pedagogies remain resilient because of the sustained dominance of modernist notions of science, not the least of which are the interests of capitalism. In the face of such dominant paradigms, postpositivist education is unlikely to bear pedagogic fruition.

On one hand we have the subject of lack, a subject that is forever subjected to misidentification, continued performativity, and infinite number of substitution of center to fulfill the lack. On the other, we have the pervasiveness of power and the disciplinary effects of hegemonic discourses. The subject is forever in turmoil and is led by the very condition of existence to seek solace in certainty and stability. It is the promises of modernity, characterised by a bounded essentialized self (natural affinity discourse), accompanied by Western science’s promises of certainty, objectivity and truth that are so appealing. When hegemony is established, providing illusory universal understanding,
shared horizons, and powerful and prestigious identities, it is no wonder that subjects rarely resist these dominant discourses.

Science is presented as a universal and transcendental epistemology by Western civilization; and, it is evident from the data that it continues to be presented and accepted in this way in the field of science education. The fact that science is understood as the way of understanding the world, speaks to the epistemological and ontological dominance of modern Western discourses. Although many scientists and science teachers would argue that universal truth and objective reality are forever unattainable, the field of discourse constructs the science-teacher-subject and acceptable performances of this subjectivity as continuing to carry this illusion.

**The Panopticon, Modern Discourses and the Discipline of the Elite-Science-Teacher-Subject**

Foucault permits us to view the continuation of modern discourses and epistemologies as a product of power and the disciplinary apparatus. Foucault’s disciplinary apparatus, integrally based on the observations of the subject, can be better understood by his conceptualization of the Panopticon. The Panopticon allows an outside observer to observe each individual or cell without individuals being able to know that they are being observed. What results is a continual sense of forever being watched. Each individual becomes subjected to a continual supervisory judgement, hence a level of constant control is established. What we can see from this study is that the science teacher wields both sides of the panopticon. The science-teacher-subject achieves elite status as the primary observer, regulating and controlling the peripheric ring (the students), and bestowing a knowledge system based on certainty, truth and rationality. However, the science-teacher-subject is also the observed as their actions are highly
regulated and disciplined as they function within the hegemony of Western science. The science-teacher-subject is tasked with assuring the continued dominance of rationality, objectivity and progress. The hegemony of Western science is so firmly ensconced that a departure from its expected norms provides little threat to the overall system. In fact, as seen with the postpositivist discourses, such departures are instead likely to be considered evidence that science is as open to alternative thought and ways of knowing as it claims to be.

The dual roles of the science teachers within the panopticon become visible within the stagnancy of science education. The continued failure of humanistic and postpositivist approaches to science, such as STSE, provides evidence of this duality. An examination of the historicity of the science-teacher-subject shows a changing and sometimes contradictory positioning of the science teacher, but ultimately, the science teacher is revealed as a subject of Western rationality and certainty. The hegemony present in these modern discourses inhibits curricular change by disciplining the performances of the science teacher subject. The attempt “to do things differently” continues to fail because of the requirement that certainty and reliability must be maintained. As Aikenhead (2006) describes, school science as a discipline is crucially outdated, but politically, traditional science curriculum is far from being out of date.

We can read from the data that science education remains firmly ensconced in modernist and capitalistic discourses. The actual science curricula (what is taught in the classroom) is an entrenched curricula, a curricula that maintains and disciplines subjectivities associated with science and the epistemological dominance of Western thought. “Thus historical precedents and the ensuing politics of social-class privilege, not
consensus, buttress the traditional science curriculum today (Carlone, 2003, p.23). The buttressing to which Carlone refers takes place through the disciplined performances of science-teacher subjects.

It is often stated that we are currently living in a postmodern world: a world where the atrocities of the Second World War jarred society out of a modern paradigm, a world where “all belief in the moral neutrality of science should have vaporized in the searing hear of the Hiroshima explosion” (Solomon, 1994, p.10). Despite multiple calls for a genre of science education that embraces postpositivist philosophies, the field of discourse reveals a reality far from this postmodern vision. Claims of truth, reality and certainty are attractive epistemological goals that inherently conflict with a postpositivist approach to science education. Dominant institutions have a tremendous capacity to regenerate themselves “not only in their material foundations and structures but in the hearts and minds of people” (Apple, 2000, p.192). I read the data to show that the regeneration of hegemony of science is institutional but it is also corporeal, the science teacher as a subject that is tasked with this renewal. We say the science teacher is elite because they are part of the regime of truth that is Western science.

The science teacher is constructed and controlled by the disciplinary apparatus of Western science, they are imbued with power through their association with scientific knowledge, however this status comes at a cost, the maintenance of the status quo. Nietzsche warns that “One seeks a picture of the world in that philosophy in which we feel freest; i.e., in which our most powerful drive feels free to function” (quoted in Spivak, 1974, p.xxvii). The “picture of the world” that science teachers adhere to is one based on the modern discourses of certainty, rationality and universal truth because it is
within this paradigm that they are interpolated as powerful subjects. The science teacher maintains the hegemony of Western science while receiving an elite status through his/her performances of its discursive norms.
Chapter Seven:
Agency and Navigating the Contradictory Discursive Field

The data provided by the thirteen participants provided a new understanding of the subjectification of the science-teacher-subject. Despite an abundance of evidence of epistemological and ontological discipline, I read the data to show that subjectification is not simply a unidimensional enactment or embodiment of discourse, subjectivity is produced by the subject interacting with a complex discursive field. The discipline and hegemony in the field of discursivity does not produce a homogenous lockstep performance by science-teacher-subjects. Although subjects may articulate definite positions to which they aspire, the contradictions and multiplicity present in the field inherently undermines this singular vision.

Within the hegemony of science, the science teacher is unable to change the way science is lived and taken up by the social body. However, as personally experienced and described in my opening vignette, the data show that teachers are still drawn to teaching science differently. In the midst of hegemony and discipline, science norms and discourses do shift and provide the potential for agency. Science teachers exist, perform and live in these contradictions. Although the way science is taken up by the social body is unlikely to change, such discursive intersections and contradictions provide opportunities for the creation of new discourses as they allow the subject to enact agency (Fairclough, 2003). These contradictions and “gray areas” can be starting places for rethinking how science is (re)considered, debated and discovered in a classroom.

Zizek and Fiennes (2013) explain that an individual is not a complete product of objective circumstances, all have a margin of freedom. I propose that this ‘freedom’ is not from discourse itself, as there is no outside of discourse, but rather a freedom to
navigate the field of discursivity. What is remarkable in the data is the impact of both the social reproduction of hegemonic discourses and simultaneous enactment of agency as these discourses intersect and are mediated by the experiences of the participants.

The discursive field produces the subject, but so too does it provide alternative discourses and subjectivities in order to refuse the dominant discourses of the field, as Foucault states “resistance is never in a position of exteriority in relation to power” (1980, p.94). Resistance and agency do not come from a prediscursive realm (Dunn, 1997), but are a product of the contradictory nature of the discursive field itself. To exemplify this creation of space for agency and resistance, three discursive contradictions in the data will be shared, followed by Ben’s experience as he enacts agency navigating the *curriculum as content* discourse.

**The Passionate Science Teacher and Science as an Emotionless Endeavor**

As was previously explored, the participants often constructed the “good” science-teacher-subject as having an innate passion for the sciences:

Samantha: When you’re passionate about it, things just fall into place, right. Your explanations fall into place when you’re passionate about it.

Geneva: I have never met a science teacher that is not passionate about science. And I think that’s crucial to them sharing their knowledge with their students. Even as a student I knew my teachers loved doing it, that was evident.

Jennifer: I don’t think it’s the same experience for them [students] as having someone who is passionate about it. I would always start my classes be telling students that I went to school to teach science, and I love science that I was hoping that they would be able to see that through the ways that I thought it.

The discursive contradiction arose as the participants also described science as an emotionless endeavor. Soon after Jennifer commented on the importance of passion for
the science teacher, she described the importance of not approaching science from an emotional perspective. This same approach was echoed by John.

Jennifer: In science, instead of looking at it [the world] from a feelings or a thoughts standpoint, it looks at it from a more [pause], I don’t want to use the word scientific but like a more logical perspective as well.

John: I think a science teacher may have their emotional aspect to it, but they tend to keep it more distant and separate. Again, because science to me seems like its back or white, it’s the way it is.

The discourses of the passionate science teacher and emotion not belonging in science were two powerful discourses in the field. Science was constructed as an objective endeavor far removed the subjective influences of emotion, philosophy and ethics, while concurrently relying on the passion for science as a fundamental characteristic of the science-teacher-subject. It is within the inherent contradiction between the discourses of the passionate science teacher and emotion not belonging in science that the potential for resistance and agency exists. The performances of the passionate science teacher breaks down the modernist motion of science as an emotionless, objective endeavor. On a secondary level, acceptable iterations of science teaching move beyond the detached transmission of content toward the inclusion of emotionality, curiosity and wonder. The contradiction opens up the space for agency and resistance, thereby re-integrating science as a deeply human endeavor. It is irrelevant whether the subject adopts the passionate science teacher subjectivity or a modernist approach to science as there exists a multiplicity of differing discourses in the field.
Postpositive and Modern Epistemologies of Science

Michelle and Michael spoke of the fluidity of science knowledge, characterised by uncertainty, and contestation.

Michelle: People often say ‘scientists don’t know what they’re talking about, one proves another one wrong every other day’.

Michael: Even scientific knowledge changes. Things change [they] don’t stay same. You have to keep on top of things. You have to be aware that what you are taught one day can be something different later.

In contrast, Stephen, Eric and John, described an epistemology of science characterised by certainly, stability, and clarity:

Stephen: I may be wrong but science is pretty black and white and that its yes you do, or no you don’t, or this is correct or this is incorrect. Very factual. For the most part in science either its right or its wrong.

Eric: Our [science teachers’] expectation is that you need to know the same things that you need to know 18 years ago.

John: You know it’s just science, it’s factual. Coming back to psychology again, just because it’s my area: a lot of it is unknown, and you’re still dealing with different cases every single time. Whereas science is factual right, its black or white, it’s a or b.

These two epistemic discourses reflect a tension between the modernist notion of science progressing towards universal truth and the belief in an inherent uncertainty in scientific knowledge. There were numerous references in the data to changing theories, scientific paradigm shifts, and incorrect scientific assumptions and yet the view that scientific research led to truth and reality remained equally powerful.

What is striking in the data, is the participants’ ability to simultaneously navigate and perform these two polarized discourses. On the surface it would seem that the performances of these discourses would be mutually exclusive, however, the data
revealed a different picture. The participants often subscribed, in both their descriptions of science and their own performativity, to both contradictory discourses of science. The polarity of the discourses creates an entire continuum for subjects to draw upon for their desired pedagogical performances. The variations and contradictions within the discursive field offer a plurality of points for resistance and agency.

**The Elective Paradox**

A central discursive tension arose as the participants discussed whether the senior level science courses should be classified as mandatory or elective for students. The science teacher participants in particular struggled when asked if students would benefit from more science courses. A paradox arose due to the status of science knowledge and science class: the science teachers felt that their courses were important for all students to take, encouraging a mandatory classification, while simultaneously wanting to keep the high standard that came with senior sciences’ elective status. The elective status was exemplified as Susan categorized those students who take all their science electives.

If students are taking Chemistry 30 or Physics 30 or Biology 30 as an elective, that also says something about the students taking those courses.

I asked Susan to tell me more about what this “something” was.

It says, academic, strong students, goal oriented, self-directed, mature, up for a challenge. So you’re getting the elite students in those courses. Because it’s an elective.

I asked Ben what he thought about a policy change that would make senior level science mandatory.

Well it would be tough, you’d have more students. More students would, would fail classes. Because there are some that are not either intelligent enough, or not willing to put in the work that’s required, they’re just too lazy to pass some of these courses. So you know, you’d just have to deal with the fact that you’d have some higher failure rates. Right now we just allow the cream of the crop to take your Chem. 30, so failure rates are going to be really low, if everyone had to take
Chem. 30, more would fail. You could do all you can to help these students with different programs, you could lower the bar if you wanted, you could set up tutorials but your overall average will certainly drop.

In studying Ben’s response, a complex combination of discourses emerges. He claims a mandatory classification of science would lead to higher failure rates due to certain students being “not intelligent enough”, “not…willing to put the work that’s required” or “too lazy”. The assumption of his statement is that those who take senior level science are intelligent enough and those who do not, are not. The second section of Ben’s description is inundated with elitist discourses, stating that “we only allow the cream of the crop” and do not want to “lower the bar” so that more students are successful. Ben’s final utterance that “your overall average will certainly drop” again reinforces elitist discourses in science education. The concern over a reduction of the class average, through the inclusion of non-science (synonymously described as less academic students) can only exist in an elitist framework. The perspective that inclusion will lower the standard, elevates the status of science class, science students and the science teacher. Furthermore, the use of the phrase “cream of the crop” is telling in that it broadly defines those students who are able to excel in science as simply better than “other” students. Said differently, success in science indicates superiority.

As Michael and I spoke about the mandatory and elective classification of science class, he reinforced the status that accompanies senior level science.

I haven’t been a teacher for long, but since you have everyone taking grade 12 English, as bad as it sounds, you’re getting every level from the most struggling students to the top tier. So the standard is potentially lower, when you’re marking something. In science the expectations is, going into the class first day you’re talking about your syllabus the first thing, [you are explaining] this is a tough class or you have to work at it, you have to keep up with your assignments. It’s already embedded into the whole persona of the class that you’re getting the top tier, if it’s an elective you’re getting higher quality students in terms of their work ethic.
Michael uses English as an example of a class where the standard is lowered due to its mandatory status that must include even those whose first language is not English. He then contrasts science class as being for “top tier” and “higher quality students” students, due to its elective status. I asked Michael if he thought that one senior level science for graduation was adequate.

Yes and no, I think that it’s enough, yes, for those students who are way below average and know that they just need these credits to graduate and be done with school, and are just kinda there to play the motions right? But the ones that we know are going to go to post-secondary and try hard and are the ‘good kids’, those are the ones that would benefit to have [more science].

In Michael’s response he immediately creates a boundary between the students who are “below average” and “just need these credits to graduate” and those “good kids” that are going on to “post-secondary”. Michael’s description constructs, through elitist discourses, the view that additional science knowledge is only for one type of students, namely those who are planning on attending postsecondary institutions. Defining senior science courses as electives, produces a discursive conflict between the dominantly stated goal of science education being beneficial for all students and the elitist discourses previously discussed. The definition of senior science as an elective paradoxically devalues the class (and knowledge) in its lack of mandatory status while simultaneously contributing to its elite status.

These two contradictory views of science education provide an opportunity for teacher agency and resistance. It is important to note that the participants did not explicitly speak or share examples of agency within the elective paradox. However, the strength of this contradiction illustrates the availability of differing discourse that can be enacted. Despite the discipline discussed in chapter five, the science-teacher-subject is not destined to see science class and science teaching in one way or for only one group
of people. The contradictions found in the aforementioned discourses provide the basis for agency and resistance. In this vein and as demonstrated in the data, even in a discursive field inundated with hegemonic discourses there remains space for agency and resistance.

**Contradictions and Agency: Ben’s Experience**

The precursor to the enactment of agency and resistance often took the form of an inner tension as the participants encountered contradictory discourses and mediated them with their own experiences. When the participants described using alternative teaching approaches, structuring their classroom differently, or questioning aspects of science and its aims, they were enacting agency by adopting competing discourses in the field. Ben provided a well-articulated example of the possibility of agency, through an inner tension, as he discussed his experiences with the *curriculum as content* discourse. His experiences were often characterized by trying, but struggling, to move away from a content focused pedagogy.

> When I’m teaching a new course, I find that I am more content driven than I want to be. I hope to move away from that as I teach it more often, and start to build in some more activities and labs. I think the content is important but I don’t want to be overly content driven. My very first few years of teaching, I think it was sort of that way [overly content driven] and then as time went on we start to build in more activities or labs, or assignments, and it became less of me teaching and more of me being sort of that facilitator.

Ben describes content as important but then states that he does not “want to be too content driven”, identifying himself as overly content driven in the past. Ben’s description constructs a difference, and an inner tension, between two competing subjectivities, that of “teaching” (constructed as delivery of content) and “facilitating”. Although Ben initially identifies this tension as “in the past”, the tension is still clearly present as Ben self-describes as struggling with overly content driven pedagogy while...
planning a new course. I asked him to further explore where the “push” to cover content came from.

I think it’s always been there, I think that the curriculums are thick in science. I think with some of the other courses that I’ve taught numerous times I’ve actually just started to weed out some of the things that I’ve realized I don’t really need to do. Even though in the beginning I thought, ‘yeah I have to cover that, it’s implied through the curriculum that I should cover that’. I just started thinning some things out because you can’t do it all. I think it’s always been there, but willingness to not have to cover every single little thing with the new curriculum. You don’t have to hit every indicator and that’s O.K. And as I’m planning it, looking back at what did the first half and I’m going to try to do just a little less [content], expect a little less in terms of the details. I guess it’s the depth of knowledge that bogs you down so much.

Ben identifies the “push” as “implied through the curriculum”. He describes the curriculum as “thick” and “bogged down”, then discusses his own agency as he has started to “weed out” and thin “some things out”. Ben’s descriptions contain negative metaphors for an overly content driven curriculum, while simultaneously highlighting his own ability and agency to determine what is best for his students. I then asked him if he believed that science teachers were generally able to navigate heavy content.

Some yes, some no. I’ve worked with some very closely who really struggle with that. And slowly after semesters and years of working together they have started to let go of that and are starting to realize ‘hey you know what, there’s even less stress on you as a teacher if you don’t try to squeeze so much in’. You can still get there [end of the course] and still do a very competent job of teaching all those different parts of your course but do you necessarily have to go into that much depth. Then it frees up just a little more time in the entire course. You’re not quite under the gun so much then, in terms of ‘oh, no I’m already three days behind because of this that and the other thing’. You also have more time for labs and things like that, you’re not quite as much under the gun to get your units covered.

Ben’s description speaks to the pressures of a content driven curriculum, characterized by “being under the gun” and “squeeze(ing) so much in”. Contained in his description is a difference between those teachers who enact agency as they navigate the *curriculum as
content discourse and others who succumb to content-based performances. The difference here is noteworthy, as it demonstrates that not all subjects interact, perform or are subjectified the same way by discourse. Ben continues to exhibit discursive agency in the face of content driven discourses, as he shares his view that you can “still do a very competent job of teaching” without going “into that much depth”. Ben’s description exemplifies the agency of teachers in the field as his performances are not fully determined by a single dominant discourse. As Butler (1990) explains, agency is located within the possibility of a variation on repetition. When Ben navigated these two competing discourses his pedagogical performances were not simple reiterations of discursive norms but he re-signified the discourses and made them uniquely his own.

Science teachers are not fully represented and subjectified by one discourse, it is within this failure that subjects enact agency in the discursive field. Just as the subject can never fully become, the failure of discourse to provide full identification is the reason that agency and resistance exist. The conflictive discursive field itself holds the possibility of resistance and agency; alternative discourses are always present, even in the presence of the powerful discourses of Western science. Hegemony does not eradicate agency. As Cameron (1992) says: “No individual and no group, however powerful, has the ability definitively to ‘fix’ the creative play of meaning” (p.195), nor in the case of this study, one’s subjectivity. The subject of lack’s reliance on discourse for identification paradoxically subverts the hegemonic apparatus that promises a particular identity.
Resistance, Agency and the Full-Fledged Science Teacher

Chapter two began with a reflection of a pre-service teacher and his goal to become a “full-fledged” teacher. This Ideal-I (Lacan, 1977) conceptualisation of the science-teacher-subject, however, is not fixed, it is illusory and imagined. Subjects perform particular discourses to be recognized as particular types of people but what is enacted differs from the imagined ideal, resulting in a degree of agency within the field of discursivity. Agency and resistance are made possible by the contradictory nature of the field itself as the multiplicity of discourse in the field permits a multiplicity of performances and subjectivities. The Ideal-I is not a unitary construct nor a transcendental signified (Derrida, 1967), therefore the subject is not fully defined and it is within these variations that agency and resistance exist.

Reflecting on agency and resistance from a genealogical frame, the “full-fledged” or Ideal-I science-teacher-subject is a subjectivity that has historically been constructed as white, Western and male. As such, the enactment of agency and the ability to resist dominant discourses is not equal for all subjects - white Western European men have been given the social capital to define the position itself and are therefore more easily recognized as a science-subjects. Those who are not as easily recognized as science subjects due to gender or race, do not have the same “freedom” to counter dominant discourses. Although one’s subjectivity must be continually performed, the condoned performances for those not seen as the imagined ideal must be narrower in focus. Returning to the data, Ben was more easily able to counter the curriculum as content discourse because he was corporally recognized as a science subject.
Chapter Eight:
Concluding Thoughts

My research employed a poststructural conceptualization of the subject to explore the discourses that subjectify the science teacher. The aim was to identify and analyze some of the subjectifying discourses in the field of secondary science education and to seek a deeper understanding of the historical, political and social contexts from which they arose. Disseminating from this primary aim, this thesis focused on two lines of inquiry: What are the discourses that subjectify the high school science teacher? And, why do we say the science teacher is subjectified in these particular ways? Using a discursive analytic, the study focused on the various descriptions and versions of science teacher identity as described by thirteen secondary teachers while drawing upon Foucaultian genealogy to demonstrate the implementation and performances of these “historical” discourses in the classroom. The research and analysis was not aimed at obtaining the “truth” of what the science teacher is, but a recognition of the science teacher as a genealogical formation integrally connected with power and knowledge.

In this dissertation I put forth a new consideration of the construction of the science teacher: The dissertation presents and exposes a field that is inundated with a cacophony of subjectifying calls (Britzman, 2003) that paradoxically produces the illusion of a bounded, homogenous science-teacher-subject. The science teacher was depicted in the data as a passionate subject that holds a natural affinity for science and teaching science. Science teachers were also described within a neoliberal and capitalist narrative as the gatekeepers to personal and societal advancement, opportunity and financial stability. Alternatively, the science-teacher-subject was constructed as a modern subject. Within this subjectivity, the science teacher was charged with
maintaining the hegemony of the narratives of enlightenment and modernist science. In contrast, the science teacher was also seen to be a postpositivist subject that is responsible for encouraging critical thinking and drawing connections between science, technology, society, and the environment.

Despite this cacophony of diverse subjectifying calls, the interpolated science teacher was continually given status and a powerful social position while being disciplined to maintain the hegemony of Western science. Following Butler (1995), mixed up with the science teacher’s mastery in performing these dominant discourses was a submission to a highly disciplined subjectivity. The science-teacher-subject gained status as he/she continued to propagate the powerful knowledge/power constellation (Foucault, 1980) found within the hegemony of Western science. We say the science teacher is elite because he/she is subjectified as an agent of the hegemony of Western science.

**Continued Hegemony and the Science-Teacher-Subject**

In 1831, the British Association for the Advancement of Science invented the term scientist. The subjectivity of the scientist achieved an elite status for the upper class, white, Western men who were recognized by it. The new term arose from a desire to create a boundary between those who practiced the pure natural philosophies and the technologists who applied such knowledge. This elevated social positioning, however, was also epistemologically grounded by the perceived ability to grasp universal truth through rational and objective thought. One may presume that over the last three centuries the elitist and modernist discourses of science and science education may have
been tempered. However, the data from this study depicts a different and sobering reality. Such modernist discourses prevail in the field of secondary sciences:

Jennifer: I like science because it’s so linear, because there’s a right answer and because it’s not wishy-washy.

Joanne: Instead of looking at it from a feelings or a thoughts standpoint, [science is about] looking at it from a more logical perspective.

Michael: It [science] is completely unbiased of everything, because of unbiased observation and deduction. So I don’t think it [philosophical discussions] belong in the science class.

Eric: [In social sciences] you won’t be able you say things definitively, which is what science aims to do. Science talks about things objectively.

John: I think science teaches may have their emotional aspects, but they tend to keep it more distant and separate, because science to me seems to be black or white, it is the way it is.

Despite the widespread rhetoric of science education evolving from its modernist roots, the discourses of both science and science teaching remain firmly ensconced within a modernist paradigm.

Rather than diminishing in strength, these modernist discourses have been bolstered by capitalistic narratives. Science is still seen in its triumphal state. During colonial times, science was accepted as the means and method of achieving a utopian society of plenty – one based on Western conceptualizations of an ideal society.

Although the semantics have changed, the data from this study reveal that the current discourses in the field are remarkably similar:

Susan: [Science] is what’s going to solve things in the world.

Cassandra: I think that a good understanding of science is essential for the world to continue to grow.

Michael: Going forward, society is actually getting more sophisticated because of our understanding of science. It really does come down to the push in our society for innovation, really boils down to math and science for innovation. That doesn’t
mean English and all the other stuff is useless, of course, you have to be able to
do those other things as well.

Eric: If we don’t teach them [students] science, then they’ll be an unfortunate
drop off in the human time period. They’ll stop learning science, they stop
understanding the world about them to a deeper extent. So things would just stop.

The findings of this study have implications far beyond the science classroom.
The revelation of the pervasiveness of modernist and capitalistic discourses in science
teaching alludes to a greater global hegemony. Science is accepted by the social body as
the means for society to develop and advance; in fact, development and advancement
have become synonymous with science.

My dissertation opened with a vignette that explored my own pedagogical
struggle which mirrors the plight of science education worldwide: the failure to move
away from archaic pedagogies based on the transmission of canonical science content.
Secondary science education finds itself faced with students’ disenchantment with high
school science (Cleaves, 2005) and declining enrolments (Osborne, Simon & Collins,
2003; Dekkers & De Laeter, 2001), however, these realities are the proverbial tip of the
iceberg. Such surface evidence is symptomatic of deeper discursive issues. This work
has shown that when questions of pedagogical stagnancy arise a more complex view of
science and science teaching must be considered. The subject position of the science
teacher is not isolated from the social body (although the subjectivities of science are
often interpreted as such), but is integrally connected to the social body and therefore the
hegemony of its ideologies. To move towards a greater understanding of the stagnancy
of science education, one must understand the role of hegemony, power and discourse in
the construction and discipline of the science-teacher-subject.
Science educators speak of inquiry learning, innovative assessment practices, advances in educational technology, and a renewal of environment awareness. Yet these conversations, although constructive, do not consider the foundational questions of science education that need to be asked. It is much easier to take up the science teacher identity and pedagogy in limited and familiar ways than to understand the global hegemony in which the science-teacher-subject is constructed. We examine classroom pedagogy in limited ways, bounded by school lines as if the larger historical and societal contexts make little difference. Given the dominance of the hegemony of Western science and the impossibility of our present lives without it, the science education in schools is just about the only part that we can actually grasp. It is for these reasons that research into science education cannot solely consider the science classroom; it also must deconstruct the discourses that construct science and the science-teacher-subject.

**Power, Knowledge and the “Truth” of the Science-Teacher-Subject**

My research into the subjectification of the science teacher involved identifying the discourses that subjectify the science-teacher-subject and examining the circulation of power and knowledge within these relations of power. Although my research and analysis could be interpreted as a critique of science itself, critiquing is not synonymous with devaluing: A critical approach does not detract from the value of science nor the benefits science knowledge has brought humanity. As Foucault (1982) explains, the questioning of knowledge is not a “skeptical or relativistic refusal of all verified truth. What is questioned is the way in which knowledge circulates and functions: In short, it is a revelation of a “regime de savoir” (p.781). My goal in writing this dissertation was to present science education in a fuller, more integrated way by acknowledging the
discourses of science as human constructs that are integrally connected with history, society, politics, privilege, marginalization and ultimately with power.

Foucault (1980) explains that knowledge is power and Western science and the science-teacher-subject does not escape this truism. What is criticized in my work is the masking of the relationship between scientific knowledge and power. The study of the subjectification of the science teacher is not simply an analysis of the “truth” of what a science teacher is, rather it is an examination of how the science-teacher-subject is a genealogical formation, one that does not transcend power but is intrinsically dependant on it for meaning.

In this study, I have followed the example of Foucault (1994) in his *The history of Sexuality* to frame the question that is central to this study: “Why do we say the science teacher is elite?” I return to Foucault’s words in this extended quotation in which he explains his rationale for addressing the topic of sexuality in this way:

I wanted to undertake a history in which sexuality would not be conceived as a general type of behavior whose particular elements might vary according to demographic, economic social, or ideological conditions, anymore than it would be seen as a collection of (scientific, religious, moral) representations which, though diverse and changeable, are joined to an invariant reality. My object was to analyze sexuality as a historically singular form of experience. Taking this historical singularity into account does not mean overinterpreting the recent emergence of the term “sexuality,” or taking it for granted that the word has brought in its trail the reality to which it refers. Rather, it means an effort to treat sexuality as the correlation of a domain of knowledge, a type of normativity and a mode of relation to the self; it means trying to decipher how, in Western societies, a complex experience is constituted from and around certain forms of behavior: an experience which conjoins a field of study (connaissance) (with its own concepts, theories, diverse disciplines), a collection of rules (which differentiate the permissible from the forbidden, natural from the monstrous, normal from pathological, which is decent from what is not, etc.), a mode of relation between the individual and himself (which enable him to recognize himself as a sexual subject amid others). (1984, p. 333-334)
Borrowing Foucault, I can illustrate what it is that my work, in part, examines:

“of the term ‘[science teacher],’” I am not “taking for granted … the reality to which it refers. Rather, it means an effort to treat [the concept of science teacher] as the correlation of a domain of [science] knowledge, a type of normativity and a mode of relation to the self; it means trying to decipher how, in Western societies, a complex experience is constituted from and around certain forms of behavior: an experience which conjoins a field of study (connaissance) (with its own concepts, theories, diverse disciplines), a collection of rules (which differentiate the permissible from the forbidden, natural from the monstrous, normal from pathological, which is decent from what is not, etc.), a mode of relation between the individual and himself (which enable him to recognize himself as a [science-defined] subject amid others). (1984, p. 333-334)

One of the points in Foucault’s The History of Sexuality is not that the discipline of sexuality gave rise to perversions and pathologies of the sexual instinct. Rather, sexuality became something that could be talked about, something that could be governed. Similarly, this examination of the science teacher and the concept of science teaching, as well as Western science, does not take up whether there is “rightness” or “wrongness” to the depiction of the science teacher or of science. My study is not a critique of science, although it may appear that way. Rather, at issue is the type of power that discourses and institutions “brought to bear on the body and on sex [read: science and the science teacher]” (Foucault, 1980, p. 47). In parallel to the above, this study traces the construction and performativity of the science teacher and, by implication, Western science in which the racialized, classed and gendered identity is embedded. The discourses of Western science—whatever they may be—are so thoroughly normalized as to allow lines of “indefinite penetration” on the part of powerful interests that underscore white supremacy, capitalism and Eurocentric forms of knowledge. In this way, a
particular concept of science is made available, controlled and disciplined in classrooms while the examination of foundational systems of Western science and knowledge remain seemingly unfathomable and unquestionable.

Moving Forward: Implications and Recommendations

My study’s aim was to construct and reveal new knowledge to further our understanding of the subjectification of the science teacher. My aim was not to recommend a better or more effective pedagogy as I sought to avoid contributing to a field dominated positivist approaches to education. Such positivist pedagogies are filled with claims of clarity, certainty and objectivity, the very discourses that this study problematizes. The data and analysis themselves are therefore not meant to be suggestions for improvement per se; they are meant to examine foundations of how science may be understood as a “regime de savoir” and so to build on how we might consider the potential of science knowledge and pedagogy. The construction of new knowledge, regardless of its theoretical framework, will always have a ripple effect that carries with it implications and recommendations.

The Weakness of Poststructural Discourses and Teacher Education

Traditionally, teacher education programs have tended to focus on the skills, content knowledge and instructional approaches that are deemed necessary for teaching. In recent years, many postsecondary institutions have begun to incorporate critical theory and critical pedagogy, expanding the curricular focus to issues of race, gender, inequality and social justice. This paradigmatic shift emphasises the importance of socially conscious students and the promotion of critical pedagogy in all schools. Such a view is in line with Pablo Freire’s (2000) understanding that education must look towards the
future, rather that the replicating the past. Freire’s vision, when coupled with the data in this study, gives rise to a number of important implications for future science teacher education.

The first implication is based on the revelation of the relative weakness of postpositivist discourses in the field of science education. Postpositive approaches to science education were present in the data but participants often described feeling isolated, on their own, or unable to perform these alternative discourses. This was captured in my exchange with Michelle:

Like you’re never taught any of that stuff. You’re not even taught. I felt that I really learned nothing in my education classes, my science education classes. We went on a field trip and looked at some native prairie and had a discussion about water for an hour. We were never taught. I don’t know any better and yet you’re expected to do it.

Postpositive discourses were relatively weak compared to the dominant (modernist and capitalist) discourses of science education. New teachers are often shaped by dominant discourses as they work to self-identify with the expected characteristics of the science-teacher-subject, a recognition that offers status to teachers who offer normalized performances. The implication here is that these critical or postpositive discourses need to be introduced and sustained throughout teacher education. It is not enough to introduce these topics in general courses aimed at encouraging critical pedagogy; they must be an integral and interwoven component of science methods courses themselves. When the discourses of the plurality of knowledge, social justice, and the politics of science are presented as separate from science methods classes, they are understood to be separate from science, and are at risk of being seen as an “add on”. The devaluing of these postpositive discourses was illustrated in the data with the relative weakness of postpositivist-based pedagogies. The participants verbally valued these approaches but
only if they “had time” (Michelle) or “didn’t have so much content to cover” (Ben). These alternative discourses may be a component of the subjectivity of the generalist, but they are not realized in science education because of the hegemony present in the discursive field.

The continued failure of reform in science education is not predestined to continue and herein lies the value of the knowledge constructed in this study. When hegemonic discourses are revealed as social constructions, subjects begin to realize the ‘self’ as a social and political artefact. Teacher education is the place where these new realizations and theorizations need to be introduced and sustained. Teacher education programs would benefit from providing a strengthening of alternative discourses before beginning teachers are caught in the disciplinary relations of power that is the field of science education. Only through education and recognition can hegemonic discourses be undercut, refused and no longer be performed as if they were the first or only choice.

**Contradictions and Tensions in the Field**

The data from this study revealed a field of discursivity dominated by the hegemonic discourses of modernity. It would seem from the data that alternative discourses are doomed to fail if these discourses intersect head-on as they are inscribed on the subject. The dominant discourses in the field afford great power, prestige and status to the science-teacher-subject. Science-teacher-subjects like what is said about them and are therefore reluctant to give them up. A paradigm shift is required.

Kuhn (1962), in his seminal publication *The Structures of Scientific Revolutions*, explains that a paradigm will only be replaced when anomalies associated with the current paradigm accumulate. Just as the retrograde motion of Mars indicated a failure of
the geocentric scientific paradigm, so too does an understanding of competing discourses in the field of science education begin to destabilize the hegemony of Western science. I experienced this destabilization with my participants as our discussions descended into deeper levels of meta-awareness. On two occasions, participants came back on their own volition to further discuss issues that had arisen. For example, Ben and Michael returned to ask my opinion (or “what I thought”) in an effort to turn the uncertainty our previous conversations precipitated into consistency and clarity. Ben returned for casual conversation and asked me: “What do you think secondary science should be? Elective or mandatory?” I replied that I did not know and that I did not have the answer. Ben had lived with this internal discursive conflict during his 20-year career, without ever addressing it. As was discussed in chapter seven, his personal conflict was a starting point for a deeper critical conversation about our beliefs of science and science education.

A similar conversation occurred while I discussed the place of philosophical debates in the science classroom with Michael. He attempted to separate science from emotion and philosophy, stating “I don’t think they [philosophy and emotion] belong in a science class”, and “[the goal of science is] to talk about things objectively”. When I asked him about a previous comment concerning his own passion for science and his need to present science curricula as emotionless and objective it gave him pause. Within this pause an opening of space was realized, a space where certainty and clarity gave way to complexity and meta-awareness. The revelation of the contradictory field of discourse is a starting point for these critical conversations.
The illusory structure of foundational or essential beliefs crumbles with an analysis of discourse. That seen as logical, clear, and objective, in the context of the subjectivity of the science teacher, is revealed as a situation fraught with inconsistencies, false dichotomies, contradictions and paradoxes. The field of discourse is in constant competitive flux, and so too are the subjectivities influenced by these discourses as they are dependent on the field for identification. It is within these contradictions, paradoxes and in-between spaces that the evolution of science education can occur.

**Towards a Pedagogy of Uncertainty**

It is clear from the data and analysis that we currently exist in an epistemological paradigm where we believe that knowledge should bring about clarity, certainty, and comfort. However, Boler (1999) writes of a pedagogy of discomfort, the view that knowledge and deep understanding do not bring comfort and clarity but rather discomfort. This is an emergent discomfort as the subject sees the injustice, violence and relations of power present in what is traditionally accepted as the neutrality of knowledge.

As the field of discourse is revealed in secondary science education, a need emerges to embrace a pedagogy of discomfort. It is a need to move away from the modern discourses of certainty, black versus white, and universal truths if the progression/evolution of science education is desired. In line with Boler’s (1999) theorization, science education must move away from certainty and towards a pedagogy of uncertainty, embracing science as a messy human endeavor that is integrally linked with culture, power and politics. Pedagogy must progress towards presenting science as an integrated knowledge system, and must understand that this evolution will not bring
with it enlightenment but rather uncertainty and discomfort. The discourse must shift to
appreciating the value of uncertainty. It is with this pedagogical shift that postpositive
subjectivities of the science-teacher can begin to gather more strength in the field of
discourse.

Recommendations for Further Research

First Year Teachers

My study provided an understanding of the dynamic field of discursivity that
subjectifies the science teacher. The process of subjectification is inundated with
relations of power between subjects and the discursive field. The subject is constructed
by the violent pushing and pulling of discourse, typified by observation, discipline,
judgment and agency. What is noteworthy is that subjectification is a process that often
passes unnoticed by the subjects’ consciousness as they become accustomed to the
discursive field. As teachers progress in their professional careers their subjectivities
becomes more sedimented and less malleable. Alternatively, beginning teachers may
even enter the field drawing on alternative discourses for a sense of professional self.
However, Alger (2009) asserts that preservice teachers’ identities are subject to radical
change once they move away from their postsecondary education. Beginning teachers
are more susceptible to being disciplined early on in their careers.

A research agenda focused on teachers and their identities as they enter their first
year of teaching would reveal much in terms of the power dynamic in the field of
discursivity. Beginning teachers have a particularly strong drive to become, to embody a
subjectivity that they have sought throughout their postsecondary education. It is not that
first year teachers present an empty tableau; rather, I propose that their subjectivities as
full-service science teachers are far less developed and sedimented than those who have
been in the field for an extended period of time. A valuable future research agenda would
be focused on understanding how first year teachers are subjectified, disciplined, and
how they exude agency during their first year of teaching. Such a study would aim to
understand how the discourses present in postsecondary education intersect with the
discourses and subjectivities present in the field. If the growth of science education is
sought, an awareness of discourse is not enough. We must also understand how
alternative discourses intersect with the field. A sound starting point to establishing such
an understanding would be to work with first year teachers.

**Longitudinal Study**

My study focused on a ‘snapshot’ in space and time. A spatial and temporal
boundary was necessary within the constraints and timelines of my doctoral work. The
‘snapshot’ encompassed the current field of discourse and contextualized the identified
discourses within their socio-historical milieu. However, an understanding of the
subjectification of the science teacher would benefit from a longitudinal study of a small
number of participants as they progress in their careers as science educators.

My study revealed that teachers often subscribe to a humanistic and modernist
view of self. This view is conducive to seeing self and identity as essential and
unchanging. A longitudinal study focused on the changing self is required as one can
only understand so much by examining discourses in a relatively short professional
period. A longitudinal study would also allow for a greater understanding of the dynamic
nature of the way subjectivities and discourses are embodied and agency is enacted.
The process of subjecification is dynamic, incessant, and always in a state of flux. These dynamic aspects of subjecification were revealed only by the participants’ verbal descriptions. A longitudinal study could also provide a more detailed focus on the categories of descriptions and allow for data to be gathered from multiple sources of discourse. I believe that important data would be generated working with teacher participants for a number of years focusing on both spoken and performed discourses. Specifically, I believe that a focus on the performativity while engaging in genealogical-based archival analysis would be beneficial. A narrower focus would enable the researcher to gather performed and enacted discourse as well as delve deeper into the historical/genealogical contexts of these discourses.

**Concluding Thoughts**

**On Desire, Hegemony and Marginalization**

We are forever subjected to performing normalized roles in order to be recognized and recognize ourselves as particular types of people. However, such discourses are not simply imposed on the subject. Instead, we are subjectified wilfully through the interaction between our desire for privilege, power, and acceptance and our exposure to the social world and the discourses it manifests. Consequently, as Zizek and Fiennes (2013) explain, stepping out of ideology hurts. It can shatter many of our comfortable illusions and thus is a painful experience that must be forced. It involves questioning accepted truths, a process that “makes you face complexity, [and] makes you face internal critique” (Lather, 2007, p.26). The data from my study showed that participants mostly navigated the field in such a way that upheld their subjectivities and their status. The participants benefit from these dominant discourses and thus the
science-teacher-subject continues to project and reaffirm such hegemonic discourses as truthful.

Hegemony promises certainty, fulfillment and universality, leading us to believe that all should partake in this universal good, defined by what is true and right. However, the promise of universality is illusory: such promises are not for everyone, someone is always excluded, and the other is always created. Similarly, Western science, as a hegemonic system, promises certainty, universality, clarity and status for its practitioners but at the expense of the marginalized other. The push and domineering presence of the elite science-teacher-subject therefore does great harm for those left on the outside. As Donald (2009) explains, aboriginal peoples and Europeans [are] on opposite sides of the palisades; they “inhabit separate realities” and these divisions become “part of the official curriculum documents and find expression in the form of outcomes, goals, and objectives” (p.4). Subjectivities based in Western science always create a marginalized other and, regardless of whether the other is defined as aboriginal peoples, racialized minorities, women, or any other marginalized group, the performances of the science-teacher-subject inflict violence on those left on the outside of the palisades.

This study revealed that performances of the science-teacher-subject perpetuate the hegemony of Western science. It would seem that the field of discursivity is monopolized by the hegemony of Western science, however, alternative discourses do exist. As such, the view that one can have science or they can have critical pedagogy and social awareness, that they are mutually exclusive, is illusory. The value of science does not diminish when the subject is connected to the human, it rather evolves into a new form wherein social responsibility is integrally connected to scientific endeavor. Further
research into the subjectification of the science teacher must embrace the contextuality of the discourses of science and thereby problematize the so-called neutrality of science.

**On the Evolution of Science Education**

A review of literature indicates that, despite multiple calls for reform, classroom teaching remains pedagogically focused on the transmission of canonical content. Calls for relevant, socially aware, and humanistic curricula have been made for decades, but little large scale change has actually occurred.

In this dissertation, I sought to divert questions of change and stagnancy that are so often levelled at the competency of science teachers towards the political, historical and social discourses that create the science teacher identity. I aimed to demonstrate that the ‘answers’ do not lie in more or varied calls for reform, but rather in a knowledge the social, political and historical contexts of science and the effects of marginalization that has been part of the legacy of science. My goal was not to produce new, better or more innovative pedagogical discourses for science education but to reveal the way power circulates, creates and disciplines particular types of identities.

Britzman (1998) writes that the consequences of the dominant educational imperative to settle meaning on the proper definition, the correct answer, the stable reply, the passionless essay is a concern for the field of education. “What would education be like without its categorical imperatives?” she asks (p. 43). The fact these categorical imperatives are compounded by the dominant and hegemonic discourses of science education is disturbing. In order for growth in the field of science education, we must turn a critical gaze to the political, social, and cultural aspects of schooling. Science educators and researchers alike must consider the effects of the *institution* of Western
science. This consideration is vital because, as Foucault (1972) explains, the institution is responsible for passing on beliefs, practices and traditions that ensure the longevity of that particular discourse or discursive regime. These sentiments are echoed by Apple whom I quoted at the outset of this dissertation that dominant institutions have a tremendous capacity to regenerate themselves “not only in their material foundations and structures but in the hearts and minds of people” (2000, p.192). This study, which saw participants constructing the science teacher as elite, produced data that revealed that science teachers effectively perpetuate the dominant institution and superiority of Western science. The participants’ continued reliance on modernist discourses to construct their identities and justify their performativity is indicative of this reproduction.

The science-subject maintains the modern illusion because of the prestige and power it gives this institution.

The study reveals a complex understanding of the subjectifying field of discourse that is deeply historical, disciplinary and inundated with violent relations of power. It is the beginning of what Pinar (2004) refers to as a complicated conversation about pedagogy, beliefs and, more importantly, about the science teacher self. Consciousness of the force of discursive power is not a positivistic solution to the subjectification of the science teacher. The awareness brought about by this study can, at best, change things only marginally and over long periods of time. This is especially true considering the nature of the hegemony of Western science. However, the stagnancy found in science education indicates that the field is ready for an introduction of this new kind of knowledge. Although conversations about science knowledge, science curricula and the
subjectivity of the science teacher are complex, the science classroom remains an ideal space for these complicated conversations to occur.
REFERENCES


Tobin, k. (2012). Sociocultural Perspectives on Science Education Kenneth Tobin B.J. Fraser et al. (eds.), *Second International Handbook of Science Education.* Netherlands: Springer


APPENDIX A: Limitations

Understanding the subjectification of the science teacher is complex, and one study cannot hope to address all questions or reveal a comprehensive understanding of this process. The limits of a single study are compounded by the need to remain contextually sensitive to the data and analysis, as one study, regardless of depth and breadth, cannot hope to provide comprehensive and transferable data. This said, two limits of the study merit discussion.

Dominant Discourses

A foundational qualifier used in my study was that of dominant discourses. The judgment of what constituted a dominant discourse was based on my own experience teaching, learning and working (and being subjectified) by these discourses. The use of the term dominant discourse is limiting as it carries connotations of generalizability and transferability, and can be interpreted as a universal qualifier. The classification of a discourse as dominant is a process of assumption based on my subjective experience; although the term connotes quantifiability, my study did not quantify discourses.

A researcher is always limited by language and the use of dominant and alternative discourses speaks to this limitation. The use of these descriptors creates a binary of strength between discourses; however, discourses are not binarily dominant or recessive as their strength occurs along continuum. At one end of the continuum there is a degree of dominance that leaves little room for alternative discourses. For example, such dominant discourses become hegemonic and are seen as true and universal. Similarly, weak or alternative discourses are not universally weak, as particular subjects are subjectified and perform these discourses more strongly than others. Some participants in the study even subscribed to and were subjectified by “weak” discourses.
over dominant or hegemonic discourses. Classifying dominance is subjective and limiting, and yet some qualification is needed when power and discipline are being addressed. Issues with the terminology of dominance are compounded by the fact dominant and hegemonic discourses are themselves less frequently spoken as they are often accepted as a commonly held belief. In many cases, dominant discourses are what subjects believe to be true, right, and natural whether or not they are named in each utterance.

**Interviews**

The data gathered in this study was constructed solely from semi-structured interviews. Semi-structured interviews allow for a certain degree of focus while maintaining a malleability to pursue areas that may arise during discussion. However, although a vast amount of data was gathered during the interview process, my study was limited to one type of discourse (spoken). Although gathering enacted or performed discourses (what may occur in their classrooms), archival discourses, and discourses from artifacts or popular media would have added depth to the field, they were not included.

The inclusion of these alternative sources of discourse could have provided an additional dimension to the subjectification of the science teacher. These alternative sources of discourse were considered during the planning phases of the study; however, I decided to focus solely only one source due to the specific aims of the study. It is important to restate that my data and analyses are contextually situated and the intention was to examine the spoken discourse among secondary teachers of the study. Although
the study itself constructs valuable knowledge for the field of science education, it was limited by the genre of discourse that I used.

Solely relying on one genre of discourse likely also limited the strength of some of the participants’ voices. Participants who were more comfortable expressing themselves and their experiences were more thoroughly represented in the data. The overrepresentation of particular participants’ experiences was unavoidable as I was able to gather more data from those who were more articulate. I am fully cognisant that there existed a loss of discourse from those whose voices were not as strong and those who had “less” to say. However, these alternative discourses were by no means less important. It is an engrained limitation of qualitative research that those who express themselves less are not heard as loudly, or even heard at all.

Concerns with the lack of data gathered from those who did not express themselves as thoroughly were compounded by my participant recruitment. The participants recruited for this study did not represent a random sample, nor was this my attention as a researcher. The voluntary participation in the study resulted in an overrepresentation of white, middle/upper class participants. I presume that the lack of diversity among participants likely led to an absence of the voices of those marginalized by the current education system in general and science in particular. In addition, individuals who dislike science or who have had negative experiences with science were probably less likely to participate in a study about science education. Although the data from this study has provided a rich understanding of the subjectification of the science teacher, these marginalized voices would likely have added a valuable perspective on this process.
Although my own subjectivity added depth to the study, I believe that limiting the data gathering to semi-structured interviews restricted my ability to gather adverse discourses of science teaching. Given that I am a fulltime science teacher, the participants likely assumed that we shared similar experiences of science education and therefore they did not have to discuss or articulate their negative experiences to me. In addition, the non-science teacher participants would likely have felt uncomfortable with sharing undesirable characteristics of science teachers out of a fear of offending me. Although I was very clear that I valued honesty and would not be offended by what the participants shared, this limitation became evident while I was interviewing Susan and she hesitantly described the arrogance of science teachers. As I reflected on the interview her description gave me pause, as I wondered if other participants had harbored similar sentiments but did not share them openly. I have known Susan for many years and was glad that she felt comfortable enough with me to discuss this component of the science-teacher-subjectivity. However, I consider it likely that many other negative perspectives were held back by other non-science teacher participants who did not feel the same level of comfort with me as Susan does.

Although the use of a homogenous data gathering method limited particular aspects of my study, the sole use of interview data was a conscious decision. The field of discourse is infinitely complex and thus cannot be addressed in only one study. My study represents a starting point and, as with any construction of knowledge, it raised more questions arise that require exploration. The questions can and should be addressed in future research endeavors.
APPENDIX B: Research Ethics Board Letter of Approval

Research Ethics Board
Certificate of Approval

PRINCIPAL INVESTIGATOR
Mark Wernikowski
22 Pearson Place
Regina, SK S4S 5W2

DEPARTMENT
Education

REB#
2014-137

SUPERVISOR
Dr. Warren Wessel

FUNDER(S)
Unfunded

TITLE
The Subjectification of Science Teacher

APPROVAL OF
Initial recruitment email/letter
Letter of Consent
Interview Questions

APPROVED ON
September 2, 2014

RENEWAL DATE
September 2, 2015

CERTIFICATION
The University of Regina Research Ethics Board has reviewed the above-named research project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this research project, and for ensuring that the authorized research is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol, consent process or documents.

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS
In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month of the current expiry date each year the study remains open, and upon study completion. Please refer to the following website for further instructions: http://www.uregina.ca/research/REB/main.shtml

Dr. Larena Hoeber, Chair
University of Regina
Research Ethics Board

Please send all correspondence to:
Office for Research, Innovation and Partnership
University of Regina
Research and Innovation Centre 109
Regina, SK S4S 0A2
Telephone: (306) 585-4775 Fax: (306) 585-4893
research.ethics@uregina.ca
September 8, 2014

Mr. Mark Wernikowski
22 Pearson Place
REGINA, SK S4S 5W2
wernmark@uregina.ca

Dear Mark:

RE: School Based Research Approval: The Subjectification of the Science Teacher

I have received your request for permission to conduct research in the Regina Catholic School Division.

You indicate that "in spite of current instructional theory and professional development science teachers have not changed their teaching strategies to any great extent in the past 2-3 decades." You indicate that "this study is designed to adopt a poststructural theoretical framework in its analysis of the processes of subjectification by the discourses found in secondary schools".

You request to recruit 10 teachers to participate in this research from the division’s secondary schools; Archbishop M.C. O’Neill Catholic High School, Miller Comprehensive Catholic High School, Dr. Martin LaBoldus Catholic High School and Michael A. Riffel Catholic High School.

You indicate that participation would involve two interviews that will run approximately 60 minutes in length and would be held outside of regular school hours between September 2014 and November 2014.

Your request to conduct this survey has been granted subject to the following conditions:

1. Participation is on a voluntary basis and participants must be assured as to the confidentiality of their response.
2. Participant consent must be obtained prior to the interview and its audio recording.
3. The names of participants and the Regina Catholic School Division are not identified in the research.
4. A copy of the completed study is forwarded to my attention at the Regina Catholic School Division office.
5. The Regina Catholic School Division will not be responsible for any possible costs to the division.

I wish you success in your research and look forward to seeing the results.

Sincerely,

[Signature]

Brian Leach
Superintendent, Education Services

/sa

Dr. Larena Hoeber, Chair, Research Ethics Board,
University of Regina; larena.hoeber@uregina.ca

Dr. Warren Wasel, Supervisor
University of Regina; warren.wasel@uregina.ca

Dr. Tyria Salim, Professional Development & Field Experiences Office; Faculty of Education
University of Regina; tyria.salim@uregina.ca

R. Currie, Director of Education
M. Braun, S. Chow, J. Chatob, C. Erson, Superintendent, Education Services

R. Ripplinger, L. Biegler, J. Brasciani, K. Ehman, RCSD Secondary School Principals

2160 Cameron Street, Regina, Saskatchewan S4T 2V6
Telephone: (306) 791-7200; Fax: (306) 347-7699
www.rcsd.ca
APPENDIX D: Initial Recruitment Correspondence

Hello colleagues,

As some of you may know I am in the process of completing my PhD in Education at the University of Regina. My research focuses on the social identity construction of the science teacher, specifically examining the way science teachers and science teaching are spoken about by secondary school teachers. An essential part of my research is gathering interview data from a number of secondary school teachers from various subject areas with various levels of experience. The interviews are primarily focused on discussing the participants’ experiences and perspectives regarding science teachers and science teaching.

I know that you are extremely busy but I would appreciate your involvement in the study. The time required for participation is minimal and I will work around your schedule. Please be in touch if participation is something that you may be open to. The study has been approved by both the University of Regina Ethics Board as well as The Regina Catholic School Division. I look forward to speaking with you further.

Thank you so much for your consideration,

Mark Wernikowski