Constructing Biology Curriculum for a Diverse Student Population: Opportunities for the Integration of STSE Education and Issues of Social Justice

by

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Abstract

Science, technology, society, and the environment (STSE) education is both a part of the mandated science curriculum in Ontario schools and also a philosophical and theoretical positioning for a science teacher. The study seeks to understand how biology curriculum can be developed that is inclusive of a diverse student body with special attention to STSE education as a vehicle for integration with issues of social justice. Participants were provided with opportunities to explore their understanding of STSE education, their role and identification as teachers, and how they meet student needs, in relation to the curriculum development process. The research then is a confluence of three areas: inclusive curriculum, STSE/social justice, and teacher identification.

This qualitative study uses individual interviews, group meetings, and participant action research to explore, how teachers, develop and implement inclusive science curriculum for a diverse student population, how science teachers understand themselves and their role, and, how teachers understand STSE/social justice perspectives and practices.
Findings showed that this is difficult work. Teachers are faced with pressures such as assessment challenges inherent in STSE education, student attitudes related to what science teaching is, and personal and contextual barriers that influence curriculum development and implementation, teaching content and issues, as well as the action research cycle in general. Teacher development of a personal critical theory of teaching and understanding of the political, historical, and sociological context of teacher work is an ongoing question from this research. Findings may have impact on how teachers see themselves and understand their role, how they approach issues in their teaching, how they understand teaching as a political act, and how they use social justice issues as one part of an STSE-informed approach to more inclusive science teaching.
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1 Introduction

For a long while I have been interested in social justice and sociopolitical issues within the high school science curriculum and in the politicization of teachers. Science, as a practice, is embedded in a society and is affected by the politics, economics, and values of that society (Gould, 1981). I have long felt that school science courses should reflect this reality, believe that there is a place for these aspects of science within the curriculum, and that the benefit of their incorporation is a curriculum that is more inclusive of all students.

1.1 Problem Statement and Purpose

In Ontario, the science curriculum mandated by the Ministry of Education lists expectations for each grade. The expectations are presented in three categories. These are: Knowledge and Understanding; Inquiry and Communication; and Science, Technology, Society, and the Environment (STSE). Knowledge and understanding is what we might traditionally call subject matter content knowledge or science facts, and inquiry and communication generally refers to practical work. The STSE expectations are intended to highlight the influences of science and technology on society and the environment and the multi-faceted relationships among all four. The manner in which teachers develop their science curriculum and how they address the STSE expectations was of particular interest to me. Although the STSE expectations are clearly set out as part of the policy document that governs what teachers should teach it has been my experience, throughout my career, that they are often ignored or treated as less important than the knowledge and inquiry expectations. I believed if teachers could raise, consider, and address important social justice issues related to science, society, technology, and the environment, within the context of STSE expectations, they would create a more inclusive
curriculum that would engage students and better meet the needs of a diverse student population. However, it has also been my experience that science teachers often missed opportunities to do so and I questioned why. According to a study by Upadhyay (2010) teachers face challenges in teaching the science content required by state standards. Even in a context such as Ontario where we have no standardized tests, there is pressure to frame the learning of science as a mastering of subject matter content knowledge rather than the ability to develop scientific literacy and to judge the reliability of, for instance, media reports of health and environmental issues.

I set out to conduct a study that would allow teachers to think about and talk about how they developed curriculum that supported the science, technology, society, and environment (STSE) expectations and how they understood their role as science teachers. It was my plan that my participants would be able to use action research in their own classrooms to develop science curriculum that supported social justice issues. Therefore, this thesis brings together scholarship in a variety of areas: curriculum development, STSE education and social justice in education, teacher identification, and action research as teachers reflect on and examine their practice.

1.2 Research Questions

The research became a confluence of three areas: inclusive curriculum, teacher identification and STSE/social justice. The three questions that guide the work are:

1. How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population?

2. How do teachers understand themselves and their role as science teachers?

3. How do teachers understand STSE curriculum as a place for furthering social justice issues?
I use the term teacher *identification* purposefully rather than *identity* as this is not a thesis that explores or furthers the traditional teacher identity or social identity literature. Rather it explores teacher images of the *self* and personal characteristics as related to question two above.

### 1.3 Brief Overview of the Study

The thesis reports on a qualitative study that uses interviews, group meetings, and participant action research. (Action research will be described in more detail in chapter 2.) The study takes place in a large urban centre in southern Ontario, Canada.

My plan was to work with a small group of teachers and facilitate their curriculum development efforts, in order to better understand how they develop curriculum for STSE education. The study began with individual interviews of each of the participants, followed by weekly group meetings during which we explored their understanding of STSE and social justice, the curriculum development process, and their role as science teachers. There were a total of seven group meetings and the participants agreed to report weekly on the progress of the action research project they were conducting in their classroom. At the end of the seven weeks the participants were again interviewed individually in order to bring closure to the study, to encourage them to reflect on the experience, and to give me personal feedback.

The participating teachers taught in medium sized to large high schools with both public and Catholic schools represented. (In Ontario both public and Catholic schools are publicly funded.) Their students come from backgrounds that range from upper middle class to living in poverty with some students living alone and supporting themselves financially. One of the schools had mostly high achieving students while the other three had a mixed student population.
The study, including participant descriptions and data collection and analysis will be described in more detail in Chapter 4: Methodology and Methods.

1.4 Who I Am as a Researcher and a Teacher

This is a thesis about teachers using an action research cycle to develop science curriculum that focuses on STSE expectations as a way to incorporate social justice issues into their science courses and in so doing coming to better understand the curriculum development process, their students, and themselves. My topic, my interests, my perspective, and the themes of this thesis are all affected by who I am as a researcher and by my experiences as a science educator over the last 30 years. I have asked myself, over the years, why high school science courses are not *the place* in the school curriculum where important social issues of the day, such as race, poverty, environmental degradation, or gender identification are examined from a biological as well as a social perspective. In this section I will introduce myself and explain my background as it impacts on this research.

I have been thinking about science and how to create a curriculum that is inclusive of and meets the needs of a diverse group of students for a long time—since my first practice teaching experience in fact. When I began practice teaching (as a formal part of my teacher education) I kept a journal. In an entry from December 1979, I wrote: “…so many kids who work so hard but somehow don’t achieve what they’d like to. I wonder if they are only as successful as they have been led to believe they can be.” And “[it seems] very few [teachers] stand back and question the relevance of what they’re doing (my host teacher does do this).” After practice teaching, I began teaching in a small rural district high school in Bruce County, Ontario. Since then I have taught in several Toronto area high schools, have been a school board based science consultant, and have worked as a course director in pre-service teacher education at three universities. When I
began my doctoral work I was teaching in the university setting. I have, for the most part, taught science, biology, and chemistry. In Toronto I taught at an alternative school that had as part of its mandate the inclusion of social justice in the curriculum. I also taught in two inner city schools, and in two schools in more privileged neighborhoods, and with students who were for the most part academically capable. I have had the good fortune to work in vibrant innovative schools with many students who were interested in ideas, who challenged me, and who challenged themselves and each other. As in any school, students ranged from the “I love science” student to the “why are we learning this anyway?” student. I have also been fortunate to work with many teachers who were interested in innovative curriculum development and who were willing to take some risks in their classroom teaching. Since those early days, a better, more inclusive, and relevant curriculum that met student needs had been on my mind. Of course, what do we mean, by better? How better? Why better? For whom better? This doctoral research was undertaken to investigate this ongoing theme of curriculum development. As I worked in different settings the theme expanded to: curriculum development while taking into account teacher and student needs and to further social justice.

After 13 years working in schools I became a science consultant and worked mostly to support elementary teachers in their science programs. Many of these teachers had little or no formal science education background and I was often the “content” or science idea person. These elementary teachers taught me enormous amounts about the inclusion of all children in the program, about meeting diverse needs, and about integration. Four years later I was seconded to a university to teach what would traditionally be called general pedagogy and science methods courses in a pre-service teacher education program. Subsequent to that, at a second university, I taught similar courses for six years. While in the teacher education settings I had two main goals: a) help new teachers develop skills and knowledge that would allow them to be good teachers
able to develop curriculum that met the needs of all students and b) help new teachers to identify
the need for, and develop the capacity to effect change in schools.

While working in teacher education, I began my doctoral work and completed the research that is the substance of this dissertation. As I was about to embark on the dissertation writing I returned to Sunnyside High (a pseudonym), a high school that provided me with all the highs and lows a teacher could ever expect. I became part of a busy staff, teaching six large classes, having a busy timetable, in a busy school, with a diverse student population. Although I was not a first year teacher I often felt as though I were one. Things had changed since I last taught in a high school! Attendance procedures, evaluation expectations, grading sheets, and report card generation were all new in some way. There were textbooks with which I was not familiar and did not particularly like, and there were students who seemed to have more diverse needs than I remembered. I planned courses collaboratively with several colleagues yet found that STSE expectations were marginalized. I must admit that progressive curriculum that included social justice issues remained a priority for me only because it already had been a priority for the previous ten years of my life. A further exploration of the tension I experienced between what I wanted to do and what I felt I could do, will be considered later in the thesis as part of the data analysis chapter.

The return to Sunnyside High was a revelation. Many emerging ideas from my study began to be considered in a new context. Although I knew that the business of curriculum development is hard work, I was feeling that I finally understood how I could develop socially relevant, meaningful lessons for a diverse group of students and with the intent of furthering justice issues. However, I knew far less than I had thought, not nothing, but then not much that was of use in my new setting. Teaching in a high school was also more exhausting than I
recalled. I felt a mixture of chagrin, fear, disappointment, and frustration. The Sunnyside High (yes, the pseudonym is meant to be ironic) experience set me back both emotionally and physically. I did not begin the dissertation. This detail, I trust, locates me in terms of past influences and experiences and in terms of the theory that underpins my practice. This may also be the appropriate place to say that as a science teacher, I love the knowledge base that we call science content and the process of reflecting upon and improving my practice. I like considering how to approach a particular topic in science with a particular group of students and how to create opportunities for learning. Teachers call this “doing the prep” or “prepping” for a course or class. Embedding content with social issues of the day should be part of regular teacher “prep” for any class and yet it has been my experience that moving beyond a mere presentation of content as neutral to a curriculum that includes critical thinking about issues and ideas is difficult and fraught with obstacles. It requires that we know ourselves, ours students, and that we understand clearly and deeply what we are trying to achieve.

There is also a body of literature encouraging, critiquing, and de-constructing the inclusion of STSE and/or justice issues into pre-service or teacher education programs (see Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2008; Sweeney, 2001; Villegas, 2007; Zeichner, 1993, 2009) and yet the literature is less robust on the success of STSE/social justice education in school science programs. Practicing teachers, once they have graduated from teacher education programs, are mostly on their own and must navigate curriculum development with few resources that specifically support justice work. In my new setting at Sunnyside High, I worked hard to develop good courses. What I learned and some of my reflections are described in more detail in chapter 5 and certainly inform much of this thesis. It was a desire to explore and understand the needs, perspectives, and challenges of practicing teachers that formed the seed for this thesis and that I felt would make a contribution to the field of science education.
1.5 Rationale for the Study

Since the Ontario science curriculum includes specifically mandated Science, Technology, Society and the Environment (or STSE) expectations, and since these expectations are often marginalized or ignored it seemed to me appropriate and necessary to examine, essentially: What is going on (or not going on) with STSE education?

Often teachers are isolated as they plan curriculum and I anticipated that teachers participating in this study would benefit from the collegial sharing of ideas, experiences, and materials and from open discussions of the challenges and obstacles that they faced in meeting curriculum (STSE) expectations while developing and implementing curriculum for their own unique and diverse group of students. The participants had an interest in exploring ways to address STSE and social justice issues in their classrooms and came to the study with that expressed desire. As a researcher, I wanted to create a safe space where my participants could explore several issues surrounding science curriculum development and implementation. These issues included STSE expectations and social justice issues, the needs of their unique group of students, and their own personal understanding of their role as a teacher. I hoped that they would use action research as a way to identify a specific need or problem in their classroom and develop curriculum to meet that need.

The research questions are further connected in this way: a more inclusive curriculum that meets the needs of students could be one that presents science practice as multi-faceted but not unattainable and school science as more than “learning content” but rather also highlights STSE and social justice issues that have contemporary significance and relevance to students.
Adams, Jones, and Tatum (1997) explain the need for teachers to know their students and to understand their needs. They state that the reasons for knowing our students includes matching their needs to curricular goals; anticipating their needs and areas of confusion; being able to match the curriculum to their level of ability and awareness; ensuring realistic learning goals; and ensuring that they can function well in the classroom that we construct.

In turn a more inclusive curriculum is also in itself a justice issue as it could open the doors to more students thinking of science as having a place in their future aspirations. A part of accomplishing this type of curriculum includes a better understanding of who we are as teachers and of what our role is. Bell, Washington, Weinstein, and Love (1997) make a case for understanding ourselves and developing self-knowledge. They state: “The self-knowledge and self-awareness that we believe are desirable qualities in any teacher become crucial in social justice education” (p. 299). They also claim that teachers are often “not prepared to address emotionally charged issues in the classroom” and that “social justice education in not simply new content but often a radical change in process as well” (p. 299).

1.6 Personal Philosophy and Theoretical Framework or Lens

I view this thesis through a personal lens, which is explained in this section. Issues related to a diverse student body (such as race, class, gender, and sexual orientation) are often ignored in the planning of a science curriculum. And yet, a science curriculum that addresses issues of equity and diversity could help meet the diverse needs of students and further social justice. I draw upon Peter McLaren (1998) who says that teachers, as the developers and implementers of curriculum, face the ongoing challenge to better understand themselves, their students and the complexity of diversity as a concept and its relationship to knowledge construction within their own discipline and with respect to curriculum construction. Teachers
who have interrogated issues of identity, diversity, and societal inequities are, I believe, more likely to develop a commitment to furthering social justice through their teaching. Science classrooms could be ideal settings for exploring issues of diversity as they relate to: knowledge construction, uses of scientific knowledge, societal inequities and, ultimately, social justice. Science curriculum could be more inclusive of all students. Teachers could choose to address STSE expectations more consistently and address social issues more often. To achieve these goals, science teachers need to understand themselves, their role, their students and also how issues of diversity, equity, and social justice influence science curriculum. It was my intention that this study might provide a small group of teachers with opportunities to explore these ideas.

It is also my bias that science education should have at its core the purpose of creating a better world for all and from personal experience I see that teachers often miss opportunities within their classroom to achieve this purpose. I come to this work as a science educator who has worked in various settings and who has often attempted to define the factors that affect my own decisions around what to include in my curriculum. All teachers make decisions daily about what to include, exclude, ignore, or privilege. Some curriculum choices are conscious and carefully planned and some are unconsciously made. (Curriculum will be explored more fully in chapter 3.) Every choice is influenced by who we are and how we understand our role and how we attempt to meet student needs. Every choice is affected and governed by the barriers we face and by the supports we experience. I would hope through this research to come to a better understanding of the barriers and to be able to nurture and expand, to a wider teacher population, the supports. I present the following rather long quotation from a paper by Jay Lemke, a theoretical physicist and professor in science education, as it helps to summarize my interests in this thesis. I present the quotation in its entirely for coherence although points 1, 2, 5, 6, and 7, below, are most salient to this thesis. Lemke (2001) suggests:
Look at each of the following questions as a question about science, and as a question about science education. Ask yourself in each case how important the question is, how relevant it is to achieving the goals of science education research, and to what extent it is addressed by other approaches in our field:

1. What is scientific activity/science education as a social institution, and what is its relationship to other institutions?
2. What practices, beliefs, and values constitute the culture of science/science education in a given time and place, and how does this culture change across historical time?
3. How does the subculture of science/science education fit into the overall cultural ecology of a larger community? With what other subcultural systems is it allied or in conflict?
4. How are the specialized language of science/science education and its forms of writing and discourse similar to those of other sub-communities and different from them? Why? With what larger-scale social consequences?
5. How do the metaphors and practices of the scientific community influence the kinds of research questions that are asked in particular historical periods, or help determine which kinds of people feel attracted to or excluded from its culture?
6. How is science/science education as a community dependent on economic and political forces outside it, and how does it both resist and accommodate to this dependence?
7. How has science/science education as a culture, including its beliefs about legitimate methods and questions, and its beliefs about its objects of study, been shaped historically by the overrepresentation and underrepresentation in its ranks of different social categories of people: men and women, Europeans and non-Europeans, wealthier and poorer classes, young and old?
8. How does science/science education as an institution and a culture define the kinds of personal identities it welcomes and supports, and in what respects is science/science education more and less compatible with masculine versus feminine identities, middle-class versus working-class identities, and the global spectrum of national and ethnic cultural identities?
In answering these questions, we should also ask ourselves which sciences we are thinking of. Can we generalize about science as such, or is each different science unique? I tend to agree with the arguments by philosopher Sandra Harding (1986) that too much of what is said to characterize science as such in fact characterizes mainly physics as a paradigm science, and that physics is an “atypical science”. (p. 299)

Each of these questions can be posed both about science and about science education, and about the latter both as a teaching practice and as a research field. Indeed I pose these questions to myself all the time and I ponder the implications that the answers have for the teaching of science and for research on science education. Also, with these questions in mind, I wonder how teachers can develop and implement a more inclusive curriculum that addresses the socio-political aspects of science. I have these interests with respect to all curricula but will focus on STSE for this study as I see STSE connected to social justice issues as being able to provide a unique opportunity to make science more inclusive both in terms of interests and access.

1.7 What to Expect from the Thesis

The thesis is about the work of science/biology teachers as they strive to make a more inclusive curriculum that meets the needs of their students through an action research project. While at first embracing action research as a way to explore curriculum development the participants experienced uneven success with it and so the thesis is also about my uncovering and understanding the barriers they faced. It is about teachers as they explore and come to a better understanding of themselves and of the needs of their students. It is about how and why they make curricular decisions and about their own developing theory related to including more STSE education, and about how teachers do or do not position social justice issues in their science courses.
The next two chapters (2 and 3) describe scholarship in the areas that support the study. There is a review of relevant literature and a summary of the theoretical underpinnings that have acted as the lens through which this research study is examined — specifically these are: curriculum in general and curriculum design in science; issues of personal identification and teacher identification; the premise and construct of action research as a teacher research tool; STSE education, including some history and future directions; and social justice as an idea and possible force in science and science education. Chapter 4 describes the methodology and methods used in this study including an introduction to my participants, the type and manner of data collection, and how data was analyzed. Chapter 5 describes the data and analyzes what we can learn from it including detailed profiles of three of the participants. Chapter 6 is a discussion of findings including some conclusions with respect to the research questions, implications of the findings and recommendations for future research and/or teacher classroom and self-work.

1.8 Summary

This introductory chapter has provided the reader with an overview of my interests in the thesis topic (developing an inclusive curriculum for a diverse student population); my purpose, questions, and an overview and rationale for the study; who I am as a researcher and my theoretical lens; and what the reader can expect from this thesis in terms of subsequent chapters.
2 Curriculum, Teacher Identification, and Action Research

Recall from chapter one that this research is a confluence of three areas: inclusive curriculum, teacher identification and social justice. Specifically:

1. How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population?

2. How do teachers understand themselves and their role as science teachers?

3. How do teachers understand STSE curriculum as a place for furthering social justice issues?

This chapter explores research literature related to questions 1 and 2. Literature related to question 3 will be explored in chapter three. Specifically, this chapter explores research literature about curriculum and curriculum development; inclusive curriculum; issues in biology/science curriculum; what I identified as gaps in the literature for the purpose of this research; teacher identification (and a short section on students) as it relates to this thesis; and action research (in the spirit of teacher as researcher) as a way to explore curriculum construction.

As an introduction, I share with the reader a passage that was distributed by Derek Hodson during one of my doctoral courses. I have no author or source for this passage and so apologize to the author—yet feel compelled to share it as it conveys my feelings and seems a perfect introduction to the chapters that follow.

Inclusive curriculum is based on a philosophical approach to education, which places all students at the centre of the curriculum by validating the multifaceted experiences
of their lives in terms of their gender, race, socio-economic class, religion, language, ability/disability, sexual orientation, and age. This approach is a fundamental rethinking of what is included as knowledge to be taught, the processes through which knowledge is taught, and the structures, which are formed, in order to carry out the task. It is an approach, which seeks to empower teachers and students to examine their individual and collective identities and to use their understanding in creating a more equitable society. (Source unknown)

### 2.1 Curriculum and Curriculum Development

Curriculum is a complex notion dealing with both the content, purpose, and strategies of teaching and learning plans. In many instances the choices teachers make regarding content ideas and examples are inextricable from other considerations of pedagogy. Indeed, these choices are affected by what we believe to be most important in terms of the needs of our students, the underlying philosophical underpinnings of our discipline, and the purpose we consider the curriculum to have. Also, our personal understanding of what we believe to be possible in a particular educational context will affect what we choose to do and, how we do what we do. Eisner (1979) makes the distinction between the *explicit* curriculum (what is taught is seen as obvious and as pedagogically needed), the *implicit* curriculum (students are expected to comply with cultural norms of the school setting such as answering questions or copying notes), and the *null* curriculum (or what is omitted). Eisner (1979) argues that we need to examine what is omitted and I would add that we need to consider the nature of the omission—is it unknowing or unexplored or is it by design? Are we avoiding topics, questions, or perspectives; are we unaware of multiple perspectives; or are we omitting perspectives we deem problematic and
controversial? Apple (2004) refers to the hidden curriculum, an idea that overlaps with Eisner’s implicit curriculum. The hidden curriculum, he argues, is “the tacit teaching to students of norms, values and dispositions that goes on simply by their living and coping with the institutional expectations and routines of the schools” (p. 13). Apple (2004) would also encourage us to “pay closer attention to the ‘stuff’ of curriculum, where knowledge comes from and whose knowledge it is” (p. 13), and to help educators to become more aware of the underlying ideological perspectives that they hold.

Educational theorist Larry Cuban (1995) suggests that there are actually four different curricula taught in schools. First, the official curriculum is what we in Ontario would refer to as the curriculum documents set forth by the Ministry of Education. Second is the taught curriculum or the lessons that take into account teacher planning, teacher preference, teacher comfort with different topics, and the adjustments that are made for specific groups of students with their unique needs. Third, is the learned curriculum, which includes the taught curriculum as well as all the other things that might be learned by students such as classroom behaviours and attitudes that comply with teacher expectations. Students may learn respect for others, they may learn to ask questions or to keep quiet, they may learn to consider multiple perspectives or to copy and memorize without questioning. Fourth, is the tested curriculum, which is comprised of parts of the other three. Here he argues for teacher construction of tests since standardized assessments, he feels, are poor measures of what is learned.

The idea of curriculum conjures many meanings and perspectives. Connelly and Clandinin (1988), suggest that within school settings and from the perspective of teachers, curriculum is usually referred to as the plan or text or government document that governs what to teach. Academia refers to curriculum as encompassing many of the questions of perspective and
possibility and Connelly and Clandinin would like us to consider that it is the teachers’ personal
knowledge which governs all significant matters and curriculum, as something *experienced in
situations* (Connelly & Clandinin, 1988). Hood (1998) refers to curriculum as a product of
choice, where, “choosing from among many curricular possibilities is always first and foremost a
political act” (p. 177). Young (1998), suggests that “curriculum debates, implicitly, are always
debates about alternate views of society and its future” (p. 9). He makes the distinction between
curriculum as practice and curriculum as fact and says:

> From this view teachers’ practices are crucial in both sustaining and challenging
prevailing views of knowledge and curriculum. The curriculum thus ceases to be separate
from the activities through which teachers devise assignments, produce marks and grades
and differentiate between subjects and identify pupil achievements. The implication of
such a view is that if teachers subject the assumptions underlying their practices to
critical examination, they will understand how to change curriculum. (p. 27)

I agree, substantively, with what Young is saying. However, I suggest an addition. From my
experience as a teacher and working with both pre-service and in-service teachers education, I
suggest this change to Young’s last sentence above: “if teachers subject the assumptions
underlying their practices to critical examination, they will understand why they need to change
curriculum”; I would question if they understand *how* to do it. It is this distinction that forms one
cornerstone of this thesis.

> From my experience, while a classroom teacher, I did examine the curriculum and I did
apply the principles above. I felt that I clearly understood why changes in the curriculum were
necessary in order to make it more inclusive, and yet, I often stopped myself from achieving the
type of curriculum I imagined because I taught a group of students who were struggling with
content and ideas and who were not available for the sort of curriculum experience that I wished for them. They did not want to be challenged. They were often absent and hence curriculum continuity was lost, and they were intellectually immature—by which I mean that they were not open to new ideas, they disliked ambiguity, they rejected multiple perspectives (asking for example: “What is the right answer?”) and they resented and were uncomfortable with any part of a science class that was not about copying notes or answering questions from the textbook where they could be assured of the correct answer. In the end my students’ profiles and my personal issues of identification (how I saw myself, my background, and my role) came to have a greater influence on the practical considerations of curriculum development and implementation than what I believed to be sound, albeit theoretical, curriculum underpinnings. I knew what I wanted the curriculum to be, I knew why I wanted to raise certain issues, and I felt committed to exposing my students to multiple perspectives, but I did not know how to do it.

According to Stenhouse (1975) one of the challenges of curriculum studies is that at times there is a discontinuity between what we hope to achieve and our attempts to achieve it. I believe that this idea is important for my research. In conversations with classroom teachers, I have found this to be a recurrent theme: teachers want to create a more inclusive curriculum but feel discouraged and frustrated in their attempt to do so. It seems that they face challenges and barriers, some of which are obvious and easy to articulate, such as insufficient background knowledge and time restraints, while others are subtle or perhaps not fully understood by teachers themselves, such as student and school expectations or anxiety about being controversial in the classroom (personal communications with students in Additional Qualifications (AQ) courses, OISE/UT, 2005).
As a summary to this section, I would state that curriculum and curriculum development have a fluid and complex definition. Curriculum is the daily lesson, it’s the long-term plan we make including assignments or projects, and it reflects the expectations or objectives we are trying to meet. Curriculum is also the teachable moment, the newspaper article read in the morning paper that is brought to class, the unexpected student question and how we choose to answer it or dismiss it. Curriculum is how we follow-up on a topic the next day, how we explore the tangent, how we choose a resource. Our curriculum reflects the vision we have for what students should learn and is quite simply everything we do, what we don’t do, what we teach, what we imply by the choices we make, and what we assess. The curriculum will also reflect what is important to a community and a society at a particular point in time. Curriculum and curriculum development (or design and construction) in science education does not usually differentiate what knowledge is needed for different aspects of school science. (Knowledge for and from STSE education is explored as part of the interpretation of findings in chapter 5.)

2.1.1 School Based Issues and Teacher Support for Curriculum Development and Implementation

bell hooks (1994) says that schools are organizations for reproducing culture, and that educational decisions are never politically neutral. This is my position as well. As Hodson (1999) says: “all curriculum knowledge should be regarded as problematic and open to scrutiny, critical appraisal, and revision. Everything should be subjected to rigorous scrutiny for evidence of sectional interests and influences that are prejudicial to the promotion of social justice” (emphasis in original, p. 791). Therefore, all curriculum development and practices could (and should) be examined and interrogated. Hodson goes on to suggest the use of action research with a supportive facilitator as a way to achieve this sort of curricular scrutiny and change, and
emancipatory curriculum development (Hodson, 1999). Action research is discussed in more detail later in this chapter.

Lynch (2000), states that teachers need to be supported in considering individualized and personalized approaches rather than a one-size-fits-all approach to curriculum development, and I agree with this position. For example are teachers encouraged to consider modifying practices by starting with what knowledge students bring to class rather than forcing student learning into existing structures and practices (Hollins, 1993)? Also, are teachers supported in considering, as Corson (1998) would suggest, different curricula and different practices for some marginalized students? Honouring what students bring to class, including taking into consideration, among other things, their language, race, ethnicity, class, gender, and sexual orientation, and providing individualized curriculum and practices for marginalized students are all part of what I refer to as an inclusive curriculum.

According to Cummins (1996), a progressive curriculum development ethos would be one in which teachers are encouraged to ask: Who benefits from particular educational practices and decisions? Teachers, of course, must be willing to place their own practices and decision-making biases under scrutiny as well. In the end, teachers should be willing to ask questions of themselves and of their school practices such as: Why and how do schools reproduce oppressive structures seen in society? and How can we work within schools and at the same time work to change unequal school practices (Cummins, 1996)?

Teachers need support to consider the relationship between the content they need to teach, how issues of diversity affect knowledge construction within a discipline, and how this is related to broader structural and societal issues of power and privilege (Sleeter, 2000). As James Banks (1996) says: “Students should be given opportunities to investigate and determine how cultural
assumption, frames of reference, perspectives, and the biases within a discipline influence the ways knowledge is constructed” (p. 169).

Curriculum design and implementation should account for all students to be included through decisions of what to teach and why, and, how an inclusive curriculum can be achieved. Teachers, in my opinion, have a responsibility in developing a curriculum that will improve science education, make science more inclusive for all, and thus further social justice. Teachers and the curriculum they develop have a great deal of power and influence in students’ lives. Understanding the sociology of science can also help teachers to develop their curriculum (Cunningham & Helms, 1998; Smolicz & Nunan, 1975). Schwartz (2006) suggests that we need a new approach to curriculum writing that educates teachers during the curriculum writing process itself and yet many resources that would be helpful to teachers in addressing the above issues are not part of what teachers read or use when developing curriculum. Resources such as: *Teaching for diversity and social justice* by Adams, Bell, and Griffin (1997) and *Science education as/for sociopolitical action* by Roth and Désautels (2002) address themes of equity and education, and propose an approach to teaching that takes into account issues of diversity such as race, class, gender, or sexual orientation. Adams et al. (1997) in their edited sourcebook provide actual examples of lessons and lesson ideas that could be used. Roth and Désautels (2002) make a case for a more political approach to science education with examples based on: science for social responsibility, science for a free-society, cross-cultural science education, or from explorations of specific issues such as food production. I would argue that they make a case for change (the why) and explore or share specific curricular suggestions (the what). What I feel is missing in these books is an exploration of how teachers can approach the curriculum design process for themselves. Teachers do not read these sorts of books as a matter of course (although they might read them for a course) and even if they did I believe that they would close the book
and ask “but how do I incorporate these perspectives into my grade 9 class on cell structure tomorrow?” These sources will be examined in more detail in chapter 3 in the discussion of social justice issues in science classrooms.

### 2.1.2 Biology (or Science) Curriculum

Currently, there is debate over what to include in a modern biology course. Biology is becoming an ever growing and rapidly changing field. Biology teachers feel the pressure to teach more and more and so to cover content in, at times, a rather cursory manner. Also, some feel they are missing opportunities to examine an issue or idea in some depth and from several perspectives that would be of interest, and of benefit, to students. Biology teachers seem divided on whether or not to include values or issues in their biology courses. Some say that teaching values should not be part of a biology course as it confuses students (Allchin, 1999). In response, Peggy Cunniff (2000) says: “Teaching involves more than having students memorize facts or procedures. They need to learn to analyze facts and come to their own conclusion regarding issues in the real world” (p. 86). She goes on to suggest a new biology curriculum which is “at the center of our culture and its trends toward the future, and that views humans as unique animals. This will require a curriculum that integrates aspects of the social, physical, humanistic, and behavioral sciences” (Cunniff, 2000, p. 86). Because of the sheer volume of content that is mandated (or as teachers might say “must be covered”) biology teachers will include some topics and exclude or omit others. Indeed, the curriculum could be examined to determine the null curriculum or areas, issues, and perspectives that are not included (Eisner, 1979). In Ontario schools, for example, the concept of race or sexual orientation could be ignored or excluded from biology courses because there are no specific curricular expectations that refer to these areas. Yet, recently much has been written on the biology of “race”, on the biological basis for
classification and the genetics of difference in humans, and on the genetic basis for the
determination of sexual orientation. Biology or science educators could, if they chose, address
the history of science with respect to race within the biology curriculum and specifically within
the topic of genetics (Norman, 2000). Science is a well-established authority in school and in
society, and as such Norman (2000), suggests that a science classroom could provide an ideal
opportunity to show students about the social construction of knowledge within science and the
role that ideology plays in the construction of that knowledge (Norman, 2000).

More recently the National Research Council, in their report from the Committee on a New
Biology for the 21st Century, (2009), encourages a biology curriculum that is integrated in nature
(in the way that biology research is integrated) with physics and chemistry and shows students
that solving problems involves knowledge and expertise from several disciplines acting together.
Additionally they state: “The committee recommends a national initiative to accelerate the
emergence and growth of the New Biology to achieve solutions to societal challenges in food,
energy, environment, and health.” (p. 88) and make a case for attracting and retaining the best
biology students. It assumes that we all understand what is meant by best. I would argue that the
best students are ones that can affect positive change in the type and purposes of biology
research into the future. Also the best students would have a thorough knowledge from
additional disciplines such as social, physical, humanistic, and behavioral sciences (see Cunniff
above) as well as being able to place biology research and issues within STSE and justice
contexts.

2.1.3 Curriculum for a Diverse Student Population

Much of the literature on curriculum development is general in nature (see for example
Connelly & Clandinin, 1988) and includes attention to: a) pedagogical issues such as student
groupings, b) strategies that encourage debate or action (Adams, Bell & Griffin, 1997), and c) ideological issues of power and hegemony that influence curriculum decisions and of what constitutes knowledge in contemporary classrooms (Apple, 2004). General sources that explore curriculum for a diverse student population and for the promotion of social justice (see for example Adams et al., 1997; Corson, 1998; Mahalingam & McCarthy, 2000) do not include work done in science or biology classrooms or any analysis of the discipline of science within a “curriculum for social justice” framework.

Books that focus on science education for social justice (or for sociopolitical action such as in Roth & Désautels, 2002) do not explore the curriculum development process. Although valuable in presenting an argument for a new way to teach science (i.e. for sociopolitical action) and clear in the exploration of specific examples of issues based science approaches (for example teaching about abortion or global food production) what is not explored is the ongoing, daily work of teachers in developing curriculum materials that meet government expectations. Overall, after extensive reading, I felt that there was a gap in the literature regarding what does and does not happen at the level of the classroom with respect to specific teachers developing curriculum for specific students. I was curious whether the curriculum development process was so idiosyncratic (or as Apple (2004) suggests has too many variables) that it defies analysis and synthesis or whether it was possible to glean some common themes, strategies, and recommendations that might inform the process.

There is an additional older source that I would like to highlight here. Racist science, racist society by Gill and Levidow (1987) is a publication that warrants special attention as it relates quite specifically to this thesis and was the first academic source that planted the seed that would become this work. Gill and Levidow argue for examining how science is taught in a racist
society and yet sadly, 25 years later, we continue to theorize about inclusive curriculum for diverse student populations, but fall short of making comprehensive changes with respect to what happens in our racialized classrooms. This work contains an entire chapter (by Michael Vance) on race and biology, which inspired my development of a curriculum project on the social versus biological construction of race (financed through CIDA and co-authored with Margaret Wells and provided in Appendix 2) that specifically addresses science teaching and social justice. I mention this here as the curriculum was used by one of the participants in this study. The project will be described and the participant’s work will be examined in chapter 5.

2.2 Teacher and Student Identification

This thesis is not an exploration of teacher identity in science education, however from the beginning I felt that something about teacher identification (who the teacher is, what he/she believes and what he/she as an individual brings to the table) was key to the curriculum development process. I was convinced that in order to fully understand their own teaching practices and decisions they make with respect to curriculum development and implementation, teachers needed to locate and interrogate their own identification and the factors that influence them. Thus, knowing/understanding oneself and how one directs curriculum construction became the second cornerstone in this thesis. Therefore, briefly, below I will explore some key ideas regarding teacher identification. Teachers, I believe, also need to understand this process in the students they will teach—this is discussed in the next section.

There is a rich and established tradition of thought around teachers understanding themselves, their identity, and their biases and/or assumptions (see for example: Delpit, 1995; Howard, Grant & Zeichner, 1995; Schon, 1983; Sleeter, 1993). It has been suggested that teachers would benefit from: interrogating their own understanding of diversity and its
relationship to social change (James, 1999), interrogating difference and issues of identity and stereotyping (James, 2012b), and reflecting upon how their practice and their identity influences and guides their pedagogy (Grant & Zeichner, 1995; Schon, 1983).

Although this study is not an examination of student identity, I include here a short piece regarding a question asked by several researchers (Cummins, 1996; James, 1999; Yon, 2000) and implied in much of the group talk with my participants, and that is: How do teachers understand and take into account the identity of the students they teach? When we say “a diverse student population” what do we mean? Do teachers understand student/youth identity as a fixed entity or one that is fluid and elusive (Yon, 2000)? Do teachers understand diversity as something that needs to be changed, ignored, or perhaps something that should just go away (Cochran-Smith, 1992; Cochran-Smith, 2003)? All teachers would benefit from an exploration of the impact of racism, classism, sexism, and homophobia on their student’s lives. Science teachers, and in particular biology teachers, have, I would argue, a unique opportunity to address issues of difference and diversity within the context of their biology curriculum and within the context of our understanding of the biology of humans. For this study, diversity is understood to be individuals having identifications related to language, race, ethnicity, class, gender, and sexuality. Diversity could be understood in terms of its implications and consequences both for individuals and society. It is in many ways a social construction as well as a lived reality that results in positioning individuals. Diversity should be considered, as McLaren (1998) says, in this way: “People don’t discriminate against groups because they are different but rather the act of discrimination constructs categories of difference that hierarchically locate people as ‘superior’ or ‘inferior’ and then universalizes and naturalizes such differences” (p. 281). I believe this to be true in society, in schools, and within science classrooms. Could a re-envisioned biology curriculum, be one in which students “see” themselves both in terms of their
physical bodies and in terms of their lived realities? Could a different sort of science course be one that includes issues that are of significance to individual students; one in which students see themselves in the curriculum and therefore feel included? (I am making the assumption that as students feel included in a science course it will increase their interest and motivation to do science.) The exploration of my three research questions (about inclusive curriculum development and how teachers achieve it, teacher identification, and STSE and social justice) will provide, I hope, insights into the issues that I see as essential to creating a more inclusive curriculum. In preparation for this sort of curriculum work, McLaren (1998) suggests that teachers and researchers need to understand the complexity of diversity as a concept and need to understand its relationship to curriculum construction. There is a wide body of literature that focuses on how teachers can examine issues of diversity, social justice, and the creation of a more equitable society (Cummins, 1996; Dei & Calliste, 2000; Delpit, 1995; Ghosh, 1996; McLaren, 1998). What is absent from the literature, in as much as I have been able to deduce, is an examination of diversity and social justice issues within the curriculum development process of biology or science classrooms.

The term inclusive curriculum as used in this thesis is distinct from culturally responsive teaching or culturally responsive pedagogy. As Ladson-Billings (1994) states “Culturally Responsive Teaching is a pedagogy that recognizes the importance of including students' cultural references in all aspects of learning” (1994, para. 2). It may subsume what I refer to as inclusive curriculum and generally includes many aspects of teaching such as relationships with parents, student-centred instruction, teaching from multiple perspectives, and also a re-shaping of the curriculum (Hollins, 1996; Ladson-Billings, 1994; Nieto, 1996). My interest lies in examining curriculum in a more comprehensive manner than suggesting to teachers that they use varied resources, use co-operative learning strategies, and develop integrated units—the three items
often mentioned in the literature (see for example Hollins, 1996; Ladson-Billings, 1994; Nieto, 1996) and going beyond culturally responsive to a wider consideration of students lives and a community informed pedagogy (James 2012a). My interest lies in understanding how teachers can build inclusive curriculum for a diverse student population.

Finally, I want to end this section with a point about inclusive curriculum and its relationship to social justice. UNESCO (2001), in their rationale for inclusive education state:

Inclusive education starts from the belief that the right to education is a basic human right and the foundation for a more just society. And inclusive education is concerned with all learners, with a focus on those who have traditionally been excluded from educational opportunities—such as learners with special needs and disabilities, children from ethnic and linguistic minorities, and so on. (p. 16)

While acknowledging that inclusive education is in part about children who are having difficulties or children with disabilities they go on to say:

However, inclusive education is not concerned only with disabled children, or with finding an alternative to segregated special schooling. Many other groups—children living in poverty, children from ethnic and linguistic minorities, girls (in some societies), children from remote areas and so on—find learning difficult in ordinary schools as they are currently constituted. They too may find the curriculum uninspiring and the teaching demotivating, or be alienated by the culture of the school, or be unable to access the language of instruction, or experience any number of other barriers. The inclusive approach, therefore, seeks to understand these barriers and to develop ordinary schools, which are capable of
meeting these children’s learning needs. Inclusive education therefore is not simply about reforming special education and an inclusive school is not simply one, which educates some disabled children. Rather, inclusive education is about reducing all types of barriers to learning and developing ordinary schools, which are capable of meeting the needs of all learners. It is, indeed, part of a wider movement towards a more just society for all citizens. (p. 22)

UNESCO states: “In some countries, inclusive education is thought of as an approach to serving children with disabilities within general education settings. Internationally, however, it is increasingly seen more broadly as a reform that supports and welcomes diversity amongst all learners” (UNESCO, 2001, as quoted in Ainscow, 2005, p. 109). According to Vitello and Mithaug (1998) the aim of inclusive education is to eliminate social exclusion that is a consequence of attitudes and responses to diversity in race, social class, ethnicity, religion, gender, and ability. Finally, in the UNESCO (2009, n.p.) glossary, the entry for Inclusion states:

Inclusion can be seen as a process of addressing and responding to the diversity of needs of all children, youth and adults through increasing participation in learning, cultures and communities, and reducing and eliminating exclusion within and from education. It involves changes and modifications in content, approaches, structures and strategies, with a common vision that covers all children of the appropriate age range and a conviction that it is the responsibility of the regular system to educate all children. It implies a radical reform of the school in terms of educational policy and curricular frameworks, which includes educational content, assessment, pedagogy and the systemic grouping of pupils within institutional and curricular structures. It is based on a values system that welcomes and celebrates diversity arising from gender, nationality, race, language, social
background, level of educational achievement, disability, etc. Inclusion also implies that all teachers are responsible for the education of all learners.

The next section will explore action research as it relates to this work and the next chapter will describe research literature on STSE education and social justice in education.

2.3 Action Research

This section of the chapter will describe my understanding of action research and explore why and how it is used in this thesis. John Elliott (2005) tells us that the idea of action research in the field of education emerged in the United Kingdom in the context of school-based curriculum development during the 1960s and was used as a way to approach the problem of alienation of large numbers of students in secondary schools. A number of innovations were proposed. Some suggestions were: to use content as a way to think about problems and issues of everyday life; to organize curriculum around everyday life themes rather than traditional subjects; to foster integration among different subject areas; and to encourage cross-discipline teacher collaboration (Elliott, 2005). Good ideas all—yet 50 years later, our schools continue to experience teacher isolation, alienation among students, complaints that content is not relevant to student lives, and little integration of subject matters. My research questions and my study are grounded in some of the innovations Elliott sought, even though his examples are from the humanities (not from science classrooms) and his focus is to explore the possibilities of moving from authoritarian classrooms to democratic ones. For my purposes, I suggested using action research as a way for teachers to develop curriculum in order to move from a science curriculum that is centred on knowledge acquisition or learning facts, often in isolation, to one that examines science in a social context and with a social justice view.
2.3.1 Historical and Contemporary Definitions of Action Research

Kurt Lewin is credited with first coining the term action research in 1934 (Mills, 2003), and he came to see it as giving “credence to the development of powers of reflective thought, discussion, decision, and action by ordinary people participating in collective research on ‘private troubles’ that they have in common” (Adelmen, 1993, p. 8). Action research was taken up in different parts of the world—each location with a distinct focus. In the United Kingdom, John Elliott (1991) explored curriculum reform and greater professionalism in teaching and Stenhouse (1975) felt that curriculum should be relevant to students’ experiences and promoted the notion of teacher as researcher. In Australia, Carr and Kemmis (1986), emphasized a more critical and also collaborative approach to curriculum planning and development. Different locations, different sociopolitical influences, and yet, always, the primary goal of action research was to examine educational practices and enhance the lives of students.

Mills (2003) states that action research is any systematic inquiry, done by teacher researchers or principals, in the teaching learning environment, in order to gather information about how their school or classroom operates, how they teach, and/or how their students learn. Information is gathered about the question or problem at hand, in order to gain insight, develop reflective practice, make changes, improve student outcomes, and improve the lives of those involved. Hammersley (2004) states that there should be an intimate relationship between inquiry and some practical or political activity, but that action research will only be successful if the two are not treated as equal. That is, inquiry must be primary or subordinate but the two cannot be equal. He asks: Is action research a form of research or a form of action? and Which is primary? (This notion will be interrogated in the data analysis chapter—as I believe that my participants saw them as equal but confined to different domains: our meetings (for
inquiry/research) and their classroom practice (for action). Action research, as defined by Reason and Bradbury (2001), is:

…a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview, which we believe is emerging at this historical moment. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities. (p. 1)

Action research, according to Huang (2010), is experiencing a resurgence and answers to the critique that social science research is not useful to the very subjects it seeks to understand. She defines action research as:

an orientation to knowledge creation that arises in a context of practice and requires researchers to work with practitioners. Unlike conventional social science, its purpose is not primarily or solely to understand social arrangements, but also to effect desired change as a path to generating knowledge and empowering stakeholders. (p. 93)

Elliott (1978) sees action research as anchored in a problem and so can be used for the purposes of deepening the teacher’s understanding of the problem. If the purpose of action research is to study everyday practical problems experienced by the teacher (Elliott, 1978), then its focus is to investigate actions and social situations, experienced by the teacher, as either unacceptable (or problematic), changeable, requiring a practical response, and to deepen a teacher’s understanding (and diagnosis) of the problem at hand. Contextually, it is school centred, teacher centred, and classroom centred. In attempting to explain “what is going on”
action research tells an interpretive story from the point of view of those involved in the problematic situation (Elliott, 1978). Elliott’s approach is teacher and curriculum centred. It overlaps with, but is distinct from, the perspectives of Kemmis and McTaggart (1988) who describe action research as an approach to improve education by changing it and learning from the consequences of those changes. They view it as a participatory, collaborative, theory building activity. It is research through which participants, in collaboration with others, improve their own practice by posing questions and coming to understand actions and consequences of their work. Since it involves taking action to make changes that can effect expectations and interests beyond those of the participants they also view it as a political process. According to Kemmis and McTaggart (1988):

> Action research develops through a self-reflective spiral of cycles of planning, acting (implementing plans), observing (systematically), reflecting, and then re-planning, further implementation, observing and reflecting. It is a systematic learning process in which people act deliberately, though remaining open to surprises and responsive to opportunities. (p. 175)

Mills (2003) provides a distinction between critical action research and practical action research. Critical action research, sometimes referred to by others as emancipatory action research, is rooted in a critical theory perspective. It is action research that is democratic, socially responsive, and takes place in context of teachers’ everyday lives. Critical action research is meant to help teachers examine the everyday, taken for granted, ways of their practice. In the critical action research tradition, knowledge and information gained from action research can liberate students and teachers and enhance learning and influence policy. Practical action research, according to Mills (2003), emphasizes the how to for teacher researchers who have
decision-making authority and are committed to professional development and to school improvement. It is useful (and practical) for teacher researchers who want to reflect on their practice using a systematic approach often referred to as an action research cycle. The action research cycle of choosing an area of focus, posing a question, determining data collection techniques, analyzing and interpreting data, and developing an action plan is described below in more detail.

Using action research to develop curriculum is supported in the literature, see for example Riding, Fowell, and Levy (1995). In this study, I encouraged my participants to examine how they develop curriculum and to consider the barriers they could identify when including STSE perspectives. I also wanted them to experience personal professional development and to produce a product (a piece of curriculum) as an anchor and focus for our discussions. It is hard to categorize what I did in terms of Mills’ distinction (above) or even in terms of the previous definitions. My action research project, then, as negotiated with my participants, became a hybrid of the two perspectives Mills describes. I see it as a strength that action research definitions differ, vary, overlap and that in general, action research traditions are difficult to categorize. The ambiguity provides for growth and fluidity as action research is used in different context and for different needs.

My participants had agreed to use action research and when their efforts often seemed stalled, confused, and disorganized (overall messy action research) I felt worried. Eventually, I came (as Brydon-Miller, Greenwood & Maguire (2003), suggest we do), to see the messiness as attractive and helpful to the ultimate goal of understanding or shedding light on the research questions. What they call the “beauty of chaos” (p. 21) will be discussed in chapter 6. Some of the insights in this thesis came from what participants did not say and did not do with respect to
action research. Clearly action research is complex, nuanced, evolving, and understood in different ways for different contexts and continues to be understood differently over time. (See Carr and Kemmis (2005) for an update of their seminal book: *Becoming critical: education, knowledge and action research*).

### 2.3.2 The Action Research Cycle

Many sources suggest practical approaches as well as step-by-step procedures to conducting action research. (See for example: Atweh, Kemmis, & Weeks, 2002; Kemmis & McTaggart, 1990; McNiff, 2002; Mills, 2003; Stringer, 2004.) Common among all of these is the notion of a series of steps, tasks, and reflections that are then repeated in a cyclic fashion. Mills (2003) has practical advice for using such a cycle. He suggests the following: Begin by examining your values, history, and beliefs. Choose an area of focus and develop a focus statement. Define your variables, make up research questions, determine what will you do and with whom, make a timeline, and determine what sort of data will be collected. Data collection techniques can be as varied as interviews, rating scales, inventories, observations, visual recordings such as photos, journals, or surveys and questionnaires. In the end the teacher researcher is trying to answer the question: “What is going on here?” The next step is data analysis and interpretation. Data is analyzed for patterns, insights, and meaning. Mills encourages teachers to take a leap and record what is learned. I appreciate his practical approach that logically leads teachers to develop an action plan that addresses their area of focus by reflecting on such questions as: What did you learn? What are the recommendations? What can be done and who will take action?

I was interested in learning from my participants how the principles of action research could be the fibre of every teacher’s day: identify a question, try something to address it, record
your findings, reflect, and make an action plan. I would argue that teachers often perform many of these actions in the course of everyday planning and teaching except that they rarely record their findings in writing. The teachers in this study had had some exposure to action research and were enthusiastic about attempting to use action research for their curriculum development project. What they knew was quite general and, as will be described further in chapter 5, was applied in vastly different ways. I had a hope that my participants would develop the tools to be able to use action research daily and in an ongoing sustained way to investigate their practice, and not only for a special project overseen by a university researcher, but as simply what teachers do to improve their practice. To achieve this I support Sommers’ (2009) vision of different types of reporting and dissemination of action research methods and results of studies. Sommers (2009) bases his assertion on a three-pronged purpose for action research: to advance knowledge, to improve a concrete situation, and to improve research methodology and to this end I encouraged participants to share their progress, to share the curricula they developed, and to report on both successes and challenges.

2.3.3 Benefits and Challenges of Action Research

There are strengths (or advantages) and also challenges (or limitations) to using action research. According to Dick (2009) resources describing action research need to find a balance (especially for the novice teacher researcher) “between ‘as simple as possible’, so as not to frighten beginners, and ‘no simpler’, so that it actually works” (p. 429). His sentiment resonates with me as I attempted to do just that: present action research as a simple and doable process with the intent that it “worked”. Goodnough (2010, 2011) reflects positively on a long-term study of teacher identity changes after action research participation. She states that teachers in her study were positively involved in critical engagement of new ideas but that critical to success
is time to be reflective and in her study teachers had several days to plan and implement (and one assumes to write about) their research. Bryant and Bates (2010) write of resistance to action research in the context of students in a teacher education program, and found that the student teachers who resisted in participating fully in action research lacked understanding of its purpose, felt discomfort with the emphasis on process, and resisted the time needed to fully invest in it. Mills (2003) acknowledges the challenge for teachers to write about their action research and how he tries to persuade teachers that there is value to (formally) writing about their action research. He suggests that the process of writing helps the teacher researcher to clarify, reflect upon, and refine what he/she wants to say.

Another challenge in action research is that as teachers engage in research, the context specific reflexivity of the process produces a moving target of sorts and so the purpose or question of the research necessarily changes and the teacher researcher is forced to re-evaluate, re-appraise, and shift the focus of the work. Feldman (1994, p. 94, as quoted in Hodson 2009) summarizes the sentiment in this way:

Even as she goes about doing her research, her understanding of the education situation changes, her horizon shifts, and she finds that the target of her research has shifted with it… As the teacher engages in the research process she comes to a different understanding of her education situation and results in her deciding to act in different ways.

I see here some parallels with my research participants who stated that they wanted to be co-operative yet could not seem to fully engage in action research. Although chapter 5 holds a more thorough analysis of the participants’ relationship to action research, I will say here, that Anita in
particular kept changing what her research could be and Mary who in many ways was the most thoughtful about action research as a process—never began her research.

2.4 Summary

This chapter is meant to help the reader appreciate that curriculum is a complex field, with multiple meanings, definitions, and traditions. I wanted to emphasize that I mean curriculum to include all aspects of teaching and pedagogy. Similarly action research has come to mean many things. It too is a complex field with multiple meanings and traditions. In this study I used a type of participatory action research in which teachers investigate their own practice around a question that stems from their reflections and aspirations about improving their teaching practice. Teachers who develop a curriculum that is inclusive of a diverse student population would do much to inspire and retain students in the sciences. Biology, usually the most popular of the sciences in high schools, which includes a focus on social issues and social justice (the focus of the next chapter) could contribute in an important way to students’ experiences and potentially to future interests.
3  STSE (Science, Technology, Society, and the Environment) and Social Justice

In this chapter we explore STSE and social justice as it relates to this thesis and the research questions: 1. How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population? 2. How do teachers understand themselves and their role as science teachers? and, 3. How do teachers understand STSE curriculum as a place for furthering social justice issues? Recall that chapter two described literature associated with questions 1 and 2 above, and related to curriculum, teacher identification, and action research. This chapter will explore the research literature about STSE and social justice that relates to question 3.

STSE is explored first in terms of some definitions, ministry of education curriculum policy documents, and the STSE literature including how STSE can be an approach to teaching science and a movement to a more politicized science education. Next, social justice is defined and described in general terms and in a science education context, and finally, the overlapping ideas of STSE and social justice are compared with respect to ramifications and implications for the classroom. For the purposes of this thesis I use the terms STSE and STS (the STSE precursor) interchangeably as a concept and both terms are used depending on the scholarship.

3.1  STSE: Definitions and Context

In science education, “Science, Technology, Society and the Environment” is usually shortened to “STSE” and refers to the specific relationships between science (S) and technology, (T) society (S) and the environment (E). STSE can also refer to an abstract idea and can
contextualize science within social, cultural, and political influences (Pedretti, 1996, 2003). At times STSE education refers to a progressive movement to improve science education. STSE also refers to a group of curriculum expectations found in ministry of education documents and in this context can also include such topics as careers and Canadian contributions to science. Characteristics and components of STSE include the interrelationships of science and society with technology and the environment and often also include:

- local and global perspectives to contextualize science
- environmental problems and threats
- technology development and use and how it is affected by the economy
- the nature of science and multi-cultural aspects of science
- social justice issues and social responsibility
- historical perspectives
- real-life situations
- ethics and personal values that effect decision making
- citizenship and taking action, and
- controversial issues and a commitment to face controversy

(see Aikenhead, 1994; Alsop & Pedretti, 2001; Pedretti & Little, 2008; Solomon & Aikenhead, 1994; and Ziman, 1994). There are benefits to including an STSE focus in science education. STSE education has the potential to make science more relevant to students, to encourage problem solving, to foster critical thinking and intellectual independence, and to raise and examine issues of social change and societal injustices.

While the benefits seem obvious, logical, and most importantly achievable, my experience is that teachers “add-in” a “bit of STSE” here and there, when there is time, or when they
determine that they need some assessment data on STSE expectations, and miss opportunities to use STSE education as a central organizing focus in a unit, to enhance and support critical thinking skills, and to explore social issues.

3.1.1 STSE as Ministry of Education Curriculum Document Expectations

STSE education or education about science, technology, society, and the environment is a part of many curriculum documents and specifically a prominent section of all Ontario science curriculum documents. STSE in the science curriculum in Ontario has specific expectations that are articulated for each unit under the heading of: Relating Science and Technology to Society and the Environment. These are commonly called the “STSE” expectations as distinguished from Knowledge (or basic concept) expectations and Inquiry (or skills of investigation) expectations. STSE expectations could be seen as providing a place to interrogate complex questions that affect us. It should not, I argue, be a catchall for interesting bits of science that do not fall into the knowledge or inquiry parts of courses and lessons. In my experience teachers will also use the term “STSE” to refer to a part of their lesson that has a relevancy factor. I have heard teachers, in reference to a content topic, say: “maybe we can do a debate in order to cover some STSE”. In chapter 5 this idea will be further explored as teachers often referred to STSE as an entity that was synonymous with “relevant to students” or loosely about the nature of science as opposed to science subject matter content knowledge or scientific inquiry. Sometimes teachers equate STSE with “that which is controversial”.

Controversial or not, STSE may also focus on the implications of aspects of the content for society or the environment. Examples might be implications of administering versus rejecting vaccinations, or implications of spraying with pesticides versus not spraying in areas where Malaria or West Nile virus is endemic. Some topics lend themselves to an STSE focus easily (for
example: energy, pollution, disease) some topics – particularly descriptive ones, such as parts of the cell or cell theory are more of a stretch and may use STSE as a way to examine applications and uses of the knowledge. Consider the examples below of a knowledge expectation followed by an STSE expectation and its matching sample questions, taken from Ontario grade 11-12 science guidelines:

**Example 1: Cellular biology, grade 11, college level**

**Knowledge Expectation:** B3.1 explain the roles of various organelles, including lysosomes, vacuoles, mitochondria, cell membranes, ribosomes, the endoplasmic reticulum, and Golgi bodies, in the processes of digestion, cellular respiration, and protein synthesis. (Ontario Ministry of Education, p. 65)

**STSE Expectation:** B1.1 evaluate the effectiveness of medical devices and technologies that are intended to aid cellular functions or processes (e.g., insulin infusion pump, chemotherapy).

**Sample questions [to support STSE]:**

How can stem cells be used in the treatment of leukemia? How effective is this type of treatment? Why is laser technology more effective than conventional surgery in removing cancerous tumours? What are some of the effects of kidney dialysis on the renal system and other body systems? and What are the advantages of using nanotechnologies in the imaging and diagnosis of cellular abnormalities? (Ontario Ministry of Education, p. 64)

As we can see, for this topic, the STSE expectation (and accompanying sample questions focus on technologies and separate in focus (although not so much in theme) from the Knowledge expectation. My interest in this thesis is in how teachers would develop curriculum that
addresses these expectations in a way that promotes and provokes critical thinking and multiple perspectives and/or by using a social justice lens regardless of whether the topic lends itself to an STSE focus.

It would be my position to integrate the STSE expectations into the unit in as much as possible, practical, and appropriate. Additionally the STSE expectations can also serve as an approach or focus that will help guide the teaching of the key subject matter content knowledge that frames the curriculum unit or topic. A further consideration is the pedagogy surrounding STSE. That is, a pedagogical approach that validates multiple perspectives, sees all answers and all questions as problematic, and acknowledges that all questions can have multiple and often conflicting answers. Some STSE pedagogy is “in the moment” teaching and so not always planned in advance; some is how we, as educators, react to student answers to our (or ministry suggested) questions. As examples, are answers treated as simple or as complex notions and a jumping off point to larger discussions? In my study, I did not watch and record how teachers posed questions or how student answers were used to further discussions. Still from my own experience I feel that this is a key part of teaching and makes real the idea that what we teach and how we teach reveals who we are in fundamental ways. In chapter 5, I will further explore this idea that who we are affects how we teach and how we make decisions about what to teach.

One key part of an STSE focused science curriculum is to view the expectations as a guide or ethos that will inform our approach and as distinct from a curriculum that “covers” or addresses the STSE expectations as a series of points, like a checklist, to be simply, “checked off” as they are mentioned or presented to students. An STSE focused science curriculum, is more like an umbrella that we carry with us as we teach. An STSE focus can also provide a foundation for our pedagogical decisions as we explore philosophical and political aspects of
science—whether about subject matter content knowledge, inquiry and investigations, the sociology and nature of science, or specific controversial issues. How we design our STSE curriculum will depend on the contextual and practical realities of our setting, the science topic or unit, our students profiles, and our own comfort levels (both with content knowledge and controversy) and perspectives. Still scholars ask why after STS thinking and writing and promoting for over 30 years, is STS still the over-looked or marginalized part of courses (Nashon, Neilson, & Petrina, 2008)? I have the same question. The next section explores curriculum planning and classroom practice.

3.1.2 Classroom Practice: What Might a Science Class/Course Look Like?

Unlike some of the more factual expectations that focus on subject matter content knowledge such as, for example, “what is the function of mitochondrion in the cell?” STSE approaches may require teachers to embrace ambiguity, controversy, and sociology (or the structure and functioning) of science which may be difficult for science teachers who are content experts and who are uncomfortable with ambiguous or multiple perspective questions. One could argue that as a minimum, teachers could at least cover the STSE expectations, which are, after all, right there, clearly stated in the curriculum. One might argue that embracing social justice perspectives and controversial issues may be too ambiguous in practice but that the actual STSE expectations are a minimum or baseline that certainly can be taught.

Aikenhead (1994) explores curricular aspects of STSE and considers several ways to include or integrate STSE approaches into everyday teaching, planning, and pedagogy. He describes using STSE to motivate students and make lessons more interesting, casual or purposeful infusion of STSE into the traditional science lesson, or infusion of science content
into lessons in which STSE is the focus. We will see in the data chapter that my participants at one time or another discussed using several of these approaches. His categories are summarized below: (I have edited and collapsed some categories for clarity—see Aikenhead, 1994, p. 55-56 for a full description.)

a) STS content is mentioned as a way to make lesson more interesting and students are not assessed on the STS content.

b) Casual infusion of some STS theme into the science content.

c) Purposeful infusion of STS where the STS content is integrated into the topic to systematically explore the STS content through coherent themes.

d) STS content serves as the organizer for the science subject matter content.

e) STS content is the focus of instruction and is meant to enrich the science learning.

   Students are assessed equally on STS and pure science content.

f) STS content is the focus of instruction. Often a technology or an issue is the focus.

   Science content is mentioned but not taught—sometimes it is used as a link. Students are not assessed on the pure science content to any appreciable degree.

A few notes on these categories: Aikenhead makes the distinction between STS content and [pure] science content. More recent scholarship is likely to use the terms science subject matter content knowledge (CK) and STSE education or STSE perspectives. And so, the (Aikenhead) categories can be useful not so much to describe our overall approach to planning science curriculum in general but rather to describes how we approach a specific topic with specific students with specific needs and abilities. As with everything in STSE education I would argue the fundamental underpinning to any query is context, context, context. Additionally he suggests that teachers may feel comfortable at one of the levels and be reluctant to move to the next one. I would add that teachers may feel varying levels of comfort with each approach depending on
what is best suited to specific science content and in relation to their own level of understanding of the content. If we are not experts in the content then we may be less likely to use the STS(E) content as the focus of instruction and so may use the casual infusion for one topic and then STS as the focus for another.

3.1.3 STSE Education

As a reminder, the terms STS and STSE are used interchangeably. In most instances they refer to the same tradition of thought; at times STS simply denotes an older term. Fuglsang (2001), has this to say about STS:

I have suggested that science, technology, society (STS) consists of several seemingly competing, if not conflicting perspectives because they relate to different notions of power, policy, and method. Nevertheless, the perspectives can be combined. Combining the perspectives does not mean however that we create a unitary approach of STS. What I intend is rather a pluralistic and open approach. To open the doors among the different perspectives is a major challenge for STS, which may also require a thorough deliberation of the different related policy interests. (p. 46)

More recently, the “E” for environment was added during a period where environmental issues were often lost and there was a need to highlight them. Currently “STSE” is used in all Ontario classrooms and with ministry (or department) of education documents across Canada.

Ziman (1994) suggests a multiplicity of approaches for STSE education—each with advantages and drawbacks. Furthermore he argues that this multiplicity, far from making the field incoherent, makes it rich with possibilities and introduces a political element to the discussion that is not embraced by all. His approaches are organized around the following ideas:
relevancy, careers, history of science, philosophy and sociology of science, and solving problems of the day. Although Ziman suggested these approaches over 30 years ago, his summary remains relevant and I submit that little has changed in the STSE landscape. From my experience in schools and in working with teachers I have observed and noted that many teachers avoid framing STSE within sociological, political, or philosophical perspectives but mostly adhere to relevancy, careers, and problem solving aspects of STSE education.

Problem-solving aspects of STSE are often connected to an issues based approach (see among others Aikenhead, 1994; Pedretti, 1996, 1999, 2003) including issues based case studies, historical case studies, and controversial issues. Often the issues have environmental, health, well-being, and medical contexts. Ironically, as STSE education becomes more focused in issues, teachers must begin to navigate the philosophical and sociological landscapes of the purposes of STSE education from decision-making and taking action to critical social reconstruction. Perhaps, in part, this is one of the reasons for the disconnect between teachers beliefs about the importance of STSE and teachers’ practice in the classroom—both their current practice and their predictions of what they will do—for, as novice teachers will tell you, they value an STSE approach and see it as important for others, always, but for themselves when they have more experience (Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2006). As novice teachers they feel the pressing demand of other priorities such as learning subject matter content knowledge, identifying student needs, planning lessons, and generally navigating school practices. If the sentiments of these pre-service teachers have any predictive value it does not bode well for practicing teachers if they enact what is suggested in the Pedretti et al. paper—which is that STSE is important but that they (the pre-service teachers) were too busy or too inexperienced to deal with all the demands of STSE and that perhaps they would get to it when they had more experience, at some point in the future.
Many of the foci of STSE education mentioned above overlap with a science education that includes notions of values, the nature of science, stewardship, decision-making, and taking action (see Pedretti 2003; Pedretti & Little, 2008). It is my experience that teachers use the term STSE to refer to a number of elements of science teaching. STSE may refer to, for example, a societally relevant part of the science curriculum; issues teachers deem as potentially controversial to students; or aspects of science that are neither knowledge (facts and content) nor inquiry (laboratory or practical work. Interestingly, in my experience, STSE does not usually refer to technological advances, which are often imbedded in the knowledge/content of the course or in practical activities, and seldom to environmental issues. More recently, Pedretti and Nazir (2011) have asked what STSE looks like in practice and identify six currents into which STSE education can be organized:

1. The application/design current involves designing or modifying technologies and developing inquiry skills.

2. The historical current seeks to embed science and the work of scientists in a historical and socio-cultural context or milieu and often includes philosophy of science or nature of science perspectives.

3. The logical reasoning current assumes that science issues (socio-scientific issues—often controversial issues) can be examined logically and with reference to science content knowledge that can guide us and potentially help us to make decisions about the issues.

4. The value-centered current involves examining socio-scientific issues through attention to ethics and moral reasoning.

5. The sociocultural current aims to position science within a sociocultural and/or a socio-political landscape, to make science more accessible to all students, and can include examining science as a way of knowing, embedded with a particular worldview.
6. The *socio-ecojustice* current positions science as influenced by political and economic factors, and as promoting social justice and activism. (see Pedretti and Nazir, 2011, for a full description of each current)

Some of the advantages and disadvantages of these currents are described elsewhere in this chapter. For example while both current 3 and 4 can deal with issues, the focus of current 4 is more toward character education and moral development and can have the inherent problem of trying to promote certain values over others. Also the need for a sociological approach to science education (from current 5), which Ziman supports, is discussed elsewhere. Current 6 is in many ways the backdrop of much of this thesis and is echoed in the work of Hodson, Calabrese Barton, and others mentioned in this chapter. Current 1, application and design, is usually familiar to and could be appealing to teachers, however it does position science as creating products in objective ways. Current 2 can highlight science as being done by humans in a social and historical context but can also present it as (historically limited) folklore as in Mendel’s plants or Darwin’s voyage.

It was assumed that science teachers used all or most of these currents depending on teacher comfort, student needs, students readiness, and the course specific content. The educators in my research group had expressed an interest in enhancing their STSE repertoire of knowledge and approaches (never having read the Pedretti and Nazir “Currents” paper of-course) and specifically had expressed an interest in the social justice aspect of STSE (or current 6, socio-ecojustice). As will be described in chapter 5, one of the projects undertaken by a participant fell clearly within current 2; while the other participant’s project is more difficult to categorize and perhaps is a cursory mix of currents 3, 5, and 6.
3.1.4 A Word about Socio-Scientific Issues (SSI)

Zeidler, Sadler, Simmons, and Howes (2005) argue that STSE lacks a framework that takes into account child development and character (or virtue) development and suggest socio-scientific issues (SSI) as the over-arching idea of which STSE is a part. Socio-scientific issues, according to Zeidler et al. (2005) help students to reflect upon elements of morality and virtue—which they do not define—that speak to their personal (physical and social) lives. They suggest that within science there exist socio-scientific issues that can be examined and that SSI empowers students to examine issues from a perspective of morality, virtue, and character development. As Zeidler et al. (2005) state “SSI education is equated with the consideration of ethical issues and construction of moral judgments about scientific topics via social interaction and discourse” (p. 360). I would prefer (in the social justice tradition) to view all knowledge as problematic and worth examining. I prefer to avoid terms such as ethics, virtue, and morality as part of a framework for teaching with the understanding that individual students come to school with a variety of personal ethical/moral perspectives that need to be respected as part of an inclusive curriculum. I would argue that what Zeidler et al. (2005) see as a lack of coherence I see as a strength that allows for all issues and all knowledge to be viewed as controversial (thereby negating that some are controversial and some are neutral) and to examine science from a socio-political-justice perspective that considers how science affects and is affected by society (or in the STSE tradition how science, technology, society and the environment affect and are affected by one another.) Zeidler et al. (2005) argue that STSE lacks a coherent framework and that SSI provides one. I do not agree with this assessment. I argue in this thesis that teachers face barriers and challenges common to both SSI and STSE that prevents a more issues-based, political approach to science teaching. This is explored in Chapter 5, which examines the data.
and chapter 6, which suggests a framework for enhancing STSE in school science programs. Zeidler et al. state the following:

Whereas the overarching purpose of the STS approach is to increase student interest in science by placing science content learning in a societal context, SSI education aims to stimulate and promote individual intellectual development in morality and ethics as well as awareness of the interdependence between science and society. SSI therefore does not simply serve as a context for learning science, but rather as a pedagogical strategy with clearly defined goals. Certainly, knowledge and understanding of the interconnections among science, technology, society, and the environment are major components of developing scientific literacy; however, these interconnections do not exist independently of students’ personal beliefs. It is our stance that STS(E) approaches can be remodeled and substantially improved by adding an essential missing component—consideration of each student’s own moral and ethical development. (p. 360)

Once again—I do not agree and do not situate STSE education as these authors suggest, that is, as a context for learning or in the context of increasing student interest. This is a narrow view of STS(E) and as the literature suggests has never been the perspective of scholars such as Glen Aikenhead, Joan Solomon, John Ziman, or Erminia Pedretti. Socio-political-cultural aspects of science are at the heart of the matter and I suggest that when coupled with social justice perspectives and issues of the distribution of power and wealth, STSE can be a rich landscape for a comprehensive science education. One last word: I suggest that SSI has at its root its own political agenda of morality education and character development which I find problematic as in the end I am forced to ask: whose morals and whose ethics are privileged and whose are
underrepresented? In many ways SSI and STSE are indistinguishable but for the inclusion of morality, virtue, and making moral judgments.

3.1.5 STSE as a Movement or a Call to Action

STSE in the language of teachers can also refer to an idea or a movement. Hodson (2003) suggests that there are four levels of commitment to STSE education that are found in science education. They are:

- **Level 1:** Appreciating the societal impact of scientific and technological change, and recognizing that science and technology are, to some extent, culturally determined.
- **Level 2:** Recognizing that decisions about scientific and technological development are taken in pursuit of particular interests, and that benefits from some may be at the expense of others, and that scientific and technological development are inextricably linked with the distribution of wealth and power.
- **Level 3:** Developing one’s own views and establishing one’s own underlying value positions.
- **Level 4:** Preparing for and taking action (Hodson, 2003, p. 655).

Hodson suggests using the four levels of commitment in STSE education progressively, to gradually move from general understanding, to focusing on contextual issues, to establishing personal beliefs, and finally towards highly informed and committed action to address important social and environmental issues. I propose that level two (unlike the other levels) is often overlooked. Often there is little recognition and inclusion of issues of wealth and power in science as a practice or as a body of knowledge and yet this level has an easy and fluid connection to social justice. Also, perhaps, teachers need to go through these levels in terms of their own understanding of STSE education, before they can use the levels in their teaching. To clarify,
teachers cannot develop a pedagogy that leads students to take action if they see STSE education as mostly a way to appreciate the impact on society of science or the use of STSE issues as a way to make science more relevant and interesting.

Some educators see the approaches (from Ziman) and integration (from Aikenhead); currents (from Pedretti and Nazir); commitment levels (from Hodson); and components, topics or orientations of STSE education (Aikenhead; Hodson; Pedretti & Little; Zeidler et al., and others) as natural and concomitant with a social justice orientation to science teaching. Initially I found myself trying to analyze what parts of STSE education were best associated with a social justice lens. But simple matches do a disservice. All science education would benefit from a closer examination of justice issues. As Hodson (2004) suggests, science education should have the purpose of promoting socio-political action and that as teachers politicize the curriculum, the curriculum (as experienced by students) is:

intended to produce activists: people who will fight for what is right, good, and just; people who will work to re-fashion society along more socially-just lines; people who will work vigorously in the best interests of the biosphere. (p. 6)

And so, whether we use an integrated approach, focus on issues, use an application and design current, or use a sociological framework, I submit that all science teaching and all STSE education can benefit from a student centred approach and from a socio-political-cultural and justice lens. Bhaskar Upadhyay (2010) agrees that teaching science for social justice needs to occur in a context that is open to students’ sociocultural and lived experiences. As Young (1990, as referred to in Upadhyay, 2010) suggests, science teachers when teaching for social justice must focus on individual students and the social and cultural contexts in which they live.
3.1.6 Using a Social justice Lens

In some ways the current science curriculum documents provide opportunities for doing what Hodson suggests above. However “the” curriculum does not really exist per say, since a curriculum is enacted differently by each teacher. Lets take a specific example of a “sample issue” from the grade 11 cellular biology unit in the Ontario Ministry of Education curriculum guidelines:

Sample issue [to support STSE]:

For many people with diabetes, insulin pump therapy has replaced multiple daily insulin injections. The pump dispenses accurate doses of insulin and achieves reliable blood sugar control. However, not all jurisdictions fund the pump for all diabetics, and some people prefer self-administered injections to being hooked up to a machine (Ontario Ministry of Education, p. 64).

What is the central “issue” if we were to name it? Is the issue funding and why the pump is not funded for everyone or is the issue about personal lifestyles in that some people do not like to use the pump resulting in health concerns and health system pressures? How is funding determined in different jurisdictions? What are other underlying issues that might scaffold a discussion of this issue? A classroom discussion about the issue presented in the document will be different if the teacher chooses to examine it in terms of bigger issues of personal responsibility and personal control, versus access to health care and funding, or as a technological advance for managing metabolic disease pathologies. What might a teacher do to tease out the issue of the challenges faced by diabetics living in poverty? Clearly, “the” curriculum becomes morphed into a variety of lessons depending on the perspectives teachers
(and students) raise and whether a justice lens is used to purposely complicate matters. Teachers are left to interpret based on their own equity and social justice framework or lens. The next section examines social justice and social justice in science (and STSE) education.

3.2 Social Justice

Social justice is generally or broadly understood to refer to “the right treatment of others and the fair distribution of resources or opportunities” (Reiss, 2003, p. 160). Social justice involves the removal of behavioral and institutional barriers, including prejudice and discrimination, which preclude equality of opportunity, freedom, and responsibility to choose and realize individual capabilities (Sen, 2009). It often is referred to in terms of a movement to address justice issues such as inequalities, oppression, issues of marginalization, and unequal distribution of wealth. Social justice issues often include inequalities due to race, class, gender, and sexual orientation or are linked to matters of poverty, disease, and environmental degradation. Social justice is a set of principles (or a lens through which we interrogate and critique issues) and that can be applied to individuals, groups, or institutions.

Although science education and in particular STSE education can include justice perspectives, Calabrese Barton and Upadhyay (2010, p. 5) state that “social justice research in science education is still in its infancy”, but that science education can promote social justice perspectives. In particular they argue that it is important to view learning about science as a practice as well as learning science as content, as a civic right. They suggest that “teaching and learning science involves critical activism and citizenship and [that] the goals of science literacy involve personal, social, and economic empowerment” (p. 5). For this thesis these above named aspects or issues will be referred to as social justice issues (and at times here and in the literature they are also described, depending on the source and the context, as issues of equity, diversity,
Citizenship education is a more American construct and I focus more narrowly on social justice, however as Banks (2004) states: “Citizenship education should help students to acquire the knowledge, attitudes, and skills needed to act to make the nation and the world more democratic and just.” (p. 289) and these are sentiments I agree with and which are reflected in this thesis. We might ask: What is science education for? (see Wellington, 2001 for full exploration of this) and Does social justice have a place in science education? Conventional science teaching most often includes, according to Hodson (2003), “dealing with established and secure knowledge, while contested knowledge, multiple solutions, controversy, and ethics have been excluded” (p. 664). Social justice generally explores issues of race, class, gender, sexual orientation, language, and ethnicity, among other things. Social justice pedagogy could additionally take into account multiple perspectives, treating all knowledge as contested and problematic, and address issues of power and inclusion.

Hackman (2005) states that a social justice approach to education includes the following five elements:

- content mastery of factual information as it is the essential basis for learning,
- critical thinking and the analysis of oppression so that students can critique systems of power and inequality of society,
- action and social change so that students can move from cynicism to hope and possibility,
- personal reflection allows teachers to critically reflect on personal qualities that affect their practice, and
- awareness of multicultural group dynamics including classroom dynamics and identity construction of teachers and students helps teachers in how they approach the first four elements. (p. 104)
Hackman suggests that if we work on any one of these elements the outcome will benefit students, classrooms, and the school community and that addressing all five will lead to an operative and functioning social justice education environment. She emphasizes that by listing these five components of social justice education she is not intending to limit the conversation but rather enhance it, provide some clarity as to what social justice education entails, and create a starting point for moving forward. Upon comparison with STSE education (Pedretti & Little, 2008; Pedretti & Nazir, 2011) we see overlapping themes of critical thinking, reflection and decision making; and, action, change, and social justice.

3.2.1 Science Classroom Practice and Pedagogy

Science classroom practice could reflect science as an endeavour that is affected by and imbedded with issues of power, wealth, and the tenets of the nature of science including practitioner bias (Banks, 2004; Calabrese Barton, 2003; Dei & Calliste, 2000; Gill & Levidow, 1987; Harding, 1998; Hodson, 1998a, 1998b; and Sleeter, 1993, 2009). Social justice is also about curricular decisions that teachers make with respect to their content choices and examples as they plan lessons and classroom practice. These two come together in the classroom in different ways. I suggest that social justice in the context of high school classrooms involves both the more abstract notions of power and the nature of science (NOS) and specific content choices and examples that reflect social justice issues which may be controversial in nature. A teacher may interrogate science as a practice and explore the nature of and bias within the practice, but not include examples of injustice in the lesson content. A teacher may include many examples of injustices or of how science is implicated in societal ills but not interrogate this concept with respect issues of power, or in a context of the history of oppression.
A truly culturally relevant (Ladson-Billings, 1992, 1995a) and community informed (James, 2012b) pedagogy brings social justice into our pedagogy by including issues of power and NOS with specific content examples. Oulton, Day, Dillon and Grace (2004) relate such ideas to teaching with controversial issues. They state: “that the principles and methods relating to the teaching of controversial issues are themselves controversial.” (p. 489) and suggest that we must recognize that one of the underlying features of teaching with controversial issues is that we acknowledge that balance is impossible to achieve in our pedagogy and that we help students to be aware of bias in materials and that we help students to develop the skills and aptitudes necessary to identity bias for themselves. Helping students to recognize bias and injustices related to the construction of for example race, gender, and sexual orientation, have a place in biology and science classrooms. It takes science to a more human level and presents it as work done by people within a societal context (Harding, 1998). It presents all science knowledge as constructed in a contemporary world, as originating from multiple perspectives, as offering multiple views about the world, and as implicated in both good and bad outcomes. Science is responsible for many advances such as antibiotics, vaccinations, and clean water, which we deem as good. Science is also implicated or responsible for the construction of ideas (some oppressive and contentious) about personal identity such as race, ethnicity, gender, and sexual orientation. Additionally science is central to our understanding of topics related to the environment such as pollution and environmental degradation; and to health and medicine, such as genetically modified foods or drug testing research and ownership of knowledge. All of the examples above are important, I would argue, to student’s lives and yet are often ignored or excluded, by teachers, from courses. The reasons that such science is not included are what I tried to understand.
There is a body of literature that addresses social justice and teacher education and examines the work of faculties of education within an American context (see for example Adams, et al., 1997; Apple, 1999; Cochran-Smith, 2001; Sleeter, 2009; Zeichner, 1993, 2009). Zollers, Albert, and Cochran-Smith, (2000) advocate for the inclusion of social justice issues such as race, class, and disability in the teacher education programs that prospective teachers experience as they prepare to teach a diverse student population. In a study conducted by them, they found that faculty supported the goal of teaching for social justice and also that “teaching for social justice” meant different things with respect to: definitions of social justice and equity, understandings of injustice, and the degree of responsibility of individuals to advocate for social justice. As examples: some participants felt that teaching for social justice was important for religious reasons or due to cultural traditions while others framed injustice as largely political in nature; some felt that teaching for social justice was an institutional responsibility while others felt it was a personal responsibility to confront injustices and create a more just society. It seems clear that “social justice” while a concept that it is hard to disagree with is also a complex idea about which teachers exhibit a range of perspectives.

The literature seems, after extensive search, less robust in the area of social justice as a force or focus that directs and influences science curriculum development in the context of practicing teachers. Social justice is often investigated within social studies curricula (Cammarota, 2007), at the higher education level, or in terms of high school (usually social studies) curriculum that looks at social justice issues from the perspective of some aspects of students’ lived realities, such as poverty or discrimination, and with respect to what students can do to change these elements. Others make a case for socially just teaching within the context of teaching disciplinary content concepts (Moje, 2007). Miller (1999) says: “social justice has always been and must always be, a critical idea, one that challenges us to reform our institutions
and practices in the name of greater fairness” (p. x). There is a body of literature that explores social justice in education through the creation of safe schools, safe spaces, and more inclusive communities for Black youth, Queer/gay youth, and urban youth (see Cosier, 2009; Payne, 2009; Mayo, 2009, McCready, 2009; Blanchett, 2009). Interestingly, the Handbook of Social Justice in Education, edited by Ayers, Quinn, and Stovall (2009), while including a section on pedagogy, has little, except for one chapter related to mathematics curriculum development, about what practicing teachers do to construct curriculum. Again the research is mostly taken from an American perspective.

There are some researchers who write about science and social justice such as Christine Sleeter and Angela Calabrese-Barton and much of what they write has influenced me. For example Calabrese-Barton (2003) shares stories from the lives of students as they explore science that has meaning for them and experiences that help them to construct science knowledge. Although she promotes a need for a vision of school science that is responsive to student needs, which I support, she does not address this issue in the way that I would like to take it up, which is, in terms of what practicing teachers can do to develop (imagine, construct, implement, and revise) curriculum with specific students in mind. Sleeter (1992), in considering what sorts of staff development is most effective, suggests a whole-school reorganization process rather than professional development (PD) that focuses on changing individual teachers beliefs and/or practices. Overall, while she sees the school as the centre for change she also notes that teachers complain about lack of time to plan and implement new units or new activities and that they would like more feedback and ongoing help. She notes that the structural aspects of schools (timetables, class size, curriculum and program mandates, relationship between school and community, and school bureaucracy) all serve to limit how teachers construct their students’ needs and how they understand their possibilities for teaching in a different manner. While she
was writing these sentiments over 20 years ago, I re-iterate as with other points in the last and this chapter: little has changed in the last quarter century.

A fully developed science course should include, in my opinion, an examination of the idea that science has been implicated in social injustices; it should include a social justice perspective. As Reiss (2003), Sleeter (2000, 2009), Gitari (2003) and others have expressed: A social justice approach promotes educational equity, honesty, and excellence. In schools, science education should be honest and authentic—it should reflect, in as much as we can know: what science is, what scientists do, and how research is funded; and the benefits and costs of scientific research, innovations, and products. Cunningham and Helms (1998) argue for a science education that is more authentic and inclusive for all and suggest that the way to achieve this is:

Infusing sociological concepts into curricula can enhance science study by a) preparing all students for the problems and decisions they will face in our increasingly science-dependent society; b) engendering more interesting and accurate views of science; and c) attracting, interesting, and retaining more [often underrepresented] students in science. (p. 496)

They argue that the sociology of science offers one path to a more diverse and inclusive (more democratic) participation in science. These sentiments seems connected, therefore to this thesis, seeing science as a social activity that is influenced by and in turn influences society and developing a more inclusive science education that meets the needs of students.

It is my belief that if students experienced a science curriculum that included contemporary issues (such as the ones named above) of relevance to students with a justice focus, they would benefit in terms of increased interest and engagement in science courses and that in the end we as a science education community would inspire more students to engage with
science content and science practices both in terms of personal edification as well as future study beyond high school. Gitari (2003) in fact argues for social justice and equity to be the organizing principle for science courses that are geared to access university programs (i.e. programs that support students who have often faced failure and marginalization in the past). Science education with a social justice focus could be one way to contextualize science content knowledge, which may otherwise be seen as abstract and inaccessible, and together with considerations of pedagogy, is key to supporting all students, regardless of previous experiences or biases they hold of science not being for them (Gitari, 2003).

Imagine a genetics lesson for example that begins with Mendel and his pea plants, moves to Punnett squares and pedigrees, next explores the inheritance of traits including skin colour or the inheritance of deleterious genes that cause birth defects, and finally moves to discussions of the history of forced sterilization programs and eugenics movements of the past. Mendel and the Punnett square has moved from an abstract idea to a concrete issue that shows the connections between science knowledge, issues of power and the (mis)use of science, and people’s lives.

Throughout this thesis I consider science to easily overlap in many ways with justice issues. Science as a body of knowledge is a socially constructed (Aikenhead, 1994; Harding, 1998; Kuhn, 1975) and is affected by the same forces of power, privilege, and control of economics that influence all aspects of society (Young, 1987). It is a culturally determined practice that can have multiple purposes and agendas (Gould, 1981; Hubbard & Wald, 1999; Young, 1987). Science knowledge can be used to privilege some and oppress and marginalize others in society (Calabrese-Barton, 2003; Sleeter, 2009), is implicated in many contemporary issues such as poverty, hunger, resource allocation, disease, and environmental degradation (Calabrese-Barton, 2003; Apple et al., 1994), and has both historical and contemporary
connections with issues of race, gender, and sexual orientation (Willinsky, 1998). As Calabrese-Barton (2003) argues: “until an approach to science and science education in our (urban) classrooms focuses on what it might mean to create a more just world, then we will fall short of our goal of truly building a science education for all” (p. 18). Or, as I would say the aim is to build a science education that is inclusive of a diverse student population.

Reiss (2003) supports what I propose: science education that promotes justice education and that is inclusive of the diverse group of students we teach both inside and outside of classrooms. He suggests specific pedagogical approaches for topics such as food, nuclear power, and individual difference and says: “good school science not only provides but requires opportunities for debates about such issues as the fair distribution of resources like food, clean water, and energy” (p. 161), and also:

…A science education that takes seriously the search for social justice as one of its aims would be a richer education and an education more likely to satisfy students interested in fairness and human concerns. It would, though, be an education that would make new demands on science teachers in terms of aims and pedagogy.” (Reiss, 2003, p. 163)

I agree that there is a place for the above listed aspects of science within the science curriculum and that the benefit of their inclusion is a curriculum that is more inclusive of all students. Yes, it places demands on teachers yet I believe it is necessary. If there is a place for a social justice perspective in science education then perhaps an entry point that is possible and logical for all teachers is through the mandated STSE expectations. Some students will always love science regardless of what is taught or how. Some students see themselves as future scientists. This thesis does not explore the identity issues of such students but suffice it to say
that they “see” themselves as being able to enter the sub-culture of science and in the future become scientists (see Aikenhead, 1997, for an exploration of the sub-culture of school science).

This thesis could include such students but it pertains also to all the students who do not feel included and explores ways to make the curriculum more inclusive of them. How to achieve an inclusive curriculum is the question. Presenting science as a human endeavor, and showing a comprehensive view of what science is in all its facets—the research, the problems, and the work of scientists, is central. All students in all science courses could explore issues of how and why science is done, how the body of knowledge referred to as “science” is generated, what the purposes behind the knowledge generation might be, and how science has contributed to oppressive structures we find in society.

If science is indeed a socially constructed and culturally determined practice then those who enter the culture are the ones who can ask and pursue questions. It matters who influences and guides or controls science and, therefore, it matters who enters science. Perhaps it is time to reconfigure science education so that marginalized groups of students can see themselves as able to enter the culture of science and, indeed, will choose to enter. Only then, in the future might we have their science, and a science that addresses issues of access, privilege, control, wealth, power, and the creation of knowledge. Marginalized groups of students, who have been studied in terms of marginalization in school in general and often from science specifically include: aboriginal youth, black youth, girls, urban youth, and homeless youth (see Aikenhead, 1994; Aikenhead & Michele, 2011; Calabrese Barton, 1998; Emdin, 2010 & 2011; Harding, 1998; Hubbard, 2001; and James, 2010, 2012a, 2012b). If science is a culture and school science a sub-culture, (Aikenhead, 1997), then the science curriculum has potential to empower students to recognize, understand and enter the field and become part of a discipline that creates a better
world. I repeat, a focus on or highlighting of STSE overlapping with a social justice lens can be a way to address this and create a more inclusive curriculum for a diverse population.

A teacher can of-course plan a curriculum unit with a social justice theme or overview. “Social justice” as stated earlier in this chapter is a commonly used term and there is an assumption I believe, that we all know what it is and that we all support and endorse it as an idea. Who, after all rejects justice? Still it should be more than a commodity among teacher talk. STSE as a concept or a teaching perspective is also the language of teachers. It is likely that there is a more common understanding in Ontario schools of what STSE entails and as such is an easier entry point for discussions of social justice, equity, and student inclusion in the science curriculum. This thesis in not about the maverick, the activist, or the nonconformist teacher, it is about the teacher who wants to be more inclusive and who wants to include more relevant justice issues in his/her class. I suggest that examining the STSE perspectives one supports in one’s own teaching and exploring how the STSE part of a science course can lead to the inclusion of social justice issues is key to this work.

A review of literature necessary for this thesis and this context is an interesting journey that speaks in part to language use in education research and how words such as democratic education, citizenship education, multicultural and/or anti-racist education and teaching controversial issues, represent evolving and shifting ground. I have included literature that is known by most in the field of social justice and STSE. There is an extensive body of work on citizenship education and on the teaching of controversial issues and since most of it recounts research in primary schools or in social studies/social sciences classrooms, I have included only some sources here that I felt were most salient to my topic.
I would argue that social justice themes, ideas, and orientations or a social justice lens can inform and be applied to any of the approaches, tenets, or components of STSE education discussed earlier in this chapter. STSE education can include social, political, cultural, global, local, economic, historical, and justice perspectives as well as an interrogation of real-life situations, critical decision-making, and a commitment to face controversy and controversial issues. Whatever we as teachers do/learn/discuss with students, we can always ask: a) why we have chosen particular examples for our curriculum construction; b) how issues of access, power, wealth, and oppression are implicated in the science we are teaching; and c) how a topic in science (whether it be a technological invention or an issue of societal or biosphere importance) is implicated in injustice.

3.3 Summary

In conclusion, I came to this thesis because I felt my experience and interest in the topic of curriculum construction for social justice through STSE and in a Canadian setting was new, different, and needed. STSE and social justice intersect with issues of knowledge construction in science. Specifically, how science knowledge is constructed, by whom, and for what purpose; and what forces (such as the political, economic) and persons influence its construction. Science is not isolated from its social location and its milieu.

STSE is a way to position the science in a social context and social justice is a lens that can enhance that positioning. The thesis is a way to bring together the curriculum issues of chapter 2 with the societal issues of chapter 3. In a way chapter 2 is the what and the how, while chapter 3 is the why and the who cares? Social justice can be a lens for teachers—a way to interrogate or examine all curricula—as in donning a pair of glasses to view matters differently. I am suggesting that the STSE expectations of the Ontario science curriculum are an ideal and
accessible path to introduce some social justice issues into a science course. The inclusion of a justice issue, when tied to a specific expectation, can be assessed for its efficacy and re-visited in future iterations of the curriculum. The next chapters describe methods, followed by data analysis and interpretation, and some conclusions.
4 Methodology and Methods

This chapter describes details of the research plan, methodological considerations, a description of the participants in the study, and an outline of data collection and analysis. Recall from chapter one that the research is a confluence of three areas: inclusive curriculum, teacher identification, and social justice. The three questions that guided the work are: 1. How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population? 2. How do teachers understand themselves and their role as science teachers? and, 3. How do teachers understand STSE curriculum as a place for furthering social justice issues? First, I provide a general introduction to the research. This is followed by a description of the methods of the study including the use of interviews, the participants, data collection methods, and data analysis details.

4.1 Overview of the Study

This study is a qualitative research project using initial individual interviews with each of the participants, weekly group meetings extending over several weeks, and final individual interviews. During the group meetings action research was explored as a vehicle for developing and implementing curriculum within participants’ classrooms. Participants were encouraged to keep a journal and to share any of their journal entries with the group. All interviews were tape-recorded and transcribed. I kept field notes during all interviews and during the group meetings. I also kept a separate journal for personal reflections that arose prior to, throughout, and after the study.
Much has been written about the rationale for qualitative research, its methods, its strengths and weaknesses, and its appropriateness for research in education (see for example, Anderson, 1998; Erickson, 1985, 2012; Glesne, 1999; Lincoln & Guba, 2000; and Walcott, 1994) and little is to be gained by revisiting this vast literature here. My desire to gain a deep understanding of issues surrounding curriculum construction and teachers’ views necessitated, in my opinion, the qualitative approach that I used. The study proposed to investigate and understand teachers’ experiences as they develop and implement curriculum that meets the needs of their students. I wanted to use an approach in this study that would allow me to document my investigation into the barriers that teachers identify (both personal and structural) and the processes by which they overcome barriers and develop personal awareness over time. I felt that I could achieve a depth of understanding from talking, sharing, and probing with the participants and by getting to know them well and thus nurturing a feeling of trust. I assumed that we would only come to talk openly about the barriers they face when trust was established and when they felt free to talk and to ponder openly with the group about their struggles.

I also wanted to be respectful of their time and hoped that the group meetings would be more than just a chance to “talk” but would also, from sharing of resources and ideas, be of help to them. I predicted that asking them to use an action research approach would allow them to become empowered to ask their own question and to investigate their own classroom specific and context specific concerns. I wanted to establish an emotionally comfortable and supportive venue for critical discussion. It was for these reasons that I chose a qualitative study, using individual interviews and group meetings and what I anticipated would be “emancipatory” or “critical” action research.
4.2 Participants

Participants were recruited using snowball and network sampling techniques (Glesne, 1999). After setting the criteria for participants I searched for volunteers by sending out emails, or contacting by phone, teachers who fit the criteria (which was high school biology or science teachers, currently teaching in a high school, in the Toronto and Greater Toronto Area) and asked those contacted if they could pass along the invitation to other teachers who might be interested. Additionally I asked work colleagues to invite graduate students who might be interested in my topic to contact me. From this I found six participants who expressed interest in the project and in the end four committed to take part in the study group. All participants were practicing high school biology or science teachers who had (and have) an interest in the topic of curriculum development for a diverse student population and who were interested in better addressing STSE education in their classrooms. All taught in Toronto schools. Teachers from the public school board, catholic school board, and independent schools were represented. I described to each of them, in an information letter, that their participation would involve:

a) an initial individual interview during which you will be asked about your thoughts and perspectives on various aspects of curriculum development, the needs of your students and addressing issues through STSE expectation in your classroom.

b) attending a curriculum development study group meetings once per week for six weeks to discuss issues and to share ideas and resources for use in your classrooms. Issues to be discussed will include construction and implementation of curriculum, how we develop curriculum that is inclusive of a diverse student population, how we understand our role as science teachers, and how we understand the biology curriculum as a vehicle for furthering social justice issues and for exploring STSE expectations.
c) a final individual interview after the group meetings have been completed to bring closure
to the process, to share your feelings about the study and what you gained from it.

As we approached the start of the individual interviews one participant was unable to
commit due to family illness and another was unable to attend meetings due to location. We
began with three women and one man. The male participant effectively dropped out of the
project after a few meetings, although, he never openly declared that he would do so. Rather, he
kept saying that he would attend the next meeting. I attempted to keep him involved by
contacting him after the first missed meeting and by delivering, to his school, some of the
materials that we had shared in his absence. He also contacted me on several occasions, and it
appeared that his absences were unavoidable due to professional and personal commitments. In
the end, however, he stopped attending the group meetings and by the time I conducted the final
(post-group meeting) individual interviews, in which I hoped he would participate he had moved
out of province. His presence and then absence is of interest here in terms of the effect that I
perceived he had on the group and as such, his participation will only be referred to in that
context.

The three participants who attended regularly are described here. Anita, as the youngest
member of the group had four years of teaching experience and worked at a large inner city,
technical school. She had taught science at the grade 9 and 10 level and senior biology. From the
beginning she seemed open to new ideas and stated that she was searching for resources, ideas,
and a more solid knowledge base. Cindy had been teaching grade 9 and 10 science, and senior
biology and chemistry for 15 years in a collegiate. She seemed from the beginning both
confident and unsure of her ability; both content yet unsatisfied in her work. She seemed to be
yearning for more, yet simultaneously “stuck” in what she knew. Mary had the most experience.
She had taught for over 25 years in various schools and was currently at an independent school for high achieving students. She had taught, over the years, intermediate science (grades 7-10) and senior biology. As a successful and accomplished teacher she was involved in several extra-curricular activities, including leadership positions in national organizations and was, it seemed, over-extended. Still she wanted to be involved in this study and was, I believe, searching for inspiration and focus.

I should add here that when the group shrank to three participants I felt a twinge of panic—and I worried: what if another participant stops attending? However, in retrospect the ideas generated from individual interviews and group meetings proved both rich and complex and the atmosphere generated with a small committed and motivated group proved fruitful. The group became a safe place to talk and while not all the talk was about curriculum development (and in fact some became quite personal and is not reported in this thesis)—I suggest that the degree of sharing in the smaller group may have in fact been more honest and more revealing than what could have occurred in a larger group.

Data collection is described in the next section, followed by an exploration of relevant literature that grounds methodological considerations of using interviews and group meetings.

4.3 Data Collection

The study was conducted in three stages: 1. Initial (pre-group) individual interviews, 2. Group meetings, and 3. Final (post-group) individual interviews. In addition, participants kept a journal for the duration of the study. As the researcher I also kept a journal and made separate field notes after each interview or group session.
In the context of educational research, interviewing has advantages and disadvantages (see for example Anderson (1998) and Glesne (1999) as well as a fuller discussion of interviews later in this chapter in section 4.4). The process of interviewing is fluid, flexible, and ongoing. We can go back and ask more questions. We can watch for different answers in different contexts and for changes over time. Time can also be the enemy; teachers are busy and although in my experience they love to talk about their work there is a limit to the time they can spare. Group meetings can create synergy and can also become chaotic, with the facilitator (researcher) having to make decisions about reigning in the talk or allowing it flow and go where it will. In this study, individual interviews and each group meeting was audio-taped and transcribed, analyzed, and interpreted. In total this amounted to approximately 24 hours of audio taped “talk”, some from individual interviews and some from the group meetings. Analyzing and interpreting this form of data is how the researcher creates meaning beyond the interview transcript or creates what Fontana and Frey (2000) call negotiated text. As Wolcott says: qualitative researchers are storytellers. We tell the story and then we tell how it happened to be the way we told it (Wolcott, 1994). Interviews, and group sessions then, are powerful data collection methods that help us tell the stories.

4.3.1 Initial (Individual) Interviews

Individual interviews with each participant were conducted in order to get to know them, gather background and biographical information, and to understand how participants approached curriculum construction and implementation within the context of their own school setting and their biology (and science) classrooms. From these initial contacts I established some general parameters for further research, such as time lines. The initial semi-structured interviews lasted about 90 min. Using pre-scripted questions in a particular sequence, I identified challenges and
issues that the teachers faced as they developed and implemented curriculum, as they located and modified resources and as they taught the STSE components of the courses for which they had responsibility. Each interview was audio-taped and subsequently transcribed. Refer to Appendix 1 for the initial individual interview questions. During the initial interviews the prepared questions were followed closely and were asked in the order in which they appear in the Appendix.

4.3.2 Group Meetings

The group meetings occurred during the third (final) school term, after the March or winter break. They were conducted in a central university-based location and lasted between 2 and 2.5 hours. All meetings were audio-taped and subsequently transcribed. During these meetings the intent was to discuss issues of curriculum development, to identify curriculum needs, and to develop curriculum resources or materials for class use. For all participants, our group meetings occurred during what amounted to as the second half of the courses they were teaching in their schools. I both expected and hoped that they would, by this point in the year, know their students well. I also presumed that they would have some knowledge of diverse student needs and about what would be possible with their students in terms of curriculum development and implementation within the context of this study. I made no assumption as to whether the teachers came to the group with questions that they wanted to investigate or if the group talk would help them to identify issues and formulate specific questions that they might investigate using action research. The intention was that participating teachers would each, in turn, be able to share with the group the “next” (in their course syllabus) topic for which they needed to develop or modify curriculum, and that the group would support them as they planned their next unit or sequence of lessons. I had not intended that they seek out a new topic to investigate. Rather, I had hoped that
support from the group would help them to use action research to investigate a question arising from what they had actually done (as in *yesterday*) or something they proposed or hoped to do (as in *tomorrow*). I hoped that any action research would fit easily into their daily teaching routines.

Part of what the group meeting would explore was the success and challenges that teachers face (in their own classrooms) during the implementation of curriculum materials. I asked the teachers to share with the group, if they wished, any lesson materials or teaching notes that they have used in implementing the lessons. My observations during this phase focused on documenting what the teacher reported with respect to individual lessons, level of student engagement, and questions that arose during the lessons.

My intention was to facilitate the meetings by guiding the conversations yet letting them flow. Some of the same questions from the individual interviews were revisited. The next chapter describes some of the topics and issues that were taken up and pursued at each meeting and the themes that emerged through the open conversations. Unlike the individual interviews, these meetings were more “free-flowing” and although an agenda was established for each meeting the agenda was adhered to less stringently and on one occasion, not at all. Knowing when and how to intervene in the flow of the talk was a constant source of anxiety for me as the group facilitator. We met as a group seven times and shared some email exchanges between meetings.

### 4.3.3 Final (Individual) Interviews

After the group meetings had ended I conducted individual interviews with the participants. These were intended to bring closure to the process and occurred several weeks
after our last group meeting. I asked participants what they learned from their involvement in the research and with respect to the curriculum development process. The final interview was an opportunity to revisit issues that had arisen during the study and to explore any further insights they had with respect to their successes with using action research and with development of STSE curriculum for a diverse student population. Also the final interview provided an opportunity for participants to share with me any ideas or perspectives that they had not shared in larger group meetings.

4.3.4 Journals

Participants were asked to, and expressed an interest in, keeping a journal during the study. I suggested to the participants that they record questions, ideas, notes, and reflections during our meetings, as well as during the time between meetings. As Richert (1992) suggests, journals are a powerful tool for recording thoughts, for making reflections, and for planning. I provided each participant with a bound journal, which they used and brought to our meetings. Sometimes entries were shared with the group, but at the end of the study, only one participant shared her physical journal with me.

Journaling proved uneven. Participants often forgot to bring their journals to the meetings and admitted to writing minimally, claiming time constraints. Keeping a journal was another way for participants to gain insights into the process of curriculum development and into the barriers that participants faced in this work. They agreed to, and seemed happy to keep a journal, and therefore, I had expected that they would record feelings, questions, ideas, and successes and failures in the journal during the time between meetings and then at our meetings they would share some of their observations and add more ideas. From the beginning, I noted that only one participant (Cindy) was routinely writing in her journal (and genuinely used it in the way Richert
above suggests) and so I began the process of some journal writing during each meeting. This took the form of my posing a question, giving a few minutes for the group to record their thoughts to the question, and then asking them to read aloud (and therefore share) their answer. I thought that this would model journal keeping and give participants a reflective time during each of our sessions, but in the end it did not.

Cindy wrote copiously and gave me her journal during our final interview. For Cindy keeping a journal was easy, natural, and satisfying as she told us several times. She had in the past also routinely kept a journal or kept notes, and was happy to share the journal from this study with me. Her journal has many entries about identity and “who I am as a teacher” some of which I had prompted. She also recorded reflections about her teaching and her assignments or as a follow-up to ideas that were raised in our meetings. Finally she writes a great deal about her action research project—from the initial inception idea to working out the details to presenting it to us and to our reactions. She says: “I was pleased that the projects were well received by my peers – this was important to me” and “I really liked integrating NOS into my classroom.” Many of her entries do not give me new data but rather mirrored what she said in meetings, such as desire for more collegial collaborations at her school or wishes for a more integrated curriculum. About curriculum she wrote:

To develop curriculum [we need]:
- Colleagues who are willing to participate and share ideas,
- Administration has to be open and supportive.
- Mostly teachers require professional development!
- There is never the PD development and resources, which allow for the effective implementation of curriculum.

Regarding STSE she says: “STSE issues—I would love to explore locally making it relevant to students in our community.” Additionally Cindy posed questions to herself in her journal. She asks questions such as: “Who benefits from current science and technology?” and “How does
identity come through in the curriculum?” Cindy shared her journal willingly with me and asked it to be returned which I willingly did after photocopying the contents. (However, her pages were not numbered and few were dated.)

The other participants, Anita and Mary, were vague about sharing their writing and in the end did not show me their journal at all. Although neither refused to share it with me, they were not forthcoming with it, saying things such as “Oh, I forgot it at home” and “I’ll have to get it to you.” For Anita and Mary journaling was forced and difficult and each reported that she found it to be too much of a time commitment. Anita said in her final interview: “I wished I had been more diligent about the journal writing.” She said that she did use it to “scribble a few ideas after teaching” and wanted to use it more but did not due to lack of time. Still, both Mary and Anita did keep a journal (albeit minimally) and did bring their journals to meetings, yet did not share it with me at the end of the study. There are a number of possibilities as to why they did not share it with me: they saw it as an unimportant task, what they wrote was too personal and so were unwilling to expose themselves, they were reluctant to show it to me lest I judge them, and/or deemed their entries as trivial or unrelated and therefore avoided giving it to me. Without seeing it I cannot tell if they wrote a great deal but did not share it or if they wrote very little. Keeping a journal requires committing ideas to paper and therefore making them more real and more permanent. Reluctance to journaling might suggest that they did not trust what they might write. Writing might expose too much of themselves and so they wrote little or nothing at all.

I generally operated (in this study) from the position of asking three times but not more. Gentle reminders, when too often repeated, could morph into harassment. Since one participant had effectively quit the study I feared that others might follow if pressured in any way.
4.4 Methodological Considerations of Using Interviews

I believe that interviews constituted an appropriate data collection method for my research questions. (Recall they are: 1. How can teachers, using action research, develop, and implement science curriculum that is inclusive of a diverse student population? 2. How do teachers understand themselves and their role as science teachers? and, 3. How do teachers understand STSE curriculum as a place for furthering social justice issues?) Since I sought to understand the process of curriculum development with a focus on sociopolitical factors that affect curriculum, and teaching and learning—interviews followed by group meetings allowed me to pursue and probe ideas that arose. Interviewing is used extensively as a research and data gathering method in qualitative research (Anderson, 1998), and forms the one source of data for this study. Interviews, require a high level of skill, a clear purpose, at least some planned questions, rigorous data analysis and interpretation, and time. Interviewers require a careful consideration of ethical issues that might arise as the personal and sometimes the difficult is probed (Anderson, 1998). Interviewing must also take into consideration issues of identity, of power relationships and, of control (Glesne, 1999).

An interview is defined according to Anderson (1998) as a “specialized form of communication between people for a specific purpose and thus is a highly purposeful task which goes beyond mere conversation” (p. 190), and yet it is a conversation of sorts. There is no dearth of what one might call methodology books on the techniques, skills, and theoretical considerations for interviewing. Excellent sources contain sections on the nature of interviewing, developing questions, personal attributes of the interviewer, creating a helpful atmosphere, and issues of power, status and control during interviews (Anderson, 1998; Berg, 2001; Fontana & Frey, 2000; Glesne, 1999; Hyman, 1970; Merton, 1990).
People are more engaged when they are interviewed than they are by answering a questionnaire (Anderson, 1998). Since my purpose was to investigate a situation and to understand a phenomenon, I used interviews to understand teachers’ initial perspectives, to understand barriers that teachers name and to construct a path for further investigation during our group meetings. I hoped to gain a deep and full understanding that survey questions would not be probing or extensive enough to uncover. Interviews are fluid and dynamic in nature and so data can be pursued, probed, or noted and re-visited in future interviews, or in my case in the subsequent group meetings.

Good interviews are carefully planned events where there has been a consideration of how trust will be built (Anderson, 1998). Sometimes they have a clear direction and are controlled, as in my initial interviews, and sometimes they are fluid in nature and yield a different sort of insight, as in my final (post group meeting) ones. Since I wanted my participants to talk purposefully during the initial interviews I created specific questions prior to the interview. (See appendix 1). These were as Berg (2001) states the questions that focus on the central question of the study. Other questions that are similar to the essential ones and can be used to check later for reliability and during the study several similar questions were asked in different contexts for this purpose. There are according to Berg (2001), some common problems in question formulation: Questions that elicit the affective domain, such as those beginning with why, can close down conversation. Asking for a response to two questions simultaneously or asking questions that are too complex can be a problem, as respondents may not hear the entire question. Berg suggests that even the sequence of questions can affect results.
4.4.1 The Interviews as a Power Relationship

Glesne (1999) suggests that interviews are different from conversations where mutual information is shared and that we need to be mindful of status differences and of how much we choose to make the relationship less hierarchical (p. 86). Of course there are also power, privilege, and status differences that are not easy to change within the context of an interview. One’s own identity and the identity of the participants will affect and influence the outcome of the interview. The permutations are many, for example, if the interviewer is female and all interviewees are male then the dynamics will be affected by societal factors such as the status of men and of masculine culture (Fontana & Frey, 2000). If the interviewer is White and participants are Black or Brown then race is a factor. However, individuals are not only raced or gendered. Each is a complex mix of race, ethnicity, gender, sexual orientation, class, religion, and status or position that form identity and influence social interactions. My premise is that an interview is a distinct type of social interaction and as such would be influenced by issues of identity named above.

Hammersley (1993) suggests that prior association with a participant may be negatively perceived but goes on to say that this too, as in all parts of research, “is one of many deliberate choices we make” (p.40). I had met the participants in this study previous to the research within the context of the science education community. We had some shared educational history and even though I was the “interviewer” and as such had a particular type of status since I had control of the conversation, I wanted my participants to see us as being equal parts of a group interested in curricular issues. My sense is that this was largely but not totally achieved. Participants were relaxed and comfortable and certainly “opened-up” about difficult topics often
disclosing personal and painful memories but they also deferred to me and tried to please me as evinced by asking me on more than one occasion: “Are you getting what you need from us?”

I strived to create a relaxed, comfortable, and safe environment and I made the assumption that they would feel free and open, and be able to share whatever they felt they wanted to share. Still, I understand that there is always a risk in sharing stories and ideas that may be sensitive and so I must ask myself how did they decide what to share and what to keep private. What was not said? To what extent did they hear from me: “Tell me what you really think and feel.” and to what extent did I transmit a desire that they: “Tell me what I want to hear.” The following chapter further addresses this issue of “pleasing the researcher” and will provide evidence for their desire to please me.

The assumptions of the person being interviewed will affect and possibly alter what they feel they can say. Also, personal nuances, comfort level, eye contact, body postures will affect interviews. In the end, it is for the interviewer to determine how these factors affect the “conversation” and what impact they may have on the final interpretation of what is said or not said. It is for me as the interviewer to assess and assign validity to what has been recorded (Hyman, 1970). I also strived, as Merton (1990) says, to “not sit as judge, but to report on experiences which accumulatively help provide a basis for judgment” (p. 172).

4.5 Methodological Considerations of Using Group Meetings

Group meetings allow, as Anderson (1998) says: “group synergy to maximize recall and highlight the diversity of perspectives, [the group to] provide rich qualitative perspectives, [and the] group process can uncover underlying attitudes.” (p. 168). My aim was that the teachers participating in our group meetings would be able to share concerns or queries regarding specific
course content for which they felt that they needed to develop, find, or modify resources. I made
the assumption that teachers would be able to identify topics or issues that they were interested
in adding to their courses but for which they lacked knowledge and resources, and for which the
group could help them plan. The help might come in several forms, such as talking through an
idea or a concern; getting advice and support from others; or sharing materials, resources and
readings that other participants had created or located. As the researcher, my aim was to
understand the successes and challenges that teachers face as they develop and implement the
curriculum materials. I expected a dual outcome. I hoped that the group would benefit from
some “real” planning and sharing and that I could observe and document how they developed
curriculum. While I focused on factors that influenced success, caused concern, and were
identified as barriers I was also able to interrogate other issues that arose. The group was
perennially accommodating and happy to talk about all manner of topics.

In some ways the group meetings in this study were a form of (group) interview and some
points from the previous section apply here. At times, particular questions or topics were avoided
or dropped from the conversation (see Glesne, 1999) and it was difficult to tell if the participants
were distracted with personal issues, uncomfortable with the topic, or whether other forces were
at play. Glesne (1999) also refers to the “nonstop talker” (p. 91) and I am happy to report that
our group meetings did not have any such participant. Rather participants listened to each other
and were supportive by offering suggestions and advice when it was sought.

While gender is not a focus of this study, I would like to add that there was one male
participant who unofficially withdrew from the study. The remaining participants were female.
While his contributions are not included in the data I will mention his absence in a part of the
next chapter since two of the participants spoke more often and in more detail during meetings
where he was absent. This might be, of-course, due to participants becoming more comfortable as the study progressed, but I believe it is more likely because he spoke frequently and for extended periods of time. I mention it here since I was sorry to see him withdraw and yet realize that his withdrawal affected the study in terms of what the women shared and revealed when he was no longer present. Also, as a social interaction the group meeting process evolved as the influence, position, and status that each group member held within the group shifted.

I expected that participants would benefit from the sessions through the exploration of ideas, and that they would develop curriculum that they could use in their own classes. I made the assumption, although was wrong, that the sharing of ideas would have a synergistic effect on group outcomes. Although my research did not have the explicit intent of developing a broader staff development model, I remain curious about possible institutionalized or formal ways to support teachers as they change and improve the curriculum. In fact, the way the group meetings unfolded did precipitate a framework for curriculum development that I describe in chapter 6. I use the words institutional and formal here, to distinguish between the personal or individual ways in which teachers approach curriculum making. I found the personal reflections did not in fact advance us very far!

I chose to use weekly (as opposed to biweekly or twice weekly) meetings in order to build some momentum while being respectful of the limited time teachers have available, so that the research would be a commitment but not an imposition. This was a practical consideration and what I had determined would be best, based on informal discussions held with teachers prior to the study. I wanted to try to provide an experience that they would enjoy and feel connected to and feel they might repeat in other staff development contexts in the future. For example, I hoped they might go back to their schools and say that they had been involved in an action
research project and then encourage a collaborative investigation of a school-based issue with their school based colleagues in the future.

Finally, I needed to be an effective facilitator. For me this meant creating a safe and welcoming space, ensuring harmony between participants, while also allowing for difference and disagreement to flourish as a positive force. I feel fortunate that the group worked well. Participants were both respectful and honest with each other. In the end there were no complaints or discord of any kind. In fact the only regret that one participant voiced was that she felt that her students were not as academic as the others’ and she wished that there had been a participant with students who were more like hers. This highlights the advantage of an in-school group formation where participants share a common student population and common community context; however, as this same participant also voiced, she did not always like sharing teaching challenges with folks in her own school!

4.6 Data Analysis

The major data sources in this study are from: Pre-group, individual interviews; group meetings over two month period; and post-group individual interviews. Additional insights are gleaned from: participants’ journals, some lesson materials, some student email exchanges, and some student work. In addition I kept a journal and recorded field notes after each interview or group meeting. To address the goals of the study, qualitative data were analyzed through an interpretational analysis framework using thematic coding and a constant comparative method (Creswell, 2014; Stake, 2000).

For the analysis of the individual interview transcripts I examined what the participants actually said in their answers to specific questions such as: How do you meet the needs of your
students? (A fuller description and analysis of the answers to this question follows later in this chapter.) While examining the transcripts, I wanted to avoid a reductionist approach and strive for a more holistic analysis. Therefore, rather than coding for specific words or phrases I read the transcripts and colour coded sections that referred to general themes (see below). I also attempted to identify and analyze what was not being said, what was avoided, not taken up, or dismissed. What was not said, what was not written, and what was not done or attempted have become findings that are as important in this study as what was said, written, done. Each individual transcript was read several times and key answers were highlighted. Upon second and third readings I paid attention to commonalities between all participants and to distinctive ideas, concerns, or issues raised.

For both individual interviews and for group meetings (which are described in detail below) I used an inductive-deductive approach (Creswell, 2014). I began with themes that I had planned such as STSE, social justice, identity, and curriculum. I then identified emergent themes such as, for example, time, student reactions, assessment, and the mention of subject matter content knowledge.

For the group meetings, each transcript was read, first for general insights into what was being experienced, second in order to code for themes, as mentioned above, and third each transcript was re-read and then summarized to record the main theme discussed and to highlight additional ideas that arose that were not related to my research questions. A summary of each meeting appears in the next chapter. I include them in order that the reader may feel immersed in the experience and become familiar with the cast of characters. I wanted the individual personalities to begin to distinguish themselves. The group meeting transcripts were then read again for what I refer to as “what was not said” or what I perceive or construct as omissions or
avoidances. I define an omission as inadvertent and an avoidance as a conscious action. However, the distinction is only sometimes possible to deduce. For example participants rarely say anything about social justice and I believe this to be inadvertent because it is simply not part of their thinking. Action research is also rarely mentioned, but I felt that in this instance they were avoiding engaging in any discussion. Even when I specifically asked the group if they had identified a question to investigate for their action research, they simply replied “not yet” with no further discussion. Therefore, I refer to these instances as “what was not said”. In examination of the data, I use the categories Walcott (1996) suggests. These are: “description” or summarizing and relating what is actually said by the participant, “analysis” or what the participant means by what is said or what is not being said in a specific context, and “interpretation” or what I understand to be the important meaning from the text. I attempt always to distinguish between the reality of the actual transcript and my own construction of meaning (or interpretation). While primary source of data are the transcripts of individual interviews and of the group meetings I did on occasion re-listen to the audio tapes to verify who was speaking and to listen to the tone when the transcript was unclear. The ways the data analysis was accomplished are listed and described below. Data was analyzed in this way:

1. A general perusal of what was said

Each transcript was read several times to get a sense of what participants were saying.

2. Comparing answers to specific questions during individual interviews

Answers to some of the specific questions posed to each participant were examined in detail (and one example is described below in the next section). I also wondered if I would construct a different “story” from individual interviews when compared to group meetings. However, in the
end, these two sources of data usually complemented, informed, and enhanced each other rather than contradicted each other.

3. Coding transcripts with respect to topics and themes

Each transcript was re-read and coded for in two ways: identifying topics by naming them in the margins and colour coding recurring themes, with highlighters. Topics that occurred often were identified as themes and included, for example, STSE, assessment, barriers, personal identity factors, and student needs—or as Glesne (1999) describes—forming data clumps. Once I had a sense of what was being said I wondered what I had missed in terms of answers to each of the research questions and so I did an electronic search in each transcript with respect to key words in the questions such as curriculum, student needs, action research, STSE issues, social justice. Each meeting had its own flavour or new topic often unrelated to what I had hoped would be discussed but these new topics often contained relevant details related to the research questions.

4. Re-Reading the transcripts to create a story for each participant

Each time I re-read the transcripts I noted specific attributes of each participant in order to create a story or profile of the teacher in order to highlight who each was—these stories appear as a way to set the context for the findings at the beginning of chapter 5 and my own story is included there.

5. Describing the nature, implementation, and result of each participant’s action research project.

This was a holistic analysis based on sharing feelings and results of the action research (including some student work) during the group meetings and on reflections made during the post meeting final interviews.
Points 1 to 5 above were achieved by reading the transcript several times, summarizing the main conversations in each meeting in prose and then dissecting out parts of the transcript where significant things are said or identifying what I believe was not being said and speculating as to reasons for the omissions. Mulholland and Wallace (2003) state that “using multiple levels of interpretation or viewing events at different distances from the lived experience can legitimate the study more fully than a single telling” (p. 7) and they suggest that there is benefit from or validity to approaching the data from different perspectives and in so doing tell different (types of) stories. In this way I tried to come to the data from different angles in part because I did not believe that I could be objective in my analysis or that I was uncovering some “truth” rather I tried to look at the data to understand what (these) teachers do to create curriculum and to meet their students’ needs.

4.6.1 Elaboration of Data Analysis (point 2 above): Comparing Answers to Specific Questions from Individual Interviews.

Using one participant, Cindy, as an example, I detail below how I analyzed responses to some specific questions such as: “Do you/How do you meet your students’ needs?” In her response she states:

I like to think so. Every once in while I question that because there are students in my class that I know I’m not reaching them. And I’ll sit beside them and try to help them out in terms of problems and things like that but I don’t think I’m reaching them primarily because they’re not also coming to the table. You need them to come a little a bit closer and it’s very difficult to reach everybody, so that’s another dilemma. But as I said, I think most people would say that I’m very approachable and willing to put in the time for them so that they can achieve what they want to achieve. So I do feel like I meet their needs. I
meet their needs also by making sure that objectives are clear and what I’m expecting of them. So that’s really important so that I know what exactly it is that I want them to come out of the class with and by doing that I’m able to address their needs and make sure they can achieve that.

My first impression of her answer is that she is unsure and seems to be saying both that yes, she does meet their needs and no, she does not. If this same passage is highlighted with “yes” sentiments italicized and “no” sentiments underlined, we see this pattern:

_I like to think so._ Every once in while I question that because there are students in my class that I know I’m not reaching them. _And I’ll sit beside them and try to help them out in terms of problems and things like that_ but I don’t think I’m reaching them primarily because they’re not also coming to the table. You need them to come a little a bit closer and it’s very difficult to reach everybody, so that’s another dilemma. But as I said, I think _most people would say that I’m very approachable and willing to put in the time for them so that they can achieve what they want to achieve._ So I do feel like I meet their needs. I meet their needs also by making sure that objectives are clear and what I’m expecting of them. So that’s really important so that I know what exactly it is that I want them to come out of the class with and by doing that I’m able to address their needs and make sure they can achieve that.

It seems that Cindy alternates between yes and no answers initially but then more consistently feels “yes” she does meet her students’ needs. If this same passage is re-examined in chunks, Cindy seems initially to be expressing both hopes and fears, and then becomes more committed to the idea that she does meet their needs and gives some specifics as to how this is
accomplished. Again, Cindy’s words in response to: “Do you/How do you meet your students’ needs?”

*I like to think so.* (a YES statement in which she expressed her hopes)

Every once in while I question that because there are students in my class that I know I’m not reaching them. (a NO statement in which she expresses concern or frustration)

*And I’ll sit beside them and try to help them out in terms of problems and things like that* (Yes, she is trying and hopeful)

but I don’t think I’m reaching them primarily because they’re not also coming to the table. (No, with the addition that her students carry some responsibility here)

You need them to come a little a bit closer and it’s very difficult to reach everybody, so that’s another dilemma. (No, because she has too many students)

But as I said, I think *most people would say that I’m very approachable and* (Yes, because she is approachable)

*willing to put in the time for them so that they can achieve what they want to achieve.* (Yes, she takes time in order that her students can be successful)

*So I do feel like I meet their needs.* (Yes) *I meet their needs also by making sure that objectives are clear and what I’m expecting of them* (Yes, now she expresses a tactical approach of having clear objectives)

*So that’s really important so that I know what exactly it is that I want them to come out of the class with* (yes, she meets their needs by being clear of her expectations of them) and
by doing that I’m able to address their needs and make sure they can achieve that. (Yes, stated confidently as a conclusion)

Overall, what is Cindy saying? She expresses ambivalence as to whether she is meeting student needs. She wants her students to achieve and tries, in as much as she can, to give them individual attention. She feels that her students’ needs are better addressed if expectations, both for her and for them are made clear. I see her approach as hyper-personal. She makes little mention of structural issues or of curriculum related concerns. She expresses, at different times, frustration and concern yet is positive and hopeful. She puts herself at the centre of the action as though her students were all around her and she is spinning around to meet their needs. She does not seem to take a step backward and view her students from a distance and hence, I suspect, the ambivalence. Finally she makes no mention of individual learning needs or curriculum development issues.

I did not analyze every part of each transcript in this way. I include this detailed example to explain my attempt to make the distinction between what I did: Describing and summarizing what is actually said by the participant, analyzing what the participant means by what is said or not said in a specific context, and interpreting the findings or trying to tell a story about what I considered to be important meanings from the text.

4.7 Ethical Considerations

I alone had access to the data. Participants were assured anonymity through the use of pseudonyms in all written accounts of the research findings. Pseudonyms are used throughout this thesis for individual and school names. As members of a group, participants were asked to maintain confidentiality with respect to discussions and to not disclose issues that arose from the
meetings that were private in nature or that might disclose the identity of participants to others. Due to the nature of the topic (curriculum development) it was assumed that at times it would be necessary, unavoidable or even desirable to discuss topics from the group meeting with school-based colleagues, and all participants were asked to be aware that this might happen. The group meetings were seen as private and confidential, and participants were respectful of each other’s privacy. Many of the discussions were not unlike those that might occur in a graduate level education course dealing with school issues and curriculum development. There were a few topics of a highly personal and sensitive nature that were raised during the group meetings having to do with mental illness and experiences of discrimination and racism. While some of this material is reported in chapter 5 in general terms, I strived to be both circumspect and respectful of particularly private or difficult matters and avoided details that were not needed and which certainly did not further the thesis.

4.8 Summary

In this chapter I described the methods used in the study. I provided the context for the choice of qualitative methods and in particular the advantages and issues surrounding my primary sources of data collection. I describe the structure of the research, my participants, and how I approached the data analysis, which took the form of transcript analysis. In the two chapters that follow, Chapter 5: Findings and Chapter 6: Discussion, I will describe, analyze, and make interpretations from the data collected during this study, draw some conclusions, highlight implications of the research, and suggest a framework for thinking about STSE and social justice education in science in the future.

An additional source of data to which I alluded, in the introductory chapter, is my own experience and story that occurred during the course of this study. As background, recall that
after I had completed the data collection for this thesis I returned to a high school for one year and taught a full course load of science and biology courses. The next chapter begins with my own story and in this way positions me as a participant in the study as well.
5 Findings

This chapter is divided into several parts. The first part serves as a way to “get to know” the players—myself included. I begin with my own story and how it relates to the research questions, provide a brief profile of each participant, and include specifics about curriculum, student needs, and social justice from the initial pre-group individual interviews. The second part focuses on the group meetings in order to provide a summary of some key themes from each meeting. The third part of this chapter summarizes findings related to each research question. The chapter ends with a summary of post-group meeting individual interviews and some speculations about the interrelationship between students, curriculum, and teachers. Direct quotations from the participants are presented as single-spaced text.

I move back and forth in the analysis between general overviews of findings as they relate to each research question and of main discussions arising from each of the group meetings with a more detailed “transformation” (see Walcott, 1994) of the data in order to derive a deeper understanding.

As stated in previous chapters, the purpose of my study is to understand: how teachers develop curriculum that is inclusive of a diverse student body and that addresses the STSE ministry expectations (including what barriers they experience that impact on the curriculum development process), how they include social justice issues, and how they understand their role as teachers. An action research approach was used to explore the above. Recall from previous chapters, the research questions that guide the study:

1. How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population?
2. How do teachers understand themselves and their role as science teachers?

3. How do teachers understand STSE curriculum as a place for furthering social justice issues?

5.1 Getting to Know the Players

5.1.1 My Story

I begin this chapter with my own story in order to clarify what experiences I had prior to my data analysis but after the data collection. Recall that I taught a full course load (six courses) for one year in a large high school populated by a diverse student population immediately following data collection for this study.

One course I taught was a college level biology course. In Ontario college level courses are populated with students not intending to take further biology at the university level although they might in future enroll in college level courses such as a community college nursing assistant program. The students in the course were of mixed abilities in terms of reading, writing, and study skills. Although I had misgivings about the prospect of teaching full time in a busy high school while I had a thesis to complete, I did feel enthusiastic about being in a high school biology class where I could try to develop some curriculum that addressed justice issues. Recall that I had just recently conducted my research and had documented what my research group did and did not do. I had the same questions that I had asked of my group, meandering about in my thoughts. I had been immersed in the themes raised throughout this thesis and so I was looking forward to exploring, within the context of my own biology class, my own responses to my research questions.
At the beginning of the course I found that I had underestimated the amount of time required to develop new curriculum and found that I was relying on material I had used previously. I did attempt to infuse the course with some issues in response to questions from the class. For the first few months of the course, then, I took a reactive approach and in answering student questions I would try to give an answer that was imbedded in a political landscape and tried to include issues of knowledge construction and power. I hoped that my students would become more interested in science if they could see the significance, influence, and the power of science within the larger context of society. I quickly found that the students were not ready for this. A few questioned my responses. Some wondered why I would name issues of racism, sexism, and homophobia. I was surprised at their reluctance to discuss racism and homophobia. Racism made students uncomfortable (“Why are we talking about this?”) and homophobia made them angry and pious (“The bible says being gay is a sin.”). I had not anticipated this. I was committed to raising these issues and convinced that addressing them (in particular in response to their questions and hence what I perceived as their needs) was important and appropriate. I had not anticipated that I would need to wait until a time when the trust and comfort levels within the classroom, both among the students and between the students and myself, had risen. I had not taken the time to lay the foundations for the importance of questioning assumptions and I had not yet had enough class time to build some skills so that I could follow up class discussions with related reading and writing. Also I needed to re-adjust my pace so that I had time, within one class to bring some closure to discussions. I was profoundly uncomfortable with beginning a difficult issue and then risking that the bell would ring and students would leave the class with mixed messages about what I was trying to do, as I felt that was too risky and dangerous. Overall, I was operating from a particular political perspective that valued the importance of questioning issues of knowledge construction and power in science and in society but I had not
anticipated, what for me was a disturbing revelation, that I was hesitant to raise issues when I was worried about the maturity and cognitive ability of my students.

I found that it was relatively easy to be reactive in the class when students raised questions. For example, the question of why we sleep came up in one class. The next day I distributed a short reading that described a possible reason. The class, I believe, noted that I was responding to their interests and they appreciated it. Another time they begged me to do a dissection (as the more advanced level biology classes were currently doing) and I arranged it. They were thrilled, thankful, and fully engaged. However, being proactive and raising knowledge that I wanted to raise proved more difficult. On one occasion a Black student asked me about Sickle Cell Anemia (in the context of studying the structure and function of blood.) I tried to include her in the answer by stating the significance of Sickle Cell Anemia to the Black community and perhaps to herself. She took offence and wondered about the motives behind my answer. I quickly learned that by naming race one could be perceived as racist. Issues would have to wait for a while and I had to be content with a more modest approach. By the end of the year, I believe that the class did trust me and I was able to, at least at times, raise difficult issues.

Looking back I think I had two notable curriculum successes. One was creating and implementing a DNA analysis unit. The unit helped them feel that they were capable (as the TV characters of CSI) of working in a lab and it did provide some science literacy background around DNA finger printing. We had some discussions about the use of DNA technology in our society and the importance of this type of knowledge in areas of their lives such as health and criminal justice. The other success was in the microbiology unit in which I was able to raise issues about disease within a social justice framework. I provided them with readings from the newspaper. I had been clipping the newspaper for several months and had accumulated many
articles about a variety of pathogenic diseases such as Tuberculosis, Malaria, Ebola, and West Nile Fever. Through our group readings and my questions the class began to have an awareness that some of the issues surrounding disease were socially constructed. For example, diseases were often described as “foreign”. Also the students began to question: funding and research for various vaccine programs, how living in poverty can affect the pathology of a disease, and how living in certain geographic region of the world affects disease transmission. Part of my curriculum included an assignment in which students were asked to investigate a disease of their choice. They chose diseases such as HIV-AIDS, Leprosy, or Malaria, covering both viral and bacterial pathogens, and, brought a richer and more complex analysis to their research and their final written and oral presentations as a result of our previous class experiences. I believe that they had begun to form a more complex STSE framework of their own within which to place the biology content. They had begun to see disease as more than a biology topic. Rather they had begun to examine diseases in terms of social justice factors and implications for society. I return now to the research questions in terms of my own practice and experiences.

Question 1: How was I able to develop and implement STSE science curriculum that is inclusive of a diverse student population? I would say with difficulty. First it was difficult for me to understand student needs and even more difficult to be inclusive of each student. I felt that I met some of my students’ needs some of the time, but often misjudged them. Mostly I reacted to what they asked. I did develop some curriculum that was specific to my group of students. For example, one of my students suggested and then insisted that I show the class a movie about evolution that she had at home. It was not a movie about evolution, I discovered upon re-viewing it, but a rather ridiculous science fiction feature. Still she was so enthusiastic and as the other students became curious as well I agreed to show it. However I created an assignment for the movie in which a) I asked them to identify all the scientific errors (there were several about
mitosis, chemistry, the periodic table, the use of technology, and evolution) and b) I asked them to identify instances of racism, sexism, classism, and homophobia, of which there were several. It was interesting to me that several students later thanked me for showing them a different way to view a movie! Wow, I thought, I am making a difference here. Sometimes what I developed was related to their social and academic needs, and usually I designed a piece of curriculum with some (but not all) students in mind. These may have been the students that were the most disruptive or the most bored or had poor attendance and I reacted to that. With six classes to consider and four different courses to develop I often used materials I had used in the past (which were developed for a different group) and I often used materials developed by colleagues. Of course I injected my own style into the teaching and made the curriculum my own but in the end I did not develop as much new curriculum as I had anticipated. (This theme of the curriculum versus the teacher as being the most important will be re-visited later in the context of one of the group discussions.)

**Question 2:** How do I understand myself and my role as a science teacher? There is no doubt that I felt I needed to teach my science classes with a strong STSE/social justice focus. I felt strongly that my role was to help students learn both the content of science and how science both affects and is affected by societal issues. I found myself to be more cautious than I had expected and more reluctant to introduce difficult topics. In a large part I saw myself as trying to help my students “get” their credit. Interestingly I found it easier to raise issues that were more “neutral” such as disease rather than more personal such as the biology of “race”. When challenged by students who asked “why are we doing this?” I found it easier to justify the more neutral topics.
**Question 3:** How do I understand STSE curriculum as a place for furthering social justice issues? From my viewpoint, science classrooms are the ideal place to raise social justice issues. From issues of food, hunger, and poverty to environmental issues such as pollution or global warming, to the genetics of race, gender, and sexuality I continue to feel that science classrooms have an important and unique part to play in the education of youth. Even though what I was able to do at Sunnyside High was modest and at best uneven, I think that nurturing a social justice lens helps us to approach the ministry STSE expectations with a view to helping students understand the construction of knowledge in science and the forces (and justice issues) that affect science: power, wealth, access, etc.

I begin this chapter with this story of my own experience as it affects how I look at the data collected from both individual interviews and group meetings. I examined the data from this study with the assumption that my participants would have some of the same difficulties as I have had yet with a desire to look deeper to understand what other factors influence the answers to my research questions. In parallel to my story above, the next section narrates my participants’ stories (as a way for the reader to see them as individuals).

### 5.1.2 Participant Profiles: Anita, Cindy, and Mary

In this section I describe the participants in this study. I include some incidents that are not part of my central thesis and so could have been overlooked in the sea of talk. They are shared here as they tell us much about the participants. At times the participants became storytellers to the group and seemed keen to share stories. In my reading of the transcripts I came to remember some parts in terms of these stories and some are recounted here.
Anita emerged (through the group meeting process) as a teacher who cares about her students and is willing to take risks for them. She initially claimed that she needed resources, but through the process of the group meetings and from her own exploration of a resource that I had provided, she came to a realization that what she lacked was a knowledge base and not more and more resources. I would suggest that her use of the word “resource” during her initial interview was in fact code for “there is a lot I do not know”, “I need more knowledge”, and “I need help in curriculum making”. During the course of the meetings she found her voice. As she came to know the group members, she began to speak more freely and openly with an increased level of emotional intimacy. I sensed an increase in her comfort level when the lone male member stopped attending meetings. Although he was well liked and well respected, he claimed and occupied more “space” and “air-time” than the women present. His presence was felt, and when he stopped attending, his absence was noted as the women began to speak more, for longer periods of time. In particular Anita began to open up, share more, and even interrupt others!

When it was time to identify a question or curriculum piece that Anita might investigate in her own classroom she had many ideas such as creating a blog in which her students could record questions and reflections or creating a current events bulletin board within the classroom upon which her students might post articles and share ideas. Each week though she had little to report in terms of tangible progress. She had several ideas but did not follow through in terms of starting the action research cycle although she did articulate her focus: how to motivate and engage her often disinterested students. Eventually she was happy to use a curriculum piece that I had developed (with colleague Margaret Wells) on the biological versus the social construction of race, which she believed her students would enjoy and learn from. I was secretly thrilled that
she wanted to try it as it seemed to me that is was a key piece of what a “biology for social justice” class might encompass. After implementing the curriculum she reflected upon it in a positive yet unsatisfied manner. She was glad she had tried it. She felt that she would certainly do it again in future but with some modifications and she felt strongly that she would only use it again after having researched some parts that she had accepted as detailed enough prior to use but which had proved to be inadequate in details or depth. (This refers to inadequate in terms of what she reported as her needs not in terms of what students needed.) She had in fact finally started, after some false starts, the action research cycle! She now had a real question grounded in her own and her students’ experience, which begged further investigation. She told me: *Next year I would do more research before trying this lesson again, but I would really like to try it again.*

Interestingly, she was able to clearly identify how she would repeat an action research cycle after she had come to her own conclusion about her lack of knowledge. Anita, already a risk taker of sorts, told us of how the group talk had given her the idea and confidence to try a new strategy. She told us about using a strategy (that could be used for STSE, but using it for teaching content) with an unmotivated, difficult class. She told us: “my class is very unmotivated and they’ve been giving me a lot of grief” and she wanted to try something different and so thought to try a strategy that we had talked about in one of our earlier group meetings. Using a town council format students were asked to advocate for one of the body systems not to be cut from the body. She told us how she asked the class to do the following:

…pretend that they’re on a Town Council and they’re in groups and they have to represent a system. The digestive system or respiratory … one of the systems, and they have to present their arguments as to why their system is the most important system out of the whole human body and [why it should] not be cut out, because there were cutbacks and one of the systems had to be let go. So I made up this little handout and said this is the assignment and put them in pairs, …and …they actually worked well, they actually
participated. I thought they were going to grumble about presentations, but they didn’t. I said, one person, the strongest person should be the presenter, and be comfortable about presenting, and the other person, or the other people could be the writers. And so they did it, and it worked well actually. I was surprised. (Anita Mtg. 3)

This is Anita, she is a content teacher first but is deeply affected by her students’ lack of motivation and she was pleased that her students, in this instance, were more motivated than usual. She is comfortable using a new strategy (the town council) to teach content. Of course I wondered if this was a way for her to become comfortable with a new strategy that she might use for STSE teaching in the future? Although she seldom mentioned strategies she used for teaching STSE, Anita, as always, is trying to improve student interest and motivation.

Cindy

Cindy came to the group with a great deal of experience and with a demeanor that I would characterize as successful, accomplished, and able to juggle many tasks at once, but as also ambivalent in many of her conversations. Through the group meetings she clearly emerged as a teacher who cares about her students, wants to meet their learning needs, and wants them to achieve, but at the same time was sometimes unsure about the best way to proceed. One strategy for success that she described was that expectations for learning needed to be clear for students and as well as for herself. In some ways Cindy is characterized by contradictions. She is hyper-personal, sometimes frustrated and fearful, at other times positive and hopeful. She treats all of her students needs as the same and simultaneously is a teacher who believes in individualized and personal attention. Still she never made mention of learning style, individual needs, or curriculum issues.

Overall I would describe her as ambivalent and searching. She often spoke of how being a parent had changed her as a teacher. During group discussions about “race” as a social construct
she told us a story about her son (who she identifies as mixed race, but having as skin tone closer to her light skinned husband and his family, than to herself who in contrast is darker-skinned). She said: “My son who was three at the time, said to me one day, ‘mommy, you know God got confused, I think God didn’t realize that we were a white family, and put you in our family’” (Mtg. 2), and even after being probed she did not elaborate on what her son’s words meant for him or for her but moved the conversation to her grade 9 classes.

During group meeting 5, Cindy told us a story of working with a woman in her school—the school equity representative, who, at a board meeting and been unable to name anyone in her school who was a visible minority. This equity rep then realized that Cindy was a visible minority and came to tell Cindy of this revelation with some incredulity when she said: “You know Cindy I realized that you were a visible minority! But I don’t consider you a visible minority!” Cindy told us that her response to this vignette was “that’s not good. I don’t know why that’s not good. It didn’t feel good.” I’d say that her discomfort is complex—she was faced with a woman (the equity rep no less) who was claiming not to see race/ethnicity and by extension not seeing an essential element of Cindy’s identity. Cindy tells us: “it didn’t feel good that she said that, but I think part of it is that I am a visible minority, and the fact is that the more that I hide that away, that’s not good for students.” because “I remember some other person said it’s not good that you don’t tell other people what culture you’re from, because people need to see you as that culture entity, because otherwise, all they’re seeing is the stereotypes.” Still she tells us “what I don’t do with respect to diversity is incorporate more of me into the lesson.” She seems less worried about her equity rep not really “seeing” her and more worried that she does not incorporate (perhaps her own) diversity into her lessons. Again she betrays an ambivalence and some confusion about her feelings.
Of the three participants who saw the study through to completion she was the only one to do the things I had hoped: she met with me for pre- and post-group meeting individual interviews, she participated in the meetings, she kept a journal that she shared with me, she conducted action research, and she brought curriculum examples to the meetings to show the group. She felt proud of her action research project and the student products and proud to share these with the group.

Mary

Mary, the educator in my group who had been teaching for the longest time, identifies strongly as a good teacher; one who is thoughtful, strategic, and uses available resources well. She identifies as a person who has studied to be a science teacher and therefore knows how to be a good one. She trusts her knowledge and training and to some extent expects it to garner her some deference. Still, she routinely makes references to administrative forces within her school that control her teaching and planning. She is not exactly fearful of the administration but feels and accedes to their pressures. On a personal level she disclosed to us that she had suffered from some mental health issues, which she referred to as depression resulting from other conditions. After we had met several times she was able to discuss how her depression affected her as a teacher and how in turn teaching changed her. Mary said in our very first group meeting as a way to state her position to the group: “What I think is important is that the STSE really is the science…. STSE, relevance, has a lot to do with what science is” (Mtg. 1). She equated STSE with a way to make science relevant to students. And yet by the end of our meetings she expressed ambivalence with that position and with what she was willing to do in a classroom. It was as though the group meetings had somehow “talked her out of” STSE having a central or core position in school science.
Mary had specific strategies that she employed to meet her student’s needs. One story that stayed with me was about her use of the Ontario Student Record (OSR). She told us that while she found it a frustrating and time consuming process—one “controlled” by administrative forces in the school—she reads OSRs to learn about special needs of her students. As an “information seeker” with respect to her students needs she sees perusing the OSR as expedient but did not tell us how OSR information influenced her practice. She sees gathering information from the OSR as a “technical-task” and would take more time to do so if she had more time.

Mary also told us of her strategy for bringing closure to a unit, consolidating learning, and how analogies help students remember. She wanted to tell us that she was doing justice work and at first I tried to spin this story in that context—social justice through making connections. However she is actually telling us, and proudly so, that she is a good content teacher! She says:

I finished teaching yesterday, all my kids. … So I’m kind of at that point, I’ve gotten some feedback from kids, and I’m at the end of the year, so what do I prioritize [to] make it meaningful, and I’m thinking: activities and also connections, because that to me is the social justice and the social issues are where a lot of meaning comes in. I was thinking … how can I set it up so that my classes are a valued experience? Some of the things … I always ask the kids for is a PMI chart at the end [before] their formal evaluation. (Mary Mtg. 6)

PMI (a graphic organizer) refers to: Plus—Minus—Interesting thing. Additionally to bring closure to the course she told us that she makes use of analogies and that an analogy reflects “higher level thinking, and stuff like that.” She values helping students see the big picture, and tries to help her students to “construct everything in the big picture knowing you’ve got all the stupid little curriculum things that are supposed to go into the picture”. Mary wanted us to know that she is an effective teacher who helps her students bring closure to a course by bringing together many ideas into a big content picture.
Mary seldom mentioned personal interactions with her students and admitted that she does not actively seek out their interests. She seldom spoke of how she develops curriculum. She did not engage with action research, did not meet with me for her final interview, and did not give me her journal. She had admitted to me that she joined the research group in order to garner some inspiration from the meetings but it became more and more evident through the study that she was not inspired by what we were doing.

5.2 Observations From the Initial (Pre-Group) Individual Interviews

The individual interviews conducted with each participant prior to group meetings were rich in detail as the participants talked about themselves, their role as teachers, their students, and their own hopes and concerns about teaching and curriculum development (and in particular the place of STSE education in science classrooms). These individual interviews proved focused as participants provided answers to specific questions. Each participant answered fully and elaborated easily on ideas raised. The individual interviews helped me get to know the participants and helped guide how I approached the subsequent group meetings. What follows are descriptions of some of the answers to individual interview questions around a few themes: inclusive curriculum, social justice and biology, curriculum construction, and meeting students’ needs.

5.2.1 Inclusive Curriculum

When asked: “What does a science curriculum that is inclusive and equitable mean to you?” these were the responses:

Anita considers issues of meeting diverse needs in terms of ability. She says:
Well, inclusive to the students and equitable to the students? Well, I guess in that sense where it addresses their needs. When I was talking about how the curriculum addresses the needs of the college bound students or if it addresses the needs of the university bound students. I guess if it’s inclusive in a sense then it addresses those needs…(Anita initial interview)

Cindy’s seems to interpret inclusive to mean reaching and connecting with each individual and while she claims that this is important she does not say how she would achieve the student-curriculum connection. She says:

I think equitable and inclusive allows each individual student in their science class to have the opportunity to reach their potential. I really believe in that. I think that it [the science curriculum] should be able to reach out and grab and take hold of each individual student in their own context and make them feel like they are part of the decision making process of what science is – of science learning. That’s what equitable is … (Cindy initial interview)

Both Cindy and Anita see inclusive curriculum as one that helps students to be successful. Mary asked for clarification by asking: “You mean inclusive for each individual, for each ethnicity, for sex, for all of that?” and then goes on to say:

Generally I don’t actively go looking for ways to plan inclusivity. I think I do it more by working with kids as individuals. Looking at big picture stuff. For example when we get to dissections, we do fetal pigs and for some of the Muslim kids that’s an issue. Not very many, but for some of the extreme ones…but I need to be aware of that so that’s when I … I know I’ve changed…(Mary initial interview)

I think she is grappling with how to accommodate individual needs and she is aware that she is on the journey still, of understanding what being inclusive entails.

5.2.2 Social Justice and Biology Curriculum

When asked “what are some social justice issues that you consider have a place in the biology curriculum?” Cheryl’s response focused on genetics and the unstoppable advancements in technology. She responds:
Some of the key social issues I think, with respect to social justice issues is genetic issues. Talking about genetics as a vehicle to explain things and I think that students have to start to be aware of that. We talk about genetic profiling and try to get this whole aspect of trying to pin down who somebody is based on their genetic codes. I think students have to start to think twice about certain aspects and where the technology is going because it’s never going backwards now. They have to start being careful of that. I think it’s also important with the whole genetic aspect - is that when people start to feel like less or more than other people based on genetic codes or genetics, I think that’s also problematic and students have to become aware just of this idea of respect for individual and humans….and living beings…I think that’s another issue. (Cindy initial interview)

Anita focuses on genetics and biotechnologies – but adds some analysis of issues of western medicine and the complications of other worldview systems (although she does not have quite the language to describe this):

Well, I guess the human genome project – the whole idea of cloning. A lot of biotechnologies, fertility, in-vitro – those techniques. The whole idea of vaccines and vaccinations. We were talking about vaccinations in other countries and how it’s not the same – some people don’t accept it as the same over there. Western medicine is different from medicine from somewhere else and doesn’t necessarily mean it’s right. (Anita initial interview)

Mary’s answer betrays her interest in the environment as a justice issue as she says:

Human impact on the environment – on what we’re doing to the environment and I think in biology, well in all the sciences and a lot of the other things too, but biology especially because you can talk about the life rather than just the chemistry of the environment. Global warming, the whole thing about polar bears are endangered now because the pack ice is disappearing because of global warming…which yes, we’ve had historical aspects of global warming before but this is the first [time]…global warming is happening because of human activity. So we get issues with Bioactin and genetically modified foods – bring it into an ecological perspective and very hands on at the same point…are mono culture crops…the reason we need all this crap on them is because they can’t compete against the wild stuff so the odds are of them cross breeding with something in the wild is really low. (Mary initial interview)

In some ways their answers are predictable but additionally they raise issues of understanding the power and advance of technology, understanding others’ worldviews, and the importance of grounding any social issue in a deep and clear understanding of scientific principles and content knowledge before the social/societal issue can be explored in a deep and meaningful way.
5.2.3 Meeting Student Needs

When asked about how they meet the needs of their students they mentioned many things but curiously, never any approach that involved curriculum. Cindy is ambivalent about whether she is able to meet her student’s needs. When asked if she does she says:

I like to think so. Every once in while I question that because there are students in my class that I know I’m not reaching them. And I’ll sit beside them and try to help them out in terms of problems and things like that but I don’t think I’m reaching them primarily because they’re not also coming to the table. You need them to come a little a bit closer and it’s very difficult to reach everybody, so that’s another dilemma. But as I said, I think most people would say that I’m very approachable and willing to put in the time for them so that they can achieve what they want to achieve. So I do feel like I meet their needs. I meet their needs also by making sure that objectives are clear and what I’m expecting of them. So that’s really important so that I know what exactly it is that I want them to come out of the class with and by doing that I’m able to address their needs and make sure they can achieve that. (Cindy initial interview)

It is clear she is questioning if she meets their needs and how she fails when the students are less than engaged. It seems that she is filled with contradictions and wants to meet her students’ needs but is not sure if she does. Anita says simply: “I ask them.” My response was: “do they tell you?” and she replied:

For the most part – yeah. They’ve always been really good with just telling me. When Sue [another teacher] took over my level 2 class – the vocab that she used was above their heads and they told her. They will tell you right away when they don’t [understand]. You can see the frustration. They are very vocal about being frustrated. It’s not hard for anyone to read. I can feel them out when I give them [new work] Hmmm…I don’t know if I meet all of their needs all of the time, but I can meet their needs at different times for different people. I don’t know if that makes sense.

With respect to students achieving she says:

[when] I give them some sort of formal evaluation and I get it back it and its obvious nothing went through their heads. Sometimes what they write and what they tell me is not necessarily because they don’t understand but just because their writing is that poor - so it’s hard. That’s a barrier that I find, especially when I teach the 11’s.
Mary’s response to how she meets the needs of her students is in sharp contrast to Anita’s answer. She says that she checks their OSR (Ontario Student Record), which is a file that follows each student from Kindergarten to grade 12, although she admits that at her present school she does not have easy access to them. She needs to request them and then look at them one at a time in the guidance office. She mourns the ease of access at other schools and says: “All other times I’ve just sat in front of the filing cabinet and pulled the ones I need. It’s inconvenient here.” Still she does it. She goes on to explain why she likes to examine the OSR:

Because there’s a lot of things I’d like to know about in terms of learning problems with these kids. Which is not easy access to me and I have to go through people just to get a file. Okay, how else do I get to know the kids? Yes, past history. What I like [are teacher meetings] where we can talk about the kids. I personally think that’s really important because it saves time. The kid doesn’t have to wait for six weeks until I figure out who they are. (Mary initial interview)

When the above passage is examined more closely we see that she relies upon others’ information, yet wants to see the file for herself and we see that she interprets “needs” to mean identifying potential student learning difficulties. In her words: “there’s a lot of things I’d like to know about in terms of learning problems.” She is relying here on previous reports and testing. She says: “[the OSR] is not easy access for me and I have to go through people just to get a file.”

This is curious since most schools alert teachers to learning problems where special accommodations need to be made. She adds: “Okay, how else do I get to know the kids? Yes, past history.” Again, she relies on others’ records for past history. And, she likes teacher meetings “where we can talk about the kids. I personally think that’s really important because it saves time. The kid doesn’t have to wait for six weeks until I figure out who they are”. She trusts and relies upon her colleagues and the system because it saves her time. However she does recognize some pitfalls and is aware that she must use the information she gleans but still make her own judgments. She goes on to say:
It requires that if I find out something I can’t become, what’s the word, not bigoted but biased against the kid. And it does require that I have to think and talk to the kid themselves – but if the kid has got some major problems…better that I know that day one and I can work to ameliorate them out at the beginning. And I think I’m pretty good about that…about not hold biases. (Mary initial interview)

When I probed how she met her students needs by asking her specifically about student interests (as a way to move the discussion away from ability) we have this exchange:

Katherine: And their interests?

Mary: You know what – I should know more about their outside interests, but I don’t.

Katherine: I meant interest within biology….interest in the discipline?

Mary: You know what? I don’t really…if I do that, it’s more of a fluke I think. I think it’s more of the learning personality or the kid’s personality that I get to know instead. Like I’ll say…oh this is going to be a good discussion…these five kids are really going to buy in now or, okay – just make sure this kid participates but there’s not going to be a lot coming out of them.

So, she does not use student interests within the discipline to plan and develop her curriculum. She seems to be saying that her attempts to understand what they need are related to learning difficulties they may have faced in the past and to engaging students in her topics—topics she raises, content she is covering.

While meeting the needs of students can be almost a slogan in education and while my participants did engage with the question of how they met needs, I would say that there was also an undercurrent that individual needs can be difficult to ascertain, troublesome, and time-consuming to address. Additionally needs can get in the way of teaching what one wants to teach.
5.2.4 Time and/or Textbooks

Lack of time was a recurring theme, which I must admit, I was loathe to engage with believing that we make time for what we value. Still it was impossible to ignore and so I explore it here. During her initial interview (this has been quoted later as well) Mary says: “this is one thing that bothers me here because I should be pushing the kids farther and really working with the STSE stuff” and when I asked why she does not, she replied:

I run out of time and … the sad thing is as much as everybody in the ministry and supervisors constantly talks about it [referring to STSE], what is evaluated and how the teachers evaluate is what content the kids know. (Mary initial interview)

However, as I suspected lack of time is usually linked to other concerns and Mary further confirms this when she replies:

I’d need more time. It comes back to time…and it’s safe. If I stick with content, I’m going to protect myself. If I don’t stick with content I could end up losing my job…because someone who doesn’t understand which are a significant number of administrators…cause they’re protecting their butts and all the way down the line. (Mary initial interview)

Mary does not refer to the fact (of which she would clearly be apprised) that STSE is part of the ministry documents and therefore also required. It seems that she does not see STSE expectations as another type of knowledge, but rather as caught up in something that for her is risky (and so gives her fear of losing her job). But perhaps we are onto something here. Mary is astute and so perhaps she clearly sees STSE (and justice) issues as being about controversy, decision making, and power and she recognizes STSE education as difficult to teach and difficult to assess and so she avoids it in a cloak of lack of time.

At one point she told me a story of, while teaching about stem cells, a ministry inspector coming to the school: “the ministry inspector came in to talk to [us], his comment was on STSE:
[he said] there’s some really good STSE issues in the book, are you using them?” It seems that she was annoyed by being asked to use the textbook and yet acknowledged that some controversial issues such as stem cells were in the text. Using the textbook could have perhaps allowed for safe and time efficient exploration of an STSE approach to a controversial issue—and so here is the anomaly with Mary. Is she concerned about time, about safe approaches to controversial issues, or does she construct excuses to avoid what she has deemed as less important curriculum content?

Of-course the other participants also talked about lack of time. Anita in particular stated that lack of time and lack of resources was an issue for her and we will see in later sections that lack of time continues to be an issue and barrier for her throughout the study.

5.3 Group Meetings Summarized

The nature of the data is different when individual interviews are compared to group discussions, which were more fragmented with topics being taken up for discussion or discarded for new ones in a more meandering manner. As the facilitator of group discussions, I tried, with varying degrees of success, to steer conversations toward my themes: STSE, inclusive curriculum, the inclusion of social justice issues in the curriculum. However, as I would try to bring the discussion back to my agenda it seemed as though there was a powerful synergy that propelled participants as a group to take up and more fully engage in what I considered tangential topics. While individual interviews were more question and answer in nature, during group meetings more unsolicited topics such as, for example, assessment, culture (student and school culture), parent, and time restraints emerged. In retrospect I’m glad that I let the conversations meander as these tangents provided me with a reality check: teachers have several pressures and concerns that inform what they do and what they believe they can do.
In terms of the group dynamics, there existed a positive, lively, and even fun atmosphere during the group meetings. Participants shared resources and ideas and personal stories about teaching. The following are a series of brief synopses of the main themes and ideas raised and discussed at each of the group meetings. Many of the themes and ideas have been explored elsewhere in this chapter and this summary is meant to provide a general sense of the conversations we had. Some of the themes that arose from the group meetings were: what it means to be a good, fair, and inclusive teacher; factors that affect student learning; teacher “identity” or identification and issues of gender, race, and class; personal family pressures; student needs, abilities, and lack of motivation; student expectations with respect to the science classroom and with respect to the teacher; parental pressures and concerns; the curriculum development process; challenges, barriers and supports to curriculum development; STSE and the nature of science. All of these themes and ideas impact, in the end, on how we teach in order to be inclusive of a diverse student population.

Additionally I have included my field notes in this section. Field notes were made immediately after each group session and these are separate from my journal, which I kept throughout the study including prior to data collections and for several years post data collection.

5.3.1 Group meeting 1: Me and STSE

Participants struggled with the meaning of equity in an educational setting. Equity as fairness versus equity as access was raised. Participants discussed how they saw themselves as teachers and how their students saw them and how their students’ perceptions affected what they would and would not do or say in class. They also began to struggle with what “STSE” means. (Recall that STSE refers to “Science, technology, society and the environment” and is a part of the Ontario Science Ministry policy documents.) STSE was at times described in terms of the
relevancy factor in a lesson but this idea was also problematized by the group since relevancy, they said, may be personal or student specific. For example one participant shared a story of one student who found the alcohol content of a beer versus a shot of hard liquor of personal relevance since they believed it was safer to drive after drinking only beer. I would add (although the group did not) that an STSE focus might be to look at the effects of alcohol production and consumption on society. It seemed that teachers do not have a refined idea of what is relevant to kids and use kids own questions to make curriculum relevant, which is a different approach than actively seeking out and including issues of significance (such as alcohol abuse) which have an effect on society and which have a place in the science curriculum.

I did not expect the terms culturally relevant pedagogy or culturally relevant curriculum to be used, but, given that culturally relevant pedagogy is the pedagogy of social justice and inclusive education, I did pay attention to any references to examples of such a pedagogy that might arise. During the group meetings there were a very few, I believe. One was concern about dissections in conflict with religious beliefs (mentioned above) and the other was about inclusion of non-western science. Mary (during this first meeting) said that she includes examples of Chinese science because she has Chinese students. What might be the reasons for this inclusion? Was it to engage the Chinese students and would the science of other groups be included in a similar manner. Is an implied conclusion here that Chinese science is not significant for all students to understand the history and nature of science practice? Would Chinese students ever be exposed to African science or aboriginal science in her classroom? She felt she was being inclusive of her Chinese students. Exposing her Chinese students to Chinese science was a way to address the perceived needs of a particular group of students. While this is inclusive of her students in some ways, I would describe this as operating from a position of meeting immediate needs rather than operating from a position of theory which might be described as: all students
benefit from exposure and experience with many underrepresented and marginalized traditions and discourses. Additionally examining the tenets of Chinese science could have been a way to compare with the traditions of Western science but this was not mentioned. There were no specific examples of culturally relevant pedagogy mentioned in subsequent meetings.

Overall I was elated after the first meeting and I wrote in my field notes: “Group meeting 1—Wow — what a great first group meeting!”

5.3.2 Group meeting 2: I don’t want to give my opinion

During this meeting we had our initial discussion about barriers that participants face as they work and develop curriculum. Participants identified several barriers such as students’ lack of knowledge or lack of a worldview, their own lack of knowledge, and resistance to raising controversial issues. In reference to topics such as alcohol, condoms, and sex that comes up in class I noted in my field notes that one participant said: “I don’t want to give my opinion.” For example Anita tells us:

But my apprehension to all of that [raising controversial issues] when you see them only 70 minutes per period, and you have no idea what happens in their own life. And very rarely do you get a glimpse of that, and so I’m much more … I don’t say I don’t go in and talk about controversial [issues]… I’m just much more hesitant. I much more aware of what that’s going to impact in their lives. In another life.

Evolution was presented as an example of a controversial issue in this session and so it begs the question what make a topic controversial? Can any issue for which there is disagreement be controversial? I asked at one point why is evolution more controversial then gravity? Cindy felt that:
I was much more cognitive of my students’ personal beliefs when I got into controversial issues. Very much so. …Because, again, I was teaching evolution, and there was a student who was a creationist, I’m not sure where she was from, she was actually here visiting from the states. I can’t remember exactly. Taking grade 12. Definitely Bible country that she was from, and she was profoundly “this is all wrong” …and the whole class had to respect that. So it was very interesting, and that’s when I realized that I have to be more careful when you have all the different backgrounds as opposed to a homogeneous sort of school.

Anita’s approach, she told us, was present evolution as “just” a theory. She says: “But you present it as a theory, right. That’s just a theory right now. That’s my approach, and I tell them, this is a theory that you need to learn about.”

We re-visited “STSE” and analyzed some of the actual expectations from the ministry documents. A few were read aloud and we grappled with what they meant. One expectation (about media influences on attitudes towards nutrition) got several responses about other teachers’ approaches. I did not sense that any of the participants had taught any of the expectations we considered as no personal stories were shared. Cindy said that a teacher at her school ran “little ads” during the opening school exercises. She told us:

You know what they did with that in my school because of health… Last year it was smoking and all of the stuff, which by the way, the drawings are still up on the windows, which is disgusting. This year, it’s on healthy [eating], and so this whole week has been like little ads on trans-fats, [or] “don’t have gravy with your fries.” or “it’s a no fries day in the cafeteria today.” …get your kids to run these little ideas, and I think that’s much better than actually teaching that kind of stuff. Get them to research.

The response suggests that she supports this approach since it is modest and students are engaged in doing their own research and creating a product: the advert.

5.3.3 Group meeting 3: Student pressures

During this meeting being a science teacher and developing science curriculum was discussed. Still, by the end of the meeting, participants continued to be unable to ask STSE or
social justice related questions (even after I provided them with my own examples) that could be the basis of an action research project. Participants shared teaching frustrations they felt about what they thought they should do and what they could do given the restraints of the curriculum and the pressures of students who are concerned about grades. Anita says: “Everything for them is how they are evaluated.” They shared concerns such as potential complaints from parents about their lessons. And Cindy worried that “If they complain, the parents complain, the parents go to the principal, the parents go to their trustee which goes to the principal and you’re called on the carpet to explain it.” Also they stated concerns that some students might challenge them if they attempted a lesson that was perceived as “not science”. It became clear in this meeting that much of what I had hoped we would explore in terms of STSE or justice issues was perceived as “not science”. The participants worried about engaging unmotivated students who “just want to get the credit” and often had poor attendance.

The issue of students influencing the science classroom climate based on what students “think science is”, dominated many of the conversations in this meeting. We also discussed: what is the nature of science as a process, what does it means to teach science, science as authority, science as having answers, science as obscure. Participants shared stories about students who question the curriculum, and about students who want to see the curriculum documents (probably to see if the teacher is teaching what they are supposed to teach!) They also grappled with what it means to be the authority in a science classroom.

Differences in experience began to emerge from one school where students questioned the teachers’ intelligence (perhaps as a way to control the teacher) to another school where being a science teacher was seen as being a genius. The need for skill development and the tragedy of lack of skills being a barrier for otherwise promising students was raised. The challenges of fair
assessments were raised, as was the fairness of provincial testing (such as the literacy test). By the end of the meeting participants were expressing their frustration with political (as in governing party) policies that were not meant to help education but rather further political agendas of re-election. Additionally there was discussion about failure rates and whether we were meeting the needs of students if they experienced failure, then gave up, and then didn’t graduate at all. There was no discussion of STSE expectations as being a different way for students to show us what they understood about science.

During several group meetings and this one in particular all participants seemed “obsessed with assessment”. This was unexpected since I as the researcher and facilitator in the discussions never asked about assessment and evaluation, and yet upon reflection, predictable. At first I thought that the regular mentioning of assessment was simply a sign of the times. In Ontario, both the Ministry of Education and individual school boards are concerned with achieving an assessment practice that can be quantified in a technical, reliable, and valid manner. The contemporary Ontario classroom is filled with teachers who have been indoctrinated into this ethos of accountability. The teachers in my study had, it seems, accepted the notion that assessment is an objective reality and that they could come to a final evaluation that had a valid meaning and that the “grade” they determined reflected reality. Never did they state or even suggest (not in this or any other meeting) that assessment was a construction—a social construction that had been constructed individually/independently by each of them in their capacity as “teacher”. I mention this here as I feel it speaks to their beliefs and understandings about construction of any sort of knowledge and thus informs their practice. When I tried to understand: What is it that teachers know? I felt that each of my participants might have said: “Good teachers know how to assess accurately.” That this is even possible began to suggest to me that the teachers lacked a worldview that included notions such as the construction of
knowledge. It also began to make me analyze what sorts of knowledge my teachers actually had and how the data I had collected through interviews and group discussions might shed some light on the nature of their teacher knowledge and its relationship to action research, STSE curriculum development, and social justice.

5.3.4 Group meeting 4: Culture and schooling and student needs

From my journal after meeting 4:

Attendance (student attendance and non-attendance) is a huge issue in this mtg. – How do we design curriculum with this in mind. How does attendance affect our curriculum? Attendance seems to be affected by social class ($) socio-economic class and family education-culture (that is- parents who have no experience with school can’t help with school advice.)

During this meeting there were several interesting turns. The meeting began with complaints about a professional organization and how it was being run. This proved to be interesting as personal disclosures about frustrations with the organization led to other personal disclosures (almost as though a tone of disclosure had been set). There were a number of personal disclosures. One participant told us that her parents had agreed to abandon the idea of an arranged marriage for her as long as she was married by age 30, but that she was getting nervous as she was getting close to that age.

The group discussed how they created lesson plans and how they made larger curriculum decisions based on what their students needed. Something that was not said, but I would suggest was implied, was how needs were determined. A prevailing sentiment was that “if kids like the class, and come to class then I’m meeting their needs.” Also this is the first meeting where we delved a bit deeper into the ideas of how students perceive school and how parents influence and enable particular behaviours such as letting a child sleep in late if he had worked the night
before. The idea of “invisible rules about how to be successful in school” was raised. The rules were not named, but participants were clear that such rules exist and the parents whose children were successful knew the rules.

Another interesting point that was raised in this meeting was what I am calling the culture wars. Can we truly call ourselves multi-cultural, and inclusive but say to some parents: your culture, and your values of not making education a priority is wrong? How some families define schooling was raised and all the participants had faced instances in which parent sentiments were that their children should go to school and do their work and come home and do other things. Other things did not include homework or staying late for extra-curricular events. Some families see school like a job that you go to, and do and that when you leave, you leave it there. Mary felt that:

the kids whose parents were successful in schools know the rules, and they pass those unspoken rules on to the kids by making them do their homework and checking it periodically. The kids whose parents [have less schooling], and it’s not that the parents don’t care, they just have no idea. They see …the bottom line for their kid …is if you got home at 2 o’clock in the morning and you’re tired, yes it’s better, stay in bed.

Anita agreed and told us:

I’ve had arguments, not arguments, but discussions like that with parents where they feel that there’s nothing wrong with Joey sleeping in and missing four or five days in a row of school, because they’re tired or … they think that they are sick, so they have no problems with that. So, who am I to argue with them?

We had discussed a great deal about meeting student’s needs and curriculum that was inclusive of all students but this was a new perspective. How can we be inclusive when we just don’t agree with a student’s or a families’ perspective? Also this type of absenteeism affects school in deep ways, as is a challenge to implement a curriculum when students are often absent for long periods.
5.3.5  Group meeting 5: … but is it Biology?

From my journal: “I’m a little distressed! No-one is here and its 5:15.” It was the first time I began to worry about meeting fatigue. I worried that we were just “talking” and that the group might feel that I kept raising the same questions. It was in this meeting—in part so that I would be seen as raising new ideas and sharing resources—I showed the group a curriculum that I had developed with a colleague about the social versus the biological construction of “Race” (see Appendix 2, chapter 5, strategy 1). The conversation turned quickly to a discussion of the participants’ race and identity. Again I raised the question of how does who you are impact your curriculum development? Next we turned to gender, then to being open about who you are within the context of your classroom—both in terms of planning /teaching and also when talking with your students. We discussed comfort levels when raising controversial issues, when and why we raise them or not, and which issues are chosen? Mary was most comfortable raising issues in the context of the biology content.

We also discussed why, questions that would seem natural to raise in a biology class, such as race or sexual orientation, are or are not actually raised? Participants voiced needing support and confidence before raising these issues (and I explore how we might provide support more fully in chapter 6). We discussed if students might question: why is the teacher raising this?’ Anita’s solution was that: “Everybody has to be work-shopped. That’s how you do it.”, implying the need for professional development. Cindy suggested integration of issues across several courses and therefore sharing responsibility. She suggests:

I think one way of addressing some of the issues you are talking about and implementing in the science curriculum, is really doing it through a number of courses. So talking about interdisciplinary approaches within your school. That’s a way to make it real, and to make it non-intrusive, so it’s not just what’s happening in your biology classroom, but it’s progressive, so that you don’t look like that comes off in 70 minutes.
Action research was discussed briefly and I wondered why no one seemed able to ask a question that they could investigate for themselves. It is possible that I was too focused on the question formation aspect of action research. The participants did have questions and did pursue them in their practice as evinced by so much of their “talk”.

Also I was getting to know the participants to the extent that I could at times predict what would be said and by whom. From my journal, notes made after meeting 5, including Table 1 below:

I have gotten to know the participants. Each is unique but among my group each is becoming predictable, I feel I have gotten “inside” their heads with respect to some qualities such as:

- Sense of her own experience
- Self confidence
- Commitment
- Clear self image as a teacher

Table 1

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<th>Participant Qualities as Predictable</th>
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<td>Quality</td>
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Additionally we talked about how the act of being a teacher changes who you are. Specifically Mary said that being a teacher had improved her social skills and Cindy said that teaching made her a more tolerant parent.

5.3.6 Group meeting 6: What is important content?

Curriculum design versus implementation was a major theme. Can any teacher be good if the curriculum is good or will any curriculum do if the teacher is good? Student resistance was raised again and when I probed for an example Anita said:

Well they were kind of like, ‘this is not philosophy, miss, this is biology, what are we doing.’ And I’m like, ‘go with me, don’t ask questions’, and they’re ‘ok, fine, fine.’ And so they kind of resisted at first, [but then found it] interesting.

Throughout this meeting, a common theme was how do we construct our teaching? And how does the content of a particular biology topic affect us and our society? Many of the issues raised in this meeting are related to the spirit of STSE but less to the reality of what STSE looks like in schools. Examples were that science content changes and raising issues such as pregnancy. The meeting was somewhat chaotic but the issues that the participants raised could be the core of an STSE approach. From my journal:

Comfort versus contempt? What is going on? I sense something in the air as the group “settles in”. One participant brought a pet to class, another forgot her journal. Is this meeting fatigue? Two interesting points from this meeting—the amount of curriculum is an issue (meaning the amount of content from the guidelines), and

To teach social issues we almost have to “de-construct what Bio class is” Is what is implied here that maybe I don’t want to de-construct the Bio class?

The meeting left me thinking: “what is the most important content in biology?” Perhaps this is the question we should have begun with. What should be in the curriculum? What is most
important for students to learn?

5.3.7 Group meeting 7: Lets get political

This was our last meeting and the tone was fun with lots of banter. Although the session began with a specific question: What would you need in the future to do more of this work? This was one more example of how the group conversations meandered away from my agenda. Still several interesting topics arose that had not been raised previously, such as:

a) Conflict: How do we operate with conflict that arises between students when it escalates and continues over more than one class period

b) Religious accommodations in society and school: How far do we go in accommodating diversity. For example in the context of rabbinical law and sharia law, how do members of the each of these religious communities either support or reject the idea.

c) Prayer at school events: One participant expressed shock when a school athletic banquet began with a prayer of thanks (grace before dinner). She was shocked on two levels: shock that it happened at all and that all the students fell into line and bowed their heads in prayer.

d) Anonymous mail: A colleague, collecting her mail from her school mailbox, found mail related to Islam and religion in schools—and she wondered who was placing it in her mailbox and to what end. The group felt that this seemed to be a form of harassment and the group discussed what to do in this situation: Going public? Or ignoring it?

e) Diversity: How far do we go within the education system to accommodate diversity?

f) Teacher power: We discussed the idea that teachers have a lot of power to influence students.
g) Monsanto: How do we present the “facts” around the recent court case where a farmer was charged with stealing Monsanto seeds? How does our teaching reflect the choices we make and the opinions we hold about this issue. Do we present the farmer as a “thief” or as an innocent neighbour whose farm is invaded with seeds from his neighbours’ farms?

h) Science in the news as an inspiration for curriculum: Specifically the O.J. Simpson trial and how issues arising from the trial might be incorporated in a science class were discussed. The issues that arose in this context included blood and DNA testing, police interference with evidence, and race and gender.

The conversations were more political in nature than the others and I felt proud that just perhaps my participants felt more comfortable and confident to analyze issues from a more political context. Cindy contextualized the topic of the O.J trial in terms of many political issues such as violence against women, race, money and power, police actions, and science and the law. The development of political knowledge as a foundation for STSE and social justice work is taken up as a recommendation in the next chapter.

5.4 Findings Related to the Research Questions

This section describes findings as they pertain to the three research questions. It is divided into three sections one for each question and the questions are used as the sub-heading. For each question I used all data sources and the answers to the questions are my compilation based on all data available.
5.4.1 Question 1: How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population.

The meaning of curriculum construction seemed fluid and changing. It is not always clear from the data how curriculum is different from lesson planning and/or from what is mandated by the ministry in terms of expectations. Overall textbook use is seldom mentioned, while assessment issues seem an obsession (and are mentioned so often that the topic of assessment is described elsewhere in this chapter). In describing how she approaches a new unit Anita admits she refers to the textbook as well as other sources for inspiration. She tells us her process:

I guess, I do find that I lean on the textbook -I will follow the flow of the topics in the textbook because in most instances it makes sense to me. In terms of breaking it down into subunits I go, well, this is how we should start this topic. Then I’ll start to see where can I fit in an activity that relates to a topic and then I’ll do that or I’ll go on the internet and put in like a key words and then other things pop up which will make me [think] okay, maybe I can fit this in and a sequence [develops]… if I do read the paper and see something that relates and immediately pull it out and I’ll say, “This was in today’s paper guys!” “And look at how it relates to what we’re doing” and then we’ll diverge from whatever I was planning and we’ll fit that in. (Anita, initial interview)

When participants were asked: “What barriers to curriculum construction do you experience?” they had difficulty naming barriers. They often spoke of obstacles and frustrations indirectly in terms of classroom climate and in terms of the barriers students face. Some challenges in curriculum development were common to the whole group and are listed below.

- Factors related to the school, the course, or student profiles might hinder creative curriculum development. One specific example, I call the tyranny of the common exam. All students enrolled in a course are expected to write the same exam at the end of term. This is a common practice in most schools and is generally accepted as a good idea. A common exam dictates that teachers need to be careful to cover the same material as the
rest of the department. Additionally once the exam for the course is set any new curriculum would be a nuisance as it could not be included on the common exam.

• Lack of time due to all the demands that a teacher faces in a day was mentioned over and over (and in particular by Anita the most junior teacher in the group).

• Past positive curricular experiences suggested that if teachers felt satisfied with how they had done things in the past then it was difficult to justify changing or creating new curriculum.

• Personal, personality, and identification factors such as personal insecurities, mental health issues, and family matters affected the work of my participants. It became clear through the meetings that how the participants saw themselves influenced both how they felt perceived by others and what they felt they should teach.

• A lack of a clear political framework and political perspectives seemed to operate to influence both what could be included in the curriculum as well as how new curriculum was constructed.

I wondered if my teachers were unable to see their job in terms of barriers—was it all just a struggle that they had to get through. In other words were they saying we do not acknowledge barriers as we would drown and we just do the best we can for our students? Or was I projecting that onto the data from my own struggles (explained earlier) at Sunnydale High? Obviously they did deliver lessons daily but a broader curriculum construction brought the above issues into focus. They said on several occasions that their own and their students’ image of what a good science teacher does governs their pedagogical and curricular choices.

Few supports were identified and the few that were seemed more personal in nature. One example of a support was a “colleague mentorship” where staff members meet and discuss the
curriculum and determine the important things that need to be taught. Although this was mentioned more as a memory or wish rather than a common practice and I began to wonder if my participants were isolated and “lone reeds” in their schools as they seldom mentioned *actual* collaborative support, but seemed to find such support and satisfaction from our group meetings.

Action research, in terms of asking a question, collecting data, recording observations, reflecting on the results and modifying a question for a second cycle, was described to the group during the second meeting and was understood by all. Participants had had experience with action research in the past and the process seemed to be embraced. Identifying a question of interest or concern was revisited for several weeks. Still the group seemed unable to actually identify a question of interest and begin the process. Any form of recording from questions to outcomes to reflections proved difficult. Some of the proposed (initial) questions were about blogs, bulletin boards, clubs, and out of class activities. I attempted to be positive and encouraging about each suggestion, still none of these were taken up by the group. They may have sensed that it was not what I had hoped for in terms of a question. Overall, my group proved reluctant to engage fully in an action research cycle. Asking a question that could be pursued proved difficult for all. Most were reluctant to record much in terms of findings.

Anita suggested several possible questions and ideas to investigate for an action research project but in the end was content to implement (use) a curriculum that I had shared with the group on the history of the biological versus the social construction of “race”. She used my approach, recorded student responses, and shared the results with the group. She had several positive reflections about the work, seemed glad that she had attempted it, and had several concerns. Although she admitted that “if I do it again I need to do more background reading first” (Mtg. 7), overall she seemed the most encouraged about trying some more curriculum
development in the future. Anita’s experience with action research led me to wonder if this might not be a model for apprenticeship in using action research for curriculum development: make the first experience modest, and use a question and a curriculum developed by others.

Upon implementing the curriculum piece about the biological versus the social construction of race (See appendix 2), Anita reported the following to us during meeting 6:

I chose not to do it with my 11C because I was a little afraid as to where that discussion would go – [with] race and everything, and I didn’t feel comfortable giving them that activity, so I just kept it with my grade 12s.

I was reminded of my own grade 11C class (C refers to college level courses) and their reluctance to engage with difficult topics such as race, and viewed her reluctance with some empathy. She did use the curriculum with her grade 12 class, and in some ways she was happy with how it proceeded:

Well, it worked … I think that the kids who were really into it, really enjoyed it and they really liked this idea because it gave them a fresh perspective on science, it wasn’t from a textbook, it wasn’t something they had to memorize. It was something that they could take part in, and it was real. (Anita Mtg. 6)

She told us that there was some resistance to participation from some of the students, but she did not expand on why. Although she judged the overall experience as interesting and adequate she concluded that she would want to know more and read more before trying the curriculum again. Two issues arose. She stated that she needed more content knowledge and that she needed to work on the students feeling that what she was doing was not science but as she called it “philosophy etc.”. Although she did not state this I would say she also needs more pedagogical content and context knowledge and I conclude she needs more political knowledge. These forms of knowledge will be explored in more detail in the next chapter. I predict that in the future she will move forward by developing: her own ideas for curriculum, her content knowledge, and the
scaffolding her students need in order that they are less resistant to exploring new ideas in science.

For Cindy’s action research project she asked students to create a timeline for the development of a theory. Specifically she used action research to examine a nature of science themed project with her grade 9 science class about the history of the cell theory as situated in a particular socio-cultural time and place. She was proud of the idea and happy to share her results with us both by telling us what she had done and by bringing samples of student work, for our group to examine. She told us:

What I wanted them to do was look at cell theory and the evolution of that discovery and then pick 5 different events leading up to cell theory with cell theory being last. [I wanted them to] write down what the discovery was, when did it happen, what were the inventions and the technology and then talk about the culture of that time period. If I did it again I’d need more exemplars. So I did it and there were quite a few failures. (Cindy Mtg. 7)

She showed us some of the products and the group was quite impressed. She told us that she was in many ways disappointed with the cultural references that were used to contextualize the science. She felt they many had missed the point that science does not happen in a vacuum. She felt that one student’s work was outstanding but that many students did not make the connections she had hoped for. Some students made the links well to what was happening in society as the cell theory was developing as a theory and she told us that one student had said that “two ideas of science, of the culture of that period, are that science are about wonder and power… the Greeks in particular were very curious and discovering things” (Cindy Mtg. 7).

Mary, who initially had seemed to understand a great deal about action research and had expressed a desire to tackle an environmental topic, had not attempted anything by the end of the study.
With respect to action research, my participants left me with the question: “Why was action research so difficult to actually do?” It seemed to me that the challenges were not about action research as a process since they often spoke of components of the action research process in their day-to-day practice. They were able to generate many questions about their lessons and about student performance. They would talk of trying different approaches, and they discussed possibilities for changes and suggestions for further research. Rather I suggest that one of the challenges for each of the teachers was around their willingness to collect and record data and reflections. It remained unclear whether they did not have the time to record or whether there were other reasons for the reluctance to record findings. Cindy is the exception in this.

Recall from chapter 2, Hammersley’s (2004) question: “Is action research (AR) a form of research or a form of action?” and his assertion that for success the two not be equal. Table 2 summarizes the action research work of the participants using Hammersley’s distinctions.

**Table 2**

*Summary of Action Research Completed by Participants*

<table>
<thead>
<tr>
<th></th>
<th>AR as a form of research or inquiry occurred</th>
<th>AR as a form of action or some practical or political activity occurred in teachers’ classroom practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cindy</td>
<td>Yes. She provided, to our group meetings, an analysis of her students’ work.</td>
<td>Yes. She developed a practical student assignment (which explored the history, culture, and nature of science) that occurred as part of her classroom practice.</td>
</tr>
<tr>
<td>Anita</td>
<td>Yes. She explored, in our group meetings, ideas for increasing student motivation.</td>
<td>Yes. She implemented curricular ideas (such as the construction of race and an issues bulletin board) as part of her classroom practice.</td>
</tr>
<tr>
<td>Mary</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
I suggest that Cindy and Anita viewed AR for *research* (as being for me) and for *action* (as being for themselves). Likely they viewed the research component as separate from the action component, likely as equal, and as I stated in chapter 2, certainly confined to different domains: our meetings (for inquiry/research) and their classroom practice (for action). I am left to wonder if outcomes would have been different if I had attended their classrooms as an on-site AR facilitator and my presence would have given the classroom work more primacy, or if I had met with them individually to enhance and interrogate the research component?

I also wondered to what extent my study and our experience would provide the group with background and scaffolding for future successes? Anita, I trust will begin to use her classroom for further action research. She states: “[the action research made me] feel focused to specifically address an idea” (Mtg. 7). She saw her AR as more than the just using the race curriculum, but more fundamentally as a model for ways to motivate her students. As a minimum she will repeat the action research cycle with the project she did for me in order to improve it and to give her students a more meaningful experience. But she also expressed concern about how the students would understand it and was worried that they would misconstrue and misuse the knowledge and so would choose judiciously which classes to use in the future. My sense is that little will change in the practice of the other participants. It remains unclear whether, concomitantly, little has changed in their beliefs about the value of being a classroom teacher researcher.
5.4.2 Question 2: How do teachers understand themselves and their role as science teachers?

Overall, participants identified strongly as teachers and in particular as science teachers. They discussed pride in being science teachers and their unease with being seen by students outside of the narrow limits of the school. While teaching, they felt unease with, yet lacked a response to, students saying “but this is not science” when they tried to cover new topics seen as outside the norm for science or familiar topics in a new way. Following are some of the things they said about their own identification and my analysis of what it may mean:

As teachers, there needs to be, for identity, an awareness of our own, but there has also got to be an awareness and understanding of the kids. (Mary Mtg. 1)

I think a lot of students are very intimidated by adults. They don’t think of them as real people, or don’t know how to deal with them at all. So, we’re (as teachers) safe adults to talk to.” (Anita Mtg. 1)

I grew up kind of …very ethnic and my parents were very strict. Very strict. But how frequently they think that I’ve done drugs, ‘oh miss, you must have done drugs’ (as a chem teacher) they have these people in the sixties vision of me, kind of running around with a lab coat, smoking up somewhere…cooking [drugs] in the back of the lab. (Cindy Mtg. 1)

It seems that my participants are saying that you must know yourself before you can get to know your students. They see themselves as having a special status as “the teacher as safe adult” and therefore are more than other adults. It seems that students have an image of teachers that is strong and fixed and which students would prefer does not alter. Yet at time students see teachers as more “cool” than teachers see themselves. With respect to identity perhaps the participants were saying that students construct us as a science teacher, to such an extent that it paralyzes one to be seen other than in that way. As teachers we share information about ourselves in an attempt to be seen as a whole and complex person. Perhaps being seen as a whole person allows us to more easily teach outside the strict role of “science” teacher?
One of the challenges for me in the data analysis process is to use descriptors that describe and do not judge. I include here verbatim how the participants describe themselves as teachers so that it can act as a backdrop to later analysis and as a way for me to be conscious of reporting my findings without judging them. It is important to me as the “reporter” to help the reader feel familiar with these capable, committed, creative and generous teachers. Some key words are bolded as a way to highlight what I saw as key ideas they were disclosing to me about themselves, while maintaining their voice by using the longer passage. When asked “How would you describe yourself as a teacher?” Anita answered:

Well, I think … because I love school, and I just always wanted to be in the school and I always loved being a student and I always loved learning. So I thought, okay, in terms of a career, then what better thing to do than be a teacher and still be in the system. So, when I think of myself it’s more as an **avid learner** and me wanting to **motivate other** kids that don’t see that. That’s why I don’t mind teaching kids at [my school] where I don’t have the most motivated students because I like making them aware of some of the things that can happen if you do become an avid learner. I think that’s where I feel I’m stronger and in terms of teaching – I like the **personal relationships** that you have…and not necessarily just with students, but with everybody. It’s very personal. (Anita initial interview)

And later she describes how she sees herself as a teacher who is supportive of students—particularly those that have difficult lives. Anita says:

I feel a bit, like sometimes coming here and realizing that these kids, the last thing they want to do is be in a classroom learning about [Science] when they have so many other things outside. So sometimes I look at myself as sort of someone there for their **support** and I don’t know if that’s going to change everybody but I know that could **change one person** or a couple of people. I don’t know if one or two people will do for society. If I was a student too, 17 and taking care of themselves – the last thing I would think of is biology or about my biosphere assignment or whatever it is that I need to do for tomorrow. Their main priority is going to be, where’s my food coming from tonight. (Anita initial interview)

Anita describes herself as an avid learner, a motivator and a support system for her students. She believes she can be a (social) change agent and sees herself as understanding and supportive.

Finally, she is a creative person and a builder of and a part of a learning community. By the end
of the study, I believe it was Anita who was the avid learner and who embraced the research (my research) in a personal way.

Cindy when asked the same question answers:

I like to look at myself as somebody who has a lot of integrity and I am very consistent so that I like to make sure that the student know where I stand on a number of issues prior to the class ever beginning so, this year in particular I wanted to focus on listening and so those are the little things that make a classroom environment very important. So, I have a lot of integrity and I like to be very consistent about my ideas on how the class should be conducted and furthermore I like to empower the student as much as possible… I know that when I was a younger teacher, I used to struggle with [assignment expectations] and kids would always question it and now, I guess kids still do question it … I know they do. [but] I don’t feel as scared or as worried about those kinds of things because I have an idea of where things are going to go…. I’ve also become much more relaxed in a sense….. (Cindy initial interview)

Cindy describes herself as a person with integrity and one who is consistent. She wants to empower her students. Even though she has been teaching longer than Anita I sense she is still searching for answers regarding what it means to be a teacher. She admits to having more confidence with more experience and to feeling less scared or worried about her decisions, which suggests that she has struggled in the past with her own insecurities. Cindy, in the end, was the participant who was the most careful about doing all of the parts of my research that I had asked of the group. She did an action research project, kept a journal, kept notes and shared student work, and called me to make an appointment for her final interview.

Finally, Mary describes herself as a teacher in this way:

As a teacher – I’d say creative, competent in my subject knowledge but at the same point always willing to look for more stuff and new stuff cause everything’s always changing…I create assignments so the kids have to go do this stuff so I can read their assignments and I can learn from doing it – cause I don’t have time to do it all myself…. (I’m) really well organized, which is not really natural for me but to try and get everything in and done I have to be really organized. I try and provide, I think…I know the kids, the majority of them feel that I’m fairly transparent. I’m very clear about what I want them to be able to
do and to what level. I give them a lot of resources and support. **In turn I expect that they use it and when they don’t I don’t have a lot of sympathy.** But I do get a comment of “fair” coming back a lot. I probably ask them to do too much work, bottom line, but I like to go more on to quality work from knowledge and I know I want to do that and it’s one of my pet peeves with **biology** is how much…of all the knowledge we’ve got to go through – how much do I get bogged down in that… instead of getting into a really good application and discussions. I’ve done some ethics stuff this year but there’s some **good material** coming out…which is **ready-to-use.** A lot of current stuff…I do a lot of virtual labs or computer labs or web-based labs. I can’t think of anything else…does that kind of explain it? …Oh! I think…I also have a **rather pathetic sense of humor.** (Mary initial interview)

She is saying that she is a creative, competent, knowledgeable teacher who stays up to date with changes in her discipline content. She has high expectations of her students and of herself. She expects her students to meet her high standards and is unsympathetic when they do not since she feels she is being clear and fair with them. Also, as is shown below, she works hard to overcome her own flaws. She states:

…as a person, **I am extremely disorganized.** I’m very much, what’s that personality … where it’s kind of random… I function on a stream of consciousness and you can’t be a teacher and be like that. Or I don’t think you can be a good teacher and be like – so I have to force myself to be organized. It’s a standing joke all the time…I think I’m a pretty good professional but I’m a flake in my personal life. (Mary initial interview)

And later:

**I’m very serious, I love what I do,** I can’t imagine having a job that would be a job and then there’s my life. They all run together. So, my interest in biology drives what I teach. My interest in learning…I think I role model for the kids fairly well about that, but I think that’s one of the reasons I can stay fairly close to being on top of things. It’s not always work…it’s because I enjoy doing it. (Mary initial interview)

She does not separate who she is or her personal life from her life as a biology teacher. Yet, there are consequences for her as evinced when she says: “I would consider myself to be an introvert…yet when you look at me as a teacher… I would also call myself an extrovert as a teacher… by I think it’s also why this job tires me out so much… because I need to spend a lot of
time by myself just to regenerate.” She is a hard worker who sees herself as an expert science teacher. She exudes confidence in her ability to be a good teacher. She knows what to do and does it, which includes staying current with new knowledge and advances in biology. She describes herself in terms of her belief “in” herself and beliefs about herself and less so in terms of her practices or how she achieves her goals. Given these observations it is less surprising to me that she was the one participant who did not attempt any sort of action research, did not share her journal with me (she told me she had no time to write in it), and did not attend two scheduled appointments for a final interview. Some of the reasons might be in her answers to how she describes herself as a teacher in the above selections. Repeated from above, she says she is “competent in my subject knowledge … always willing to look for more stuff and new stuff, … I think it’s also why this job tires me out so much…because I need to spend a lot of time by myself just to regenerate”. She knows what to do, will look at new material but does not mention developing materials and is tired and needs time to regenerate. I wonder if she did not see the value of the task I had asked her to do? More on this later when I examine what each participant says about STSE.

The participants seem self-aware and mostly secure in who they are and how they see their role. Also, though, they seem to be “working out” how who they are can effect what they choose to teach and how they teach their classes. Finally, my analysis from everything they said about themselves and about their role is that they see themselves primarily as competent and committed subject matter content teachers.
5.4.3 Question 3: How do teachers understand STSE curriculum as a place for furthering social justice issues?

I gained several insights into the beliefs and practices with respect to STSE. I feel that participants simultaneously saw STSE as important and as a bother. STSE seemed to be one “idea” and not the interactions between the actual words. Social justice as an idea was both appealing and abstract. Still, it was seldom taken up by the group and when it was, I would say with little substance. Following are some examples of how participants spoke about STSE education including strategies, STSE versus other science content, social justice, and the riskiness of dealing with issues.

Anita tells us that if she is pressed for time she would omit a part of her lesson that could have addressed an STSE issue. She says: “Yeah, [if] I did have to cut something it would be the article that I saw in today’s newspaper. Even though it related to what we were talking about, but we have to continue on with the actual curriculum.”

Her choice of words is telling. She tells us she has to continue with the actual curriculum, by which I think there is no doubt she means the subject matter content.

Cindy says:

I think in biology its easier to do it [STSE] than anywhere else. Primarily because it lends itself to STSE a lot more than let’s say the chemistry or the physics does. I taught a little bit of the physics and I taught chemistry. Biology I find on a day to day basis, on a day to day lesson, I am far better able to make practical everyday STSE relationships with my course or curriculum than I am with let’s say the Chemistry when you’re talking about atoms or these things you can’t see. Biology students naturally are much more able to see and touch and feel and relate to. They are fascinated by their own body… they’re able to pick up from information in the newspapers and what they’re watching on TV and the latest in reproductive technology and they’re able to bring that into the classroom in a very tangible way and have maybe not an elaborate discussion as you would have if you had all
the content but certainly a fairly even keel discussion and open discussion. (Cindy initial interview)

Cindy sees STSE as related to issues in Biology. She sees STSE as a way for students to have a discussion around what they read in the newspaper and what they see on TV. She has brought STSE into the realm of scientific and media literacy but nothing deeper than that as students might lack the content knowledge for a deeper discussion.

She says:

My personal belief is that STSE should be the core of the course. For many, many years, I taught the biology in my old school and then because there were so many other areas I wanted to get into, all STSE, science and all really interesting conversations, I went to the principal and said, “I think we need a science and society course here.” And so, I brought that into the school and it was a great course. Kids loved it and they were able to elaborate on that discussion that ended in the classroom.

So now we’ve kind of gone back in terms of getting rid of that course and we don’t have a lot of the STSE as an important core because the curriculum has become key. You have to go all through all of the content in order to get to the end of the unit and by the time you get there, then, okay, finally you can talk about the STSE but it’s not sort of incorporated through out as it should be, I think. (Cindy initial interview)

She does not see STSE as part of the curriculum but as something to get to after the unit is complete. She seems to distance herself from the curriculum development process when she says “it” (meaning STSE) is not incorporated, as it should be. But, it would be “her” who is (not) doing the incorporating. Interesting – she says “not incorporated throughout as it should be” — but not incorporated by whom? She has removed herself from the curriculum creation process and describes it as having its own driving force. When pressed (I asked her: “So, personally, you’d like to see STSE be the course and you feel it should the core?”) Cindy responds:

Correct … because I feel that’s what the students actually come out of the class remembering … realizing what’s important. What I feel though is as a teacher, I’m struggling with that and it’s not the core because you have to check off all those content based things and the curriculum and the expectations have to be covered and that’s what’s covered in the exam and in the assessment and that’s really what the focus is. … Unless we weight it differently, it will never be core. (Cindy initial interview)
When she says “unless we weigh it differently” she is referring to the notion that until the exam places weight (grades) on STSE expectations they will not be valued or assessed and so cannot be core. These exam considerations, however, are under the teacher’s control. I am reminded of the notion that we teach what we value and we assess what we value.

Cindy has distanced herself from her decisions as though they were governed by school policy or departmental forces beyond her control. Cindy states that STSE is core and later that it is not. She, I am convinced, believes both statements. She is not confused, or unsure. Rather she accepts both positions and while it causes her some tension is able to hold both positions concurrently in her head and in her practice. She joined our group I think to help her make STSE more core yet through the meetings became less convinced that it was. Perhaps she (with my help and the group) talked herself out of it being core because she is insightful and began to see how difficult it is to construct a curriculum that makes it core and she already has a curriculum that she believes is very good.

STSE was also often referred to an “entity” in itself as opposed to what STSE is composed of: science and technology and society and the environment. STSE was often used as a code word for the relevancy factor but I sensed it was not seen as being the “real” content. In the end it was not clear to me how valued the STSE part of a unit was for my participants. In general they had difficulty naming actual barriers to including more STSE/justice issues into their work and I was left to wonder if they had not faced many barriers because they had not attempted much STSE teaching. Mary, during her individual interview, was asked whether STSE is a core part of the course or is it an extra that is included if there is time, and she says:

I think philosophically and as a teacher STSE is the core…it is the reason you teach science. The time reality, the fact the kids are going to be evaluated and you have to justify everything you do to the tenth degree means that, so many times, STSE is an add
Part of when I go back to create a course, I do try and have an STSE…a core to it…and try and bring in issues and relate back and forth, but a lot of the times I don’t get to it. I run out of time and I know that’s not going to be…and the sad thing is as much as everybody in the ministry and supervisors constantly talks about it, what is evaluated and how the teachers evaluate is on what content the kids know.

I really think so because you can’t evaluate how well a kid can play with a philosophical issue. They work out well for philosophy courses but I bet they spend a lot of time with what the content is versus how the kids can use it and work with it. Unfortunately, and this is one thing that bothers me here because I should be pushing the kids farther and really working with the STSE stuff. (Mary initial interview)

When I ask her: “And how could you? What would you need to push them farther?” she talks about lack of time (which is discussed in a subsequent section.)

It is sobering to think ones research is having the opposite effect of ones purpose but I had to face the possibility when Mary had this to say towards the end of the study:

My two cents on that would be that I don’t think biology should be the vehicle for dealing with social issues— with social issues being more important than biology. But I totally, totally think biology, and social issues are entwined. That they do go together. Should biology be the way you teach about stuff like or develop a value system. No, it should be part of it, because I think … The distinction there is that biology as a science gave me this information, so I just work with the ethics, the issues around it, but in a biological context, not in strictly a social issues context. I think the context should be kept, and I mean, yes there could be an integration with [other] classes, say history, or a civics course, or something like that. (Mary Mtg. 6)

Note what she says: Biology “gave me this” with no consideration that knowledge is constructed even though we had discussed this often in our meetings. What can I interpret from her words? I believe that she is struggling with biology class as a vehicle for justice issues versus social issues imbedded in the biology. However she does like the idea of pushing kids and does not find the idea of making them uncomfortable as a way to stimulate learning, to be a problem for her. In fact she supports the idea of making them uncomfortable as evinced by this statement:

But it would be kind of like you’ve got them on edge, what’s going on, this is not uncomfortable, this is not the way it’s supposed to be? I think there is potential for a huge amount of learning there, where you kept them going and yes, it was just like ‘work with me here.’ I think you probably got more profound learning. And it won’t happen to all of
them, but a couple of them kind of going, ‘whoa, yeah! … a different way of thinking of things. (Mtg. 6)

Social justice issues permeated several of our meetings but I felt that they were never fully explored. Throughout the research I felt that I had a different definition of social justice and short of saying: “this is my definition and please adhere to it” — I was flummoxed as to how to create a common understanding of this commonly used term. However, if we compare the tone of the conversation from group meetings 1 and 7 perhaps there has been a shift. In meeting 7, the topics are more political in nature and the discussion more open about how to understand justice issues such as, for example accommodations for diverse populations, corporate influences in farming, and scientific literacy related to science and the justice system. (See section 5.3.7 which describes Meeting 7)

Mary, consistently made it clear that she was more comfortable with “sticking to content” than to investing time to include more STSE in her teaching. However, what she did not address is the meaning of content. In our group meetings we often talked about STSE issues as tied to the curriculum and I would call this content (as it is mandated by the ministry). In the next exchange I interrogate this a little further. She says: “You have to be pretty radical if you’re willing to, I think put yourself on the line to do something which should be the focus.” When she says “should be the focus” she is referring to STSE. Still she seems to have ambiguous feelings about teaching STSE when she reveals:

Now, for me and people who know the subject area, that’s not the case. But when the ministry inspector came in to talk to us about STSE he said there’s some really good STSE issues in the book, are you using them? But with the inspector his whole focus was, what was in the textbook? Are you using [it]? Because we want [the] STSE done in the textbook. (Mary initial interview)
Her issue seems to be with a ministry inspector telling her to use the textbook to cover STSE expectations, and yet, is reluctant to put herself in a situation where she feels unprotected or vulnerable and so I would have assumed that teaching STSE using the textbook would be safe and preferable. I found this puzzling and so I probed further and asked her: “What are some societal issues that you think have a place within the biology curriculum but are not in the guidelines?” I was expecting her to say if it’s not in the guidelines then I do not risk including it but instead she replies with a myriad of ideas which I have bolded for emphasis:

**Human impact on the environment** – on what we’re doing to the environment and I think in biology, well in all the sciences and a lot of the other things too, but biology especially because you can talk about the life rather than just the chemistry of the environment. **Global warming**, the whole thing about **polar bears are endangered** now because the **ice is disappearing** because of global warming…which yes, we’ve had historical aspects of global warming before but this is the first one that’s based…[on] human activity…. We get issues with **biotactin** and **genetically modified foods** – bring it into an ecological perspective and very hands on at the same point…are **mono culture crops**…the reason we need all this crap on them is because they can’t compete against the wild stuff so the odds are of them cross breeding with something in the wild is really low. Is it possible? Yes. Is it probable? No. So, play with those issues and take a look at those. Like what’s the worse case scenario…if you don’t have genetically modified foods you have to continue to use a lot of **chemicals and pesticides and herbicides** and that stuff, and **fertilizers which are causing real problems**. So the issue is not that there’s not going to be problems, the issue is which problem are we going to work with and trying to get people to look further down the road. Politics. Politics is brought in to everything. Because we’re getting **environment, medicine, genetics** all that stuff – **health care**…I know I push the kids a lot to say…you need to think about this when you turn 18 and you can vote and with this group – you are the intelligent kids. You have to know about this. You have the responsibility to know about this and talk to other people on the Go Train or on their way to work. (Mary initial interview)

It seems that she is willing to include a large number of topics that are not in the guidelines when she can justify to herself that it is of importance and future significance to her students. She seems to have a sophisticated understanding of the tensions within these issues and of the importance of politics to science. I believe this speaks to how she feels about certain other types
of social justice issues. Perhaps she does not see some issues as significant or not as science or not as important to her students or she is simply not comfortable with certain types of controversy.

Upon further reflection I would say that she saw stem cell as controversial and likely to land her in trouble. I wonder if she is of the opinion that including an issue is controversial but that omitting it is neutral. I would argue that both positions—including a topic or omitting a topic—are controversial positions and so neither is neutral. Additionally I wonder when teachers refer to fear of losing their jobs if this is code for “I don’t want to do it as it feels risky to me?”

My participants seldom spoke of teaching strategies or distinct approaches for teaching STSE. Anita during her initial interview tells us that she likes to use newspaper articles to approach some STSE issues. She tells us:

…sometimes I find articles like Time Magazine. Sometimes…I like putting in some articles that relate to science and what are the ethical issues behind it or what debates [there are] around this issue.

And later:

I think that kids do have an opinion and I think it’s more comfortable for them to form an opinion based on what they feel …there is a science behind it but it’s more or less how do you feel about this part of science being part of your society. It’s easier for them to relate to that because it’s not about how does a virus reproduce. They can understand and they can give an opinion as to how they feel about it …It’s more of an opinion as to, what would happen if we had cloning of humans. So, in terms of anything, I find that’s the only way I’ve been able to [incorporate STSE] and I feel that I’m limited by that.

Anita, who emerged as a risk taker and a creative teacher admits that STSE approaches for her are limited to articles and the ensuing discussion that arises from student opinions. She admits that she does not engage in deeper analysis of issues. Her approach to issues is also rather “content free” (or at least content-light) in that she feels that students will all have an opinion
about the issue as it relates to their life. She is presenting a view of issues as easy to engage with and less threatening than having to learn (difficult) content knowledge.

Mary is clear with respect to strategies for teaching STSE. When asked about preferred teaching and assessment strategies for implementing lessons that addresses STSE/societal issues. She answers without hesitation: “A lot of cooperative learning…” and goes on to say:

cooporative learning as a vehicle to get in to critical thinking. To analyze, to share ideas…I think sharing ideas and opinions is really important. Just that talking is a valuable learning experience because you hear where different people are coming from and I think that is going to make somebody a better and more well-rounded person because it’s going to make their way of looking at things richer. So cooperative learning stuff where there’s dialogue—usually some sort of controlled dialogue—something to be done. A debate type of atmosphere … simulation … something along that line.

Mary sees sharing ideas and opinions as valuable. She makes no reference to the knowledge base needed in order to participate in her suggested activities. Given that she has placed a high premium on the importance of learning content it would seem that for all aspects of her teaching, including co-operative learning as a strategy for STSE education, content should figure prominently. She states the importance of learning through controlled dialogue, and so, I thought that perhaps cooperative learning through discussions (embedded in content) about STSE might form the seed for an action research question for Mary but in the end it did not.

Cindy spoke little of approaches to STSE but she did use an interesting approach for her AR project that is worth adding to this section (although the project is discussed elsewhere). She used a storyboard project, which intertwined the history of a scientific development (cell theory) with other events and cultural landmarks happening at the same time in history. From her journal:

Students were asked to choose 5 different moment in time leading up the to the development of cell theory… [So that] students could see the relationship of how the
science of that time period happened in context ... These connections are key in students developing an understanding of NOS.

Overall, the participants used some of the language of strategies for teaching STSE: debate, simulation, issues, recent (media) articles, opinions, and yet they seldom gave us examples of how they had actually and specifically used these strategies for STSE education. One exception is Anita’s use of the Town Council (described earlier in this chapter) but her use was for a human body systems content lesson. Participants did not raise ideas of the knowledge, skills, or attitudes needed for students to engage with STSE education.

5.4.4 Knowledge and/or from STSE

Knowledge in a general sense has been raised often in this chapter, usually in the context of teaching content knowledge (CK). After we had had two group sessions I was clearly beginning to reflect on the relationship of CK to other types of knowledge that I believed was either being raised or being left out of our talk, and in my journal I wrote:

Suggestions for session 3: [ask this]

What knowledge bases are necessary for teaching?

As a teacher what forms of knowledge is important?

Can we name categories of knowledge?

Categories of knowledge that are important for teachers of science are Knowledge of:

a. self
b. youth (age group we teach)
c. how individuals learn
d. science content “facts”
e. NOS (nature of science)
f. History of science
g. Sociology of classrooms, of science
h. Politics
i. Culture (youth, student)
In this section I would like to further explore this idea and also inform the discussion with reference to some scholarly literature. Young (2013) suggests that:

> the purpose of the curriculum, at least in modern societies, is not only to transmit past knowledge; it is to enable the next generation to build on that knowledge and create new knowledge, for that is how human societies progress and how individuals develop. (p. 101-102)

I wondered if my data could shed any light on the relationship (if any) among the outcomes of an STSE/social justice focused approach in science education, transmitting knowledge (CK), and creating new knowledge for societies and for ourselves. Young feels that “knowledge” has been avoided by curriculum theorists and by the curriculum development discourse. He says:

> What is the important knowledge that pupils should be able to acquire at school? If as curriculum theorists, we cannot answer this question, it is unclear who can, and it is more likely that it will be left to the pragmatic and ideological decisions of administrators and politicians. (p. 103)

Young (2013) further suggest we consider the rights of the learner by arguing “that curriculum theory must begin not from the learner but from the learner’s entitlement to knowledge” (p. 101).

> While I did not directly ask my participants, in many instances they were addressing this query: What is important knowledge and to what knowledge do students have a right? I think they were often grappling with this very question as shown by their comments. Cindy, for example says:

> But I find to have an effective STSE program, or whatever you’re working with, there is so much other stuff that students have to get knowledge of and understand, and skills.
You get so bogged down in actually teaching them *that* before they can have a meaningful STSE experience. (Mtg. 1)

Knowledge is synonymous with content to be learned and content must be learned before students can have a meaningful STSE experience. The sheer number of things that a science teacher has to “know” makes it difficult to do more than teach content. She says it is difficult “because of our discipline, because of the sciences, somebody pointed that out to me, and said, ‘look what you have to deal with every day, you have all that equipment and knowledge’” (Mtg. 1).

Anita’s students will participate in the class and in learning something new if they know it will be on the exam. They say to her: “If this is going to be on the exam, and this is going to be a body of knowledge that I’m going to be tested on, then I’ll take part” (Mtg. 6). Knowledge for Anita is in part what students come to class with and already have. She implies that controversial issues can be easier to teach (than say molarity) when the students know something about the topic or are familiar with it. She says:

But I like it when the kids … see science as something that they can use. When you talk about something that they can suddenly relate to. I like that. So if I’m going to talk about something that is controversial that they know a little bit about, then I already have a base where they feel more comfortable, because they already have a base of knowledge—[with which] to talk about it with me. (Mtg. 2)

None of the participants spoke of knowledge creation either as a part of what scientists do (even when I asked directly) nor as a part of what students do as they learn. Anita implies that controversial issues can be easier than learning content because the students already know something. While this could be true for some issues, it is likely true most of the issues that she has raised.

To further explore what type of knowledge is needed and how knowledge is a part of STSE education, I need to digress slightly to remind the reader of Anderson and Krathwohl’s
(2001) re-conceptualized version of Bloom’s taxonomy. They re-named and re-ordered Bloom’s categories to match what they considered an increasing level of difficulty of thinking skills by presenting the revised (re-ordered and re-named) taxonomy as these cognitive processes:

- **Remembering**:Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
- **Understanding**: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
- **Applying**: Carrying out or using a procedure through executing, or implementing.
- **Analyzing**: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
- **Evaluating**: Making judgments based on criteria and standards through checking and critiquing.
- **Creating**: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

(Anderson & Krathwohl, 2001, pp. 67-68)

(See Anderson and Krathwohl (2001) and Krathwohl (2002) for a full history, description, and justification for the changes they propose.)

Although not asked I would venture that my participants would say that they use all levels of this taxonomy in their teaching and assessment, however, when they spoke they mostly referred to the first 3 levels (or lower level thinking). Additionally (and of use to us here), Krathwohl (2002) has defined Remembering (formerly the knowledge dimension) of the revised taxonomy in terms of these categories of knowledge:
• Factual (knowledge of basic elements, terminology, and specific details needed to solve problems within a discipline)

• Conceptual (knowledge of interrelationships between basic elements including classifications, principles, theories and models)

• Procedural (knowledge of how to do something including methods of inquiry, skills, techniques, algorithms and when to use appropriate procedures)

• Metacognitive (knowledge of cognition, as well as contextual and self-knowledge)

To develop and design an STSE curriculum (and in particular if embedded in a social justice perspective) with opportunities to examine ideas from multiple perspectives, from societal and/or community contexts, and with critical viewpoints, teachers need to use all cognitive levels and in particular the higher order levels of analyzing, evaluating, and creating. Additionally teachers may need to help students to access knowledge that includes factual, conceptual, and metacognitive knowledge types as well as (what I will suggest is) critical knowledge, which I define as the knowledge to analyze and synthesize their thoughts, place ideas in a new context, bring in multiple perspectives, and make connections.

Cindy, while in many ways proud of her students’ work from the “NOS/cell theory in context project” (recall this was her action research project) also expressed disappointment that several of her students did not fully understand that she wanted them to place the development of cell theory into a historical, cultural, and societal context. Perhaps they lacked the critical knowledge to understand what was expected and/or to re-position ideas within a context of culture and place and so construct a new understanding of the influences of society on science and vice versa.
Anita, likewise, was satisfied with using the construction of race curriculum with her students. Recall that part of their work was to create a timeline of the changes in thinking of how race was viewed as fixed biologically or fluid socially. However, placing ideas from different periods of history on a timeline does not in itself help students construct a new understanding of race as a construct, or help them compare the biological and social construction of the idea, or what it means for people living racialized lives. She implied that if she was to repeat the lesson she needed to know more factual and conceptual knowledge and that she would better prepare her students. I suggest that while she might have indeed needed to know more, perhaps is it the critical knowledge category that needed development for her and scaffolding for her students.

I raise the topic of knowledge here, in this chapter, and not in the next one as I do not want to take this up as a recommendation but rather raise it as a way to interpret the data: perhaps what did not happen with respect to curriculum development for STSE and social justice was affected by the type of knowledge needed to engage with STSE education. Although assuredly the type(s) of knowledge needed in order to engage (for both teachers and students) with teaching and learning about STSE and social justice in science have implications for the prominence of STSE education in the future. Additionally it makes one wonder if science education (and in particular STSE education) can move from a knowledge acquisition model of teaching and assessment to a knowledge critique and construction model.

5.5 Observations From the Final (Post-Group Individual) Interviews

I have referred to the pre-group individual interviews extensively in this dissertation thus far but have said little about the post interviews. They were a source of frustration and
disappointment for me since they were a struggle to achieve and one participant in particular avoided and basically declined the final interview and I feared she would ask (although did not) for all aspects of her participation to be removed. Also I place the final interviews here for the end of this chapter, as they are in some ways a conclusion in themselves. The final interviews provided me insights with respect to the following:

- what was learned about the process of curriculum development, STSE, and inclusivity
- feelings about the research study
- reflections about action research
- successes

Additionally the final individual interviews provided opportunities for the participants to share any ideas that they had not wanted to share in the larger group, and to re-visit topics from the initial individual pre-group interview.

5.5.1 Reflections about Group Meetings

Both Cindy and Anita expressed similar sentiments with respect to appreciating the meetings and the sharing of ideas. Anita said: “[the meetings] were helpful and it was interesting to listen to all the different perspectives from the other members.” She felt that the conversations were more rewarding for her than conversations she had at her school.

She appreciated the advice of the group members. Although she never used the term pedagogical content knowledge (PCK), I think that much of what Anita told me in her final interview confirmed that the group helped her to think about and to refine her PCK in terms of planning lessons for her students in the best way to help them learn new concepts. She added: “The group and the action research helped me because I brought in resources—this is for my grade 11
class—from my own action research and from the group. It did engage them because they weren’t engaged [before].”

5.5.2 Changes in Practice

Anita appreciated thinking of STSE in a different way and found that discussing some of the STSE issues was good for the students. She felt that her students were less intimidated with STSE topics because “it was not just a pure science process – and so they were often discussing ideas and so they all felt that they could contribute to the discussion.” She also expressed a sense of success with respect to her increased use of the newspaper. She had encouraged students to bring in articles about science and post them on a bulletin board in the class. She felt it was a success and her students could see that the articles connected them to contemporary (or as she said: “this is happening right now”) ideas. However she was still concerned about how to evaluate an activity such as the bringing in of articles and how to evaluate discussions. She felt that overall she had shifted her practice a little more to an issues based approach because her students were interested and more engaged with this approach and this was a huge success for her since, as she had often voiced before, her students lacked engagement with science.

5.5.3 Action Research (AR)

With respect to the action research projects Cindy was pleased with how her project unfolded. Although she would have liked to meet with our group over a longer period of time, she appreciated that the actual AR project fit within a shorter timeframe. Cindy also paralleled my own sentiments that AR needs to be more modest in scope than how it is often approached (as in a year long project). She said that the short time line helped her to be more focused and
task oriented and more successful since she did not get sidetracked. Cindy acknowledged participating in other AR projects in the past, which helped her understand the process. She says:

I feel that I was more effective as an action research teacher practitioner in this group and I am thrilled beyond belief with the project that I did and the end result and I think that your topic [STSE] focused me. I think that I can now extract more out of it from my own analysis and for NOS and identity and for students to get that. I like that I did this one thing.

She also says in reference to AR “I think that if you can come out with one or two successful assignments and assessments per year then you’ve been successful” and as I had suspected she did not really have a question about her practice that she was investigating through AR but used AR to develop an assignment. This was how she developed curriculum: bit-by-bit and by developing an assignment and the matching assessments.

Anita had told us in the group meeting that she would try the race curriculum again but in her final interview she had moved from that position. She had developed some ambivalence and said:

I’d try it again but I’m not sure everyone would be OK with it. We are dealing with students who have parents that have different ideas. People might be uncomfortable with the race curriculum and I can see students take whatever they heard at face value.

She confirms and echoes what was raised often in the meetings and what I learned during my year at Sunnyside High: raising difficult knowledge is risky, and particularly so when we fear that students will misunderstand what we are attempting to do. Perhaps she has misgivings about repeating this topic without the support of the group or in the new school that she will be transferring to for the following year and where she rightly assumes that she will not know her students well enough.
5.5.4 Time redux

Anita had mentioned lack of time as an issue from her initial interview. In her final interview it is still foremost in her sentiments. When asked to identify her biggest challenges she says: “lack of resources and time” and that she would like to have access to teaching ideas and to be able to know how to modify them for her students. She added later in her final interview, that time continued to be a pressure and found that some of what she was implementing with respect to exploring issues was taking time from, and her students away from, the content. She noted that “they [her students] still have to learn about the digestive system”. Implying that the content part of the course still governed what she felt she could do.

Cindy grounded her concern about time in her appreciation of how the AR part of the study was more modest and so she was able to make time for it. However, I want to add, that it seemed she did make time for topics and ideas for which she wanted to make time. She seemed to approach lack of time in a different way from Anita (or Mary) and to make time, or carve out a space in her teaching, for matters that she considered worthwhile.

5.5.5 Curriculum Development

Cindy expressed that we would have benefited from trying a teaching idea that others in the group had also tried and then comparing student outcomes. She would also have benefited from an exploration of the ethics behind how we use science. She says: “We should be thinking more about our ethics and morals because once you invent a technology scientists cannot say “oh, it’s not our responsibility, let society deal with it”. Both of her ideas would have been possible but were not raised while in the group. Also she seemed to have forgotten that I had
suggested her idea (i.e. trying a teaching idea and comparing success) to the group and that the idea had been taken up by Anita.

Anita and I discussed that any curriculum can never be “fool-proof” and in fact how it is used or received by students depends on the teacher. Also Anita said that time continued to be a pressure and found that some of what she was doing around issues was taking time away from the content and as she said “they still have to learn about the digestive system”! Finally Anita felt that she had become more self-aware from this project and had come to appreciate that how you see yourself affects the type of teacher you are. She said that she is more aware of what she is willing to try and that she learned that she is a risk taker and is willing to try anything! She became aware that she was more willing to try new ideas than the others—and was not sure if it was due to her lesser experience or whether she had just had better luck with taking risks.

5.6 Interrelationships Between the Student, the Teacher, and the Curriculum

The interrelationship between the students, the curriculum, and the teacher, while implied throughout this thesis has not been directly addressed and I did not want to leave the interpretation of my findings without an interrogation of the interrelationships. Below I describe three approaches to curriculum design and implementation. While each of my participants could be aligned with each of these approaches depending on the context, each participant is, I suggest more closely allied with one. I present here three approaches. Each approach is informed by compiling various sentiments from my participants into a composite.
5.6.1  The Curriculum Rules Approach

The teachers see his or her students as more or less a homogeneous group and the students are taught as one group. The curriculum is seen as fixed (as presented in Ministry documents and in textbooks) and the teacher teaches all classes in the same manner, which can be practical and time efficient. Sometimes a common exam drives what needs to be covered. The students, the curriculum, and the teachers are seen as separate. The teacher is an expert and has good technical teaching skills and solid pedagogical content knowledge (PCK). The teacher believes that what they do is “right” and needed and so of-course will meet the needs (at least the learning needs) of the students. The curriculum exists separate from the teacher’s control. The teacher could be absent and the students would experience the same curriculum with a substitute teacher. Implementation is often seen as neutral and fixed. The curriculum could be informed by a culturally relevant pedagogy but only in a general way. Some students will be marginalized with this approach and may be heard to voice such sentiments as: I don’t like science, I don’t get science, or science is too much memory work. Many students like this approach and will tell the teacher in subtle ways: tell me what I need to learn and do and help me to get good grades.

5.6.2  The Students Drive Approach

The teacher uses the curriculum but interacts with and “constantly re-constructs” it as the lessons unfold. This continual re-imagining of what is to be taught might be due to student needs and pressures or it might be due to specific teacher attributes or both. How students respond to the lessons affects the teacher in profound ways and can derail an otherwise solid curriculum plan. Overall the teacher’s purpose is to help the students with whatever their needs in order to achieve the curriculum. Students may, through their interactions, questions, demands, or behaviour force learning in peculiar directions. Students’ needs are sometimes met but it is not
always clear to the teacher if this is the case. The planned curriculum is often changed or adapted to suit students as the teacher tries to be flexible. This can have positive and negative effects as it can engage or sidetrack and derail. Students are seen as individuals. Students drive the curriculum and also student drive and commitment can be a driving force while disengagement can be a “careening off path” force. Students likely see the course as fun but some will feel frustrated and/or marginalization from science.

5.6.3 The Balanced Approach

The three components (students, teachers, and curriculum) affect each other in a fluid manner. Students are seen as individual with individual needs. Students’ needs are met mostly—perhaps not every student every day but most students on most days. Learning everything in the course is important but not the only driving force; the curriculum is fluid, the teacher is sometimes the leader and sometimes watching from the side. The lesson can change while it is being enacted and might change for a subsequent class. The teacher might modify-in-action as the lesson unfolds. The teacher’s purpose is to use the curriculum to meet the needs of the students. Students are given choice whenever possible and appropriate. The teacher might read to one class every day or use the newspaper to develop literacy skills with another class. Generally students are engaged and find schooling effective.

I felt after working with my group and getting to know the teachers that if I entered their classroom (which I had not done) that I would see these three approaches, or at least elements of each enacted.
5.7 Summary

This chapter has summarized the findings from this study in terms of the research questions and with respect to other issues and topics that arose. The intent, through stories about the participants and through passages in their own voice, was to create a picture of the experiences of the participants in this study with respect to science curriculum issues that they faced, including inclusive curriculum and STSE education. Through conducting and sharing action research we learned about their questions, their practice, and their students. Many observations proved interesting and several difficult to discern. In particular I was intrigued by some contradictions. Participants seemed particularly concerned with covering the knowledge (content) expectations from the curriculum guidelines and often referred to this as “covering the curriculum” but none said that they felt compelled to teach the STSE expectations that are also clearly mandated in the same ministry documents. I regret not pressing them on this point. Another recurring contradiction was that in both individual interviews and in group meetings, and from each participant, STSE is was describes as an extra, that we add on when the real content is covered and that STSE was/should be core to what we do in science.

In the next chapter we will turn our attention to implications and recommendations for future work in the areas of planning and teaching inclusive curriculum to support STSE and social justice and to meet student’s needs.
6 Discussion: Conclusions, Implications, and Recommendations

This chapter structures the discussion arising from this research in terms of three areas: conclusions, implications of the research and for future work, and recommendations for science educators. I begin the discussion with some preliminary answers to the guiding research questions, followed by some speculation as to political content and context knowledge. Next I discuss implications of the research and implications for future research, and end with two recommendations for the development of teacher political knowledge and for a framework for planning and school based broad curriculum development.

6.1 Conclusions

When I began this research I frankly thought that it would be more straightforward. I expected teachers to develop some STSE curriculum that addresses a social justice issue. I expected that they would use an action research cycle for the development process and that in the process they would come to explore and better understand themselves and their role as teachers. Now, as I interpret my findings I am using a different lens than the one I used when I began this study. My return to Sunnyside High affected me and in fact caused me to examine the data in a different light. There is nothing straightforward about creating an inclusive curriculum that addresses STSE and social justice issues. There is nothing straightforward about action research. And understanding who we are as teachers and how we understand our role is perhaps most difficult of all. My participants were admirable—they hung in there with me (mostly) and tried to grapple with my questions (mostly). This is by way of saying I am less surprised now by the conclusions that follow, here in this chapter, than I would have been when the project began.
learned more than I could have imagined although the participants said and did less than I would have hoped. In the next section I begin to describe some conclusions as they relate to the research questions and I repeat the sentiment (from chapter 4) that I strived, as Merton (1990) says, to “not sit as judge, but to report on experiences which accumulatively help provide a basis for judgment” (p. 172).

6.1.1 Conclusions with Respect to Research Questions

In this section I present descriptive responses to the three research questions as a way to remind the reader of key ideas and as an introduction to the rest of the chapter. Subsequent sections of this chapter will discuss the responses in relation to the research literature and explore both implications of and recommendations from the research.

Question 1: How can teachers, using action research, develop, and implement STSE science curriculum that is inclusive of a diverse student population?

My participants did not imagine curriculum development as a way to create inclusive experiences for all students and they did not use action research. Constructing curriculum does not seem to have any generally understood or accepted meaning separate from lesson planning and “coming up with ideas”. It is as though each teacher brought to the term “curriculum development” his or her own meaning. If developing curriculum is context driven and context dependent then it follows that student interests, difficulties, motivation, needs, and future goals should impact the planning. However, typically in planning (and assessment), the students were viewed as one semi-homogenous group most of the time, and curriculum planning considerations were made with the class as a whole in mind and with broader considerations of assessment in mind. For my participants, developing curriculum had more to do with covering
content and evaluating content knowledge than with meeting the needs of individual students. Student needs were often framed in terms of getting them motivated, helping them to cover or get through the science material, and helping students to pass. STSE curriculum strategies were taken up so seldom that I can recall the few instances, for example: using the newspaper to introduce and discuss an issue, or including historical contexts as part of a topic. My participants did not embrace action research and did not see themselves as teacher researchers. Although they had questions about their practice they seemed unable or unwilling to explore their questions using action research.

I never questioned that my teachers had a theoretical framework from which they operated—but they seldom articulated it, and so it remained less examined, less reflected upon, and less changed. Perhaps their framework for teaching is there, affecting them—but perhaps they have seldom examined it, and so are not aware of how it affects them.

Question 2: How do teachers understand themselves and their role as science teachers?

The teachers in this study saw themselves as science content experts, and in part this was their definition of “science teacher”. They saw their role as covering the content and by content they meant the “factual” portion of the Ministry guidelines. They seemed heavily influenced by what they reported as specific expectations from their students. For example they were easily “shut down” by comments from student such as: “Why are we doing this—its not science”. I think that the science teachers in this study have a status that they like and want to protect—it makes them feel proud and satisfied to be a science teacher, and as Anita told us, her students think she must be a genius to be a science teacher. Also, they don’t have a framework from which they could explain to students why they are teaching science classes in a different way. The teachers were busy preparing for classes while dealing with school factors, departmental concerns, and
educational forces such as worry about assessment, and so overall, their personal interests and motivations suffered. Lack of time seemed a prominent issue. Overall the teachers expressed that they had too many students with too many needs and that there was always much to do. While they made attempts to heighten student interest and motivation in science class, they were deeply influenced by what their students said, expected, and sometimes demanded and they often felt discouraged when they tried to implement innovative, or new strategies that were atypical for a school science setting. Once disappointed with a new approach they would revert to what they had done before or to a strategy (such as using the textbook), which they admitted might be less effective but was safe.

Question 3: How do teachers understand STSE curriculum as a place for furthering social justice issues?

They don’t really. The participants, it seems both wanted to approach STSE with justice perspectives and at the same time did not see how to include social justice issues in their everyday practice. They struggled with the meaning of social justice and equity in science education as well as STSE education as a whole. They often conceived of “STSE” as one thing or idea, and as synonymous with “relevant material” or “controversial issues”. Social justice in the science curriculum was new to them and it proved risky to try something different with a group of students when they feared the students were not fully engaged in schoolwork. They often empathized with this dis-engagement and wanted to do the best for their students but didn’t see a revolution in curriculum as the way. It does not seem be on their radar that more culturally and community informed content (topics) and pedagogy might engage their students and address student needs in a new and different way. However some participants had very capable students who were engaged and felt that class time was precious and needed to be spent on science
content and not on STSE. Again I think they did not have a framework to use from which they could super-impose social justice ideas onto STSE expectations and so enhance their teaching to the benefit of all students. They saw STSE ideas as an add-on, something to include when all of the required content was covered (which, they admitted frankly, was never) and so struggled with the additional idea of social justice Simply put: it was enough of a challenge to address STSE education, which is in the curriculum, without infusing the STSE with justice perspectives. I think this was due to not having a political landscape from which to operate. They lacked what I would like to refer to as “political context and content knowledge”. The lack of political knowledge is explored in the next section, but first some general observations.

6.1.2 Challenges and Benefits of Group Conversations

One challenge of this research was to keep the main areas, inclusive STSE curriculum, teachers, and social justice, in focus. During the group discussions, I found that as we focused on one we would lose the others. As a researcher I was unable to keep all three in focus. It seemed as though we were always snaking about rather that connecting the three.

While the group meetings often seemed unfocused or what Brydon-Miller, et al., (2003) refer to as chaotic—I learned to embrace the chaos! While the meandering conversations were at times frustrating, they also provided a different type of insight into teacher beliefs, perspectives, and concerns. And so, I developed a reluctance to reign in the talk as I sensed that it shut down ideas but in turn the meetings lost some cohesion. While I viewed my central themes as part of one idea: inclusiveness curriculum development, for STSE and social justice and, for a diverse students population, perhaps in future each of these themes could be explored independently. However, there is a different conclusion: what I was asking proved difficult and frustrating to the participants and so they controlled the group conversations by talking a great deal of other
experiences, challenges, and successes, which for them proved more satisfying. They liked talking to each other about teaching in general.

The group meetings became more than just “my” research meetings. They became a social gathering, and a meeting place of some importance to the participants, as shown by sadness they expressed when each meeting came to an end and some participants “lingered on” to chat. Also when the study had run its course and the meetings were to cease they all expressed sadness that we would not be continuing to meet. The group meetings had become an important part of the weekly routine of these teachers and confirmed, as I suspected, that teachers like to and need to talk and share their experiences. Often the participants expressed how the shared thoughts during the meetings had helped them think through or unravel ideas during their teaching. Additionally our meetings served a different purpose from the conversations they had with colleagues at school. Perhaps our meetings were a safer space for teacher talk and an opportunity to raise issues, that when raised within a school setting, become encumbered with other (school and personal) consequences.

6.1.3 Conclusions about STSE

STSE refers to Science, Technology, Society and the Environment and is meant as the relationship between these four. For example how does science affect society and how does society affect science, or how does technology affect the environment. However, in my transcripts there is no evidence of discussion that looks at these inter-relationships. STSE, rather is used as a code word for “other” or “not the real content” or “relevant” or “application of knowledge”. My conclusion is that STSE is seen as unproblematic, less important than content, and avoidable (Pedretti, Bencze, Hodson, DeCoito, & DiGiuseppe, 2003). Teachers avoid what they do not value although they may give additional reasons for STSE marginalization in
their classes such as: a) lack of time to do STSE (when there is much content to cover), b) lack of resources, c) students who question an STSE approach, and d) that they find STSE difficult to assess (see also Bellomo, 2003). Assessment was an issue whose importance I had underestimated and noted that it often arose in our meetings as a serious concern. I submit that teachers bring issues of importance (such as assessment) to the forefront of any topic under consideration. If the theme of my study had been assessment I have doubts that STSE and social justice would have come to the forefront or even have been mentioned.

6.1.4 Lack of “Political Knowledge”

The participants seldom if ever referred to STSE as difficult to teach, problematic, or political in nature. One participant (Mary) did on one occasion refer to the importance of some content as political—but she meant that her students who were going to be leaders in the future needed to know science in order to vote appropriately and perhaps govern. Even the notion of controversial issues—the mainstay of much STSE education—was seldom interrogated. Similarly, they seldom asked questions about social justice in terms of its tenets, philosophical underpinnings, or importance. They would occasionally sprinkle the term social justice into conversations and would at times raise issues that were in my estimation justice issues but never named them as such and seldom talked about justice work in their own pedagogy. I came to the conclusion that they lacked “political knowledge”; an idea that I will explore in this section.

Shulman (1986) introduced the idea of pedagogical content knowledge (PCK) as the overlap between content and pedagogy or how to best teach particular content. PCK is more than just good teaching and includes knowledge of subject matter content knowledge, curricular knowledge, knowledge of different pedagogies, and knowing the best way to teach particular content to particular students. I do not dispute that my participants used their considerable PCK
and strove to develop it further. Barnett and Hodson (2001) in their paper *Pedagogical context knowledge: Toward a fuller understanding of what good science teaches know*, expanded on the notion of PCK by introducing the idea of pedagogical context knowledge and expanding on Clandinin and Connelly’s (1995) metaphor of *knowledge landscapes*. Pedagogical context knowledge includes all of:

a) pedagogical content knowledge (described above),

b) professional knowledge (teacher traditions),

c) classroom knowledge (classrooms and students), and

d) academic and research knowledge (concepts and theories of science).

Barnett and Hodson (2001) suggest that teachers travel between these knowledge bases as they teach depending on the context of the teaching. Hence, together they form a *pedagogical context knowledge*. A theory of “tutto (everything) teacher” if you will. Additionally they suggest that the knowledge bases float on educational and societal landscapes and together help govern teacher decisions. My interest, developing and implementing an STSE curriculum with social justice focus, requires I believe, an additional knowledge landscape: *political knowledge*. I came to the conclusion during this study that my participants and most teachers lacked a knowledge base to interrogate: issues of power, oppression, economics and the distribution of wealth, and questions of who benefits from knowledge construction in science. As well, political knowledge would help us understand the forces and societal factors affecting equity, diversity, and social justice; and the history, philosophy, and sociology of science. All of these are political in nature and this additional knowledge base (*political knowledge*), is necessary for an STSE education that goes beyond awareness of social issues and moves towards taking action (Hodson, 2003) as well as providing the foundation for the interrogation and inclusion of social justice issues into science education not in an add-on “lets examine an issue” manner, but as a basis for developing
a social justice lens that governs all our work with students and informs the curriculum construction process.

In *Science Education as a Call to Action*, Hodson (2010) argues that “it is important for students to learn that scientific/technological activity is influenced by a complex of social, political, and economic forces, and it is important for them to formulate their own views on a range of contemporary issues” (p. 203), and that the curriculum needs to take them even further to a place of sociopolitical action. But how is this possible for most teachers if they lack “political knowledge” and if they do not see themselves as operating in a political landscape. Kyle (1996, as quoted in Hodson, 2010) further argues, “Education must be transformed from the passive, technical, and apolitical orientation that is reflective of most students’ school-based experiences to an active, critical, and politicized life-long endeavor that transcends the boundaries of classrooms and schools” (p. 1). A life of politicized endeavour! —lofty outcomes for an education system that does not always support controversy and the politicization of teachers, and for a system that does not include political action as worthy of professional development. Professional development (PD) in science is often offered in areas of technology, assessment and reporting, and practical work and skills of inquiry.

What might a different type of PD include? From this study I conclude that teachers could benefit from an investigation of the history of oppression and of oppressive structures (such as racism and sexism) in society and in education (Willinsky, 1998). At a discipline specific level teachers could examine how knowledge is constructed within science and how factors such as power and economics affect what research is done and what forms of knowledge become part of the school (government mandated) science curriculum. Teachers might explore how did topic “X” become part of a particular course? Teachers might benefit from school wide initiatives to
enhance pedagogy (in all disciplines) that meets the needs of a diverse student population and that supports social justice. This will be expanded upon in the recommendations section of this chapter.

In concluding this section I would like include one additional point. As I have stated above I felt that my participants lacked political knowledge. I did not sense that they lacked subject matter content knowledge (or what Barnett and Hodson (2001) refer to as academic and research knowledge). Still I would like to add that in order to develop curriculum for social justice and STSE, it is necessary for teachers to have a broad and deep understanding of the material they are teaching. Without “content proficiency” which I suggest goes beyond content familiarity or content knowledge, teachers will not be able to develop their own curriculum but rather will use, often uncritically, materials they find on the Internet and in textbooks, videos, or computer simulations.

6.1.5 Changing Practice for Social Justice

Each participant seemed to have a desire to re-frame who they were as teachers and to explore their successes and their challenges through discourse—although, perhaps not so much through action. Perhaps the way to effect change is to support and promote action that will lead to self-reflection as an end rather than self-reflection to promote changes in actions. In other words: work on what we do and we will change who we are—not the other way around. This is not what I believed was the best approach when I began this research. I was convinced that teachers needed to understand themselves, think about who they are and use their reflections to guide actions and behaviours including the behaviour of curriculum making.
The challenge for me was to understand one aspect of practice (and teaching and learning): developing curriculum for STSE education and for social justice that would meet the needs of a diverse student population. It is clear from my data that teaching, as a practice, is highly personal, context dependent and context driven, subject to change due to location, student driven and at times student controlled, and idiosyncratic. Still the teaching of science and biology continues to happen in every high school in this province and so the question remains: how can we use STSE education (a part of science education) to make science more meaningful and authentic to a diverse student population, when what is important to the teacher may or may not be relevant to some or all of our students?

It became clear from our discussions that the same piece of curriculum in the hands of two different teachers becomes a different curriculum. Anita, in fact alluded to this in her final interview when she said that it would be good to have a teaching partner to discuss teaching practice. She likes the idea of trying something new and then comparing with a colleague who has tried the same curriculum with a different class. She is acutely aware that teaching is highly context specific. She states that “what will work with one class may not work with another class as every year the delivery may be different and this is heightened with a different group of kids”. She maintains that the biggest obstacles to doing more social justice work in her classes are lack of time, and lack of resources and ideas. She would like to be given a bank of ideas that she can then modify.

6.1.6 Conclusions Regarding Action Research

This thesis is also about action research and how action research (or the teacher as researcher tradition) is both powerful and empowering yet difficult and at times frustrating. Action research might be measured or assessed in terms of success or failure of the research
question/hypothesis first identified. It could also be examined in terms of the underlying awareness that teachers may acquire from learning what it is, and from attempting it. The research has led me to ask: Can a modest form of action research become, for science teachers, part of the fibre of their day? Can teachers continue to act as “action researchers” or teacher researchers once their formal involvement in a study has ceased? Can teachers be researchers each day in a consistent sustained way? Interestingly, Cindy in her final individual interview echoed these sentiments.

Action research proved to be as difficult as it is promising. My participants who did try to complete an action research cycle spoke highly of it in their final interview and found it rewarding. I am left to wonder if they will try it again and if it will become part of their practice in the future without an ongoing facilitator and guide. In other words can teachers conduct research on their own practice is a systematic way and record their findings? It may be possible but it is far from easy or common.

I am left with questions: how do we support teachers in articulating and understanding their own beliefs and practices and in asking questions about their practice? I think that action research continues to hold the promise of being able to support teachers to make change and it can give teachers the opportunity to say “I can try to make a change in my practice, as identified by me, and that I see as needed, here, in this context with this group of students.” Anita said in her final interview that the group meetings and the action research gave her permission to try something that she might not have, in part because she knew that she could talk about her experiences in the subsequent meetings. For her, action research has provided her with a much-needed alternative social space (see Pedretti & Hodson, 1995) for teacher talk—and as she said, a place apart from her school colleagues. She was certainly glad of the support and she was
pleased that she was able to improve the motivation level and the engagement of her students, about whom she has been quite worried. I was glad that she felt it was successful and that she could attempt further action research cycles in her next year of teaching. I maintain that action research when first tried should be modest and therefore more likely to be successful. Teachers need to be able to believe and “know” that they can do it again in the future without the help of an outside facilitator. Of course the facilitator role can be assumed in the future through school supports. I feel that Anita used her action research project and her reflections to achieve what Carr and Kemmis (1986) refer to as informed and committed, reflection and action (or praxis). They state:

We can now see the full quality of praxis. It is not simply action based on reflection. It is action, which embodies certain qualities. These include a commitment to human well-being and the search for truth, and respect for others. It is the action of people who are free, who are able to act for themselves. Moreover, praxis is always risky. It requires that a person 'makes a wise and prudent practical judgment about how to act in this situation'. (Carr and Kemmis, 1986, p. 190)

A question remains for me: my teachers embraced the idea of action research when introduced to them in the group meetings but then were resistant to doing it (and one even discarded the whole idea!) Is action research too difficult? Has it gone out of style? Perhaps it is being subsumed by ideas of professional learning communities (PLCs), which entails working with other teachers for support as topics of common interest and needs are explored. (See Pedretti & Bellomo (2013) for an account of how teachers used PLCs to explore and advocate for STSE education in their schools.)
6.2 Implications of the Study

In this section I outline some implications that arise from the research as we look to the future. I’ll explore implications for STSE education as well as implications for future research and for teacher action research.

6.2.1 Implications for STSE Education

STSE is a mandated part of the curriculum documents (Ontario Ministry of Education, 2000 & 2008) used by teachers and yet it remains marginalized and poorly implemented (recall from chapter 3, Aikenhead, 1994; Hodson, 2003, 2009; Nashon et al., 2008; Pedretti et al., 2008). I suggest, that in part at least, this is due to a lack of any deep understanding of the politics of all situations, all knowledge, and all curriculum—what I refer to previously as political knowledge embedded in a political landscape. It also includes a fear that if we raise political issues then we are political with the underlying assumption that this is perilous and unauthorized in classrooms. I think we need to complicate STSE education (that is, make it more complex and multi-facetted) and thus broaden teachers’ understanding of what it can entail. We need to encourage teachers to organize one unit of study with STSE as the focus and core of the unit and help them with strategies for instruction as well as assessment.

How does what we know, understand, and can articulate, overlap or not, with what we do? Teachers have learned to use the term STSE in a repetitive way and not always in a clearly defined or demarcated manner. They will refer to “the STSE part of the course”, or say “I’m doing an STSE activity with my class today” but I would question what they mean functionally or purposefully. In what ways, if at all, do they interrogate issues with students and examine, for example, the impact of technology on society or the economic and institutional power structures
that support current research into a new drug. Not often! So they use the term STSE and collect some grades to enter in the STSE column of their assessment record, but have not necessarily explored deeper issues of STSE education (that are discussed in chapter 3) or of justice issues such as who benefits, who governs or directs science, and who is marginalized and/or impoverished by science knowledge and research. I think teachers use the term STSE in a repetitive way but not in terms of functional experience.

Perhaps we should stop using STSE as a new word. Perhaps we should refer to the actual words: science, society, technology, the environment, and the interrelationships therein or perhaps we should refer to STSE in terms of the currents proposed by Pedretti and Nazir (2011) such as sociocultural or socio-ecojustice, and certainly we should frame future research with more complex language than “STSE”.

6.2.2 Implications for Future Research

As I examined, described, and began to analyze my data (the data) I started to ask other questions such as:

1. What are my participants not saying? (Why are notions of funding, control of research, and injustices arising from science never mentioned?)

2. Why, if they had agreed to be part of a research project on “STSE” did they seldom mention the words society, technology, and environment?

3. What motivates their actions with respect to, for example, including a new idea into their planning; a new idea that they had not considered previously such as including some Chinese science when they have a large Chinese population in the class.

4. What is the relationship between who they are, what they know, and what they do?
5. What layers of teacher knowledge will influence, guide, and determine what they do in their classroom practice? And What aspects of pedagogical content and context knowledge need development?

6. Why did I keep thinking that they lacked political knowledge? Am I saying that they lack a political framework based on power, control, and the need for justice? Are they apolitical or do they have a different political framework from my own?

The questions above prompted possibilities for a different study in the future. One which focuses on teachers’ beliefs and practices, and includes individual interviews, some group meetings with the school staff including curriculum leaders and administration, meetings with groups of students, participant observation of classroom practice including an analysis of teacher assignments and the resultant student work, and observations of student classroom interactions.

6.2.3 Implications for Teacher Professional Development (PD)

If we re-visit, from chapter 3, Hodson’s (2003) four levels of commitment to STSE education, I would say that my participants are difficult to place in any level. (Recall they are: 1. Appreciating the societal impact of scientific and technological change, and recognizing that science and technology are, to some extent, culturally determined. 2. Recognizing that decisions about scientific and technological development are taken in pursuit of particular interests, and that benefits from some may be at the expense of others, and that scientific and technological development are inextricably linked with the distribution of wealth and power. 3. Developing one’s own views and establishing one’s own underlying value positions. 4. Preparing for and taking action.) They were probably all in level one and so exploring these levels would be a basis for teacher PD. In some ways I wish I had asked my participants to travel through the levels as
they explored some activities provided by me and I see this as a form of PD that I would like to explore in the future. As I mentioned in chapter 3, I continue to believe that level 2 has particular challenges and that more political knowledge would be of benefit as teachers navigate any and all of the levels.

Anita during her final individual interview expressed her appreciation of the project as it provided her with much needed and beneficial PD. She told me that she does not learn much from the PD that she currently experiences in her school and felt that what we did in our sessions could be a model for PD in the future. She liked that she could talk about and explore questions she had about her own class rather than experiencing (tolerating actually) the agenda of others who provide a one-size-fits-all, imposed agenda, that seldom met any of her professional learning needs or goals.

She echoes what Putnam and Borko (2000) say:

> when diverse groups of teachers with different types of knowledge and expertise come together in discourse communities, community members can draw upon and incorporate each other's expertise to create rich conversations and new insights into teaching and learning. The existing cultures and discourse communities in many schools, however, do not value or support critical and reflective examination of teaching practice. (p. 8)

Putnam and Borko (2000) support professional development that would “ground teachers' learning experiences in their own practice … with a large component taking place in individual teachers' classrooms” (p. 6). The idea of teaching as a form of PD was endorsed by Anita when she suggested that she would like to teach the same lesson as a colleague and then compare their experiences, and by Cindy who would have liked it if we had organized that as an outcome of
our group meetings. The idea of teaching as a form of PD, with the necessary time and infrastructure to create discourse communities that support teachers to compare, share, and adapt their practice have implications for all forms of PD in the future.

6.3 Recommendations

Most science topics or units that are taught in school have questions connected to them that impact on the human experience and on our lives. Including an STSE perspective can help us examine the purposes, uses, and products of science and can help students understand science as a body of knowledge and science as a process—one fraught with the frailties and biases of all human work. I argue here that STSE perspectives can help teachers engage students and help make the curriculum more rich, more relevant, and more inclusive of all students with all sorts of interests, and questions, and aspirations.

The first recommendation that I can make is for the development of PD opportunities that help teachers explore political content and context knowledge, or in other words builds a political landscape in which to place teaching and learning. Additionally I suggest that the work be school-based. Here is why: Taking graduate courses and attending workshops helped me enormously to develop, refine, and give language to my ideas around the socio-political underpinnings of science and to build a social justice lens. And yet when I returned to a high school setting and tried to infuse my courses with a socio-political-justice theme I found the students unavailable and myself isolated and stalled. A school-based PD would be more powerful. Perhaps a re-framing of an entire course around issues so that all teachers invest in its development. Perhaps a Masters degree to enhance political knowledge landscapes in all disciplines, and offered at the school, where teachers take the courses together as a cohort, would create an ethos and culture that would permeate the school, the other teachers, and the student
population. Perhaps students would be less likely to question why issues are raised in a science class if everyone (each teacher) is doing so.

In the end, teachers control the curriculum. Students do tasks based on teachers’ questions and of-course the questions can only come from the perspective that the teachers hold. We need, I suggest, a re-envisioned view of education, one in which students sometimes generate the questions and issues that they want to research. Then, our expectation should be that they research it from multiple perspectives. Our instruction would be to help students see their issue or questions as complex and to guide their research. Increased political knowledge can help us as teachers to teach students to routinely ask:

- Whose knowledge is this?
- How did it come about (how was it constructed)
- Who benefits from this?
- How will this knowledge be used for good or harm to few or many?

Increased political knowledge can also give teachers the language to support students to navigate the nature of science, decision-making, values, and taking action around social issues.

My second recommendation is for a different approach to STSE curriculum development. I began by listing all the interrelated factors affecting the teaching of science with a social justice perspective. The list included:

- Students (including their needs, aspirations, identity, and diversity)
- Content choices and examples
- Issues of power, access, and inclusion
- Culturally relevant and responsive pedagogy (including community informed pedagogy)
- STSE education (including values, NOS, stewardship, action, decision-making)
• Bias within the discipline of science

I struggled with the structure and organization of some sort of graphic that would connect the factors into a comprehensive and useful rubric. I tried to organize all the ideas into a wheel which led me ask what would be at the centre of the spokes? Perhaps I could place students at the centre, or the community at the centre, or was it more logical to place social justice or STSE at the centre. I liked the idea of a wheel with its spokes (and many connections) but wondered if in fact the fluidity of the wheel might also be frustrating and intangible for teachers grappling with so many forces and ideas. However, I also wondered if a wheel was the best visual when I found myself ambivalent about what would be at the centre? I abandoned the wheel for a more balanced structure which will be the substance of the rest of the chapter. Unlike the wheel I strived for a structure that would represent different curriculum design considerations that were at once independent and yet affected one another.

I considered the literature about STSE education, social justice, and science, as well as practical considerations related to students, assessment, schools. At the risk of being too prosaic I thought about STSE education with social justice influences in terms of: the what, the how, the who, and the where. The what is the content of STSE education, the how are the approaches or teaching strategies that teachers use, the who are of-course the students we teach, and the where is the school context. The framework comes, in part, out of the discussions, questions, and concerns of my participants, and is informed by the research literature. It is represented in Figure 1. To be clear it is not meant in any way to be a rubric (as in assessment where the rubric lists the criteria to be used) and it is not meant to be an algorithm or set of steps or rules of any sort. Rather it is meant to be as complex, multifaceted, and diverse as possible. Ideally it would be three-dimensional with a social justice lens as the over-riding umbrella, the four quadrants as a
tilting boat, dipping back and forth as one quadrant is brought into focus, with the boat floating in a sea of political knowledge. Before using it a teacher should add anything they see as missing. The framework can be used as a reminder of the myriad of considerations that a teacher can use, include, embrace, or overcome.

**Figure 1.** Framework for Curriculum Construction for STSE through a Social Justice Lens
The STSE content themes quadrant was explored in some detail in chapter 3. The approaches quadrant includes strategies, such as discussions of issues, role-play, (town hall meetings and/or debates), exploration of values, and taking action and can be difficult, or categorically foreign strategies, for science teachers and these are matched to the currents for STSE education (application/design, historical, logical reasoning, value-centered, sociocultural, and socio-ecojustice, Pedretti & Nazir, 2011). The student quadrant includes all the issues that help us meet student needs and create an inclusive experience. And the school includes all the structural and institutional factors that can help (or hinder) teacher work.

The four quadrants are connected with a social justice lens as a central glue that brings cohesion to decisions and can include considerations of one or more of the following: distribution of power and wealth, access to information and resources, a commitment to equity and diversity, and civic and social responsibility. The STSE content themes quadrant can be further complicated when specific topics (such as food or disease, for example) are matched to the STSE content themes. Or in other words each STSE content theme can include a variety of topics. Figure 2 below show examples of how specific topics can be mapped onto the STSE themes that best support the substance of the topic.
Figure 2. Sample of a Possible Teacher Mapping of Topics to STSE

This sort of mapping (of which the examples above are just that—some examples) can be continued as teachers choose the best approach for particular content. To begin, the teacher would formulate their topic. For example: the effects of climate change on societies. Next the teacher would choose one or more STSE content themes to act as the connector for the topic and STSE content. Novice teachers might choose one to begin. For example, climate change maps onto the theme of the nature of science (although it could also connect with society and/or the environment—depending on the approach taken). Next the teacher would consider which approach and/or current best supports what they want to explore. For example exploring climate change and its effect on societies that are coastal and living in poverty is supported well by using a case study approach and current 6 – eco-justice. Next the teacher would consider issues related to students such as ability and interests and finally the teacher would consider school factors such as community resources, or team teaching with a school colleague, or forming a Professional Learning Community (PLC) for this curriculum development. Some strategies such as role-play are more suited to an issue that will be examined form the viewpoint of different stakeholders; while taking action, perhaps in the form of a letter campaign might be a good fit with a local issue that affects the community. Every strategy could be used with every topic or
theme and these would be teacher decisions based on factors from the bottom two quadrants. And so the mapping of content, to approach, to student needs, to school context factors would inform one another and the curriculum construction process.

We can assume the whole framework floats on a political landscape or sea. Attention to the top two quadrants addresses STSE education and would take into consideration frameworks by Aikenhead, Ziman, and Pedretti (see chapter 3). The bottom two quadrants harken to sentiments of Calabrese Barton (2003) and her desire for a science curriculum that connects with students and Sleeter (1992) who promotes the idea of school wide curriculum development and implementations rather than addressing individual teacher’s beliefs and practices. (I support such an approach when imbedded in the top two.) I suspect that this approach—comprehensive with respect to what is done, how, for whom, and with school central support will incidentally do much to address issues of teacher “self” such as: What do I know? What am I comfortable with? What are my biases? With whom can I team teach? To whom and from whom can I give support and get support?

Attention to the bottom two quadrants with the top two in mind develops a culturally relevant and community informed pedagogy (see chapter 2) and helps us develop and grow as teachers as we meet student needs. Additionally, the framework components will benefit from teacher personal growth and development including developing one’s political knowledge.

When my research began I wanted to understand how teachers develop and implement STSE education with a social justice focus as a way to meet the needs of a diverse population. Since STSE is a mandated part of the curriculum I assumed that I would learn how each participant approached STSE education. Their conversations with me, and their reluctance to engage more fully with STSE ideas inspired this framework to be used as a guide to curriculum
development. Future research could entail using the framework, recording outcomes, sharing curriculum development, reflecting on practice and pedagogy, and reviewing the quality of the curriculum developed.

6.4 Final Thoughts

I remain firmly committed to developing curriculum in science and biology that meets the needs of a diverse student population and continue to trust that STSE perspectives and social justice issues are both a vehicle for and a necessary part of this work. I continue to believe that the nature of science and how science is constructed should be central to school science and that all students should be able to learn science as both a body of knowledge and a process for generating new knowledge. Through science courses that move beyond subject matter content knowledge acquisition as the major force to a balance between content and STSE perspectives, I trust that more students will become engaged in science, become successful in science, and perhaps enter the world of science in their future to do science. We will know we have been successful as educators when in the future the issues that are taken up in school science have shifted, and represent a more just and equitable world.
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Appendix 1:
Questions for Participants

1.1 Questions for initial interview

• What biology courses are you teaching?
• How long have you been teaching?
• How might you describe yourself or identify yourself as a teacher?
• What teaching strategies do you use to implement a lesson or series of lessons that address a societal issue?
• What barriers and/or support mechanisms (internal/personal and external/ institutional) do you encounter as you develop curriculum?
• What resources do you use?
• What barriers and/or supports have you experienced as you try to examine the societal implications of biology content in order to engage your students?
• How do you understand the needs and interests of your students?
• How do you understand your role in meeting the needs and interests of your students?
• Do you feel that you meet their needs and if not how might you better meet them?
• How do you plan and develop your curriculum?
• To what extent does curriculum construction respond to the interests, needs and aspirations of your own group of students?
• How do you make sense of the biology curriculum in terms of Ministry expectations (with a focus on the STSE expectations);
• What does a science curriculum, which is inclusive and equitable mean for you? How might such a curriculum look in your classroom?

• What materials are readily available and what sorts of materials must you seek out and/or develop yourself?

• How do you as a biology teacher understand yourself, your students, and your role as an educator?

• What are some issues (social justice issues) that you consider to have a place within the biology curriculum?

• How do you think that the discipline of biology might be a vehicle for the furthering (or for the support) of social justice issues?

1.2 Questions for further exploration during group meetings

• How can teachers construct lessons in science or biology to address social justice (equity) issues of “interest” to their students?

• How can you ensure the inclusion of all students in the curriculum in order to increase meaningful learning for all and as a way to enter into the subculture of science and ultimately as a way to a further social justice?

• If students benefit from understanding what science is, how it is done, and what factors influence knowledge creation in science, then how might we develop curriculum to help students in this understanding?

• Can students become more interested in science if they can see the relevance of science and if they can see the significance and the power of science within the larger context of society?

1.3 Final interview questions
My plan is to use some of the questions from the initial interview list. Other questions might arise through the research that cannot be anticipated at this time.

However, it is expected that questions during the final interview will focus on the following:

- bringing closure to the process
- asking participants what they learned about with respect to the process of curriculum development; about their involvement in the research and about their successes in teaching a diverse student population
- revisiting issues that arose in the first interview
- allowing teachers to share with me any ideas or perspectives that they did not share in larger group meetings, and
- expressing their feelings about the action research process
Appendix 2:

Curriculum for Exploring the Social and Biological Construction of Race

This appendix has been re-formatted from an OISE/UT-CIDA project, Educating for Global Citizenship in a Changing World, a project coordinated by Mark Evans and Cecilia Reynolds, which can also be found in its entirety at:

http://www.oise.utoronto.ca/cidec/Research/Global_Citizenship_Education.html

by following the link to:


The website page states:

This resource provides teachers and other educational stakeholders with a range of ideas and practices for teaching and learning about citizenship within today's global context. It is intended that this resource will be helpful to those who are critically considering ways in which global perspectives might be infused into our classes and school-wide programs. The ideas and practices were investigated, developed, and piloted by practicing teachers and teacher educators in school settings in the Toronto area with the support of the Canadian International Development Agency's Global Classroom Initiative.

Chapter 5:

Connecting Moral Issues of Global Importance to Students’ Lives

By Katherine Bellomo, Stephan Latour, Nancy Steele and Margaret Wells

The teaching strategies outlined in this chapter are based on the premise that simply giving students information about important social issues is inadequate. Students, when considering international development and co-operation issues or Canada’s responsibilities as a member of the global village, need to feel that these issues are connected to their lives and they also need to
understand how ethical decisions that they make have an impact on larger international realities.

The educational literature in the fields of global education, social justice education, and moral education provide direction for effectively connecting moral issues of global importance to students’ lives and their sense of global citizenship. In describing the consensus on components of global education in Canada, Graham Pike refers to the sense of the need to engage “both heart and mind.” Global educators recognize the importance of focusing on the development of students’ attitudes and values in addition to their acquisition of skills and knowledge. As Pike states, global educators:

seek to encourage caring attitudes towards other people and other species; concern for the plight of the disadvantaged, for the poor and the oppressed; and they emphasize the need to challenge and expand insular views of the world. (Pike, 2000).

Similar pedagogical approaches can be seen in the field of social justice education. The authors of *Teaching for Diversity and Social Justice*, outline five principles for social justice education:

1. Balance the emotional and the cognitive components of the learning process.
2. Acknowledge and support the personal (the individual student’s experience) while illuminating the systemic (the interactions among social groups).
3. Attend to social relations within the classroom.
4. Utilize reflection and experience as tools for student–centered learning.
5. Value awareness, personal growth, and change as outcomes of the learning process (Adams, 1997).

In developing these principles for social justice education, the authors draw on a diverse body of literature including laboratory and inter-group education, cross-cultural and international training, experiential education, ethnic studies, feminist pedagogies, critical pedagogy, social identity development models, and cognitive development theory. The strategies outlined in this chapter demonstrate the teachers’ awareness of and attempts to enact these five principles.

In the field of moral education there are many, often competing, approaches including character education, values clarification, cognitive developmentalism, and the ethic of care. Katherine Simon, whose research grows out of her work with the Coalition of Essential Schools, explores these approaches to provide a context for her own ethnographic study of how what she refers to as “moral and existential issues” are addressed within the core subjects of standard high school curricula. Simon acknowledges that she is influenced by John Dewey’s belief that schools can and should connect the great inquiries of humanity to the curiosity of students. Her study explores the many missed and avoided opportunities for raising moral and existential issues through the curriculum but also reveals how teachers can invigorate their classrooms by raising morally complex issues that are at the heart of intellectual inquiry. She calls for further research that would result in the development of curricula that are based on “the questions and curiosities that truly engage students’ passions”: 
The point would not be to create curricula that are “relevant” in the most narrow or immediate sense of the term, but to create curricula that help students connect their own lives to the great traditions of human inquiry and to ongoing social needs and dilemmas. (Simon, 2001)

The teachers, whose work is profiled in this chapter, have not shied away from raising complex moral issues with their students and, as a result, their classrooms are places where students can consider important social issues of global importance in a manner that connects these issues to their own lives.

**Strategy 1: Deconstructing “Race”**

*Reflections on the Strategy Applied*

This strategy was used in a grade 11/12 science course. We chose the activities in this strategy to focus both on a concrete example of the social construction of scientific knowledge and on the dilemma of acknowledging the fact that “race” is no longer considered a valid scientific category but continues to have considerable social power. This particular group of students had already done work on the social construction of scientific knowledge and this shaped their response to the questions around science and to the creation of a timeline on the history of the scientific understanding of the term “race.” A group of students who did not have this background might have far more questions about this material or might find that it was too removed from their preconceptions of science as simply factual.

The class was somewhat “racially” and ethnically diverse but we imagine that this strategy would work differently in a more diverse class. One major challenge faced in designing the strategy was in thinking about the class activities in connection with Activity Sheet 1. In the instructions for this activity, we suggest that the students form into small “racial” groups based on their own understandings of what groups exist in Canada today. On the one hand, we felt that this was an important part of the strategy because it allows students to acknowledge their own and other people’s “racial” categorizations and how this both does and does not refer to important aspects of their identity. On the other hand, we were concerned that this might reinforce the concept of “race.” Would it push students to identify “racially” even if they did not want to do so? Due to time constraints during the field test we did not actually have the students form “racial” groups but we did tell them about this aspect of the strategy and asked for their feedback. Many wrote about how problematic they thought forming “racial” groups might be. They were concerned about people feeling “left out” especially if they were in a category of one. A district science co-ordinator who was present during the field test also commented on the problematic nature of this activity. In the end we have left the original directions in the resource with a caution that teachers need to have established a respectful classroom environment and need to be sure that no student will feel isolated if this activity is undertaken.

The students’ engagement with this material was clear from their insightful responses to the questions we posed. When we asked what “racial” groups they could identify in Canada today,
they named a number of different groups but also challenged their own and their peers’ responses. For example “Asians” was named as a “racial” group and then later “Chinese”; one student asked whether this meant that “Koreans” should be named as a separate group? Similarly one student named “Jews” as a racial group and several students protested that they were a religious/cultural group. When this was discussed further there was an acknowledgement that historically Jews had been seen as a racial group. This prompted another student to add “Muslims” to the list of “racial” groups? As the list of groups expanded, several students commented on the problematic nature of the list since there were no obvious criteria for deciding who would be considered a “racial” group. This reinforced our opening discussion with the students about the purpose of the strategy as an exploration of the fact that while racial categorization was not scientifically valid, it remained socially powerful. One student who is Jewish from Morocco said that if we had formed “racial” groups she would have placed herself in the “African-Canadian” group because Morocco is in Africa. The complexity and ambiguity of racial classification seemed very clear to the students. The teacher told us that in the days after the field test the students continued to discuss the question of “racial” grouping and the impact of the timeline on the scientific understanding of “race.”

Learning Expectations

• Demonstrate an ability to effectively use strategies within the inquiry process when studying questions of civic importance in their school or local community.
• Communicate their own beliefs, points of view, and informed judgements, and effectively use appropriate discussion skills.
• Explain how different “racial” groups define their citizenship and identify the beliefs and values reflected in these definitions.

You Will Need

• Activity Sheets 1 to 8 (included in the Steps at Glance section)
• Teacher Notes for Debriefing What is Science? (included in the Steps at Glance section)

Steps at a Glance

Step 1

• Ask students to write a definition of “race” in their notebook. Have them share this definition with one other student in the class and come up with a new definition that represents the best ideas in both definitions.

Step 2

• Record all the definitions provided by the student pairs. Debrief the factors on which the definitions for what constitutes a racial category are based, for example, skin colour,
texture of hair, shape of nose, and so on. Explain that while “race” is no longer considered a legitimate scientific category in such disciplines as biology and anthropology, it continues to have significant social power and impact on our lives.

**Step 3**

- Ask students to list the “racial groups” that are commonly talked about in Canada today. Ask students to break up according to the “racial groups” to which they feel they belong or in which they are seen as belonging by other people. Each group should answer the questions on Activity Sheet 1. If the teacher and students feel uncomfortable with breaking up into racial groups, the teacher can ask students to answer the questions individually or in random groups. Debrief with the whole class. If there are “racial groups” named by the class at the beginning of this step who are not represented in the class, consider what might be answers to the questions on Activity Sheet 1 from the perspective of members of this group. This activity requires that a respectful and inclusive classroom environment has already been established; the teacher should be cautious about undertaking this activity if it is likely to isolate any student.

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**Your Racial Group**

*(Activity Sheet 1)*

1. Are there “positive” stereotypes about your group? Are there “negative” stereotypes about your group?

2. How do these stereotypes affect you?

3. What are real commonalities among people in your group?

4. What are real differences among people in your group?

5. What are the advantages that come from being a part of your group?

6. What are the disadvantages that come from being part of your group?

7. Are there times when you do identify as a member of this group and other times when you do not identify as a member of this group? What influences you in each situation?
Step 4

• Ask students individually to write a definition of “science practice” and of “a scientific fact” by completing the following sentences:

A. Science is...
B. The practice of science involves...
C. The work of a scientist is to...
D. A scientific fact is...

• Ask students to form into groups of three or four and to compare their individual definitions and then to see if they can come to some agreement within their groups. One way to record the class discussion is to post four pieces of chart paper—one with each of the sentences A-D and to complete each sentence based on the class discussion.
Additional questions that can be discussed with the whole class are:

➢ How do we know anything with certainty?
➢ Under what conditions do we believe or trust information?
➢ How might the body of scientific knowledge (“facts”) change?
➢ What factors might influence the methods of science?

Read to the class this quotation by Stephen Jay Gould (1981):

Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.
Teacher Notes for Debriefing

What is Science?

When students are to define science their answers might show as much variety as would be found among a group of scientists who are asked this question. Goldstein and Goldstein state that three features characterize science:

1. It is a search for understanding, for a sense of having found a satisfying explanation of some aspect of reality.
2. The understanding is achieved by means of statements of general laws or principles—laws applicable to the widest possible variety of phenomena.
3. The laws or principles can be tested experimentally.

(Goldstein, M. & Goldstein, I. F., 1978.)

Science is a body of knowledge and a method for generating that knowledge (sometimes called facts). The body of knowledge changes as scientists accumulate new evidence and the methods used will depend on many factors including the status of the scientists.

Scientific knowledge might change when new evidence or new data is gathered from new experiments; when new scientists present an opposing theory; or when new technology/equipment that allows data to be found and or looked at in a different way.

Different scientists might have different lenses through which they view data. Money or funding might be more or less available for research. Some topics for research fall into and or out of favour or fashion, for example, human cloning.

One might contend science is about understanding the world, experimentation, and collecting and analyzing data or about ideas. Further, it is about power, politics, and asking a question. It is also about money and getting funding in order to do ones research. There is support for the idea that there is a “method” of science. Most scientists do something that involves theory, experimentation, data collection, and analysis and drawing conclusions, but depending on the area of science under investigation, the actual method varies greatly. Science is a socially constructed and culturally determined practice.
Step 5

• Using a jigsaw strategy, engage students in an inquiry into the history of the scientific understanding of the term “race.” Divide the class into home groups with six students (one for each worksheet) in each group. In home groups, students share any information that they already have about when the concept of “race” was first developed. Each member of the home groups joins one of the six expert groups with a reading about the history of the concept of “race.” (See Activity Sheets 2–7). In expert groups, students should read and discuss the worksheet and prepare to teach this material to their home group. Students reform into home groups and teach each other the material that they had. Using all of this information, each home group should create a timeline for the history of the scientific understanding of the term “race.” In debriefing the timelines, discuss the continued impact of the concepts of “race” from earlier scientific work.

Earlier Categories of “Race”—Linnaeus

(Activity Sheet 2)

Swedish naturalist Carolus Linnaeus, in his work *Systema Naturae* of 1758, divided *Homo sapiens* into four basic varieties:

- **Americanus** (people indigenous to the Americas)
- **Europaeus** (Europeans)
- **Asiaticus** (Asians)
- **Afer** (Africans)

Linnaeus used the concept of the four humors to describe these racial groups. This concept, popular in ancient and medieval Europe, suggested that a person’s temperament was the result of a balance of the four fluids—blood, phlegm, yellow bile, and black bile. Depending on which of the four substances dominated, a person could be sanguine (blood dominates), sluggish (phlegm dominates), choleric/prone to anger (yellow bile dominates), or melancholic/sad (black bile dominates). Linnaeus described his four racial groups as follows:

- Indigenous Americans—red, choleric and upright. These people are ruled by habit.
- Europeans—white, sanguine, muscular. These people are ruled by custom.
- Asians—pale yellow, melancholy, stiff. These people are ruled by belief.
- Africans—black, phlegmatic, relaxed. These people are ruled by caprice.
Despite the negative descriptions of some people in these groups, Linnaeus did not view his categories as hierarchically organized.

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**Earlier Categories of “Race”—Blumenbach**

(Activity Sheet 3)

Johann Friedrich Blumenbach, a German naturalist who wrote a book entitled *On the Natural Variety of Mankind* published in 1795, developed a classification for human beings. He associated each group with a particular geographic area. His categories were:

- Negro (Africans)
- Mongolian (Asians)
- Malay (Southeast Asians)
- American Indian (American)
- Caucasian (European)

Blumenbach introduced the term “Caucasian” to describe whites; he took the term from an area around Mount Caucasus and stated that this area produced “the most beautiful race of men.” In fact, physical beauty was used by Blumenbach as a criterion for ranking human groups. Using this criterion, Blumenbach created a pyramid with Caucasians at the top representing the ideal form, two lines of departure from this ideal ended in the two least attractive human groups, that is Asians on one side and Africans on the other side. American Indians were an intermediary group between Europeans and Africans and Southeast Asians were an intermediary group between Europeans and Asians.

However, Blumenbach did assert that all humans were members of the same species. He was opposed to the slave trade and worked to abolish it.

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**Earlier Categories of “Race”—Morton**

(Activity Sheet 4)

Samuel George Morton was an American anthropologist who believed in polygenesis, that is, the idea that each “race” was created separately. As a result, he saw each “race” as being fixed, intrinsically different from the other races, and incapable of being changed. Morton also believed that intelligence is linked to brain size and ranked the races (in intelligence, personality traits and
morality) according to skull size. In *Crania Americana* published in 1839, he outlined his racial categories:

- Europeans whom he described as the Caucasian race were the most intelligent.
- Asians who he referred to as Mongolians were described as “ingenious, imitative and highly susceptible of cultivation (that is learning)”.  
- Native Americans were described as child-like in their intellectual capacity and incapable of abstract reasoning. They were also described as “crafty, sensual, ungrateful, obstinate and unfeeling.”
- Africans were described as the least intelligent race that could be “joyous, flexible and indolent” but had a great talent for music and acute senses.

In the United States, Morton’s writings were used to justify the idea that the Constitution did not apply to enslaved Africans or to Native Americans. By the middle of the 1800s, the idea that some “races” are superior to others had become conventional wisdom supported by science.

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**Earlier Categories of “Race”—Davenport**

*(Activity Sheet 5)*

Charles Davenport was a biologist who was impressed by the ideas of Francis Galton. Galton was an English mathematician who coined the term “eugenics”—a Greek word meaning good in birth or noble in heredity—to describe attempts at “race betterment” by encouraging more births from those groups considered superior and fewer from those considered inferior.

In 1904 Davenport established the Station for Environmental Evolution at Cold Spring Harbor on Long Island in New York. In 1910 he established the Eugenics Record Office where researchers studied human heredity and tried to prove that social traits such as pauperism, criminality, and prostitution were inherited.

In 1911 he published a popular textbook, *Heredity in Relation to Eugenics*, for use in college and high school biology classes. In this text he advocated such measures as restrictions on Jewish immigrants from Russia and southeast Europe in order to preserve the morality and health of American citizens.
Franz Boas was an anthropologist who challenged much of the scientific community of his day on the idea that some racial groups were superior to other groups. He immigrated to the United States because of the discrimination he experienced as a Jew in Germany. In the United States he was particularly troubled by the situation of African-Americans.

In 1905 he asked Andrew Carnegie, an industrialist who donated money to various projects, to fund an “African Institute” which would educate the public about African civilizations in order to counter racist stereotypes of African-Americans. He also hoped that this institute would undertake studies of the contemporary situation of African-Americans. Boas was unable to secure funding for this institute.

Boas actively encouraged African Americans to become anthropologists in order to include multiple perspectives in the discipline. One of his students was Zora Neale Hurston, an African-American woman who traveled through the southern United States tracing the folklore of African-Americans.

Contemporary scientists view the concept of “race” as a meaningless scientific category. As biologist Ruth Hubbard has written: “Demographers, politicians, and social scientists may want to continue using ‘race’ to sort people, but as a biological concept it has no meaning” (Hubbard, 1995).

A study done by geneticist Richard Lewontin in 1972 demonstrated that despite obvious physical differences between people from different areas, the vast majority of human genetic variation occurs within populations, not between them, with only six percent accounted for by traditional racial categories (Shreeve, 1994).

Physiologist Jared Diamond has pointed out that while racial identity is based on visible physical characteristics, the division of human beings into groups based on other factors would yield very different categories. (Diamond, 1994) For example, based on the presence or absence of a gene, such as the sickle–cell gene that confers resistance to malaria, Yemenites, Greeks, New Guineas, Thai and Dinkas would be in one “race” and Norwegians and Xhosas, a black South African
group to which Nelson Mandela belongs, would be in another. Based on the retention into adulthood of the enzyme lactase, which allows people to digest milk, northern and central Europeans, Arabians, a West African group known as the Fulani would be one “race” (who do have the enzyme) and southern Europeans, aboriginal Australians and Americans and most other African Blacks would be in another “race” (who do not have the enzyme).

The Human Genome Project has established that there is no biological or genetic basis for the concept of “race.”

Step 6

- Provide students with Activity Sheet 8—Articles 1 and 2 of the UNESCO Declaration on Race and Racial Prejudice adopted on November 27, 1978 (the full text is available at www.unesco.org). Have students read over these two articles and brainstorm ways of talking about human groups that respects their human differences without using any notions of “race.” How can we acknowledge racial prejudice without reinforcing the concept of “race?”
UNESCO Declaration on Race and Racial Prejudice. Adopted November, 1978 (Activity Sheet 8)

Article 1

1. All human beings belong to a single species and are descended from a common stock. They are born equal in dignity and rights and all form an integral part of humanity.

2. All individuals and groups have the right to be different, to consider themselves as different and to be regarded as such. However, the diversity of life styles and the right to be different may not, in any circumstances, serve as a pretext for racial prejudice; they may not justify either in law or in fact any discriminatory practice whatsoever, nor provide a ground for the policy of apartheid, which is the extreme form of racism.

3. Identity of origin in no way affects the fact that human beings can and may live differently, nor does it preclude the existence of differences based on cultural, environmental and historical diversity nor the right to maintain cultural identity.

4. All peoples of the world possess equal faculties for attaining the highest level in intellectual, technical, social, economic, cultural and political development.

5. The differences between the achievements of the different peoples are entirely attributable to geographical, historical, political, economic, social and cultural factors. Such differences can in no case serve as a pretext for any rank–ordered classification of nations or peoples.

Article 2

1. Any theory which involves the claim that racial or ethnic groups are inherently superior or inferior, thus implying that some would be entitled to dominate and eliminate others, presumed to be inferior, or which bases value judgements on racial differentiation, has no scientific foundation and is contrary to the moral and ethical principles of humanity.

2. Racism includes racist ideologies, prejudiced attitudes, discriminatory behaviour, structural arrangements and institutionalized practices resulting in racial inequality as well as the fallacious notion that discriminatory relations between groups are morally and scientifically justifiable; it is reflected in discriminatory provisions in legislation or regulations or discriminatory practices as well as in anti-social beliefs and acts; it hinders the development of its victims, perverts those who practise it, divides nations internally, impedes international co–operation and gives rise to political tensions between peoples; it is contrary to the fundamental principles of international law and, consequently, seriously disturbs international peace and security.

3. Racial prejudice, historically linked with inequalities in power, reinforced by economic and social differences between individuals and groups, and still seeking today to justify such inequalities, is totally without justification.