"SOCILOGICS" AS AN ANALYTICAL FRAMEWORK TO EXAMINE STUDENTS’ DISCOURSE ON SOCIOSCIENTIFIC ISSUES

by

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ABSTRACT

This study develops and tests the strengths and weaknesses of an analytical framework entitled sociologies to examine students' responses to socioscientific issues. Sociologies (Latour, 1987) is defined as the unpredictable and heterogeneous networks of links and associations that constitute the construction, accumulation, and mobilization of knowledge in the face of controversy. Recognizing the asymmetry of knowledge production, sociologies looks at how some knowledge is rendered more credible, and more powerful, than others. The framework consists of five questions: a) how causes and effects are attributed; b) what points (ideas) are linked to which other; c) what size and strength these links have; d) who the most legitimate spokespersons are; and e) and how all these elements are modified during the controversy. Latour calls the answer to these five questions "sociologies". Under this rubric, the production of knowledge is contentious because knowledge is socially constructed in a world where discourse and politics and knowledge and power are inextricably related. I argue that the framework of sociologies is an improvement upon commonly used analytical frameworks in socioscientific research in education as, unlike previous forms of analysis, it foregrounds the social construction of knowledge (as evidenced in discourse) and highlights the contentious, complex, unpredictable, and dynamic nature of knowledge production prevalent in these issues.
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CHAPTER 1

WHAT ARE SOCIOSCIENTIFIC ISSUES?

Overview

Chapter One provides an orientation to the problem, delineates the central question to be addressed in the thesis, and presents an overview of the ensuing chapters.

A Problem

On page four of my daily newspaper, I learn that the measurements taken above the Antarctic are not good this year: the hole in the ozone layer is growing ominously larger. Reading on, I turn from upper-atmosphere chemists to Chief Executive Officers of Atochem and Monsanto, companies that are modifying their assembly lines in order to replace the innocent chlorofluorocarbons, accused of crimes against the ecosphere. A few paragraphs later, I come across heads of state of major industrialized countries who are getting involved with chemistry, refrigerators, aerosols, and inert gases. But at the end of the article, I discover that the meteorologists don’t agree with the chemists; they’re talking about cyclical fluctuations unrelated to human activity. So now the industrialists don’t know what to do. The heads of state are also holding back. Should we wait? Is it already too late? Toward the bottom of the page, Third World countries and ecologists add their grain of salt and talk about international treaties, moratoriums, the rights of future generations, and the right to development.

The same article mixes together chemical reactions and political reactions. A single thread links the most esoteric sciences and the most sordid politics, the
most distant sky and some factory in the Lyon suburbs, dangers on a global scale and the impending local elections or the next board meeting. The horizons, the stakes, the time frames, the actors - none of these is commensurable, yet there they are, caught up in the same story.

On page six, I learn that the Paris AIDS virus contaminated the culture medium in Professor Gallo’s laboratory; that Mr. Chirac and Mr. Reagan had, however, solemnly sworn not to go back over the history of that discovery; that the chemical industry is not moving fast enough to market medications, which militant patient organizations are vocally demanding; that the epidemic is spreading in sub-Saharan Africa. Once again, heads of state, chemists, biologists, desperate patients, and industrialists find themselves caught up in a single uncertain story mixing biology and society.

On page eight, there is a story about computers and chips controlled by the Japanese; on page nine, about the right to keep frozen embryos; on page ten, about a forest burning, its columns of smoke carrying off rare species that some naturalists would like to protect; on page eleven, there are whales wearing collars fitted with radio tracking devices; also on page eleven, there is a slag heap in northern France, a symbol of the exploitation of workers, that has just been classified as an ecological preserve because of the rare flora it has been fostering! On page twelve, the Pope, French bishops, Monsanto, the Fallopian tubes, and Texas fundamentalists gather in a strange cohort around a single contraceptive. On page fourteen, the number of lines on high-definition television bring together Mr. Delors, Thomson, the EEC, commissions on standardization, the Japanese again, and television film producers. Change the screen by a few lines, and billions of francs, millions of television sets,
thousands of hours of film, hundreds of engineers and dozens of CEO’s go
down the drain. (Latour, 1993, p. 1)

I have found no better way to introduce the pervasiveness and multidisciplinary nature
of controversial issues than this extended quote from Latour. As Latour illustrates, any
newspaper on any day will provide numerous examples of such issues. They cannot be
avoided and they form a significant part of daily experience. They raise interesting questions
about whether there is an issue, who it concerns, what, if anything, is to be done about it, and
who gets to be involved in the decision-making process. The answers to these questions will
differ according to a variety of factors: what is and is not considered as evidence, whose
concerns are and are not heard, the degree of personal involvement, etc. Approaches to issues
may differ in orientation: some will be concerned only with politics, others only with
economics, others with ethics, and others may mix perspectives. Approaches may differ in
form: some may rally resources, others may resist in silence. Indeed, the questions brought to
bear on issues and the responses proposed may vary within and across people, contexts, and
issues.

These issues, often referred to as socioscientific issues, are addressed in a branch of
science education known as Science, Technology, and Society (STS) education. These issues
are of concern to science education because they typically involve science in some way, shape,
or form. For example, they often involve scientists as “evidence experts”, specialists who are
asked to prove (via evidence) the existence of a problem or to come up with (via new evidence)
a solution to a problem. It is hoped that by bringing these issues into science education
students will see how science is relevant to their lives, specifically how it is relevant to the
controversial issues they encounter on a daily basis.

This thesis focuses on analysis of student discourse about socioscientific issues and the
way different frameworks used to analyze discourse highlight and mask particular forms of
knowledge. Discourse is used to signify the system of relations between parties engaged in a communicative activity and a concept meant to signal the inescapably political contexts in which we speak and work (Apple cited in Lather, 1991). Frameworks are broadly defined as a collection of questions to be asked, issues to be raised, and methods to be used in the analysis of an issue (Minsky, 1975). I examine these questions, issues, and methods in the analysis of socioscientific issues because they uphold particular distinctions which, in turn, reflect dominant ideologies and power arrangements (Cherryholmes, 1988). I critique the distinctions upheld in prominent analytical frameworks in research pertaining to socioscientific issues and argue that another analytical framework, sociologies, upholds questions, issues, and methods that better reflect the complex nature of socioscientific issues.

What is a Socioscientific Issue?

Wessel (1980) describes three dimensions of a socioscientific issue: (1) the public has an interest in the resolution of the conflict because of its impact on how they live; (2) the information required to formulate a rational judgment of an issue is complex, arising from multiple sources and often inconclusive; (3) judgment on these issues requires balancing a number of quality-of-life concerns about which different people have widely varying values and feelings. Another characteristic of socioscientific issues is that they have a certain endurance in time and space; a rapidly passing disunity will not be called a controversy, nor a dispute involving only a single person. In general, although not always, such controversies exist over a longer period of time and divide groups of people (Brante, Fuller, & Lynch, 1993). Such issues often involve complicated networks of evidence and counter-evidence, of claims and counter claims. Honest and intelligent disagreement over socioscientific issues is possible as the issues typically “encompass a substantial amount of information or putative facts, some of which are likely to be independently contentious” (McPeck, 1990, p. 7). As a result,
...the difficult part of making choices is not the compilation and assessment of incontrovertible scientific evidence. Rather it is the weighing of inconclusive and ambiguous evidence in the context of a variety of political, economic, social, and ethical considerations. (Nelkin cited in Trachtman, 1981, p. 12)

Portraying evidence as contestable and contextual goes against common societal and educational expectations of science as a source of neutral, universal knowledge. An interpenetration of the social and the scientific calls into question the objective, universal nature of scientific knowledge submitting science to the uncertainty, the messiness, and the situatedness of the social. As such, it is understandable that many science educators (and I include both teachers and researchers) would reject such assertions that threaten science's epistemic authority. Yet, even a casual review of the paper over the morning's coffee indicates how many different elements, actors, and disciplines are involved in the complex networks of each issue. Dividing these issues into discrete areas, each of which can be dealt with by a specific discipline, denies the mixture of knowledge, interest, and power that each involves; knowledge of things on the one hand and human politics on the other are inseparable. Such epistemological questions are prominent concerns of socioscientific discourse both inside and outside of education (See Aikenhead & Solomon, 1994; Dant, 1991; Fuller, 1988; Lynch & Woolgar, 1990). Yet, within education, an interpenetration of the social and the scientific and the ensuing epistemic uncertainty are rarely reflected in educational research pertaining to socioscientific issues. Specifically, the constructed, political, and dynamic nature of evidence in socioscientific issues is not reflected in the analytical frameworks commonly used for assessing students' responses. Consequently, students are being evaluated by frameworks that

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1 In the social studies of science a distinction is often made between scientific controversy and a science-based controversy. Scientific controversy primarily concerns contending knowledge claims where at least one of the parties has scientific status. A science-based controversy typically includes several actors of various kinds crucially affecting the outcome of the dispute. The difference is a matter of degree. Take for example the differences between continental drift theories and nuclear power plants; the former are called scientific and the latter science-based (Brante, Fuller, and Lynch, 1993). Socioscientific issues may encompass either or both kinds of controversy.
do not take into account the contestability and dynamics of knowledge production and that reify science’s epistemic sovereignty.

Current Analyses of Socioscientific Issues

To date, educational research initiatives concerning the assessment of students’ responses to socioscientific issues include large-scale studies that employ a variety of assessment formats (Aikenhead, Fleming, & Ryan, 1987; Gaskell, Fleming, Fountain, & Ojelele, 1992) and smaller-scale studies that categorize students’ responses into various classification systems (Fleming, 1986a, 1986b; Solomon, 1984, 1992). Briefly, large-scale assessments tend to use a multiple choice format in which students select one reason to substantiate their choice. These forms of analysis reify acceptance of singular, static responses to complex issues. Smaller scale assessments have tended to divide students’ responses into dichotomies that privilege science. One system distinguishes between domains of knowledge: symbolic or life-world (Solomon, 1984). Another distinguishes between types of cognition: social or non-social (Fleming, 1986a, 1986b). In both cases the scientific thinking (symbolic and non-social) is upheld. However, this privileging of science presupposes a non-contentious view of science, one that presupposes disciplinary agreement, unanimity, and stability.

In this thesis I critique the analytical frameworks commonly used in the analysis of students’ discourse about issues on the following grounds. First, the construction of single response selection items serves to reinforce a notion that minimal support is required to substantiate the positions students advocate. This is a problem related to the unit of analysis presently used in research on socioscientific issues. To date, the unit of analysis, a “point of view”, typically consists of only two elements: a position and a reason for that position. This unit of analysis is too simplistic to accommodate the heterogeneity of elements students associate in their points of view. Second, the constructed dichotomies serve to privilege scientific discourse (symbolic knowledge and non-social cognition) over other forms of
discourse (life-world knowledge and social cognition). These divisions (typically between the scientific and the social) are problematic in that they uphold the epistemic authority of science (which has been greatly challenged) and do not reflect the complex, interdisciplinary nature of socioscientific issues. Third, knowledge is portrayed as objective and static, that is, its construction is generally not highlighted or portrayed as contentious and dynamic. Fourth, further consideration is needed with respect to how the analytical frameworks themselves enable and constrain students' responses to issues presented.

In contradistinction I propose that analytical frameworks for socioscientific issues: 1) insist upon forms that uphold a diversity and depth of elements in a point of view; 2) consider all forms of discourse as equally rational, though not as equally credible; 3) highlight the inextricable interrelationship between power and knowledge; and 4) systematically include a form of reflexivity to query how the research context both enables and inhibits the (re)production of discourse.

Another Analytical Framework

My response to the above critique is to introduce, develop, and evaluate an analytical framework (which I argue is a form of discourse analysis) entitled sociologies. Sociologies was introduced and developed by Bruno Latour in his 1987 book Science In Action. In this book sociologies is proposed as a means of mapping the associations scientists and engineers construct in their attempts to make their claims more credible than the claims of other scientists and engineers. Theoretically, sociologies deconstructs a uniform notion of rationality (typically one affiliated with scientific understanding), argues against a relativistic view that all claims are equally credible, and foregrounds the social construction of knowledge. Concretely, sociologies consists of a framework of five questions to examine: 1) some of the ways in which knowledge is constructed, accumulated, and mobilized in the face of controversy; and 2) how it is that some knowledge is rendered more credible than others.
My objectives in this thesis are to develop the framework of sociologies for use in education, apply it to students’ discourse, and then evaluate the framework in terms of the criteria previously posed. The central question addressed in this thesis is as follows:

What are the strengths and weaknesses of sociologies as an analytical framework to examine the production of knowledge as evidenced in students’ discourse pertaining to socioscientific issues?

To determine the strengths and weaknesses of sociologies as a framework for analysis I apply sociologies to students’ discourse concerning one socioscientific issue, the disposal of toxic waste. Examples of students’ discourse were gathered during the Socioscientific Issues Component of the 1991 British Columbia Provincial Science Assessment (Gaskell, Fleming, Fountain, & Ojelel, 1992).

Sociologies is not considered to be a solution to all problems in the analysis of socioscientific issues nor an entire system of analysis for assessment. The aims are modest; what is hoped for is that use of the questions developed by sociologies will provide a point of entry for the discussion and analysis of complex socioscientific issues that does not automatically start with assumptions of hierarchical categorical distinctions that automatically privilege science, nor ignore the political, socially-constructed, dynamic aspects of knowledge production.

Chapter Orientations

In Chapter Two I examine challenges to the epistemic authority of science and offer some examples (by a philosopher of science and feminists) in which knowledge production, particularly in science, is seen to be constructed, contextual, and contentious.
In Chapter Three I look at the broad field of STS in education as reflected in a number of definitions of the area provided by different writers. Briefly, they argue that if the intent is to approach the study of controversial socioscientific issues by considering the interaction of science, technology, and society, the perspective on the issues will be very different when seen either from a societal, technological, or scientific viewpoint. Indeed, I suggest that thinking of these three terms as separate domains is an approach of limited value in considering socioscientific issues. I then examine the various forms of analysis currently used in socioscientific research in the curricular domain of science education. I argue that the various means of analysis of students' responses to socioscientific issues do not reflect the political, socially-constructed, dynamic nature of such issues and that we need analyses that uphold an interpenetration of knowledge, power, and change.

In Chapter Four I introduce the work of Bruno Latour and of actor network theory out of which Latour developed his concept of sociologies. I attempt to show how this work rejects a dichotomy between knowledge and nature on the one hand, and power, politics, and society on the other. In particular, I suggest that the potential usefulness of this approach to socioscientific issues is that it does not attempt to subsume the social in the scientific, nor the scientific in the social. I look specifically at sociologies as it was developed by Latour and why I believe this framework of analysis can be adapted for use in education in relation to socioscientific issues. It must be noted that Latour's work was developed in a different context and has proceeded in different directions than what I am proposing. Therefore, while Latour's concept of sociologies is the inspiration and starting point for my analysis, the manner in which I have developed the framework and the use I make of it is significantly different from that of Latour.

In Chapter Five I describe the interview data that were used for this study from the British Columbia 1991 Provincial Science Assessment (Gaskell et al., 1992). I then make the case that the analytical framework of sociologies is a simplified form of discourse analysis. I
then outline the five questions of sociologics that I have developed for analysis in this study. The chapter concludes by noting the limitations and delimitations of the study.

In Chapter Six I apply the framework to four interviews. The strengths and weaknesses of the framework to analyze each interview are noted. Commonalities of students' sociologics (the associations they construed in the face of controversy) across 60 interviews are included at the end of the analysis chapter. Finally, I note the overall strengths of each question, then outline certain weaknesses within the framework as a whole that need to be addressed.

In Chapter Seven I address the strengths and weaknesses of the framework. I suggest some modifications to improve sociologics and argue that, while limited, sociologics does provide a form of analysis that begins to address the political, socially constructed, and dynamic nature of knowledge production as evidenced in discourse pertaining to socioscientific issues. I emphasize the use of this framework for providing 'a' means of inquiry, not 'the' means of inquiry, and as a 'point of entry' for the discussion and analysis of socioscientific issues. I conclude that sociologics can be used as an analytical framework that can help students and educators develop a greater understanding of the complexity of socioscientific issues and sensitivity towards the divergent and local subjectivities therein.
CHAPTER 2

CHALLENGES TO AND PORTRAYALS OF SCIENCE

Overview

This chapter introduces some of the prominent theoretical issues being discussed in the STS field both inside and outside of education. I outline some of the challenges to science outside of STS education and depict some ‘alternative’ ways of portraying science. I conclude that STS research in education needs to take these challenges to science into account and that attempts to resolve controversial issues by applying an approach which privileges detached, scientific reasoning will fail to recognize the complex interpenetration of the heterogeneous elements which make up controversial issues.

Challenges to Science

The knowledge claims made within the European-Western scientific tradition and warrants for making these claims have been critiqued by many. These critiques take many forms:

• internal challenges within the history of science which challenge traditional histories of science and concepts of scientific progress and change. (Kuhn, 1974)

• critical theory which emphasizes the role of science in the development of instrumental reason and techniques of domination, destruction, and social control. (Benjamin, 1968; Habermas, 1984, 1987; Horkeimer & Adorno, 1972)
sociological and ethnographic studies of science and scientists which emphasize the degree to which scientific concepts and facts are socially constructed. (Barnes, 1976; Barnes and Shapin, 1979; Barnes and Edge, 1982; Bloor, 1976; Dant, 1991; Fuller, 1988, 1993; Law, 1994; Lynch and Woolgar, 1990)

various forms of philosophical inquiry which question many of the traditional assumptions concerning rationality, reality, and the autonomous, rational subject. (Heidegger, 1977; Rorty, 1979, 1989)

feminist critiques of science which emphasize the gendered nature of many scientific practices and assumptions. (Haraway, 1991; Harding, 1986, 1991)

various forms of post modernity and post structuralism which challenge the foundations of modernist thought and emphasize the relationship between power, knowledge, and truth and which deconstruct assumptions of rationality and the autonomous subject. (Derrida in Boyne, 1990 and in Megill, 1985; Foucault, 1980, 1984)

These critiques differ widely (their attitude to science, rationality, and concepts of truth vary substantially) and to attempt a detailed summation of each is beyond the scope of this thesis. What is important here is the degree to which collectively they provide a challenge to the Enlightenment’s ideals in general and conventional concepts of science and scientific method in particular. Many of the major forms of 20th century thought, with strong antecedents in the 19th century, have questioned the basic tenets of the ideals of modernity - rationality, science, and progress. Rationality and the individual [male] subject are no longer assumed; they are contested and contextualized issues. Notions of uniformity and universalism are challenged by plurality, diversity, and complexity. Meaning is seen to be contextualized
and subject to change. The rationality and even the existence of the aware individual, the subject, are challenged. Knowledge, truth, and power are seen as interrelated concepts.

These viewpoints threaten what is often referred to as the “cognitive authority” of science. Fuller (1988) identifies three arguments which are commonly used to justify this authority:

1. scientific knowledge is necessary for technological progress;

2. science is non-emotional, unbiased, and unpersuaded by appeals to the authority of tradition;

3. science pursues knowledge for its own sake. (p. 177)

Science is upheld as the force which drives the rapid and continuing technological progress which has occurred in the last 200-300 years; one of the major arguments for the primacy of science is this success. The second and third arguments noted by Fuller provide a means to isolate and mark off the scientific domain from either technology or society. Most advocates of science and scientific method will acknowledge that science is not practiced in accordance with these principles, but they advocate them as ideals and it is suggested that the nature of the scientific community and the use of scientific methods brings science far closer to these ideals than technology or society.

Fuller (1988) points out that there are clear beneficial social consequences that arise from a discipline which gains the title of “science”:

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2 Crudely put scientific method is best because it has been so successful. The justification for science and scientific method is the overwhelming demonstration within the last 300 years that it works and that there has been a dramatic and continuing development of scientific knowledge and technological innovation. If scientific methods are not justified why has there been this unprecedented development? The implication, and sometimes the direct assertion, is that there is something unique in scientific method which has created this success and which entitles science and scientific method to cognitive supremacy.
It acquires the authority to promulgate truthful and reliable knowledge, control over education and credentials, access to money and manpower, and the kind of political clout that comes from possessing knowledge that is essential yet esoteric. (p. 177)

If accepted, these critiques are serious challenges to conventional views of science and threaten the benefits which flow from such sovereignty. Hence, a program (such as STS outside of education) which views science as simply another form of socially constructed knowledge and which seeks to demystify the claims of science to objective truth and a neutral, detached point of view is a basic challenge to the concept of science as a distinct discipline and to the claims it makes. In such programs science is subsumed in a certain view of the social. It becomes another area in which knowledge is socially constructed and truth claims are contested and established in political contexts. Scientific knowledge becomes a social construct, as historically and socially contingent as any other form of knowledge.

Taken to its extremes, this perspective encompasses a form of relativism perhaps best represented in some post-modern or post-structural positions in which truth claims are equally valid but those which are accepted or imposed through the social processes of a particular historically-situated society become true for that time and that society. To go even further and dissolve the subject into a product of discourse or the play of signifiers without a signified (as some poststructuralists approaches do) is an epistemic leap almost incomprehensible to scientific discourse or to STS studies (educational or otherwise).

In the next section I explore perspectives that have attempted to address these critiques, perspectives that see science as historically contingent and socially constructed while maintaining that not all claims are equally valid.
Socially Constructed Science

This section looks at some of the responses to the critiques of science noted above. The first perspective presented is that of Rouse, a philosopher of science. Rouse takes the work of a prominent figure in post structuralism, Foucault, and examines the application of the construct power/knowledge to the natural sciences. The subsequent perspectives are those by two prominent and recognized feminist writers, Harding and Haraway, that call for new notions of objectivity in science and engaged and accountable positioning. These responses were selected because they: 1) recognize that science is important, that it does matter and has very real power effects; 2) reject the privileging of science on the basis that it consists of an objective, detached rationality and a value-free neutrality; 3) realize that choices have to be made and power and politics are intertwined in any such decisions; and 4) struggle to avoid the issue of relativism or any suggestions that one choice is as good as any other. So, while concepts of science remain problematic and inextricably linked to the social this does not necessarily mean that science is unimportant or that it is mere rhetoric: choices must be made - arguments must be defended. However, these writers argue that it is not possible to make these arguments from some position of neutrality above and away from local subjectivities (i.e., Haraway’s god trick).

Joseph Rouse (1987, 1993) examined the application of Foucault’s concept of power/knowledge to the practices of the natural sciences.3 Rouse argued for a clear connection between scientific knowledge and power:

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3 The works by Foucault on which the greatest emphasis is placed are Discipline and Punish: The Birth of the Prison; The History of Sexuality, Volume I: An Introduction; and Power/Knowledge: Selected Interviews and Other Writings 1972-1977. As Rouse acknowledges, this is an extension of Foucault’s concepts developed in relation to the social sciences to the natural sciences which is something Foucault himself did not do.
Extending knowledge outside the context of the laboratory typically requires also extending the materials and practices that made possible the disclosure and tracking of laboratory phenomena. The world we inhabit is riven with enclosures, partitions, and purifications, marked by measurements, counts, and timings, and tracked by new forms of visibility, documentation, and accounting, all in order to make scientific knowledge possible. The things within it have become analyzable and interchangeable stocks of resources, and our dealings with them have become interactively complex. Both the configuration of our political life and many of the conflicts that arise within our politics are shaped by these practices that are part of the growth and reaffirmation of natural scientific knowledge. Of course as Foucault himself would have insisted, these are not just constraints; they are productive of such things as wealth, mobility, health, or military force, as well as knowledge. (1993, p. 143)

Rouse suggests that Foucault’s use of the notion of “sovereignty” in political theory and his analytics of power have close parallels in the natural sciences with the concept of “epistemic sovereignty” and an analytics of knowledge. He suggests that like Foucault’s image of power, natural scientific knowledge is dynamic, disseminated, strategically linked, contested, relational, and productive. Phenomena such as electrons, viruses, or quasars only become possible objects of knowledge or discourse within a “complex practical field”, shaped by the availability of functional and reliable equipment and a variety of subtle technical and theoretical skills. A series of patterns of directions develop not because a particular pattern was there all along, but because some practices reinforce and strengthen one another and are thus often reproduced. These dynamics between practices are constitutive of knowledge:

Thus knowledge is not a status that attaches to a statement, a skill, or a model in isolation or instantaneously. Rather, their epistemic standing depends upon
their relations to many other practices and capabilities and especially upon the 
ways these relations are reproduced, transformed, and extended. (1993, p. 153)

Knowledge develops particularly around points where it is resisted. Where knowledge 
is unchallenged, where it “goes without saying”, there is limited or no development. The 
practices in which knowledge is embodied are also the site of production of health, wealth, 
military force, etc. The expansion of scientific knowledge and its associated controls and 
constraints is not just incidental but is integral to the ways in which knowledge circulates and is 
validated. Therefore, just as there is no sovereign, real or imagined, from whom all power 
flows, there is no epistemically sovereign point outside of the domain in which contested and 
heterogeneous knowledge claims circulate to form an objective evaluation of what is true.

Rouse directly confronts the suggestion that this implies some form of arch-relativism 
or that there is no foundation to any critique or legitimization of knowledge or power. He denies 
the inference that because there is no epistemically sovereign or privileged standpoint for 
legitimating knowledge this means that all knowledge claims are equally valid. He suggests 
that questions about legitimization are on the same level as any other epistemic conflict and are a 
part of a ‘struggle for truth’. He suggests that the conflict between competing standards only 
appears irresolvable when it is removed from any real setting in which there are interested 
parties and something at stake:

Epistemic conflict is always shaped by the goods, practices, and projects whose 
allocation and pursuit are at issue, and by the institutions and social networks 
that are organized around those pursuits. In such real contexts there are 
constraints upon which arguments and evidence will count as relevant and 
persuasive, based upon the need for support from others and for reliability from 
things. It matters what will count as persuasive to others who occupy strategic 
points in the circulation of knowledge and argument, and it also matters how
things will manifest themselves in the context in which their behaviour is recognized to be relevant. (1993, p. 159)

Rouse points out that it is crucial to recognize that these alignments are subject to challenge and change over time. He summarizes his position as follows:

The moral for epistemology is, I hope, clear. The turn to a non-sovereign epistemological dynamics does not replace argument for a concern for truth with power and domination, even while insisting that argument and claims to knowledge are never politically innocent. The contested circulation of opposing knowledges, which cannot be consistently combined into a unitary framework of propositions, is a struggle for truth. Truth matters. Precisely because it matters, truth is often fiercely contested. And if we cannot stand outside that contest to assess it from a neutral standpoint, this does not mean that all claims to truth can be put forward on an equal basis. Knowledge claims are historically, socially, and materially situated in contexts that govern what can be intelligently and seriously asserted and how much or what kind of argument is necessary to support it. But such epistemic contexts are always in flux, their boundaries and configuration are continually challenged and partially reconstructed, as epistemic alignments shift. And these alignments are always intertwined with alignments of power and political resistance. To recognize this interconnection is not to devalue knowledge or science for political purposes; but to take seriously the stakes in struggles for knowledge and truth and to place epistemology and philosophy of science squarely in their midst. (1993, p. 161)

As such, Rouse rejects the conventional notions of science as a distinctive, privileged, and neutral domain with a greater access to the natural world. He sees a much more explicitly political role for epistemology in the evaluations of the role of science in the production of
power and knowledge. He also rejects any suggestion that the denial of an abstract, privileged concept of knowledge means that the only alternative is a politically-detached relativity. Science does matter and it is because it matters that its claims to epistemic sovereignty must be challenged.

Similar concerns from feminist viewpoints are presented by Sandra Harding (1986, 1991) and Donna Haraway (1991). Both these writers advocate what Harding terms a "feminist standpoint epistemology" and both respond to the issue of relativism. Harding suggests that the feminist standpoint epistemologies recognize that all human beliefs "including our best scientific beliefs" are socially, historically, and culturally situated, but argues that they require a critical evaluation to determine which social situations tend to generate the most objective knowledge claims. She advocates what she terms strong objectivity which calls for the scientific examination of the social locations of scientific claims. To be truly objective scientific research must also examine "Those broad historical social desires, interests, and values that have shaped the agendas, contents, and results of the sciences much as they shape the rest of human affairs" (1991, p. 143) but which are usually unquestioned:

Political and social interests are not "add-ons" to an otherwise transcendental science that is inherently indifferent to human society; scientific beliefs, practices, institutions, histories and problematics are constituted in and through contemporary political and social projects, and have always been. It would be

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4 Harding reviews at length various feminist challenges to traditional notions of science as a neutral, non-gendered form of activity concerned with a natural world and removed from the issues raised by feminism. In this study I emphasize the point of feminist standpoint epistemology and the issue of relativism. For a review of the broader feminist critique refer to Harding and the works that she cites. I focus specifically on Haraway's article concerning the issue of situated knowledges and the implications of this for a feminist notion of objectivity. Some of the other articles in her collection deal with other feminist issues in science.

5 Both also discuss a form of feminist empiricism which works within scientific disciplines to show how gendered assumptions and biases have distorted empirical findings. Both writers emphasize that they do not reject empirical research. What they challenge are some of the assumptions which go unchallenged in this work.
far more startling to discover a kind of human knowledge-seeking whose
products could - alone among all human products - defy historical “gravity” and
fly off the earth, escaping entirely their historical location. (p. 145)

Harding suggests that “The best as well as the worst of history of the natural sciences
has been shaped by - or, more accurately, constructed through and within - political desires,
interests and values” (p. 146). There is therefore no basis on which to maintain the value-
neutrality of science. “Nature-as-the-object-of-human-knowledge” is always already
constituted in social thought. This means that science should “legitimate within scientific
research, as part of practicing science, critical examination of historical values and interests
that may be so shared within the scientific community, so invested in by the very constitution
of this or that field of study, that they will not show up as a cultural bias between
experimenters or between research communities” (p. 146).

For Harding, this does not mean that a choice must be made between value-neutral
objectivity and “judgmental or epistemological relativism” (which she defines as a position
which denies the possibility of any reasonable standards for adjudicating between competing
claims). To reject that there is one universal standard removed from social, cultural, and
historical influences, does not mean that arguments cannot be made that one position is better
or less partial and distorted than another. While she recognizes and discusses strong objections
to any notion of value-free objectivity, Harding argues that the concept of objectivity should
not be rejected:

Research is socially situated, and it can be more objectively conducted without
aiming for or claiming to be value-free. The requirements for achieving strong
objectivity permit one to abandon notions of perfect, mirror-like representations
of the world, the self as a defended fortress, and the “truly scientific” as
disinterested with regard to morals and politics, yet still apply rational standards
to sorting less from more partial and distorted belief. Indeed, my argument is that these standards are more rational and more effective at producing maximally objective results than the ones associated with what I have called weak objectivity. (p. 159)

Harding recognizes that there is power in arguments which lay claim to objectivity and she is not prepared to renounce this. She believes that notions of objectivity like ideas such as science or rationality have both progressive and regressive tendencies and that it is important to develop the progressive and to block the regressive.

Donna Haraway (1991) also confronts the issue of how to combine a recognition of the social construction of science with some form of feminist objectivity. Haraway points out the dilemma for feminists who have attacked traditional abstract male notions of scientific objectivity using the argument of the social constructivists:

I, and others, started out wanting a strong tool for deconstructing the truth claims of hostile science by showing the radical historical specificity, and so contestability, of every layer of the onion of scientific and technological constructions, and we end up with a kind of epistemological electro-shock therapy, which far from ushering us into the high stakes tables of the game of contesting public truths, lays us out on the table with self-induced multiple personality disorder. We wanted a way to go beyond showing bias in science (that proved too easy anyhow), and beyond separating the good scientific sheep from the bad goats of bias and misuse. It seemed promising to do this by the strongest possible constructivist argument that left no cracks for reducing issues to bias verses objectivity, use verses misuse, science verses pseudo-science. We unmasked the doctrines of objectivity because they threatened our budding sense of collective historical subjectivity and agency and our 'embodied'
accounts of truth, and we ended up with one more reason for not learning any post-Newtonian physics and one more reason to drop the old feminist self-help practices of repairing our own cars. They're just texts anyway, so let the boys have them back. Besides, these textualized postmodern worlds are scary, and we prefer our science fiction to be a bit more utopic. (1991, p. 186)

What Haraway is referring to is the radical, social constructivist position in which all truth and all knowledge claims, including scientific truth and knowledge claims, are a matter of rhetoric. What counts is persuading the relevant, social actors that your version of manufactured knowledge is correct or is the best route to power. This is a contested field in which contests of knowledge and power take place and the emphasis is on the practice of producing and defending knowledge claims which form the basis of a form of social power:

From this point of view, science - the real game in town, the one we must play - is rhetoric, the persuasion of the relevant social actors that one's manufactured knowledge is a route to a desired form of very objective power. Such persuasions must take account of the structure of facts and artifacts, as well as of language-mediated actors in the knowledge game. Here, artifacts and facts are parts of the powerful art of rhetoric. Practice is persuasion, and the focus is very much on practice. The strong programme in the sociology of knowledge joins with the lovely and nasty tools of semiology and deconstruction to insist on the rhetorical nature of truth, including scientific truth. History is a story Western culture buffs tell each other; science is a contestable text and a power field; the content is the form. Period. The form in science is the artefactual-social crafting of the world into effective objects. This is a practice of world-changing persuasions that take the shape of amazing new objects - like microbes, quarks and genes. (1991, p. 184-85)
Haraway sees the military metaphors and the contest for a socially-negotiated reality as metaphors which clearly illustrate an abstract, male masculinity. While they challenge the traditional notions of scientific objectivity, the nature of these metaphors are problematic for Haraway. The metaphors substitute one form of abstract male masculinity for another supposedly more ‘radical’ version. She argues for the need for a feminist version of objectivity which will go beyond radical, historical contingency and social construction and will provide a better account of the world, a “successor science”, a term developed by Harding (1986) to refer to a form of science which continues to insist on legitimate meanings for objectivity and which offers a “more adequate, richer, better account of a world, in order to live in it well and in critical, reflexive relation to our own as well as others’ practices of domination and the unequal parts of privilege and oppression that make up all positions” (Haraway, 1991, p. 187). The problem with this approach is that it seeks to maintain two positions which could be seen as opposite poles of a dichotomy; the need to show historical contingency and the social construction of knowledge in order to critique present assumptions which are patriarchal, racist, and oppressive, and the need to make claims about a ‘real’, objective world which is more than a position in a contest of rhetorical claims. She summarizes the problem as follows:

So, I think my problem and ‘our’ problem is how to have simultaneously an account of radical, historical contingency for all knowledge claims and knowing subjects, a critical practice for recognizing our own ‘semiotic technologies’ for making meanings, and a no-nonsense commitment to faithful accounts of a ‘real’ world, one that can be partially shared and friendly to earth-wide projects of finite freedom, adequate material abundance, modest meaning in suffering, and limited happiness. (1991, p. 187)

Haraway describes this problem as the attempt to climb the “greased pole of objectivity” while trying to hold on to both ends, both of which are important.
Her solution is to change the metaphor and argue for a version of “embodied objectivity that accommodates paradoxical and critical feminist science projects: feminist objectivity means quite simply situated knowledges” (1991, p. 188). This version of objectivity opposes any notion of disembodied knowledge, a view from nowhere which Haraway terms the “god trick”. It emphasizes limited location and specific knowledges rather than transcendental knowledge which separates the subject and the object. Any viewpoint is a partial perspective taken from a specific, local position; there is no form of unmediated, transparent vision. A viewpoint from a particular location is also accountable unlike forms of unlocatable, and therefore unaccountable, knowledge claims. This accountability means that “admitted or not, politics and ethics ground struggles over knowledge projects in the exact, natural, social, and human sciences. Otherwise, rationality is simply impossible, an optical illusion projected from nowhere comprehensively” (Haraway, 1991, p. 194). Haraway argues for what she terms “a doctrine and practice of objectivity that privileges contestation, deconstruction, passionate construction, webbed connections, and hope for transformation of systems of knowledge and ways of seeing” (p. 191). The potential transformatory utopian and visionary nature of science is important for feminists but this view cannot be uncritical:

I think Harding’s plea for a successor science and for postmodern sensibilities must be read to argue that this close touch of the fantastic element of hope for transformative knowledge and the severe check and stimulus of sustained, critical inquiry are jointly the ground of any believable claim to objectivity or rationality not riddled with breath-taking denials and repressions. (1991, p. 192)

Haraway sees the goal of feminist standpoint theorists as the goal of an epistemology and politics of “engaged, accountable positioning” which seeks to provide “better accounts of the world, that is, science” (p. 196). This means that there can be no suggestion of a
rationality which is distant or disengaged and which is free from any reflexive challenge. “Rational knowledge is power-sensitive conversation” (p. 196).

In this approach Haraway explicitly rejects the concept of relativism which she sees as simply another side of the totalizing, objective view from nowhere:

The alternative to relativism is partial, locatable, critical, knowledges sustaining the possibility of webs of connections called solidarity in politics and shared conversations in epistemology. Relativism is a way of being nowhere while claiming to be everywhere equally. The ‘equality’ of positioning is a denial of responsibility and critical inquiry. Relativism is the perfect mirror twin of totalization in the ideologies of objectivity; both deny the stakes in location, embodiment, and partial perspective; both make it impossible to see well. Relativism and totalization are both ‘god-tricks’ promising vision from everywhere and nowhere equally and fully, common myths in rhetoric’s surrounding Science. But it is precisely in the politics and epistemology of partial perspectives that the possibility of sustained, rational, objective inquiry rests. (1991, p. 191)

It is important to note that neither Harding nor Haraway is suggesting that science is unimportant, nor are they suggesting the empirical studies have no value. Neither writer advocates a rejection of science nor dismisses the importance of scientific thought. In fact, it is the very importance of science in society that makes it essential that science become aware of the politics and partial perspectives in which it is always implicated.
Summary

There are clear parallels between the positions of Harding, Haraway, and Rouse. Each writer challenges the concept of objective, detached rationality; each rejects any attempt to privilege science as above and apart from the social and historical setting in which it operates and is situated; each rejects any notion of value-free neutrality; each rejects relativity and the refusal to take and advocate normative positions; each recognizes the importance of science and rejects positions that consider science unnecessary or irrelevant; and each suggests that science and politics, or power and knowledge cannot be separated. The emphasis in each case is different. For example, Haraway and Harding emphasize gender and race in particular and ‘subjugated positions’ in general. Their standpoint epistemology suggests the importance of considering and empowering these standpoints. Rouse would not necessarily disagree with these positions and he does emphasize the role of science in supporting existing assumptions which privilege particular groups in society. However, his emphasis is more general and less specifically identified with a particular social standpoint. Yet, while there are likely to be significant points of disagreement, there is substantial common ground between these authors. This common ground provides a perspective and an approach to science which is mostly absent from the science curriculum even when it is influenced by STS approaches.

Challenges to a separate, privileged viewpoint for science establish important points in relation to the consideration of socioscientific issues. The three points considered particularly important here are:

1) science is situated and socially constructed (i.e., it should not be considered without regard to its social, historical, and political context),

2) knowledge and power are not separate, hence “power/knowledge”,

3) advocating such a point of view concerning science does not involve espousing relativism.

Any attempt to resolve controversial issues by applying an approach which privileges detached, scientific reasoning will fail to recognize the complex interpenetration of the various factors which make up these issues. It will also mean taking a political position which often denies the involvement, interests, and complicity of science in the issue in question. Science is part of the controversy and conflict; it should not be depicted as a neutral arbiter that can develop an objective solution which will be accepted by all rational people. STS education must not privilege science as somehow separate from the issues in question or the technological and social aspects which are also involved. However, most STS education creates a bias in favour of science and scientific solutions to the issues. It is this privileging that I question, not the idea that scientific knowledge should be taught. What must be emphasized is that there is no neutral place from which to judge issues; it is important that students realize that all participants, including themselves, have perspectives conditioned by their context.

The next chapter looks at how science is portrayed in research on socioscientific issues by examining the distinctions (between the scientific and the social) central to several prominent analytical frameworks.
CHAPTER 3

SCIENCE IN SOCIOSCIENTIFIC ISSUES

Overview

In this chapter I will contrast how science is being represented in the definitions and analytical frameworks in research on socioscientific issues with the positions on science developed in the previous chapter. I conclude that STS education is in need of a framework that upholds a view of knowledge production in socioscientific issues that is complex, contingent, contentious, and dynamic.

Science In STS Education

The educational literature on STS is extensive. A discussion of the history of the development of the STS concept is beyond the scope of this work. (For an overview of the American perspective see DeBoer, 1991; for a general discussion of the British viewpoint see Solomon, 1988; and for a Canadian perspective see Aikenhead in Aikenhead & Solomon, 1994.) In general the term STS gained currency during the late 1970’s and became widespread in the early 1980’s when it was adopted by a number of groups in various countries. For example, it was adopted by the Association for Science Education (1981), the National Science Teachers Association (1982), and the Science Council of Canada (1984). It became increasingly popular during the 1980’s and has become a component of the science curriculum in a number of countries. In the development of Science - Technology - Society as a theme for inclusion in science programs, there has emerged a view that science cannot be taught in isolation from the social world. However, the linking of the terms Science - Technology - Society creates a number of questions concerning the nature of the relationship between the terms and how the study of the area is to be approached.
The linkage of the three terms science, technology, and society raise a series of questions concerning the meaning and scope of STS studies:

- What does Science - Technology - Society mean?

- How are the terms related?

- Are there really three separate domains?

- If so, how do we define them?

- Which domain, if any, ought to dominate?

- How does considering the social and technological impact perspectives concerning the epistemic authority often attributed to science?

Many of the answers to these questions are implied in the assumptions upon which definitions of STS are based. Four different approaches and definitions therein are discussed in the next section.

Definitions of STS

STS and the Scientifically Literate

At the Fourth International Organization for Science and Technology Education (IOSTE) Symposium in August, 1987 STS was defined in the following terms:

STS was generally understood at the Symposium to mean teaching science content in the authentic context of its technological and social milieu. Students tend to integrate their personal understanding of the natural world (science
content) with both the man-made [sic] world (technology) and the social world of the students’ day-to-day experience (society). (Hofstein, Aikenhead, & Riquarts, 1988, p. 358)

The report of the STS working group of the symposium also referred to the 1982 position statement of the National Science Teachers Association (NSTA) in the United States which emphasized STS in the context of scientific literacy:

The goal of science education during the 1980’s is to develop scientifically literate individuals who understand how science, technology, and society influence one another; who are able to use knowledge in everyday decision-making. Such individuals both appreciate the value of science and technology in society and understand the limitations. (NSTA, 1982, p. 1)

The working group paper suggested that to achieve these goals Science - Technology - Society instruction would teach about natural phenomena in ways that connect science with the technological and social world of the student. However, the discussion also revealed a series of problems and concerns about STS, some of which included:

- the lack of a clear definition of STS;
- a lack of theoretical structure;
- the high esteem accorded to the disciplines of physics, chemistry, and biology in their traditional forms;
- the nature of the STS material tends to be fluid and tentative as compared to the ‘clear-cut’ information style of traditional science courses.
Problems in assessment were also discussed. It was felt that evaluation and assessment in this area was particularly difficult due to a lack of valid and reliable evaluation tools. The STS working group felt that this was an area which should be a specific focus for future research, conferences, and symposia.

From this symposium we learn that one of the central reasons for introducing STS to science education is to create 'scientifically literate individuals' who can bring a knowledge of science to other areas of their lives. The intent is to show that science is relevant and important beyond the classroom. ‘Science’ is perceived as a separate domain which interacts with other, separate domains, notably technology and society. There is a natural world, a ‘man-made’ world (sic), and a social world which essentially correspond to the three domains. However, the nature, definition, and interrelationship of science, technology, and society remain unaddressed.

A very similar point of view was expressed by the Science Council of Canada (1984) in Science for Every Student: Educating Canadians for Tomorrow's World. This report endorsed a concept of scientific literacy that has a “comprehensive nature” (p. 18). The Science Council made, among others, the following recommendations:

- Science education must provide a more accurate view of the practice, uses, and limitations of science.

- Science education must include the study of how science, technology, and society interact.

- Students must be taught how Canadians have contributed to science and how science has affected Canadian society.
• Teachers and curriculum planners must evaluate students’ progress toward all the goals of science education, not just their learning of scientific content.

Science education was to be "... the basis for informed participation in a technological society, a part of a continuing process of education, preparation for the world of work, and a means for students’ personal development" (p. 33). Science education, via scientific literacy, will enable informed decision-making.

**STS and Decision-Making**

A similar approach appears in Bybee (1987). Bybee develops a justification for STS as part of the educational purpose in science education. He suggests making STS part of science education but not the sole organizing theme. He suggests three essential themes: science and technology concepts; the processes of inquiry; and Science - Technology - Society interactions. The general aims are:

• to present science knowledge, skills, and understanding in a personal / social context.

• to include within the curriculum knowledge, skills, understandings relative to technology.

• to extend the inquiry goal to include decision-making.

• to clarify the knowledge, skills, and understandings relative to the S-T-S theme that are appropriate to different ages and stages of development.

• to identify the most effective means of incorporating S-T-S issues into existing science programs.
• to implement S-T-S programs into school systems. (Bybee, 1987, p. 679)

The overall goal was to enhance the personal development of students and to contribute to their lives as citizens by reinstating personal and social goals as part of the science program.

Once again this program recognizes science as a separate domain (from the technical and the social) with its own knowledge and methods. It seeks to integrate a sense of the relevance of science to making decisions about personal and social goals, but advocates a program where the concepts and methods of science are learned in isolation from the social and the personal. Only at a later stage are these concepts applied to reasoning and decision-making skills in a broader context. While there is a brief discussion of the interaction of science and the social, the emphasis is on a one-way flow from science to the social.

**STS and Critical Thinking**

Another depiction of STS education is found in Zoller (1992). Zoller privileges the technological. He advocates distinguishing between “technical literacy” (having the practical ability to handle or use the “stuff”) and being technologically literate (having the capacity to critically assess technology, as a basis for rational decision-making and action). For Zoller the crucial problem is “not the technical aspects of handling and processing information, but rather the reasoned ability to select and to interpret critically available information” (p. 85). He suggests the need to develop this ability is the deep-rooted rationale for Science - Technology - Society (STS) Education. It is a literary ability, what he calls technological literacy, “the combined functional capability to understand and communicate the interactions among science, technology, and society; to assess technology; and to exercise the rights and responsibilities of citizenship” (p. 86). Using the concept of science/technology/environment/society (STES) he advocates the development of critical thinking and the application of “value judgment through synthesis of general strategic knowledge and of specialized domain knowledge” (p. 88). Zoller is critical of traditional science teaching:
...contemporary science teaching (from the junior high level and up) is still
disciplinary and in the cognitive domain, often sterile, lacking in social
relevance, and based on textbooks presenting "neat" and "clear-cut" theories,
rules of nature, and "correct" solutions to problems. It calls, further, for
exercise-solving skills (mainly the application of already known algorithms),
but not problem-solving skills (Zoller, 1987). Solutions to exercises require
factual and formal knowledge rather than reasoning and the application of value
judgments. Science teaching typically appeals to knowledge and
comprehension, but rarely to analysis, synthesis, and evaluation. It encourages
the formal problem-solving "technician" and discourages the qualitative or
creative reasoner. Science teaching thus propagates the naive conviction that
science and technology can establish both what we can do, and what we should
do. (Zoller, 1992, p. 88)

Zoller concludes with various specific recommendations for introducing and
implementing STES into schools. These recommendations emphasize interdisciplinary, critical
thinking, system-oriented unit courses and curricula in science, vocational subjects, health
and consumer education, and social studies. Critical thinking and system thinking (defined as
inclusive thinking) are emphasized.

This approach begins to synthesize the social and the scientific. As such, it is more
radical in scope and more polemical in style than the other approaches considered. It is also
more critical of traditional approaches to science education and proposes significant curricular
changes in many areas. There is a recognition that value judgments play a role in decision-
making and a belief that these value choices can be informed by a greater appreciation of the
interrelationship of the social and the scientific. The objective remains a scientifically-literate
individual capable of exercising the rights and responsibilities of citizenship by a selective and
critical use of information. However, now the sovereign individual - replete with critical
competencies - stands above the political, the contestable, the problematic. The individual is upheld as an autonomous being, somehow separate from and not enmeshed in a complex, manipulative society. The contextual, political constraints upon the individual remain unexamined. Reasoning skills are upheld as rational, logical, and universal hence removed from the contentious multiplicity of divergent, local subjectivities. The messiness of the social and its influence upon the individual remain at bay.

STS with an Emphasis on the Social

Solomon (1988) was one of the first to elaborate what the relationship between the terms STS might mean in science education. For science she suggested that STS ought to educate students concerning the provisional and uncertain nature of scientific theories, of scientific prediction, as well as its cultural dependence. As well, STS education ought to place a greater focus on the two-way interaction between theory and experiment to show both the power of scientific imagination and also the provisional nature of its theories. For Solomon, technology is to be seen as the application of knowledge, scientific and other, for social purposes. Students ought to recognize the pressures for innovation and its cultural dependence. In other words, seeing technology as the unproblematic application of science is unacceptable; STS must discuss the social effects of innovation. For society, Solomon said STS ought to introduce a sense of the political, encouraging students' “participation in democratic ways of expressing their opinions and understanding how society can act through the legislature” (p. 382). Moreover, the social part of STS ought to encourage “reflection on ethical problems in a social setting” (p. 382). Ethics and notions of social justice are to be made available to students and are certainly thought to be within their reasoning abilities.

Summary (Definitions)

These approaches to STS implicitly, and in certain cases explicitly, privilege science and scientific methods. They uphold three separate domains of knowledge which, while
related, can be distinguished. The approach to be followed is to promote the use of scientific knowledge and methods to resolve socioscientific issues. The relationship between science and technology or science and society is asymmetrical; science clearly dominates.

However, it would be unfair to say that discourse within the field of STS education portrays science as a neutral, value-free discipline in which scientific methods are used by scientists to discover increasingly clear pictures of a natural reality which can be controlled for the benefit of humanity. The perspective adopted by most advocates of STS studies is considerably more nuanced than this. Discourse in STS recognizes the importance of value judgments and social influences on scientists' decisions and there is a recognition that scientific truths are always open to challenge and revision. In this sense science is fallible and is not seen as presenting a true, transparent picture of a natural reality which is constant and unchanging. Any scientific theory is open to challenge and revision and cannot be regarded as having provided the final answer to any point. Further evidence or a new theory may establish a more probable and apparently more accurate picture of the problem. Yet, while science is considered fallible, it is privileged as a superior and highly successful method of reasoning which brings an increasingly accurate, if still incomplete, picture of reality. Hence, there is some recognition in STS discourse that social, political, and economic contexts have an influence on society. In particular, there is a continual emphasis that science cannot be studied in isolation. However, the concessions to the social are clearly limited; the concessions to technology are even more so. This asymmetrical relationship is carried to the degree that technology is often considered as simply applied science. Where it is considered as something other than applied science, technology is still not emphasized as an area of study. While there is a considerable emphasis on the degree to which science effects technology, there is very limited study of the degree to which science is influenced and altered by and dependent upon technology. Technology is considered more in its effects upon the social seen as 'the way we live' but in this regard science and technology are often considered as a single category. It is
also assumed that understanding scientific concepts and methods will assist in understanding technology but no sense that an understanding of technology is necessary to understand science. Overall, science remains an essentially distinct and privileged discipline. What Fuller terms the “cognitive authority” of science is clearly accepted and together with the notion of a rational, autonomous, and scientifically literate individual provides the underlying assumptions on which the objectives of many STS programs are based.

I suggest that these arguments form a part of the underlying assumptions of the notion of scientific literacy that STS studies attempt to develop. Science is seen as an extremely important and successful discipline whose relevance and importance must be made clearer to students. As a result of STS studies, the student in STS is better able to limit the effect of bias, emotion, and tradition in making decisions and appreciates the importance of the pursuit of scientific knowledge. The additional scientific knowledge gained and the perspective attained will give the individual a greater “cognitive authority” (to use Fuller’s term) or ability. STS studies are not designed to challenge these assumptions; in fact they uphold them. While this emphasis on and preference for science is understandable in a program arising out of science education it does not necessarily provide a satisfactory basis for the consideration of socioscientific issues.

Analytical Frameworks in STS

This section examines the frameworks being used for analyzing socioscientific issues in both large and small scale STS research concerning socioscientific issues. As was stated in Chapter One, frameworks are broadly defined as a collection of questions to be asked, issues to be raised, and methods to be used in the analysis of an issue (Minski, 1975). Examining these questions, issues, and methods is important because they uphold particular distinctions which, in turn, reflect dominant ideologies and power arrangements (Cherryholmes, 1988, p.
To interrogate this normativity in STS education I examine the frameworks brought to bear on students' responses by four recent groups of researchers in the field.

I begin by examining distinctions upheld in early research on socioscientific issues: Solomon's early work in which she introduced the two-domain theory of knowledge into STS research with respect to students' discourse concerning energy and Fleming's work that constructed another two-domain theory and introduced an innovative line of interview questioning to research in socioscientific issues. I then turn to Solomon's more recent work on distinctions concerning the social construction of meaning/knowledge in STS issues. This is followed by an examination of the distinctions upheld in analytical frameworks used in two large, recent studies of socioscientific issues. While binary distinctions are still upheld in many of these research contexts the boundaries have begun to blur in both the theoretical realm (questions posed) and in the practical realm (analytical frameworks).

**Small-Scale Research**

**Two Types of Knowledge: Life-world and Symbolic**

In Solomon's early work she argued there were two different domains of knowledge and that students should be capable of distinguishing between them and able to operate within them both. Her position was based on a theoretical perspective in cognitive science developed by Schutz and Luckmann (1983). According to Schutz and Luckman there were two interpretative systems of knowledge, the life-world domain and the symbolic-universe domain. The life-world knowledge was the student's everyday knowledge. Life-world knowledge had both social value and persistence (that is, it is not easily modified nor replaced) because it was continually reinforced by communication with others and by language itself. Life-world structures were not easily eradicated by the symbolic system because the symbolic system formed "an overarching system with a radically shifted perspective of interpretation which is foreign to the natural attitude and considerably more fragile" (Solomon, 1983, p. 50). This
overarching, fragile system was called the symbolic universe. It “stands above the life-world structures, seeking to explain our experiences in another province of meaning” (Solomon, 1983, p. 50). Its social currency was weaker than the life-world domain: it was restricted to a specialized context (science classes) and limited time frame (periods within a school timetable). According to Solomon, while school science endeavoured to teach students how to think in the symbolic domain, life-world knowledge often persisted:

Crossing over from one domain of meaning to the other involves an abrupt discontinuity of thought which Schultz and Luckman compared to the shock of waking up from a dream into the real world. This emphasizes another point of difference: from the everyday perspective, gaps or problems in the symbolic domain can be ignored, whereas experiences in the real world draw our attention back from the symbolic level to the habitual knowledge of the life-world. Thus, ease of movement between these two domains is not symmetrical for the two different directions. (Solomon, 1983, p. 50)

Solomon did not suggest that one or other of these domains was the ultimate way of knowing. Rather, her goal was for students to discriminate when to use each domain and be fluent enough to move within and between them. Solomon (1984) then went on to explore when students switched from one domain to another, what prompted or cued them to do so, and how they discriminated between domains. Thus, in Solomon’s work there are two separate domains and therein the life-world domain repeatedly dominates. The symbolic world remains untouched by the life-world domain, there is no discussion of the social in the symbolic.

Two Types of Cognition: Social and Non-Social

Fleming’s (1986a, 1986b) research was predicated on the assumption that socioscientific issues are multidimensional and ambiguous. His research thus involved
identifying the different domains of reasoning and investigating any relationships between these domains. Fleming explored students' responses to two socioscientific issues: nuclear power plants and genetic engineering.

Fleming’s (1986a, 1986b) theoretical framework was based on cognitive structural distinctions being hypothesized in developmental psychology. Specifically, his research was built upon two principles proposed by Nucci and Turiel: 1) that the development of social cognition is independent of the development of non-social cognitive structures; and 2) that there are distinct domains of social knowledge (Nucci and Turiel cited in Fleming, 1986a). Briefly, non-social cognition is a result of interactions with the physical world resulting in structures about that world, whereas social cognition occurs as a result of interactions with the social world, giving rise to social cognitive structures. Three conceptual domains formed the basis of an individual's construction of the social world: the psychological (knowledge of self, identity, and the causes of one's own and others' behaviour); the moral (concepts of justice and fairness); and the societal (issues of social regulation and social organization). Each domain is thought to be:

...developmentally and conceptually distinct, parallel, and irreducible to one another. There may be points of intersection, coordination, or overlap between the domains or they may be coordinated in the sense that one system provides information that stimulates or facilitates change in another. However, they are not viewed as interdependent systems. Thinking is organized and changes sequentially within a domain but not across domains. (Fleming, 1986a, p. 678)

So, while Fleming assumed that socioscientific issues were multidimensional and ambiguous his major categorical distinctions did not uphold these assumptions (assumptions pertained only to the social).
In addition to standard questioning techniques Fleming introduced a unique manner of probing students’ responses, what he called a “salient event”. In this type of probe a student is presented with a second set of questions pertaining to the issue at hand. These subsequent questions are designed to bring the issue closer to home. For example, with the nuclear power plant issue students were asked whether they would wear a small device that emitted the same level of “safe” radiation that was purported to emit from the power plant. This salient event made many students rethink their position. Whereas some might have previously said that they had no difficulty with the building of a nuclear power plant as it seemed safe enough, these same students declined to wear the radioactive device. In other words, when the issue involved them personally some student’s reasoning altered. In this regard Fleming introduced the idea of testing the strengths of students’ responses to these issues. As such, this new type of probing added new dimensions (the consistency and contextuality of a point of view) to STS research. Thus, Fleming introduced a new way of looking at the potential ambiguity of students’ responses through methodologically incorporating the notion of contextual dependency to response production.

However, the line of questioning in the interview may result in a complex domain interaction being reduced to a singular domain. For example, in one interview reported by Fleming (Fleming, 1986a, p. 685) a student was wrestling with the pro’s and con’s of building a genetic engineering plant. The student said that they had not thought about it a lot but that there were obviously pro’s and con’s: potentially harmful effects to themselves as well as others (social) and potentially beneficial effects resulting from experiments (interacting with the non-social). The student was then asked which “one” would you support? Instead of exploring where and when these domains might or might not overlap the student was forced to choose. Can we then assume that they reason primarily in one domain? Students who were weighing options and complexities were often forced to make one selection. This reductionism does not uphold the theoretical position of multidimensionality often espoused in STS.
discourse. Moreover, the non-social domain continues to uphold a non-contentious view of science, one that presupposes disciplinary agreement and unanimity, not multidimensionality and ambiguity. Solomon begins to explore some of this complexity by looking at the social construction of meaning and knowledge in students' discourse that occurs in a social (group) context.

The Social Construction of Meaning and Knowledge

In 1987 Solomon began to consider the social influences on pupils’ understandings of science. She reported that previous foci had been on personal experience and personal knowledge and that the social influences concerning the construction of meaning tended to have been ignored. For Solomon, the social and the personal elements in the construction of meaning may be “indissolubly complementary” (1987, p. 60). She argued for relevant content to demonstrate the relation between the social and the scientific, especially for new courses such as the new STS courses. This implied some teaching about the consensual nature of scientific knowledge (Ziman cited in Solomon, 1987) which introduces an element of the social into the very heart of scientific thinking. Solomon said that “our students are strongly social beings for whom the teaching of a rigidly insulated science which makes no contact with the everyday context is simply not an option. Social influences of every kind permeate both the learning of science and its application” (1987, p. 79). Yet juxtapositions between the scientific and the social were still upheld, “...in socially acquired knowledge exchange of meaning and consensus take the place of logical testing, and typification by context replaces abstraction and conceptualization (1987, p. 78). Everyday, contextual thinking was still juxtaposed with logical reasoning. The social, not the scientific, is said to have features such as “presentation of self”, “ritual”, and “a need for consensus”. However, is this not true of the scientific? Is not science careful of how it presents itself? Does not science have a plethora of rituals to which scientists abide? Is it not true that the scientific community works by a kind of consensus model building test upon test, affirmation upon affirmation?
In 1988 Solomon attempted to clarify aspects of science, of technology, and of social
decision-making in STS. Students were asked to describe any school experiment that helped
them understand a scientific theory. Students had little difficulty describing the experiment but
identifying the theory proved to be very hard. When asked to explain what technology was in
a particular context (purposefully avoiding the connection between technology and machines)
students were quite successful, 57% defining technology as the use of knowledge for a social
purpose. Then, when asked about a social issue on which there were different points of view,
85% managed to construct “plausible arguments” (1988, p. 386). (The requisites for these
plausible arguments were not delineated.) Students were reportedly very motivated in this
particular section and did well in their responses. Some students even began to suggest ways
in which regulations might be brought in to control or monitor experiments to protect and
enhance the differing and complex values and concerns in the issue. Solomon concluded that
students’ skills of social understanding and empathy were far greater than their knowledge
about scientific explanation or about the social nature of technology. In her analysis scientific
explanation and evidence remain uncontentious and distinctions between what is scientific,
social, and technological though somewhat blurred are upheld.

12 Characteristics of the Social Construction of Knowledge

In 1992 Solomon reported on the analysis conducted on a project called DISS,
Discussion of Issues in School Science. DISS began in 1988 and was part of a research
programme designed to find out more about the Public Understanding of Science. DISS
explored how 17 year old students use knowledge when they express themselves about
science-based social issues, issues they have watched together in a classroom. The group ran
in about 12 schools over a two-year period. Group discussions were taped and pre and post
questionnaires were administered to students. In the group discussions teachers did not set any
specific questions, rather they simply encouraged the students (3-4) to talk about the issues
together and to record their discussion. Transcripts were examined for the amount of school-
based knowledge used during discussion but the purpose of the DISS study was to examine the origins and characteristics of the student’s knowledge and to find out how it related to the social messages from the media.

Solomon wanted to establish a research background to the study of student discussion and to recognize some of the complexities of researching social issues as discussed in a group. As there was not a single theoretical model from which to analyze the group discussions, Solomon looked at the literature primarily in social psychology, media, and literacy studies. In line with her previous work she wanted to further problematize the understanding of scientific information; how meanings, images, contexts are constructed and responded to at the individual and social level. Several prominent questions emerged in her literature search across domains:

• Do people understand science for its own sake, is their interest indeed greater in the subject than their self-reported knowledge of it is?

• Is understanding of science more than just facts and processes, perhaps understanding of applications as well?

• Is understanding individualistic, that is idiosyncratic, or social?

• Is there a divide between interest and attitude?

• How can analysis take into account perceptions, value systems, and social strategies used to understand science?

• What is the place of emotion in understanding?

• What is the place of contextualized understanding?
• Why does student talk always seem to move away from scientific knowledge and into the realm of personal values?

While new issues are introduced in relation to knowledge production (the place of emotion and the role of the context) Solomon’s questions, while indeed broader in scope, continue to uphold binary divisions (i.e., between the individual and the social, interest and attitude, interest and knowledge, the scientific and the personal, etc.). Perceptions, values, and social strategies are recognized; they are used to understand science, not as a part of it. Science remains distinct.

Solomon reported that the processes by which the knowledge and values were negotiated proved to be a very subtle task to analyze. The behavioural outcomes she reported were as follows:

• In the DISS transcripts there were many passages where the students simply described to each other the images that they had all just been watching, a kind of framing the issue for discussion.

• Students often caricatured the knowledge giver, putting words into their mouths as they “felt their way into an empathetic reaction”.

• Talk between friends may have a number of purposes: scene-setting, deliberation, or advocacy. DISS transcripts confirm the presence of all three modes of discussion.

• Persistence, joking, and emotional reactions played important parts in the construction of meaning.

• For different issues, we might expect different perceptions, especially if the students’ own health, homes, or families are involved.
• Children’s views needed to be prompted and reinforced by talking it over in order to be properly knowable.

• Some students seem to be more reflective on paper than in discussion.

• Some students may need social reinforcement to be sure of what they want to say or to see some social issue as a possible concern for them.

• Different topics produced very different types of responses: individualistic on kidney donation, political on nuclear power, sex-related on genetic counseling.

• Data from DISS show both idiosyncratic and social features to student discourse. For example, the perception of common images may forge bonds that are not so idiosyncratic in nature. Indeed, rather than a smothering of differences, group discussion is seen to be a cognitive process of construction. Both idiosyncratic and social features would seem to be important for assessing the effects of classroom discussion of social issues.

In particular Solomon created twelve characteristics (selected from the discussion transcripts) to analyze students’ discourse. The students were scored for each occasion in which they expressed:

• knowledge from television or radio,

• a demand that more research be done on a topic,

• a vague need for action - “they should...”,

• frustration at lack of available knowledge,

• a comment for or against industry,
• an intention to respond by individual action,

• an idea for a civic strategy,

• knowledge from reading,

• persistence in argument - “Yes, but.”,

• a collaboration in sentence construction or repetition of phrases,

• an attribution of bias in knowledge presented,

• confidence in giving out new items of knowledge.

Thus, the social construction of knowledge was depicted (to a greater and lesser extent) by six elements:

• how knowledge is acquired (television, radio, books),

• whether knowledge is required (requests for knowledge, frustrations at lack of knowledge),

• what types and forms of knowledge are created (prescriptions, commentaries, ideas),

• whether normativity is recognized (attribution of bias),

• how knowledge is presented (confidently, persistently, collaboratively, repetitively), and

• how knowledge is responded to (intention to respond with individual action).
This analytical framework begins to depict knowledge production as more constructed, contextualized, and contested: knowledge is constructed via various forms (prescriptions, ideas, commentaries) and in different ways (assertively, persistently, etc.); it is contextualized (tied to a source and normatively based); and it is contested (force of presentation varies).

Students’ discourse in DISS (views and knowledge about science-based issues) were also analyzed for gender differences (Solomon and Harrison, 1991). Given the 12 characteristics used to analyze the social construction of knowledge there was very little gender difference. Only in the case of verbal collaboration did girls score higher than the boys. On the questionnaire responses (in which research shows that girls do not do as well as boys on multiple choice, tick-type responses) girls did not score differently from the boys. However, girls reportedly presented themselves as more likely to have opinions which have been socially constructed (not defined) and boys tended to accept scientific outcomes much more uncritically.

Three Response Categories

Solomon and Harrison (1991) also conducted an in-depth analysis of one topic discussed in the DISS project (leukemia cases among veterans from atomic bomb test). This analysis yielded three main categories of response: broad statements, personal statements, and contextual statements:

• Broad statements were those statements adopting a “reflective view on societal values”, a kind of removal from the immediate context. Included in this category were arguments concerning scientific thinking, the use of numbers, and abstract thinking in mathematics.

• Personal statements were seen as the opposite of broad statements. In personal statements the respondent empathized so strongly with the people in the issues that they tried to include themselves in the situation, imagining how they would feel, what they would do if involved. Included in this category
were statements where others were encouraged to imagine themselves in the situation, i.e. "It's like the government said 'You are 18 years old. We want you to join the army for six months" (1991, p. 289).

- Contextual statements were "...characterized by comments which are neither abstract, nor yet so completely personalized as those in the second category" (1991, p. 289). In this category respondents tended to take account of the situation in the issue and added comments based on their own experience or their understanding of similar situations.

Again, these categories distinguish removed, abstract, decontextualized statements from personal statements: the personal continues to be set apart. Scientific discourse is once again kept separate from the social.

When analyzed by gender by far the largest number of contributions from both girls and boys were contextual. While contextual talk might have been expected to show gender differences it did not. And, contrary to what might be ordinarily anticipated, personal statements were NOT made more often by girls than by boys in the main sequences of discussion (Solomon and Harrison, 1991). Solomon and Harrison explained the lack of gender differences as due to the fact that their data were the only data gathered on gender differences that have been drawn from responses in a social (i.e. group) situation. The authors suggest that:

...it may well be that the nature of social discourse has itself served to modify gender imbalances... the purpose of social talk is to try out opinions, receive feedback, and respond to others. This necessitates taking on board other's perspectives and even their style of discourse. Thus immediate social influences, the questions and comments of peers, may well override gender-related styles and orientations. (Solomon and Harrison, 1991, p. 291-292)
In conclusion, Solomon and Harrison argue that students use a range of different kinds of knowledge in the process of forming their opinions and that social factors bring about an exchange of perspectives which blur gender differences and render group discussion a valuable co-educational process.

Summary (Small-Scale Research)

Small scale research studies uphold a variety of distinctions. While these distinctions increased in number (broadened from a two-category classification system to a three category system to an analysis consisting of 12 characteristics) they continued to juxtapose scientific discourse with social discourse. Theoretically, binary distinctions became broader and included more elements yet science remained dislodged, separate from the contextuality (and hence problems therein) of the social. Methodologically, a new way of testing the consistency of students’ points of view across contexts was developed (salient event) and new areas of content were introduced (i.e., asking about regulations).

Large-Scale Research on Socioscientific Issues

The Views on Science, Technology, and Society (VOSTS) Research

The VOSTS research was a nation-wide, qualitative study involving approximately 10,800 Canadian students (Aikenhead & Ryan, 1989). The purposes of the study were to monitor student beliefs about STS topics and to improve upon standardized instruments. (See Aikenhead, Fleming, and Ryan (1987) for a detailed synopsis of these attempts.) These STS researchers wanted to understand the viewpoints that high school students held concerning “science, technology, and the Canadian society” and they wanted to understand them in new ways. (For a discussion of why a new instrument was needed in the STS field see the SSHRC 1989 Report in Aikenhead and Ryan, 1989 and Aikenhead, Fleming, & Ryan, 1987.) Briefly,
Grade 12 students across Canada wrote paragraphs about various issues pertaining to eight major categories:

1) Definitions of Science and Technology;
2) Influence of Society on Science/Technology;
3) Influence of Science/Technology on Society;
4) Influence of School Science on Society;
5) Characteristics of Scientists;
6) Social Construction of Scientific Knowledge;
7) Social Construction of Technology; and
8) the Nature of Scientific Knowledge.

There were nine categories in the overall conceptual scheme. One remained intentionally undefined, leaving room for the inclusion of a future category. Using a five point procedure a multiple-choice questionnaire was developed. In terms of the analysis, paragraphs were examined for “common arguments or common justifications.” These were then worked (using the students vernacular as much as possible) into common viewpoints or beliefs for each item. In the end, each item consisted of a strong statement followed by anywhere from 5 to 13 responses. Students were asked to read the statement then select the point of view that was the closest to their own. A point of view consisted of two elements: a position with respect to the issue and a reason for that position. Whereas previous assessments had elicited student positions with respect to a variety of STS issues (agree, disagree), this research wanted to encourage informed, reasoned points of view. For example, in response to a statement like: “When a new technology is developed (for example, a better type of fertilizer), it may or may not be put into practice. The decision to use a new technology depends on whether the

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It is interesting to note that while students were told that there were no right and wrong answers to these questions the summary of findings section in the SSHRC report certainly privileged some points of view above others. Some points of view were considered “informed”, “accurate”, “realistic”, and “authentic” whereas others were “outdated”, or “naive”.

advantages to society outweigh the disadvantages to society” (Item # 80133). A typical response item would be “The decision to use a new technology depends mainly on the benefits to society, because if there are too many disadvantages, society won’t accept it and may discourage its further development.” The idea was to see not only what positions students took with respect to these STS issues but why.

Specifically, the VOSTS principle unit of analysis (student generated points of view) and content (how science is defined, constructed) produced some very informative results. Overall, students held a variety of points of view, offered a rich diversity of explanations, and appeared ready to deal with the issues pertinent to the sociology of science. While there were many interesting results from the VOSTS data analysis, here are a few of the more prevalent results in terms of content:

- Students harboured diverse and contradictory beliefs about scientific knowledge.

- Unless specifically asked to do so students did not distinguish between science and technology, rather they saw it as more of a ‘technoscience’.

- Scientific research was equated with medical, environmental, or agricultural research. Science is meant to serve.

- Students were not so willing to contemplate the role of personal motives or moral values in scientific disagreements. They were more contemplative of facts, yet what a fact means needed more exploration.

- Students expected scientists to make decisions different from how they make decisions. Scientists were seen to decide via facts, whereas they did not.

- Students tended to use moral, conventional, and egocentric reasoning.
• Students responses reflected certain aspects of authentic science: the nature of classification schemes, the tentative nature of knowledge, and the social dimensions of knowledge from within the scientific community.

• Students still seem uninformed on other issues, for example, the nature of scientific models, on the outside influence of scientific knowledge, on the motivations for generating knowledge, and on the scientific method.

(Aikenhead, 1987)

Distinctions between science and the social continued to be upheld and juxtaposed: facts are opposed to other kinds of reasoning, authentic science is opposed to the tentative social, and scientific knowledge is distinct from and not influenced by the outside world. Interestingly students did not make distinctions between science and technology unless specifically required to do so.

VOSTS researchers paid particular and notable attention to how the research context constrained and enhanced students’ responses. In terms of format the analysis offered the following insights:

• Positive or negative framing of the statement can greatly affect item selection responses.

• Students tended to be influenced by the point of view expressed in the statements.

• The particular issue itself affected inconsistencies and disagreements within and between students.

• The most informative responses (including subtleties, complexities) came from paragraph responses.
Broadly speaking, VOSTS research documented students’ viewpoints concerning the characteristics and limitations of scientific knowledge construction and increased the complexity of analysis by insisting that positions be supported by reasons. In this way it reflected some of the prominent theoretical concerns in the social studies of science literature (inside and outside of education). Certainly VOSTS researchers are to be commended for the extensive consideration they gave to some rather contentious areas concerning the social construction of science. However, in spite of the new analytical forms and content this research introduced and examined, there are limitations that need to be addressed. In particular, the principle unit of analysis (one position, one reason) needs to be reexamined: it does not allow for responses to be ambiguous, complex, nor contradictory. Indeed, after having read many of the items I would find it very hard to pick one as there were often several items with which I agreed. This unit of analysis upholds singular responses to typically complex issues. Moreover, the unit of analysis reifies the end point in a decision making process, there is no room for deliberation of positions and/or accompanying reasons. The elements and processes of constructing a point of view are not foregrounded nor encouraged, they are ignored. We have no idea of the complexity of students’ thoughts, what they have considered or not considered, nor whether they hold these points of view strongly.

Recognizing some of these and other shortcomings VOSTS authors made several recommendations for future research. VOSTS recommendations included research that would entail: 1) a broader sampling of the domain of STS; 2) an introduction of a semi-structured interview component as an assessment format; and 3) a multiple-choice type of response format, using student generated “positions” as choices (Aikenhead, Fleming, & Ryan, 1987). The Socioscientific Issues Component of the 1991 British Columbia Provincial Science Assessment attempted to respond to these recommendations.
1991 British Columbia Provincial Science Assessment

The 1991 British Columbia Provincial Science Assessment (Bateson, Erickson, Gaskell, & Wideen, 1992) consisted of four different components: The Classical Component; The Student Performance Component; The Socioscientific Issues Component; and The Context for Science Component. The Socioscientific Issues Component (Gaskell et al., 1992) assessed students' responses to selected science-related social issues. The component's two main purposes were to: 1) study students' understandings of, or points of view with respect to science, technology, and societal issues; and 2) compare ways of assessing understandings of, or points of view with respect to, socioscientific issues.

Three assessment formats were used to explore student responses to the issues. Two formats involved booklets (closed and open response formats) and the third involved a semi-structured interview. In terms of the booklet format students were asked to respond to two issues. In the first issue students were asked to select points of view that were close to their own then asked to select one that was closest to their point of view (closed responses). This was different from the VOSTS format in that students were allowed to select multiple points of view, therefore permitting students to have many, if not contradictory, responses to an issue. In the second issue students were asked to write paragraph responses in response to a series of questions: "What do you think this story is about?", "Describe the different ways people in the story think about the issue.", "What do you think about this issue?", and finally students were asked to respond to the salient event (open responses). The third format (following the VOSTS recommendation) involved semi-structured, one-on-one interviews at various grade levels, notably Grades 7, 9, 10, and 11.

Results form this study indicate that when presented with a story containing two or more points of view and asked to describe what they thought the story was about, most students did not articulate different points of view. That is, they did not describe the different
positions in the controversy nor necessarily offer any reasons for positions they did describe. In other words, students did not frame the issue as a value-laden controversy. They were more likely to articulate a single point of view, a sense of overall difference without mentioning any specifics, or a general sense of the topic without identifying any sense of conflict. Yet, when specifically asked to describe the different ways in which people in the story thought about the issue, more students did identify two or more points of view. Still, less than half the students surveyed described the different points of view in terms of a justified position, that is offering reasons for positions. In the open paragraph responses students tended to offer one main reason in support of their position. In the closed format, in which students were allowed to choose multiple points of view from a list provided, students tended to select several points of view before selecting the one that was closest to their point of view. (Unfortunately, these data have not yet been analyzed to see what, if any, interesting combinations of ideas students might hold simultaneously.) The interview format produced the most complex, dynamic responses. For example, the interview format allowed researchers to explore students’ initial responses and to clarify their meaning. This often lead to students’ responses becoming more nuanced, complex, even contradictory. Also, the interview format allowed the researcher to challenge the students’ point of view. In response to these challenges students would often adjust their point of view and sometimes change it entirely.7 Yet, while the interview format reportedly produced the greatest variety and complexity of students’ responses, this heterogeneity and multiplicity was not described. The reported diversity and dynamics of students’ responses writ large and in response to probes and differing contexts remained unaccounted for. Little was said about the results of the probing questions or about the complexity and modification of students’ responses. Besides the creation of categories and percentiles offered for the

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7 However, the interview format also had problems. Along with Aikenhead, Fleming, and Ryan (1987) this study also concluded that the main drawback of the interview format was the length of time needed to conduct it and the time consuming process of transcribing and analyzing the data.
additional questions (regulatory practices) asked in the interviews (that were not asked in the booklets) the analysis of interview data was extremely limited.

Overall, distinctions in this analysis privileged responses that identified and explained difference and that emphasized reasoned positions. A reasoned position still consisted of a position and one reason. Reasons were not classified into any particular categories, that is, divisions between the scientific and the social were not upheld. Following Fleming’s research (1986a), points of view were challenged by introducing a salient event. However, there was no mention of the dynamics of student’s discourse: the variation and variability of constructions within the entity of the interview were not discussed. Following recommendations by Solomon (1992) to emphasize the civic decision-making responsibilities involved in socioscientific issues, the study did introduce a new section to research in socioscientific issues, that of eliciting students’ points of view with respect to regulatory practices concerning such issues. However, while inviting a sense of the political to research in socioscientific issues (selectivity in terms of who and what ought to be considered) the normativity of knowledge construction and production (as evidenced in the form of facts, information, data, reports, etc.) was not brought forward for inspection.

Summary

An analysis of the frameworks used for analyzing socioscientific issues suggests the following problems. First, the construction of one-reason type answers in the large-scale assessments serves to reinforce the idea that minimal support is required to substantiate choice. Second, the constructed distinctions in the two domain frameworks serve to privilege scientific discourse (symbolic knowledge and non-social cognition) over the other forms of discourse (life-world knowledge and social cognition). Third, knowledge is typically portrayed as an a-political phenomena, that is to say, its construction and specifically the construction of scientific knowledge, is non-contentious. Fourth, with the exception of the VOSTS work and
recent work by Solomon, there is little consideration of how researchers in STS both enable and constrain responses by the questions, issues, and methods they use in their analytical frameworks. In contradistinction, I propose that STS researchers begin to develop analytical frameworks that: 1) insist upon a diversity and depth of justification for choice; 2) consider all forms of discourse as equally rational, though not as equally credible; 3) portray knowledge in terms of Rouse’s (following Foucault) power/knowledge construct, highlighting the inextricable interrelationship between power and knowledge; and 4) include a reflexive component to examine how analytical frameworks both enable and constrain students’ responses.

The following chapter presents the theoretical underpinnings of Latour’s analytical framework of ‘sociologics’.
CHAPTER 4

SOCILOGIES ACCORDING TO LATOUR

Overview

This chapter is concerned with sociologies. First, I provide a brief explanation of Actor Network Theory from which sociologies originated and then outline sociologies according to Latour.

Actor Network Theory

Sociologics is embedded in a theory called Actor Network Theory (Callon, Law, & Rip, 1986). Actor Network Theory (ANT) seeks to dissolve the division between the social and the natural. It is an attempt to provide a theory which does not privilege either the scientific (nature) or the societal (society).

Theoretical Claims in ANT

Latour (1987) and Callon, Law, and Rip (1986) reject distinctions between Science, Technology, and Society. They reject both the view of science as a privileged domain of knowledge and its claims of access to reality. Latour suggests that ANT avoids the problem of naturalization (scientific rationality), socialization (social constructivism or cognition), and textualization (deconstruction). Latour suggests that these three categories are themselves part of the many trials, events, and resources which are used to attribute “textuality” or “sociality” or “naturality” to a particular actor. These designations are therefore the result of particular trials and translations rather than the cause. This approach follows the suggestion by Latour that science is politics by other means and rejects an a priori distinction between science (truth) and politics (power).
For Latour science is intricately and inextricably involved with power and the study of science from an ANT perspective leads into politics. Hence, in ANT conflict and domination are widespread. The emphasis is on examining controversies to see how particular struggles or controversies become resolved and/or appear as black boxes, i.e., taken for granted - not needing any explanation. It is only when particular controversies are examined that the black boxes begin to open to show the complex chains of actor-networks which are normally concealed by the black box effect. Without such examination, a network appears as a series of black boxes and the assumptions and dichotomies that Latour and Callon criticize appear to be clear and uncontroversial.

**Studying Science and ANT**

Actor-network theory suggests that the appropriate method for examining science is not to start with particular assumptions about nature or scientists but instead to follow and describe what scientists actually do, that is, their interactions with the other actors that they seek to enroll, both human and non-human. The players in ANT are “actors” or “actants”. An actor or actant is not an agent in the normal sociological sense, it is used as a semiotic term. The semiotic actors in ANT are hybrids which create their own actor-worlds. As such, the actor is not an entity to which human intentional behaviour can be attributed but a more abstract term which can refer to either human or non-human entities. It is not a specific unitary entity but rather the product of a more or less stable relation between various effects that together form an “actor network.” An actor-network exists when there is an interrelated set of entities that have been successfully enrolled by an actor that is thereby able to act with their support or on their behalf. The inter-related group of entities generated by the actor-network is referred to as an “actor-world”. The process by which an actor enrolls other entities is referred to as the “process of translation.”
In following the actions of scientists, actor-network theory suggests that scientists' attempts and methods of rallying resources are not different in kind from that of politicians and entrepreneurs:

Controlling resources, controlling the environment, and controlling the world that is being built, all of these are aspects of the entrepreneurial activity of scientists. In a sense then, they are not only practicing science - they are also practicing politics, economics, and sociology. Thus the analyst who follows scientists into their laboratories has no need to create his or her own categories and linkages. Since scientists are also practical politicians and sociologists, they are able to supply them in profusion themselves. The job of the analyst is rather to study the creation of such categories and linkages, and examine the ways in which some are successfully imposed while others are not. (Callon, Law, Rip, 1986, p. 10)

Actor network theory does not confine its analysis to the laboratory; it is interested in how scientists manage to extend the worlds that they create in the laboratory beyond the laboratory. Actor-network theory maps the networks created by scientists as they attempt to enroll other actors to create and extend an actor-world beyond the laboratory. To extend their networks beyond the immediate vicinity it is necessary for actors to find a means to act at a distance. In this respect Latour and Callon consider 'inscriptions' and 'immutable mobiles' to be of utmost importance:

- **Inscriptions** are literary and/or visual forms ascribed to information.

- **Immutable mobiles** are objects which are mobile and which do not change their form when moved. Such objects are mobile, immutable, readable and can be combined with one another in texts. These characteristics enable the inscriptions produced in the laboratory to have effects on networks at great
distances from the laboratory. (See Latour, 1990, p. 44-47 for a detailed listing and discussion of the various advantages of inscriptions in mobilizing allies.)

While the objects in the laboratory or the scientists themselves can move beyond the laboratory in only a limited fashion the immutable mobiles and the texts of which they form a part can become parts of far greater networks and hence have far greater importance as a political tool for the “scientist-entrepreneur,” “We are so used to this world of print and images, that we can hardly think of what it is to know something without indexes, bibliographies, dictionaries, papers with references, tables, column, photographs, peaks, spots, bands” (Latour, 1990, p. 36).

Latour relates the use of inscriptions to the question of power as he terms it: “How the few may dominate the many.” He suggests that “the scale of an actor is not an absolute term but a relative one that varies with the ability to produce, capture, sum up, and interpret information about other places and times” (p. 56) and that:

Instead of using large-scale entities to explain science and technology as most sociologists of science do, we should start from the inscriptions and their mobilization and see how they help small entities to become large ones. In this shift from one research program to another “science and technology” will cease to be the mysterious cognitive object to be explained by the social world. It will become one of the main sources of power. To take the existence of macro-actors for granted without studying the material that makes them “macro”, is to make both science and society mysterious. To take the fabrication of various scales as our main center of interest is to place the practical means of achieving power on a firm foundation. (Latour, 1990, p. 56-57)
“Paperwork” does matter. The chains and cascades of files provide a major means by which a few actors can consider and effect millions of others. Without these chains of inscriptions and cascades of files, much of what passes for power could not be exercised.

Latour and Callon (See Callon, Law, Rip, 1986, p. 11 & Latour in Lynch and Woolgar, 1990, p. 37) both suggest that while science cannot be reduced to texts, the publication of a scientific text is both a goal of scientific activity and a means to build an actor-world by persuading and enrolling others. Therefore, a prime method of studying the process of how a scientific world is created is to study the texts that are created. Instead of following particular actors, the texts created can be followed instead. By following the texts it is possible to follow the controversies and reveal the various actors and actor-networks and their struggles to create a particular scientific actor-world.

The Networks and Translations

The process by which an actor enrolls other entities is referred to as the “process of translation.” An actor which has successfully enrolled other entities so that it speaks or acts with the support of these others forms a “translation center.” Law defines “translation” as the:

...process by which putative agents attempt to characterize and pattern the networks of the social: the process in which they attempt to constitute themselves as agents. Thus an agent is a spokesperson, a figurehead, or a more or less opaque ‘black box’ which stands for, conceals, defines, holds in place, mobilizes and draws on, a set of juxtaposed bits and pieces. (1994, p. 101)

This definition catches the sense that while the agent or actor may appear as a single entity this semblance of unity is a black box which conceals the fact that the agent has successfully translated a series of other entities to form an actor-network of which the agent is also a part. The actor is both part of the network and a point within it. The actor cannot be considered apart from the actor-world of which it is a part. In turn, each of the entities within
the network are themselves black boxes or simplified points which are also networks in their own right. As well, each entity exists as a simplified entity only in the context of the actor-world in which it exists in relation to other, simplified entities.

These networks and the entities of which they are comprised are involved in a continual process of circulation and change. Any network which is achieved is contingent and fluid. Any black box may open up and disrupt the network. Achieving and maintaining the status of an actor is likewise a contingent and continual process with no beginning and no endpoint. Actors are continually seeking to enroll new entities within the actor-world or to resist being enrolled by some other actor. Law summarizes this process as follows:

Agency and size (together with machines, social entities and every other object to which one can point) are uncertain effects generated by a network and its mode of interaction. They are constituted as objects to the extent, but only to the extent, that the network stays in place. But the components of the network have, as it were, no natural tendency to play the roles to which they have been allocated. They tend to want to make off on their own. Indeed, they act in the way they do because they, too, are effects generated by a network and its mode of interaction. So, agency and other objects, together with the dualisms that infest the modern world, are all relational achievements. And since they may be undone, this is a sociology of contingent ordering, a sociology of verbs rather than a sociology of nouns.

Translation, then, is to do with verbs, but one could say that its object is to try to convert verbs into nouns. Of course, this is impossible. Verbs are verbs are verbs. To think otherwise is to cleave to the modernist dream of pure order. Nevertheless, some verbs may end up acting for longer than others. Some may even look like nouns for awhile. So, translation is a play to achieve relative
durability, to make verbs behave as if they were nouns. (1994, p. 103) (my emphasis)

This process of translation, this play to achieve relative durability, to make verbs behave as if they were nouns, applies to all actor-networks and to all actors. Since an actor can be anything which acts or shifts actions, there is no difference in treatment between human and non-human actants, between animate and inanimate objects. This is one of the most distinctive elements of actor network theory. It places no special emphasis on the human subject or cognition. In all cases the method employed is the same: map the chain of associations which are created and modified in a series of trials of translation in order to constitute an actor-network, the entities within it, and its relations to other actor-networks. (Sociologics is a series of five questions designed to assist this mapping process.) There are no prior assumptions about how actors will behave, how actors will be defined, where the analysis should start or how to distinguish particular actor-networks as social or natural. There is no distinction between the micro and the macro; size and power are effects of particular networks but while particular networks may be bigger or stronger than others, they do not differ in nature or in the process by which they are formed and modified. In all cases, the appropriate procedure is to follow and describe the associations that are observed.

**Important Points about Actor Network Theory (ANT)**

Before moving onto a discussion of sociologics I briefly highlight some of the important points in ANT to be kept in mind when considering sociologics:

- ANT does not distinguish between human and non-human agents, all are actors. ANT rejects distinctions between nature and society. It emphasizes hybrids and chains. What is particularly important for the purposes of this thesis is ANT’s emphasis on relationships and networks rather than distinct domains.
• ANT adopts a political, rather Machiavellian model - agents are essentially defined by trials of strength - each agent is formed by translating and enrolling the interests of others. It is by following the controversies that actor-networks can be mapped. By tracing controversies it is possible to observe science-in-the-making.

• ANT is highly textual: there is a strong emphasis on semiotics in both the terms and the methods employed. The emphasis is on inscriptions, immutable mobiles, and the study of the texts produced.

• ANT appears radical in its attempts to transcend natural and social distinctions. Yet, it continues to use many social-historical concepts such as power, social influence, and Machiavellian strategy. Indeed, there is very little critical engagement or analysis of these sweeping philosophical and methodological claims.

Both within and outside of the field of the social studies of science ANT has been highly criticized. (See the Collins and Yearly vs. Callon and Latour debate in Pickering, 1992; Shapin’s review of Science in Action, 1988; Shaffer’s review of Pasteurization of France, 1991; Knorr-Cetina’s review of Pasteurization of France (1985); Brown on Laboratory Life, 1994; Slezak, 1994; and feminist critiques from Harding, 1986, 1991 and Haraway, 1991.) It has been criticized for being:

• too political (emphasizing the political at the expense of all other factors) and as not political enough (too formal and detached or that it concentrates too much on laboratories and the values expressed therein suggesting that it ignores factors such as class, gender, race, and institutional interests in favour of a textual approach).
• too concerned with social and historical factors and not concerned enough with these factors.

• being an unwarranted attack on science and as too accepting of scientific norms, glorifying a heroic image of scientists.

• too relativist and as not relativist enough.

• too post-modernist and post-structuralist, yet Latour strenuously attacks postmodern or post-structuralist positions as intellectual and moral dead-ends.

Sociologies: What is it?

In his book Science in Action (1987) Latour followed scientists and engineers at work in the production of credible facts and efficient artifacts in technoscience. In particular Latour looked at the strategies by which scientists and engineers substantiated their claims. By a variety of strategies scientists and engineers rendered their knowledge more credible, more powerful than that of other scientists and engineers. They did this by increasing the number of elements tied to their claim: papers, laboratories, new objects (i.e., microbes), professionals, interest groups, etc. These elements, called actors, can be human, non-human, and hybrids, e.g. a cyborg. Non-human actors are typically visual forms arising from printouts, generally from laboratory instruments, such as graphs, photographs, or new entities, such as microbes, quasars, or blackholes. Hybrid actors are heterogeneous mixtures of forms, both human and non-human. The idea is to get so many elements linked to a claim that the possibility of questioning it, given the multiplicity of associated elements to consider, becomes relatively impossible. In this way a claim, at least temporarily, resists all efforts of modification.

Latour has two terms: “Technoscience” describes all the elements tied to the scientific contents and “science and technology” designates what is kept of technoscience once all the trials of responsibility have been settled (Latour, 1987, p. 174).
Sociologies is a way of mapping the construction of associations and the ways in which scientists and engineers attempt to make their claims more credible than others. As such, it is an attempt to account for difference between claims. What is unique about Latour’s attempt to account for differences between claims is that he is no longer interested in legitimating through dichotomies that privilege rationality and logic (typically associated with science). He suggests that instead of legitimating by appealing to derogatory or laudatory adjectives and their accompanying adverbs, such as, “strictly logical” or “completely illogical”, “purely rational”, or “totally irrational”, we look to the strengths and weaknesses of claims:

If we are no longer interested in adding to the many little clashes between beliefs, in establishing any grandiose dichotomy - child versus adult, primitive versus civilized, pre-scientific versus scientific, old theory versus revolutionary theory - then what is left to us in order to account for the many little differences between chains of associations? Only this: the number of points linked, the strength and length of the linkage, the nature of the obstacles. Each of these chains is logical, that is, it goes from one point to the other, but some chains do not associate as many elements or do not lead to the same displacements. In effect, we have moved from questions about logic (is it a straight or a distorted path?) to sociologies (is it a weaker or a stronger association?). (Latour, 1987, p. 201)

Once released from the belief in the irrationality of certain claims and the symmetric belief that all claims are equally credible Latour suggests that we follow those who are trying to render their claims more credible than others. As people strive to render their claims credible “...they map for us and for themselves the ‘chains of associations’ that make up their sociologies (Latour, 1987, p. 202). Yet while all the chains are logical, that is, they go from one point to another, some chains do not associate as many elements or do not lead to the same displacements.
Displacement: Hard and Soft Facts

Displacement is the degree of negotiability between competing claims; the greater the crossing or clash between claims the less negotiability there is; often one claim must be displaced. Take this child’s experience of displacement as an example:

A mother is walking in the countryside with her daughter. The little girl calls ‘flifli’ anything that darts away very rapidly and disappears from view. A pigeon is thus a ‘flifli’ but so is a hare fleeing in panic, or even her ball when someone kicks it hard without her seeing it. Looking down in a pond the little girl notices a gudgeon that is swimming away and she says “flifli”. “No” the mother says, “that is not a flifli, that is a fish; there is a “flifli” over there” and she points to a sparrow taking off. Mother and daughter are at the intersection of two chains of associations: one that ties a ball, a hare, a pigeon, a gudgeon to the word ‘flifli’; the other one that distinguishes a verb ‘flee’ that could indeed apply to several instances above - but not to the ball- and a noun ‘bird’ that would apply only to the pigeon and the sparrow. The mother, not being a relativist, does not hesitate to name ‘incorrect’ her daughter’s usage of the word ‘flifli’. ‘It is one or the other,’ she says, ‘either a verb or a noun.’ ‘Flifli’ recalls a set of instances that are not usually associated in the mother’s language. The girl has to reshuffle the instances gathered so far under the word ‘flifli’, under new headings ‘bird’, ‘fish’, ‘ball’ and ‘to flee’. The child in the story above does not know in advance how strongly her mother clings to the definition of ‘bird’ and ‘to flee.’ She tries to create a category that mixes everything that darts away, and she fails every time, confronted by her mother who breaks down this category. The little girl is learning what a part of her mother’s world is made up of; sparrows, balls and gudgeons cannot all be ‘flifli’; this cannot be negotiated. The choice for the daughter is then to give up
her category or to live in a world made of at least one element different from that of her mother. (Latour, 1987, p. 199-200)

In this example we can see that the displacement is “large”. That is, there is no room for negotiation for the little girl. However, many claims do leave a margin of negotiation. As such they spread easier because they allow each of the actors they encounter to transform them, to adapt them to local circumstances. These types of claims typically interest more people since less control is exercised on them. “However, there is a price to pay for this solution. In such a venture the statement will be accommodated, incorporated, negotiated, adopted and adapted by everyone and this will entail several consequences” (Latour, 1987, p. 208).

Latour outlines five consequences for those statements that leave a margin of negotiation: (1) the statement will be transformed by everyone but these transformations will not be noticeable, because the success of the negotiation depends on the absence of any comparison with the original statement; (2) it will have not one author but as many authors as there are members along the chain; (3) it will not be a new statement, but will necessarily appear as an older one since everyone will adapt it to their own past experience, taste and context; (4) even if the whole chain is changing opinion by adopting a new statement - new, that is for the outside observer who behaves according to the other regime below- this change will never be noticeable since there will be no measurable baseline against which it notices the difference between older and newer claims; (5) since the negotiation is continuous along the chain and ignores clashes, no matter how many resources are brought in to strengthen the claim, it will always appear as a softer claim that does not break up the usual ways of behaviour.

However, sometimes there is no room for negotiation. This is often the kind of statement chosen by people who are called scientists and engineers.
They (scientists and engineers) prefer to increase control and to decrease the margin of negotiation. Instead of enrolling others by letting them transform the statement, they try to force them to take up the claim as it is. But as we have seen, there is a price to pay: few people may be interested, and many more resources have to be brought in to harden the facts. (Latour, 1987, p. 209)

Consequences for these *harder* claims are: (1) the statement may be transferred without being transformed - when everything works according to plan; (2) the owner of the original claim is designated - if she or he feels cheated, a bitter struggle ensues about who should be credited for the claim; (3) the claim is a *new* one that does not fit into the fabric of everyone’s past experience - this is both a cause and a consequence of the diminishing margin of negotiation, and a cause and a consequence of the bitter fights for credit; (4) since each claim is measured by comparison with the previous ones, each new claim contrasts clearly with the background; thus it seems that a *historical* process is at work characterized by new beliefs that constantly disrupt the older ones; and (5) all the resources brought in to force people to assent are explicitly arrayed, making the claim a *harder* fact⁹ that appears to break through the usual softer ways of behaving and believing.

These latter claims (harder) are not the rule but more the exception according to Latour, since they are needed only in a very few cases to displace others on a large scale. Hard claims are:

... rare and costly occurrences that are only met in the few cases when someone tries to make others move out of their normal course and still wants them to participate faithfully in the enterprise. There is a direct relation between the number of people one wants to convince, the angle at which the claims clash

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⁹ Latour uses the phrase “claims” interchangeably with “facts” when talking about the hard and soft claims scientists and engineers construct.
with other claims, and the hardening of the facts, that is the number of allies one has to fetch. Faced with harder facts, we will no longer endow them with some innate and mysterious superiority, we will simply ask who is going to be attacked and displaced with them, relating the quality of the facts with the number of people moved out of their way, exactly as we could do when comparing a slingshot, a sword and an armoured tank or when comparing a small earth dam on a little brook with a huge concrete one on the Tennessee River. (Latour, 1987, p. 210)

In summary, Latour describes two ways to increase the size and strength of claims in technoscience. The first is a kind of adaptation model in which a margin of negotiation is left open to transform the claims and thus adapt them to particular contexts. The second is a displacement model wherein there is little room for negotiation. The main characteristic of both these types of claims is to be unpredictable - for the observer - because they are totally heterogeneous - according to the observer's own classification (Latour, 1987, p. 202). One cannot know in advance what nor how many elements will be associated, what they will displace (negotiability), who will be involved, nor how they will change.

**Sociologies: A Way of Mapping Associations**

Latour says that our typical actions like dividing, classifying, or ranking do not do justice to the unpredictable and heterogeneous nature of links and associations people construct in the face of controversy. He suggests that in order to study these unpredictable and heterogeneous associations the only thing we can do is to follow whatever is tied to the claims. To simplify, Latour suggests we study:

(a) how causes and effects are attributed,

(b) what points are linked to which other,
(c) what size and strength these links have,

(d) who the most legitimate spokespersons are,

(e) and how all these elements are modified during the controversy.

Latour calls the answer to these questions “sociologies.” These questions and their answers attempt to delineate the construction, accumulation, and mobilization of knowledge in the face of controversy. Under this rubric, the production of knowledge is contentious because knowledge is constructed in a world where discourse, politics, knowledge, and power are inextricably related. In other words, instead of clearly dividing science from the rest of society, Latour makes no distinction among the various allies that are summoned in a controversy. The goal is to map the associations without distorting them into ‘good’ ones and ‘bad’ ones. Latour offers a metaphor to help:

...sociologies are much like road maps; all paths go to some place, no matter if they are trails, tracks, highways or freeways, but they do not all go to the same place, do not all carry the same traffic, do not cost the same price to open and maintain. To call a claim ‘absurd’ or knowledge ‘accurate’ has no more meaning than to call a smuggler trail ‘illogical’ and a freeway ‘logical’. The only thing we want to know about these sociological pathways is where they lead to, how many people go along them with what sort of vehicles, and how easily they are to travel; not if they are wrong or right. (Latour, 1987, p. 205)

In other words sociologies enables us to get close to the clashes between the inside and the outside of networks as evidenced in people’s “chains of associations.”
STS and The Network Metaphor

Sociologics introduces a metaphor, that of a network. A network is a series of connected points. As such it is a web, not a hierarchical structure. A network changes; it is fluid, not static. Its non-linear form invites various points of entry, one can enter the network anywhere. In a network, anything can be a point. Points can be humans as well as creations of science, such as quasars, pulsars, antibodies, etc. A network is relational, it can be looked at in terms of what it does and does not connect. It can be looked at in terms of its coherence (how well it meshes things together, the similarity of its points) and its heterogeneity (what points do not seem to fit, or which are contradictory). As such, there are relations that are both included and excluded (allowing for political notions of inclusivity and exclusivity). A network invites multiple kinds of relationships: oppositional, associative, conditional, simple, complex, ordered, chaotic, etc. A network is dynamic; it needs to be sustained as it may be constantly challenged by other networks that go places faster or easier. A network can be tested, one can see what parts of the net hold tightly when challenged and which give way easily. In short, the metaphor of a network allows one to map what relations are upheld (what is and is not associated) and to what degree these relations are upheld (what parts are weaker and stronger) when controversy arises.

Inside these networks (scientists) make traces of all sorts circulate better by increasing their mobility, their speed, their reliability, their ability to combine with one another...weaving together a multitude of different elements which renders the question of whether they are ‘scientific’ or ‘technical’ or ‘economic’ or ‘political’ or ‘managerial’ meaningless. Finally we know that the results of building extending and keeping up these networks is to act at a distance, that is to do things in the centers that sometimes make it possible to dominate spatially as well as chronologically the periphery. (Latour, 1987, p. 232)
Latour proposed sociologies to follow “science-in-the-making”. However, the same questions Latour uses to follow technoscientific controversies can be used in education to follow “socioscientific issues-in-the-making.”

Why Bring Sociologies to an Examination of Socioscientific Issues in STS Education?

Sociologies offers a “point of entry” into socioscientific issues. It offers a way of analyzing that privileges neither science, technology, nor society: the distinctions so often upheld between these three domains are not upheld in this approach. The questions that make up sociologies are designed to follow the controversy no matter where it leads, into any and all domains. They attempt to interweave nature, politics, and discourse. But can you mix the naturalized phenomena of science, the fields of power of the social, and the truth effects of discourse? Well, we already do according to Latour:

The ozone hole is too social and too narrated to be truly natural; the strategy of industrial firms and heads of state is too full of chemical reactions to be reduced to power and interest; the discourse of the ecosphere is too real and too social to boil down to meaning effects. Is it our fault if the networks are simultaneously real, like nature, narrated, like discourse, and collective, like society? (Latour, 1993, p. 6)

Indeed when we map the networks that weave our world we find that microbes are natural and political. There are all kinds of human and non-human agents: citizens, neurons, texts, politicians, institutions, viruses, experts, radiation, etc. A single text can weave the real, the social, and the narrated.

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10 See Latour’s book the “Pasteurization of France” for a wonderful depiction of how microbes “came about”.
11 Latour offers an example of the anthropologist, an ethnographer who brings together in a single monograph the myths, ethnosciences, genealogies, political forms, techniques, religions, epics and rites of the people she is studying (Latour, 1993).
Yet, sociologies does not dismiss science. The first question, "How causes and effects are attributed" foregrounds one of the principle relationships that science upholds (and that upholds science), notably causal relationships. Associations depicting causality (cause and effect relationships) potentially offer explanation and prediction. Explanations and predictions concerning natural phenomena are pivotal to scientific endeavours. That is to say, understanding how natural phenomena operate and anticipating their future actions are powerful objectives of science. Sociologies recognizes the attribution of causality and foregrounds how this particular and powerful relationship is authorized.

The major difference in using sociologies in an educational context compared to a social studies of science context is primarily one of scale. In following a controversy via scientist’s discourse there might be many actants involving multiple networks over a long period of time, depicting what one might call a "macro-type" account of a controversy. However, in following a controversy via student’s discourse the actor-networks would be necessarily limited in extent and duration. That is, limited time and resources constrain the extent to which actor-networks could be mapped in schools. So, while the questions used to guide the mapping of controversies remain the same, the time and resources devoted to pursue those questions may differ.

Summary

In this chapter I have attempted to outline the theoretical underpinnings of the framework of sociologies, that is, how sociologies strives to account for difference without authorizing dichotomous distinctions between domains, such as Science, Technology, or Society, nor distinctions between whether associations are or are not rational or logical. The idea is to move away from predetermined categorizations and to follow associations to see what these associations allow and do not allow in terms of how well they withstand challenges. I also endeavored to outline Latour’s framework of sociologies.
The following chapter presents the methodological perspectives brought to bear in this study, describes the data collection procedures employed, argues that sociologics is a simplified form of discourse analysis, then outlines the five questions developed for use as the analytical framework in this study.
CHAPTER 5

RESEARCH METHODS AND THE FRAMEWORK OF SOCIOLOGICS

Overview

This chapter has four sections: the first describes the specific research methods used in this study, such as data selection, elicitation, transformation, etc.; the second positions sociologies within a research approach entitled discourse analysis; the third outlines the framework of sociologies as developed as a form of discourse analysis; and the fourth presents the limitations of the study.

Section One: The Methods

The data used in this research were purposefully-selected interviews from the Socioscientific Issues Component of the 1991 British Columbia Science Assessment (Gaskell et al., 1992). In this section there is a rationale of why data from the Socioscientific Issues Component were selected for this study as well as an overview of the data collection procedures used therein.

The Base-Line Data: A Provincial Science Assessment

Large-scale science assessments have taken place approximately every four years in the province of British Columbia since 1976. The 1991 Science Assessment consisted of four different components: The Classical Component; The Student Performance Component; The Socioscientific Issues Component; and The Context for Science Component. (A summary of all components of the Assessment is available in the British Columbia Assessment of Science Provincial Report, 1991, # FCG 185. Bateson et al., 1992.) This discussion is concerned with the Socioscientific Issues Component.
The Socioscientific Issues Component (Gaskell et al., 1992) was a new component to the Provincial Science Assessment. It was introduced in response to a growing emphasis in school science on exploring the relationships between science, technology, and society. (See the Science Council of Canada, 1984 & National Science Teachers Association, 1982.) The focus of this component was the assessment of students' responses to selected science-related social issues. The component’s two main purposes were to: 1) study student understandings of, or points of view with respect to, science, technology, and societal issues; and 2) compare ways of assessing understanding of, or points of view with respect to, socioscientific issues.

My participation in the Science Assessment was of one of the four primary researchers in the Socioscientific Issues Component. The research team consisted of two professors (The principal investigator Dr. James Gaskell from the University of British Columbia and Dr. Reg Fleming from the University of Saskatchewan) and two graduate students (Alfred Ojelel and myself from the University of British Columbia). As part of the research team I was involved in all aspects of the socioscientific issues component: designing the assessment, developing and piloting the instruments, developing the coding schemes, training the leaders of the coding schemes, analyzing and interpreting the data, and writing the reports.

The data used to explore Latour's framework of sociologies were drawn from the Socioscientific Issues Component of the 1991 British Columbia Science Assessment described above. This data base was chosen for two reasons: 1) the Socioscientific Issues Component of the 1991 British Columbia Science Assessment is the most current large-scale assessment study on students’ responses to socioscientific issues; and 2) my familiarity with the assessment data and interest to “do something more” with these data.

The Issue

There were four issues explored in the Socioscientific Issues Component:
• Forestry Management Practices. A discussion of how many, and in what ways, trees should be cut from the points of view of environmentalists, forest company representatives, forestry workers, union representatives, and academics;

• Use of Animals in Scientific Research. An analysis of the advantages and disadvantages of using animals in scientific research from the points of view of university medical researchers and animal-rights activists;

• Use of Tanning Parlours. An examination of the safety and aesthetics of tanning in parlours from the points of view of dermatologists and suntanning parlour clientele;

• Toxic Waste Disposal. An exploration of the economic and health consequences of toxic waste leaking on the grounds of a company which is the economic mainstay of a community from the points of view of town members, and union and company representatives.

The issues were presented to the students in one of two media presentation formats: print or video. These two formats were chosen to simulate how students would be exposed to socioscientific issues in their everyday lives. The print versions were then created to correspond to the videos. However, the print versions are not simply transcriptions of the videos. Every effort was made to write and design the print version like a good newspaper story: beginning with a quote or vivid image, a double column print format and a fictional press agency by-line.

I chose to apply the framework of sociologics to only one issue, the issue of the disposal of toxic waste. I chose only one issue because I wanted to evaluate the sensitivities of the framework within a given issue. I chose the issue of toxic waste because: 1) it was created
for use in science education classes.\textsuperscript{12} (The other three issues were taken from the television
news as presented by the Canadian Broadcasting Corporation.); 2) it was one of the two issues
for which I was the principle interviewer (tanning also) thus I was very familiar with the data;
and 3) my overriding interest is in health issues, particularly public health issues.

The following story is the reconstructed print version of the toxic waste controversy
presented to students in the Socioscientific Issues Component of the 1991 British Columbia
Science Assessment.

\textsuperscript{12} It is part of a series called "Perspectives in Science" developed by the National Film
Board of Canada.
The Great Debate

Stephen has developed an unpleasant rash which some other children in the town have also had. Although the doctor is skeptical, Stephen's mother, Margaret, wonders if the rash may be due to some hazardous chemicals called pentachlorophenols leaking from rusting barrels into the town's water supply.

The barrels are stacked outside a chemical factory, and some university scientists have found that toxic chemicals from them are getting into the underground water system. A citizens' committee has been formed and is calling on the company to pay for a major cleanup. Such a cleanup might involve a reprocessing system, an incinerator, and maybe even piping fresh water into the town.

Stephen's mother, Margaret, has attended a meeting of the citizens' committee. Her husband, Eddie, works for the chemical company, and has just been elected president of the union local. Eddie feels his son's rash has nothing to do with the toxic waste. He comments, "He is probably just allergic to school!"

Eddie argues with Margaret that his first responsibility is to protect the workers' jobs, not to push the company into an expensive clean-up program which might lead to massive lay-offs, or worse, closure of the plant.

The issue comes before a meeting of the union executive. At the meeting Nick, a member of the executive, says, "Sure, jobs are important but so is everybody's health. We have to think about the future of the kids. I think we should support the citizens' committee in calling for a major clean-up."

Bill, another member of the executive, disagrees. "We are talking about big bucks here," he says. "Doing a major clean-up might mean the company pulling out and we'll all lose our jobs. Besides, those university scientists who tested the underground water are just a bunch of do-gooders." Bill thinks there is no point in having a clean environment if you don't have a job. "Why not ask the company to just clean up the surface of the dump site? That would cost less money, and would probably satisfy most people for the time being." Nick is not convinced, and remains concerned about the health of his family.

The executive is asked to vote on the issue. There are the same number of votes on each side. Eddie has to cast the deciding vote.
The Protocol

An interview protocol was developed and piloted at the Grade 7 and 11 levels. Questions and directions with which students had difficulty were modified. Following saturation quotas suggested by Aikenhead, Fleming, and Ryan (1987) 15 interviews for each issue at each grade level were conducted. Students (n=120) were randomly selected by the Ministry of Education from two elementary schools and two secondary schools. At the beginning of every interview it was stressed to students that this was not a test, there were no right and wrong answers, their answers would be kept confidential, this was not a test of reading (print version only), and if there were any words they could not understand they should ask about them. In the pilot interviews students participated in a one-on-one, semi-structured interview with a researcher. Each interview was approximately 30-40 minutes in duration. The pilot interviews resulted in a refinement of the interview protocol to be used in the oral assessment component of the study and in a series of multiple-choice statements for the booklets following a procedure developed by Aikenhead, Fleming, and Ryan (1987).

For the actual study 240 students participated in a one-on-one, semi-structured interview with one researcher. Again, participating students were informed about the nature of the study (i.e., to explore their views on socioscientific issues), were assured that this research was not a test, and that their responses would remain anonymous. The interviews took place at the students’ schools. Each interview was approximately 30-40 minutes in duration. All interviews were tape recorded, then transcribed.

Interview questions were divided into five sections: 1) how students’ depict the controversy, specifically what different points of view the students identify; 2) the basis for the students’ point of view; 3) the role of information in forming a point of view; 4) issues concerning science and scientists; and 5) the consistency of students’ points of view when
presented with a similar issue at a more personal level. Figure 1 outlines the overall interview framework for each issue.

**Figure 1**

Interview Framework

Introduction.

1. Student version of the story.

   a) What’s it about?

   b) Identify points of view.

   c) Suggest reasons for different points of view.

   d) Student’s point of view elicited.

2. Basis for student’s point of view.

   a) Role of school in general.

   b) School subjects.

   c) Teachers’ views.

   d) Other sources: media, friends.

3. Role of information in forming point of view.

   a) Would you like additional information?
b) Where would you get this information?

c) What information could make you change your mind?

4. Issues concerning science and scientists.

   a) Regulations and who should make them.

   b) Context dependency of rules.

   c) Methods of dispute resolution between scientists and non-scientists.

   d) Methods of dispute resolution between scientists.

   e) Who is a scientist?

   f) Scientists and social responsibility.

   g) Influence of jobs and other economic factors.

   h) Concepts of health.

   i) Concepts of safety and risk.

   j) Student’s concepts of related science knowledge.

5. Action component.

   a) Salient issue.

   b) Compare choice with earlier point of view.
The "salient event" section is based on previous research by Fleming (1986a, 1986b) in which he found some discrepancy between students' arguments when they discussed an issue in general and when they were requested to take a personal stance with respect to the issue. The salient event attempts to shift the context of the issue being discussed to a more personal, action-oriented level. Situations were created that asked for decisive action that would not be seen later as risky or inappropriate. For example, in the Toxic Waste Disposal issue, a thermos of water was on the table. As the interviewer poured some out into a cup, the student was read the following story:

For a week, you are visiting a friend who lives in the town that has the chemical plant mentioned in the previous story. You have heard about the controversy over the leaking barrels. You had wondered about drinking water from the taps in your friend's house. Now your friend offers you a glass of tap water.

The student was then asked if he or she would drink the water. (Students were not actually allowed to drink the water even if they expressed a willingness to do so.)

Interviews Selected For This Study

Of the 240 final interviews conducted (not including the pilot interviews) 60 interviews were conducted pertaining to the issues of toxic waste. All of these were analyzed according to the framework of sociologies; only four are presented in the analysis chapter. These four cases were purposefully-selected. According to Patton (1990) purposeful sampling is a selection process to illustrate the questions under study with what are called "information-rich" cases. Patton (1990) suggests sixteen different strategies to select information-rich cases. The strategy used here is called "intensity sampling". Intensity sampling selects information-rich cases that manifest the phenomenon intensely, but not extremely. The phenomenon under study here is the heterogeneity of students' associations, specifically as evidenced in students' points of view. Consequently, the interviews were selected to demonstrate variation in points
of view as well as variation in the size, strength, and flux of associations. For example, some students supported their position on the issue with many associations tenaciously holding onto their point of view when challenged, whereas others changed their original point of view quite readily when challenged.

Section Two: Discourse Analysis

How research is designed is dependent upon many ontological and epistemological assumptions, briefly what we believe to be knowable and how we can know it. For example, do we believe there is a true, unchanging reality to “find” or “discover” in which we can determine how things “really exist”? Or, do we believe there are contingent, ever-changing realities to “construct” or “author” in which we can develop the best consensus about states-of-affairs? “Methodology is best understood as the overall strategy for resolving the complete set of choices or options available to the inquirer from selecting among methods, to world view, to enactment of world view via the inquiry process” (Lincoln and Guba, 1989, p. 183). In other words, this section describes what Lincoln and Guba (1989) call the “logic of process” which forms part of the “dependability audit.” A dependability audit outlines the decisions and interpretations made in research. My decisions and interpretations with respect to the development and application of sociologies are associated with a methodological approach called discourse analysis.

According to Solomon (1990) there are three main traditions in the analysis of discourse: 1) grammar, signaling, and ethnography; 2) meanings, framing, and interpretations; and 3) the analysis of rules for sequencing in conversation. Exploring students knowledge uses, both scientific and social, entails the second of these traditions. I argue that the analytical framework of sociologies is itself a simplified form of discourse analysis in line with Solomon’s second tradition of discourse analysis.
This section on discourse analysis has four parts. The first part is a discussion of what discourse analysis is and how it differs from a more "realistic" model of language analysis. The second presents how and why interviews are used in discourse analysis. The third depicts the knowledge claims endeavored to be made in discourse analysis. The fourth proposes how and why sociologies is situated within the research methodology of discourse analysis.

Part One: Discourse Analysis

Discourse analysis, according to Potter and Wetherall (1987), is a broad theoretical framework which focuses attention on the constructive and functional dimensions of discourse, coupled with the reader's skill in identifying significant patterns of consistency and variation. According to Gilbert and Mulkay (1984) discourse covers all forms of spoken interaction, formal and informal, and written texts of all kinds. The goal of discourse analysis is not to study the person in an environment but to study the language practices and discourses prevalent in different contexts (Harre and Shotter cited in Potter and Wetherall, 1987). The focus in discourse analysis is to examine how discourse is constructed and what it is doing (Gilbert & Mulkay, 1984; Potter & Wetherall, 1987).

The term "construction" is apposite for three reasons. First, it reminds us that accounts of events are built out of a variety of pre-existing linguistic resources. Second, construction implies active selection: some resources are included, some omitted. Finally, the notion of construction emphasizes the potent, consequential nature of accounts. Much of social interaction is based around dealings with events and people which are experienced only in terms of specific linguistic versions. In a profound sense, accounts 'construct' reality. (Potter & Wetherall, 1987, p. 33-34)

Under the rubric of discourse analysis people are always constructing versions and re-describing events; descriptions do not simply and neutrally reflect reality.
Constructs and conceptions mediate our experience in descriptions, metaphors, models and explanations. We do not have unmediated access to "brute" reality; our version of things are, for better or worse, more or less accurate for our purposes. They invite criticism. (Cherryholmes, 1988, p. 128)

Discourse analysis views language use as much more variable than a 'realistic' descriptive model of language in which discourse is a relatively unambiguous pathway to actions, beliefs, or actual events. Under the rubric of discourse analysis forms of analysis do not:

...merely reflect or mirror objects, events and categories pre-existing in the social and natural world. Rather, they actively construct a version of those things. They do not just describe things; they do things. And being active, they have social and political implications. (Potter & Wetherall, 1987, p. 6)

Hence, discourse is not a pathway to entities or phenomena lying 'beyond' the text. For example, discourse analysis does not try to uncover cognitive processes from participants' discourse. Discourse analysis views language as: 1) used for a variety of functions with a variety of consequences; and 2) both constructed and constructive.

Discourse analysis also sees variation in language differently than is often assumed in a realistic tradition. In the realistic tradition it is assumed that when people describe the same event, action, or belief their accounts will, broadly speaking, be consistent "...descriptions and explanations of events and experiences may be regarded as highly valid, when they are, by and large, the same across accounts" (Brenner cited in Potter and Wetherall, 1987, p. 34). In discourse analysis the detailed examination of variability in accounts is a basic research strategy. Because it is believed that the same phenomenon can be described in a number of different ways, it is assumed that there will be considerable variation in accounts (Potter and Wetherall, 1987, p. 35). Hence, variation in accounts plays as important a role as does the
Part Two: The Interview in Discourse Analysis

In discourse analysis the interview is not considered a research instrument for accurately revealing an unbiased set of opinions. Rather it is seen as a conversational encounter. As such, the researchers' questions become just as much a topic of analysis as the interviewees' answers: the nuances in the question are as important as the nuances in the answer. The researchers' questions are seen as active and constructive, not neutral and passive. Hence, reflexivity, here seen as a mean of exploring and illustrating rhetorical construction, is an integral component of discourse analysis.

Discourse analysis typically uses an interview format to access discourse (as opposed to questionnaires for example) because:

- The conversational format of the interview allows the interviewer to intervene, probe, and confront participants about particular points of interest. This allows researchers to push for specifics, to present alternative facts or points of view, to point out contradictions. In short, to tackle the same issue in more than one way.

- The typically open-ended nature of the semi-structured interview in discourse analysis permits the researcher to direct the conversation along certain lines yet remain flexible enough to explore through additional questioning any interesting, unforeseeable, spontaneous aspects of the discourse.

Overall, interviews in discourse analysis often differ from conventional interviews in three ways:
1) variation in responses is seen to be as important as is consistency in responses;

2) techniques which allow diversity rather than those which eliminate it are emphasized, resulting in more informal conversational exchanges; and

3) interviewers are seen as active participants rather than like speaking questionnaires.

Part Three: Knowledge Claims in Discourse Analysis

Discourse analysis endeavours to make certain claims about discourse, there is no attempt to access and assess something “under the skull” or to define or describe a person’s characteristics or qualities. For example, no claims are made with respect to cognition or attitude. Discourse analysts endeavour to make claims about characteristics of the constructive nature of discourse, that is, the way in which textual versions of the world are put together and to see what effects these versions might create. The idea is to trace the “curve of discourse”, to become more informed about and, in turn, critical of the constitutive nature of our talk. Ultimately discourse analysts hope to be able to make detailed predictions as to the sorts of wording which would produce certain effects. However, what produces effects in one context may differ in another. Briefly, discourse analysis seeks to make claims about:

- the structuring (selecting) impulses in language construction, notably their relation to social order;

- the reproductive and contestatory dimensions of our efforts to make meaning;

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13 Miller (1980) suggests that if audience is better educated about the workings of various rhetorical devices of talk it may respond in a more sophisticated and critical manner.
• the operation of social texts: to learn what effects some discourse may produce in some contexts. (Potter and Wetherell, 1987)

Part Four: Discourse Analysis and Sociologies

As was previously mentioned there are three main traditions in the analysis of discourse: 1) grammar, signaling, and ethnography; 2) meanings, framing, and interpretations; and 3) the analysis of rules for sequencing in conversation (Solomon, 1990). Sociologies is best associated with the second of these traditions (meanings, framing, and interpretations). Within this tradition sociologies focuses on how discourse pertaining to socioscientific issues is framed in terms of its construction and operation. Sociologies introduces a way of mapping and questioning the construction and operation of socioscientific discourse in STS education. It is, arguably, a simplified form of discourse analysis, that is, it does not have all the detail that most discourse analysts would demand. However, this simplification is also its strength as well as its weakness. This simplification is a strength of sociologies because if sociologies is to be used by students and educators to analyze socioscientific discourse then, at least initially, the framework must be manageable. By manageable I mean that framework should be able to be used without extensive training or time demands inherent in “full-blown” discourse analysis. Sociologies is simplified to provide an entry point into textual analysis for those students and educators in STS education who are unfamiliar with analyzing discourse. It allows them to begin examining what points are linked in socioscientific discourse, the size and strength of those links, how they alter, and who gets to make them. Moreover, sociologies foregrounds a particular association typically affiliated with science, notably the construction (what Latour calls “attribution”) of cause and effect relationships. Thus, while simplified, sociologies can provide students and educators with a means of beginning to look at the construction and function of their own and other’s discourse. In addition, as students and

14 For example, many forms of discourse analysis record and analyze discourse sequencing or intonation.
educators learn to identify significant patterns of discourse they will increase their skills to engage with and critique their own and others language. Thus language is upheld as “a force that collectively enables people to transform their world” (Fuller, 1993, p. xi).

Section Three: The Developed Framework of Sociologics

To recapitulate briefly, sociologics assumes that in the face of controversy people strive to make their claims more credible than the claims of other people. The idea is to map how people attempt to render their claims more credible than others’ claims, to see what they link together and how well it holds together when challenged. According to Latour these different links are equally logical and rational. However, they are not equally credible. In this respect the links are socio-logical, that is, they are portrayed in terms of their strengths and weaknesses, not whether they follow a particular path (which some person or group has claimed as “rational” or logical’). Hence, Latour accounts for difference in terms of credibility. He does this by examining the strengths and weaknesses of associations tied to a claim. Strength is determined by: how many points are tied to a claim (resources rallied), which links hold together when challenged and which give way easily (negotiability), and how claims that counter are untied (obstacles overcome). This is done by mapping the dynamics of definition (what is at issue), attribution (what is legitimate), and distribution (according to whom). In Latour’s words, who is accusing who, what are their proofs, who are their witnesses, how is the jury chosen, and what evidence is considered legitimate?

In this section I interpret Latour’s five questions of sociologics. Latour’s questions are: (1) how cause and effects are attributed; (2) what points are linked to which other; (3) what size and strength these links have; (4) who the most legitimate spokespersons are; and (5) how all these elements are modified during the controversy. Latour considers the entire process of sociologics in the context of competing claims: it is through this competition that competing chains of associations are revealed and perhaps modified.
Question 1: How causes and effects are attributed?

Sociologics examines how these cause and effect relationships are attributed, that is, cause and effect relations are seen as produced, not discovered. Causal relations are particularly esteemed in science because, when convincingly substantiated, such relations engender explanatory and/or predictive power. They are often used to demonstrate the existence of a problem (i.e. chemicals are causing health problems) and/or to uphold a particular position with respect to the problem (i.e. we should have a major clean up because of all the health problems that have been caused by chemicals). However, whether or the degree to which causality is legitimated, convincingly or otherwise, often remains unexamined in discourse. Latour calls such unproblematic associations “black boxes”. That is, the claims they entail are assumed to be warranted. In other words, the warrants have previously been established and although questionable; they rarely are. For example, that gravity causes all objects to fall at the same rate in a vacuum has become, and remains one of science’s black boxes. However, black boxes are not to be confused with statements that are simply unsubstantiated; these should not be taken for granted.

This research question maps and queries whether, how, and to what end causes and effects are attributed. First, is there attribution of cause and effect? If so:

- what causes what?

- who or what is responsible? Is there one causal agent or many?

- what kind of effects are there: positive, negative, long term, short term?

- what is the scope of effects: people, things, animals, environment?

- what is the scale of effects: personal, local, global?
• how certain are the effects: avoidable, unavoidable?

Second, how is the attribution presented? Is it:

• queried?

• refuted?

• assumed?

• substantiated in any way?

Third, what does the attribution create? Does it:

• provide evidence of a problem?

• substantiate a particular position?

• other?

**Question 2: What points are linked to which other points?**

The purpose of this question is to follow the associations made in a controversy. Implicit in the question is an initial suspension of judgment with respect to what ideas are and are not expressed and/or linked; the aim is to follow what ideas are linked no matter where they lead.

A *point* is defined here very broadly as an idea. An idea can be of any form or content. Ideas can be simple or complex. An idea might be a concept or a principle, a plan of action, a way of thinking. Points that are linked to one another form *associations*. Associations depict relationships. Such relationships can be more and less equal, more and less certain, and more and less inclusive. Relationships that depict similarities are often expressed through
conjunctions (such as, "and"), verbs (such as, "to be"), or through comparisons via tropes, (such as, analogies and metaphors). On the other hand, many relationships are exclusive and/or conditional in nature. Such relationships tend to be expressed by conjunctions, (such as "not", "either" and "or") or by contingencies of supposition, (such as "if this then that"), of exception (such as, "this, but not that"), of temporality ("when" or "as soon as"), or of potentiality (such as, "possibly", "maybe"). The potential number and combination of relationships is unimportant here. What is important is that these relations (associations) are unpredictable and heterogeneous.

The associations of particular interest in this study are those that support a point of view (POV). Points of view are foregrounded because to date they have been the principle unit of analysis in socioscientific assessment research. (As shown in Chapter 3.) A point of view is defined as a position with respect to the issue and a point or points offered in support of that position. (At least one point is required to support a position to be considered a point of view.) For example, "I think they should clean up the pollution because it will effect the health of the community." In this example the position is a "cleanup" and the support given for that position is "because the pollution will effect the health of the community." Thus, in this question points of view are mapped in terms of the positions taken and the kinds of points (e.g. political, ethical, economic, etc.) offered in support of that position. In this research points of view considered are those pertaining to:

- the issue as presented in the story,
- the students point of view on the issue, and

Note that points of view is being used in a limited, personal sense. It is not being used to refer to points of view in terms of their situatedness, i.e., how they relate to a larger context. For example, points of view here are not referring to viewpoints commonly attributed to "feminists", "students", or "North Americans". This is not to say that individual points of view ought not to be considered in terms of the larger context in which they are produced. They are simply not the focus of this analysis.
• the student's point of view on the second, related story.

(Note that students' points of view on regulatory practices with respect to the issue are mapped in question four.)

**Question 3: What size and strength do these links have?**

In considering size and strength of links it is important to realize that Latour considers sociologies in the context of competing claims, i.e., it is often only through opposition that chains of associations are revealed and perhaps modified. It is important to recall this because it is when people are challenged that their associations often become explicitly expressed.

The size of the links can be looked at in terms of numbers (i.e., how many points are linked to a claim) and in terms of kind and range of points, (i.e., points within a particular perspective or across perspectives). For example, a position may be supported by all kinds of economic information, or it may be substantiated by rallying multiple points from any number of perspectives, e.g., political, ethical, legal, or environmental.

Trials of strength are a process wherein one examines which links are solid and which are weak. That is, which associations hold together and which give way easily, which associations are negotiable and which are not. Latour suggests that such trials “trace the limit of a paradigm, that is, the set of elements that have to be modified for some association to be broken away or for some new one to be established” (1987, p. 210). Under this rubric strong associations are those that hold together when challenged. In fact, the strength of the links can sometimes be so strong (backed by and tied to many elements considered legitimate) that challenging the links would prove to be virtually impossible. To do so would be counter productive as those links are taken as a given, it is no longer deemed profitable to query them. In contrast, weak links are those which are easily broken apart. These links do not withstand the challenges set before them. Of course, what constitutes strong and weak is a question of
degree. Associations can hold together well under some tests but not in others. In this respect a network of associations in support of a particular claim is rarely entirely defined as strong or weak. They are more or less weak in certain areas.

This research question maps the size and strength of students' associations in two protocol sections: their personal point of view on the issue and their point of view with respect to the salient event. These two protocol sections were chosen because they were specifically designed to challenge whatever claims were put forward. Size is mapped in terms of the number and range of points presented to support a position. For example, a student may substantiate their position using a range of points: one economic, several ethical, and one political. Or, they may choose to support their position within a particular perspective and use only economic points. Strength is mapped in terms of how students' points of view respond to challenge. Do their positions change? If so, how and under what circumstances? If not, how are positions upheld?

Question 4: Who the most legitimate spokespersons are?

In the face of controversy, people often rally spokespersons to substantiate their claims or to refute a competing claim. This question looks at which spokespersons are legitimated in a controversy. A spokesperson can speak on behalf of people (e.g., union representatives) and things, (e.g., visual inscriptions in the form of graphs, numbers, photographs, maps, etc.). The spokesperson is someone who speaks for people or things, both can be represented. The idea is that when you confront a spokesperson you are not confronting just anybody, you are confronting a representative, that in some authoritative way represents many things or many people.

However, the points of view that the legitimate spokespersons express are often conflicting. For example, scientists do not always agree on what constitutes evidence: similar experiments may produce the same results but be interpreted differently, or the replicated
experiment may not produce the same results. Or again, the same piece of evidence may be considered quite differently depending upon who utters it: whether it is uttered by a professional, the media, a professional group such as the National Science Foundation, or a friend. Then again, different groups might use a piece of evidence to substantiate a claim whereas other groups might use it to refute a claim. What is important is that evidence can often be problematic depending on who produces it, who interprets it, and who expresses it. In this question the objective is to look at who gets to speak (either on behalf of themselves or others or things).

While the legitimate spokespersons are considered across the interview, this question is explicitly examined in the regulations section of the protocol. Spokespersons are examined in terms of:

• who is considered legitimate and why?

• who is not considered legitimate and why?

• to what degree is bias considered?

**Question 5: How all these elements are modified during the controversy?**

This question looks at how all the above elements may be modified over the course of a controversy. In this research I examine the modification of elements over the course of one interview. Elements can be modified in many ways: new actors (human or otherwise) may be introduced, others may be discarded, positions may change, more resources may be rallied to increase support for or to refute a claim. For example, a person may be quite willing to call for a major clean-up at any expense, even at the expense of losing jobs in a particular community, but may change their position on the issue when their own job is on the line. Or, a person might initially portray an association as unequivocal (i.e., that chemicals are harmful) and yet
query this association later under different circumstances. Typically, only associations that get modified are commented upon in this question. In other words, consistency of associations is not highlighted.

Limitations and Delimitations of the Study

Limitations of the Study

There are several limitations of the study. The first limitation concerns the application of an analytical framework on data that were not designed with this particular analytical framework in mind. The framework of sociologies was indeed applied to data ‘after the fact’. However, the interview protocol in the original research project (The Socioscientific Issues Component) does correspond to an interview protocol that would have been developed if the intent had been to use the analytical framework of sociologies to analyze the data. In sociologies people map their associations in the face of controversy, that it is when they are challenged. This was an integral aspect of the Socioscientific Issues interview protocol. Furthermore, one of the more specific associations Latour’s questions highlight is who the legitimate spokespersons are considered to be. This, too, was an integral and foregrounded part of the Socioscientific Issues interview protocol. The only association of particular interest to sociologies that was not specifically targeted in the Socioscientific Issues interview protocol was that of the attribution of cause and effect. However, as is evidenced in the following analysis chapter, the attribution of cause and effect certainly features in the students’ discourse. Perhaps this is due to the powerful role these associations inherently play in any socioscientific issue.

The second limitation to be addressed concerns the lack of student participation in the research process. In terms of student involvement in the research process limited financial resources, time, and geographical accessibility of students did not permit preliminary
involvement of, nor follow-up interaction with, students (i.e., member checking). With respect to the relevancy of issues to students, all issues were contemporary news interest items.

The third limitation to be addressed has to do with sampling data on a “one-shot” basis, that is, not mapping students’ associations over time. By accessing students’ discourse only once there is no means in this research to examine the consistency and/or inconsistency of associations over time. However, given the uniqueness of discourse assumed in discourse analysis and the inherently heterogeneous nature attributed to associations in sociologies, the singular sampling of discourse does not counteract the purposes of this study’s methodology. However, this does not mean that there cannot be consistency or homogeneity of associations in discourse. It does mean that variation, as opposed to consistency, is assumed and foregrounded.

**Delimitations of the Study**

The delimitations of the selected data base are twofold. The first is that this data base employs only one of the primary forms of discourse used in school, oral discourse. Again, oral discourse was selected because it allows for additional questions to both clarify and challenge responses. I did not try to apply sociologies to the written data base of the Socioscientific Issues Component as it was not designed to query or challenge students’ responses. The second delimitation is that the framework of sociologies is examined in only one research context. Time and financial constraints did not permit the exploration of the issues in different contexts, nor with different groups of people. As such, the associations in response to these issues by others, such as experts, scientists, parents, or educators themselves, are not available for consideration nor comparison with students’ responses.
Summary

This chapter presented some of the methodological considerations about and methods used concerning data selection, collection, and transformation in this research. An argument was made to see sociologies as a particular form of discourse analysis to enable students and educators to begin analyzing the constructive and productive nature of socioscientific discourse. The framework questions were also developed for use in STS education.

The next chapter applies the framework of sociologies to the selected data base and outlines some of its strengths and weaknesses.
CHAPTER 6

SOCIOLOGICS APPLIED

Overview

In the first section of this chapter I apply the analytical framework of sociologies to several interviews concerning the Disposal of Toxic Waste. Following each analysis is an examination of the strengths and weaknesses of sociologies in terms of what the framework enables and constrains with respect to discourse analysis in socioscientific issues. In Section Two I summarize the strengths and weaknesses of the framework in light of the analysis conducted on all interviews pertaining to the toxic waste issue (n=60).

Section One: An Analysis

To show how the analytical framework of sociologies maps associations within and across interviews in a given issue this section presents the analysis of four interviews (concerning the socioscientific issue of the Disposal of Toxic Waste). As previously mentioned, these interviews have been purposely selected (using an intensity sampling strategy, Patton, 1990) from 60 interviews that were analyzed using sociologies. Two were selected from Grade 7, one from Grade 10 and one from Grade 11. (The interview of Natasha, a grade 7 student, is included in Appendix A.) Each analysis is prefaced by an explanation of why the particular interview was selected and followed by a discussion of the strengths and weaknesses of the framework to analyze the discourse in question. A discussion of how the framework and research in socioscientific research might be improved in light of these analyses is conducted in Chapter Seven. (Please note that in order to make the data analysis easier to read I speak of the person, not their discourse. For example, instead of talking about Natasha’s “discourse” I simply speak of Natasha.)
An Analysis of Natasha's Associations

Natasha is a Grade 7 female student. She responded to the print version of the issue of toxic waste. I selected Natasha’s interview because her associations illustrated a common size and strength of students’ discourse. However, while Natasha’s associations were similar in terms of content to those of many other students, she expressed her associations tentatively. The way in which she expressed her associations (this “tentativeness of expression”) affected the strength of those associations. Her self doubt and hesitancy undermined her associations. This “modality of expression” poses interesting questions for analysis in terms of how modality enhances and constrains credibility. This is discussed after the analysis.

(a) How causes and effects were attributed?

For Natasha the attribution of cause was uncertain. She depicted the cause of the problem (a rash in question) as due to, “… some toxic materials or something and the doctors and the Mom think it is spreading, or think it can spread.” This causal relationship was uncertain: she was neither certain that the rash was caused by the toxic waste, nor sure that others (doctors and mother) were convinced that the rash was spreading. She did not mention the scientists report to substantiate the chemical-rash link yet said she would take the report “pretty seriously.” (Natasha’s associations about the legitimacy of the scientist’s report are further discussed in the fourth question of sociologies: who the legitimate spokespersons are considered to be.)

For Natasha the attribution of effects was also uncertain although she cited potential effects to substantiate her position on the issue. That is, while she remained uncertain about whether the chemicals did cause the rash and whether the rash was indeed a problem, Natasha cited other potential consequences (“the mess”) to substantiate her own point of view on the issue, “I just think it is right to clean up all the mess cause if you just clean up the top layer then it might come back, or, I don’t know.” Effects, while generally tentatively asserted, were
things that escalate, were negative and serious: she noted that chemical problems got bigger and bigger and killed trees, people got really upset, and everyone lost their jobs. Yet, not all effects were the same for Natasha. She did discriminate between the effects of some chemicals as opposed to others. That is, chemicals may have differing effects depending on their potency and, as such, require different storage regulations. For Natasha effects primarily concerned people: she focused on emotional (anger, worry) and economic consequences. However, effects also concerned the environment: the trees and the environment could be ruined or destroyed.

In terms of who was responsible for “causing” the alleged problem, Natasha assumed that the chemical plant in question was responsible. This link was never substantiated nor queried.

(b) What points were linked to which other?

Natasha’s point of view called for a major clean-up. Her support for this was that if this was not done then the problem might return (“the mess might come back”). When faced with the potential job losses that might ensue from such action she maintained her position (clean-up) but did so hesitantly, “Um, I guess so.” She then proposed a solution to unemployment by appealing to employment availability elsewhere, “Um, well people can always get jobs somewhere else, or...” Again, Natasha left her association open-ended. When asked if she would be prepared to give up her job to support her position Natasha reaffirmed her position and pointed once again to three potential consequences: emotional distress on a large scale, escalation of the problem, and extensive unemployment.

When Natasha was presented with the second, related story and asked whether she would drink the water she did not commit herself. Instead she asked for 1) more about the water (what it looks like, if it’s a weird colour, or if it smells; 2) opinions from the media and
her friends; and 3) information on whether others had drunk it. Thus, when the issue became more personal Natasha refrained from making a decision, choosing to examine evidence and obtain the opinions of others. She then created an alternative, saying she would buy bottled water. Although she created this alternative for herself, Natasha said that she would let her friends drink the water first and see what happened to them. Eventually, with additional probing, Natasha did take a position, albeit tentatively, that she would not drink the water. She then spontaneously offered a solution to the economic consequences that would arise from her position "... once the clean-up’s done and the company gets more money then they can hire more, they could keep you off for awhile and then I guess you’d be like the first priority."

(c) What size and strength these links had?

Natasha’s associations varied in size. Sometimes she would offer one point in support of her position, other times she would offer as many as four (evidence before drinking water). In her associations she appealed to medical (health) and economic values (jobs), evidence (water looked or smelt funny), others’ opinions (friends, news); she refuted alternatives (cited negative consequences to not cleaning up: emotional distress, escalation of the problem), and created alternatives (find a job elsewhere, company can rehire, and buy bottled water).

Natasha’s points of view were steadfast but they were not presented assertively: she expressed her points of view tentatively (I guess, probably, I just think) and left her claims open to alternatives (or something, or I don’t know). However, while tentative and open, her position remained consistent: she wanted a major clean up, would give up jobs (including her own) and would not drink the water (although this was dependent on certain factors concerning evidence/information from self and others).
In terms of negotiability Natasha did not consider alternative points of view (for example, that of the company). However, she did say she would like more information. Yet, when asked if any information might change her point of view she said no.

As the interview progressed, Natasha’s associations increased in size and became more open to negotiation. Instead of immediately assuming a position Natasha began to openly consider options. For example, she began to weigh out the potential advantages and disadvantages of having one scientist or a group of scientists conducting tests. She also debated whether storage safety with respect to chemicals could ever be completely safe, “...one day there might be, the chemicals might be put into a container and everybody might say it’s completely safe, but then they might not know like that the chemical does something else and it might go through the thing, or burn a hole.” She began to articulate a greater sense of complexity and to debate, though not necessarily resolve, differences.

However, it was when the issue became more personally relevant that the size and negotiability of Natasha’s associations increased the most. She delayed assuming a position and began to query evidence (4 points) and consider others’ opinions (2 points). When pressed again for her position Natasha created an alternative for herself (she said she would buy bottled water). Interestingly, risk reduction was considered with respect to herself, not others (she said she would let her friends drink the water first and see what happened to them). Eventually, she assumed a position consistent with her concern for health and said she would not drink the water.

(d) Who the most legitimate spokespersons were?

When asked about who should make the rules about chemical storage Natasha was unsure, “Um, I guess the people who do the clean-up, I don’t know.” Once again Natasha assumed a position then opened it up. When presented with a list of those she might consider
to make the rules Natasha chose the government. She supported this position by refuting alternative spokespersons, notably the company, "Cause if you let the company workers, they might, since it's their own company, they might just turn around and do something else with it...some might not wanna lose their jobs I guess." She further substantiated her belief in the government by characterizing them with an upright, ethical nature, "And the government pretty much has to do the right thing or whatever he thinks is right." Hence, Natasha depicted bias as negative with respect to the company and as positive with respect to the government.

At first Natasha was unsure who should enforce the rules, that is, who should do a check-up to ensure rules were being followed. She hesitated saying that she did not know who. Eventually, however, she suggested that she could verify through her own experience, "I guess if I went there myself and saw, then I'd know." After probing she changed her mind and said that scientists should do the check-up, "I guess a specialist in chemicals, 'cause they probably know more about it 'cause I guess they work with that topic and city workers just do all sorts of jobs...the specialists have the most experience with chemicals." For Natasha scientists were specialists, they worked on one area of work (whereas environmentalists did lots of work in many areas concerning the environment). On several occasions Natasha equated doing a variety of work with less knowledge, that is, specialists have more knowledge than those that work in a variety of areas. She used this same reasoning to have a specialist come in (as opposed to her first suggestion of city workers) to do the check-up for storage regulations. More knowledge was also tied to greater experience.

When queried about her belief in the university report Natasha said she would believe the report as it might affect her directly, that is, get into her water supply. Yet, she was unsure who, or how many scientists could or should conduct tests. First she claimed that it would be better if a group of scientists conducted the tests. Then she proposed that actually a single scientist could conduct the tests. Then she noted the advantages of a group of scientists
because they would make more balanced, less biased decisions (one scientist might just "do what he wants").

Hence, Natasha upheld the government to make rules about chemical storage. To enforce regulations she cited her own ability to verify procedures were being followed and that of scientists to conduct necessary tests. With respect to bias, Natasha associated positive bias with respect to the government. She made no mention of the potential bias of her own observations or point of view. She had some concerns about the potential negative bias of scientists when conducting tests and company workers to make good decisions when they were directly affected by that decision.

(e) How all these elements were modified during the controversy?

Overall, even though Natasha’s points of view were presented tentatively she did resist changing her claims when challenged. Her associations displayed the greatest flux when she was considering issues of legitimation (who should have jurisdiction to oversee chemical regulations) and when the issue was made more personally relevant to her.

Her associations became the largest and strongest when the issue was made more personal, both for herself and for others. However, it was not until challenged on a personal level that Natasha called for any evidence to establish the problem. She also modified the size and strength (length and deliberation) of her associations as the interview progressed: she began to suspend judgment, take the time to weigh concerns and to consider alternatives presented to her. It was at the very end of the interview that Natasha made her first and only spontaneous association: she offered a solution to compensate for the consequences which arose from her position on the issue.
Discussion of this Mapping (Natasha)

Natasha expressed the same point of view on the issue as did many other students (clean-up for health reasons). Through sociologics we can see what points remained important to her, what points were more negotiable (open) and how Natasha’s associations increased in size and in strength both as the interview progressed and became more personal. Her associations displayed three common characteristic in students’ discourse: 1) associations became the largest and strongest when the issue was made more personal; 2) it was not until challenged on a personal level that evidence of any sort was called for; 3) length and deliberation of associations increased as the interview progressed: judgment began to be suspended, concerns began to be weighed, and options began to be considered.

However, what sociologics did not foreground was how Natasha’s associations were expressed. Her associations were often expressed tentatively. For example, she tended to preface her point of view with words such as “Maybe” or “I guess” and end her point of view with phrases, such as “..or I don’t know.” This type of tentativeness and openness of expression was common to many students’ discourse, particularly of those in the younger grades.

Sociologics did not take the way Natasha’s associations were expressed into consideration. However, this is not surprising given that sociologics was developed for the analysis of scientific texts, not transcribed conversation. Yet, the manner in which Natasha expressed her points of view (tentatively) did not help to strengthen her claims even though she depicted the same content (made the same points) as many other students. As such “modality of expression” may enhance and undermine credibility, sociologics needs to examine how this modality renders claims more and less credible. How sociologics can be adapted to include “modality of expression” will be discussed in Chapter Seven.
An Analysis of Ken’s Associations

Ken (Grade 7) responded to the video version of the toxic waste issue. His interview was selected because in terms of the definition of point of view used in this analysis, Ken rarely articulated a point of view (position and support). That is, he did not typically offer support for his positions. Rather, he would articulate a position then consider consequences or say what ought to occur (offer prescriptions). Many students constructed these types of associations (linking a position to consequences or prescriptions instead of offering support for that position). This raises an interesting question for analysis in socioscientific issues: what elements ought to be valued in a point of view? This question is discussed after this analysis.

(a) How causes and effects were attributed?

Ken depicted controversy around the cause of the problem (the rash): some people thought toxins seeped into the soil and got into the water supply whereas others did not. He, himself, attributed the cause of the problem to the chemicals. However, Ken did query whether chemicals in general necessarily caused harm (See below).

Effects changed for Ken over the course of the interview. In the issue effects were local (concerning children and families) and negative (economic and health related). In his own point of view all chemicals were harmful. He referred to them as a uniform group, as “pollutants”, pollutants that would eventually “kill us off”. However, later on (when asked what additional information he would like about the issue) Ken differentiated between chemicals and their effects. He asked for more information about the different types of pollution and what each one did (effects). Then, (when asked whether any information might change his mind) Ken said he was confused about whether chemicals were actually harmful or not as:
... sometimes they say certain pollutants aren’t harming anything and then they say they are and that kind of confuses me because they keep changing their mind about everything...they say (scientists or reports) this isn’t harmful and then it is harmful and they’re arguing and arguing.

So, while Ken initially attributed a causal link between the rash (effects) and the chemicals (cause) this link was not as unequivocal as it first appeared when it came to his own point of view.

Yet, when it came to chemical storage regulations effects became harmful once again. Moreover, one could now even determine the degree of their harmfulness. This association served as the guiding principle for storage: the more harmful the chemical the further it should be kept away. Safety equaled distance, Ken no longer mentioned contamination via water systems. However, when the issue became more personal this safety was associated with technology (use a filter). Yet this safety link subsequently came undone (after an additional question to see whether Ken would drink the water or not with the filter) as Ken began to doubt the efficacy of the filter.

So, for Ken, chemicals sometimes entered water systems (toxic issue) and sometimes they did not (regulations). Sometimes all chemicals were bad (toxic issue) and sometimes there was confusion about whether they were harmful or not (point of view). Sometimes chemical effects were uniformly bad (issue) and sometimes they had varied effects (information request). Where confusion existed (chemicals harmful or not) Ken said he would chose the information that was most related to what he already had. Regardless, the further away chemicals were stored for Ken the better. However, once near, safety offered via technology became uncertain.
Ken never mentioned who was responsible for the chemical leakage.

(b) What points were linked to which other?

Ken depicted the issue as a whole in terms of causality: kids got rashes from toxins that seeped into the soil and got into the water supply. When asked whether everyone thought the same way about the issue Ken described two points of view: two positions (do nothing or clean up) and three points to account for difference: 1) whether one believed there was a problem or not; 2) everyone was basically different; and 3) value differences (jobs or health).

When asked for his own point of view Ken called for a clean-up. He did not say why. Rather he immediately focused on the consequences (economic) that ensued from his position and cited employment possibilities elsewhere. For Ken, consequential job loss was easily resolved, “anybody can move to another town and get another job.”

When the issue became more personal (asked whether he would drink the water) Ken did not take a stand. He said his response would depend on whether the family had a water purifier as it would take some chemicals out of the water. When asked again if he would drink the water Ken then said that he probably would not because some chemicals might get through. He then said he would not drink the water.

Over the course of the interview Ken expressed some other associations in relation to the toxic waste issue. When asked whether anything had influenced the way he thought about this issue Ken talked about his concern regarding forest practices in Brazil. He said they should stop cutting down the rain forests then immediately added that this request was highly unlikely to be accommodated as they (Brazilians) would hardly stop their practices while watching us do the same things here. Ken said we should change our cutting practices and become an example for such countries. He suggested two ways in which this could be done:
1) more controlled logging and 2) replantation practices. He then outlined two difficulties that would ensue from adopting such practices: logging would take a lot longer and would be more expensive. Nevertheless, he still felt adopting such practices would be a good idea.

(c) What size and strength these links had?

Ken’s associations varied in terms of size. Sometimes he offered three points to support differences in position (in his depiction of the issue as a whole) and at other times he offered no support for positions (when asked about his own point of view and concerning his position concerning forest practices in Brazil). When he did offer points to support positions there were usually two kinds, health (concerned about people and the environment) or economics (his own job protection as well as others). Ken often linked other points to his position. He appealed to consequences (two kinds: economical and ethical) or proposed solutions (two kinds, both self-oriented: change jobs or practices). His associations were the smallest in his own point of view. He readily assumed a position but did not substantiate it at all. He simply appealed to the availability of work elsewhere.

Ken’s associations were more extensive when he depicted others points of view on the issue and when it came to making regulations. In both these contexts he offered support for positions. However, in both these instances support for positions typically only came after several questions. Ken’s associations were the most extensive when he talked about what he thought should happen with respect to the rain forests in Brazil. Here he introduced a self-reflexive association (why should others change when we do not). It was also here that Ken created the most alternatives (proposing two alternative forms of action) and detailed the most consequences (two).

In terms of strength Ken did not waiver: he maintained his position for a clean-up in spite of economic consequences to himself and the community. When the issue became more personally relevant Ken refrained from taking a position. Instead, he called for something to
render his situation safer (water purifier). However, this deferral did not last long. Upon further inquiry he refuted the efficacy of the filter and said he would not drink the water.

(d) Who the most legitimate spokespersons were?

For Ken the government and the companies had all the power. The community was virtually powerless in face of these two groups. Scientists and their reports were trustworthy (scientists should do the testing, they have to “prove” things) but also confusing (could not decide whether chemicals were dangerous or not).

Ken noted conflict and tried to immediately resolve it. Resolution was sometimes easy (find work elsewhere, keep chemicals away), but not always simple (change forest practices in spite of problems).

Regulatory decisions ought to be made by a group consisting of at least two people. Ken explained that a group was best as several perspectives were better than just one. He did not elaborate (nor was he asked) why this might be the case. In this particular context Ken suggested that the group ought to include the head of a health committee. (No explanation was offered nor requested.)

Ken ascribed bias to two groups. The company was not to be trusted as they had negative prudential interests (“the company would just be for the company”), whereas the scientists could be trusted as they had altruistic interests (“scientists would be out for everybody”).

(e) How all these elements were modified during the controversy?

Ken modified his associations the most with respect to chemicals. First, all chemicals were all the same and harmful. Then, chemicals became variable (different ones with different
effects) and their harmfulness became questionable. Ken’s associations also modified during the salient issue: at first the purifier would remove chemicals, then it would not. As such, Ken’s points about effects and safety of chemicals were the most uncertain.

Ken suspended judgment only when the issue became more personal. Up until this point he readily offered a position on issues. He often only offered support for positions when asked to do so.

Unlike many students who’s associations increased in terms of size over the interview (often also increasing their strength) Ken’s associations were the largest in the middle of the interview when he spoke about the rain forests in Brazil. Ken articulated more associations with respect to this issue than with respect to the toxic waste issue writ large or to the salient event. He readily denoted specific prescriptions to resolve the issue and anticipated resistances to these prescriptions. This raises an interesting question. Would Ken’s associations have been larger and stronger or weaker and smaller if he had chosen the issue himself? That is, how does personal interest in, or familiarity with, an issue enhance and constrain one’s point of view? This is certainly too large a question to be dealt with here. For now, it is important to point out that Ken’s associations increased in size and in strength when he spoke about an issue with which he was already familiar.

Discussion of this Mapping (Ken)

One of the strengths of sociologics is that all Ken’s associations could be mapped, in this case even those that did not concur with the principal unit of analysis used (a point of view). However, the heterogeneity of Ken’s associations (what he linked to his positions) was not an isolated case. Many students tied other elements to their point of view: they denoted and responded to consequences, created alternatives, queried assumptions, etc. Students included
many more elements in their point of view than just support for positions. Sociologies could easily accommodate these additional elements. However, the principle unit of analysis used in this and other socioscientific research to date does not accommodate such additional elements. Yet, these constitutive elements of a point of view are highly valued in other domains of research, such as in the critical thinking/reasoning literature. If these additional elements, as evidenced in this analysis, are to be valued in socioscientific research then the definition of what constitutes a point of view in socioscientific research needs to be expanded. What elements ought to be included in a point of view in socioscientific research analysis and how this would be incorporated into the framework of sociologics is developed in Chapter Seven.

An Analysis of Tony's Associations

Tony (Grade 10) responded to the video version of the toxic waste issue. I selected his interview because Tony: 1) queried the cause of the problem 2) deferred his position until further evidence was obtained; 3) ascribed bias to all the actors he mentioned (although not consistently); 4) showed a particular sensitivity to consequences arising from loss of employment.

(a) How causes and effects were attributed?

Tony immediately queried the cause of the problem in the issue and insisted that more tests be conducted. Specifically, he called for more water samples to see if the chemicals were actually seeping into the water. However, once the cause was established then action had to be taken, "If the water is contaminated then it has to be cleaned up."

Effects were typically negative (health and economics affected) and used to support a position. This was often done by negating the alternative. For example, if you don't take care of the problem (no clean-up) alternative courses of action will run out and people will be too
unhealthy to work. Effects concerned people and the environment both in the short term and in the long term (effects would show up in the next generation). Effects could be foreseen (via other companies' experience) and controlled (via constant testing). Yet, if unaddressed effects could be irreversible (resources, such as water and the environment, were finite, nonrenewable).

For Tony causes and effects were systematically interrelated. For example, killing whales would affect fish which would affect the environment. Or, overplanting (South Africa) led to fields being ruined which lead to deserts which lead to people having no way to feed themselves.

While Tony queried the cause of the problem he never queried whether the company was responsible. He noted people's disagreement concerning how the company was responding to their mistake, not whether they had made one.

(b) What points were linked to which other?

Tony initially described the issue around different perceptions of the companies' behaviour: "some just want to show what some companies are trying to get away with" and others "want to go completely overboard on it" (that the company is not doing enough). Tony noted that overblown perspectives might put the company out of business. He said that both sides of the issue needed to be considered. When asked to explain why people took such different sides Tony explained that people's interests varied as some are concerned about economics ("one is really looking after his job") and others are concerned about health ("he doesn't want his children and stuff to get hurt").

When asked about his own position on the issue Tony refrained from making a decision. He saw a problem but he was not sure how serious it was nor whether it was caused
by the chemicals. He requested further tests. Then, depending on the results, he proposed two forms of action: if the problem was not too large they could pump in fresh water as a temporary measure, but if the problem was large then a full clean-up would be necessary. His support for either position was his interest in protecting the environment.

When asked about potential job loss, Tony cited employment options: one could find another job or start a new business. He suggested the business could be a clean-up business that might, in the long run, be economically profitable to the community. Tony then supported his position in three ways. First, he reiterated that protecting the environment was more important than protecting jobs. Second, he pointed towards the lack of efficacy of temporary solutions (such as pumping water in) as they will eventually run out. Third, he juxtaposed immediate job loss with permanent job loss (if you do not fix the problem, jobs will be nonexistent anyway in that there will be no place for people to work or people will be too sick to work).

When asked whether he would be willing to give up his own job, Tony said “Yes.” Again, he said that health was more important than jobs. This included the health of his own family and that of other families. Tony then created an option in the face of job loss: temporarily go on welfare until you find another job. He supported this by noting that in this way “at least the family could be fed”. He depicted a negative consequence to this solution (that living conditions would decrease) and a positive consequence (doctors’ bills might create even worse economic conditions).

When the issue was made more personal, Tony immediately took a position saying that if he had heard about the controversy he would not drink the water as it would be too dangerous. When asked what it would take for him to drink the water Tony called for a “really intense investigation.” That is, if certain groups (environmentalists or the university) thought
there was a danger then he wouldn't drink it. For Tony the testing had to be done by groups who were biased in a certain direction (wary that there was still a danger). He noted two problems with testing: they were not perfect and certainly one could always find a problem with the water if one wanted to. However, if two conditions were met (the university group could be convinced and they issued a report indicating that there was no danger) then Tony said he would drink the water.

When asked what might have influenced his point of view, Tony recalled two influences. One concerned the success of a canal clean-up that kept tourists coming and created a profitable clean-up industry that helped the local economy in the long run. The other influence was his recollection of the negative, long-term effects on the environment from the Gulf war. In that situation resources (water and the environment) were seen as finite.

(c) What size and strength these links had?

Tony did not readily articulate a point of view. Rather, he typically called for more information before making a decision. When he did take a position he tended to support this position with two or three points. He would either assert a value (usually a concern for the environment, for people's health or cite economic benefits) or refute the alternative by citing dire consequences (if you don't fix the problem then alternatives will run out and there won't be any need for jobs anyway). He tended to create alternatives, then denote and weigh costs (usually long term). It was when he was depicting these consequences or creating options for himself and others that Tony offered the most numerous and elaborate associations.

Tony's associations held together when challenged. Indeed, Tony became quite creative when challenged. He not only foresaw consequences but responded to them by creating options (develop a clean-up business). He demonstrated particular sensitivity with respect to consequences of job loss (noting that families could really suffer from such changes
in terms of basic needs such as food and living conditions. He constructed a quite realistic option (welfare) and noted both positive and negative consequences (family fed but living standards lowered). He realized that this too would be costly but argued that other options were not necessarily any more economically sound (doctors bills very costly).

(d) Who the most legitimate spokespersons were?

Tony said that groups ought to make regulatory decisions. He said that everyone’s views ought to be consulted and that everyone should work together so that their points of views would mutually affect each other. For Tony, two perspectives were essential to good decision-making, “…its’ no good having one perspective ‘cause you know, you can always argue both sides of the story.”

Companies were not to be trusted to follow regulations: they needed strict rules and for these rules to be enforced. No explanation for this position was offered nor requested. The check-up should be conducted by two groups: the environmentalists (Greenpeace) and the government (MP’s). Two groups were necessary as they could balance out each other’s negative bias (government could be bought off for re-election purposes and the environmentalists sometimes went too far in their concern for the environment).

Evidence played a large role in Tony’s associations. Evidence was obtained through testing. More evidence could help determine the cause and severity of the problem. However, evidence was also problematic: results were not perfect and problems could always be found. So, more evidence was better but imperfect and prudential. Yet, given certain evidence Tony said he would be willing to risk drinking the water (evidence seems unproblematic here). To obtain further information Tony said he would go to his local MP or to teachers.
When asked about whether he would believe the scientists’ report Tony said he did not know whether he would believe it or not as the scientists may be “just overreacting to it all.” Yet, he added that they would not “completely lie about it” and that their report would certainly have contained a “certain amount of truth.” Hence, one would have to look into it (the report) further.

Welfare was upheld as a legitimate response to unemployment (unemployment was depicted as temporary) as it puts food on the table and, although unfavourable (living conditions reduced), it is less costly than extensive medical bills.

Tony attributed bias everywhere although not consistently. Sometimes evidence was political (served interests) and sometimes it was non-problematic.

(e) How all these elements were modified during the controversy?

When the issue became more personal Tony readily expressed a point of view. Up until this time he continually deferred his position until he received further information. Information had many attributes: it could establish the problem, be imperfect, and serve interests. However, one characteristic remained constant: more of it was better. Scientific reports were uncertain but Tony turned specifically to them when the issue became more personal. That is, the very people who Tony said may have been overreacting were called upon to conduct intensive testing when the issue became more personal. So, sometimes bias hindered decision-making and sometimes it enhanced decision-making.

Discussion of this Mapping (Tony)

Sociologics provided a means to analyze the strength of Tony’s associations in terms of how his associations held together in the face of certain challenges. However, Tony’s
associations were also "strong" in other ways. First, he did not accept associations unequivocally: he queried the associations that supposedly substantiated the problem. Second, he refrained from making decisions on issues until there was more evidence to substantiate the existence of a problem. Third, he recognized that evidence was controvertible: research was imperfect, served interests, and who produced it mattered.

Sociologies mapped these three additional strengths to varying degrees, that is, more or less explicitly. The first strength, questioning and substantiating associations, is mapped in question one (the attribution of cause and effect). Sociologies places particular importance on questioning and substantiating associations that typically serve to substantiate or solve a problem. The second strength, deferring a point of view until due inquiry has been conducted, is not mapped. This is understandable given that sociologies was developed to follow how claims are rendered more credible, not how they were initially arrived at. The third strength, rendering evidence as problematic, is mapped, to a degree, in question four (who and what is legitimated). Sociologies assumes that things as well as people are legitimated and biased. Yet the mapping of evidence per se (how it is legitimated and depicting the positive as well as negative prudential interests of those who present it) is not explicitly foregrounded. Adding additional notions of strength and emphasizing how evidence is and is not portrayed are considered and incorporated into the framework of sociologies in the final chapter. For now, it is important to note that sociologies (as interpreted here) maps only certain notions of strength and evidence.

An Analysis of Veronica's Associations

Veronica (Grade 11) responded to a video version of the issue of toxic waste. I chose Veronica's interview because she depicted multiple points of view on a problem (not just two), resisted constructing a point of view (often forming one only when queried), and portrayed
issues and decision-making as complex and political. In particular, Veronica repeatedly upheld that: 1) one should be informed about an issue before assuming a position on it; 2) no position was simple (each had negative consequences to be deliberated); and 3) points of view were often, though not always, biased (typically negative).

(a) How causes and effects were attributed?

For Veronica chemicals unequivocally caused the problem: she never queried the link between the rash and the chemicals. Yet, when subsequently asked whether she would believe the scientists report that purported a link between the rash and the chemicals Veronica was not sure. She said the report contained “elements of truth.”

For Veronica causes were singular: chemicals caused health problems, effluents caused pollution, chemicals killed animals, and negligence caused accidents. Yet, while causes were singular they were not all the same. Differences in toxicity and their subsequent effects were noted, “one gram of fluorocarbon can annihilate just about anything.” Yet, this association (that a very small amount of chemical could have deadly effects) did not play a part in her deliberations concerning whether or not to drink the potentially contaminated water. On the contrary, Veronica thought she could diminish potential health risks by reducing the amount of contaminated water she consumed.

Veronica attributed effects as negative, never positive. For example, when considering potential job loss that might ensue from a major clean-up proposal Veronica said that, “Well, I think it’s a no-win situation in that case because if the clean-up’s not done then the community suffers and if it is done the community suffers because jobs may or could be lost.” For Veronica effects were not only negative, they were also long term: they did not go away easily and did not necessarily show up over the course of one’s lifetime. Moreover, effects were inter-related and often escalated: rashes could lead to cancer which could lead to more birth
defects. Effects were harmful and pervasive: they harmed people, animals, and the environment.

In terms of who was responsible for causing the rash Veronica assumed it was the company in question. Yet, according to Veronica, these types of problems were really due to a very small percentage of companies (1%). She said that most companies were responsible concerning the disposal of their wastes and that only a negligent few posed such problems. She noted the example of the Exxon Valdez company and commended them for their efforts to clean up the environmental problems arising from their oil spill. She attributed this oil spill to the company’s negligence. So, while companies were generally responsible and negligence an exception, this association was not brought to the case in question.

(b) What points were linked to which other?

Veronica depicted the issue as non-controversial, “It’s about the toxination of the water.” When queried she outlined a range of points of view. She explained that differences in points of view were due to the way in which people did and did not choose to respond to problems (whether or not to face them). She suggested that something ought to be done as health problems would escalate. Yet, when asked what she thought should be done Veronica deferred taking a position saying that she did not “know enough on the subject to comment about that.” When subsequently presented with a choice of two alternatives (a minor and a major clean-up) she did choose (the major clean-up). Her reason was that a major clean-up would be better than its alternative (the minor clean-up). Veronica immediately noted a limitation to this position: that the major clean-up would only partially alleviate the problem as toxins take a long time to get rid of.

When challenged by the potential job loss that could arise from a major clean-up Veronica described the costs either way, “if the clean-up’s not done the community suffers, if
it is done the community suffers still because the jobs may or could be lost.” Again, only when forced to choose did she reassume her previous position. She supported it in two ways: 1) valuing future health (children might be able to grow up healthy); and 2) refuting the alternative (minor clean-up). (She refuted the alternative by claiming that it was not an effective way to remove the toxins and that taking such ineffective action might mislead people into a false sense of security.)

When asked whether she would be willing to give up her job, Veronica said, “Yes.” Her reasons were threefold: 1) she was not concerned about herself; 2) long-term thinking in these issues was important; and 3) other jobs were probably available. She readily assumed the personal consequences her position might entail.

When asked whether she could imagine anything that might change her point of view Veronica described the response of the Exxon Valdez company (the company assumed responsibility for its mistake and took action to rectify the ensuing damages). She proposed alternative action plans that the company might have taken to avoid the oil spill, delineated the complications of these alternative actions plans, and concluded that there was no easy solution.

When the issue was made more personal (whether or not she would drink the water), Veronica answered that she did not know. She articulated two influential factors. The first was her friends opinions which she valued because of their extended experience with the problem and because alternative sources of information were not satisfactory (“the media might blow the problem out of proportion”). The second factor was evidence. She would ask “if there had been any symptoms” and inquire into the safety of the water. However, her desire for symptomatic evidence was countered by a very strong concern to not offend her friends (as if her friends would be insulted by her asking questions about the safety of the water in their
home). This was a common student concern, one that seemed to greatly affect their ability to articulate their concerns about the safety of the water.

When then asked whether she would drink the water over the entire week, Veronica still did not make a decision. She said it would again depend upon evidence: if the evidence was serious (someone had died of cancer) then she would be unsure about the safety of the water. If there was no evidence available Veronica suggested that it might be fine to drink the water as there is no concrete reason not to. However, she quickly added that she would be very careful to not drink a lot of the water. She then created an alternative for herself “to drink juices that have not been made with the particular water in question.”

(c) What size and strength these links had?

In terms of size Veronica’s associations were larger than most other students. She supported her positions by linking two to three points. In these points she would appeal to values (health, economics, ethics) and evidence (look for symptoms). She also employed other means to substantiate her position. She would: refute alternatives (efficacy of minor clean-up), reduce the problem (employment elsewhere not a problem), create alternatives (companies could have tried other options), and call for resolution via negotiation processes (compromise). Her points repeatedly articulated a sense of the complexity of such issues. For her, solutions were not simple, nor to be arrived at quickly. Before committing herself she typically deliberated consequences, considered alternatives, or sought additional evidence. It was typically only when forced to choose (sometimes only after several requests) that she made a decision. She responded to challenges in a number of ways.

First, as previously noted, she often portrayed a “no win situation” between different points of view: she would portray difficulties, create an impasse, then stop. On her own she did not attempt to resolve the conflict. For example, when faced with a situation in which
scientists, management, and the community disagreed she outlined three potential points of view then described some of the consequences arising from each one (usually noting one limitation for each option).

It's another no-win situation because, if like say, a scientist goes in there and comes out with like three scrolls of stuff that's wrong, then the management said "Well, we can't do this because we don't have all the monetary funds to do it and the community hears about it and they get all worried and worked up and so..."

However, when forced to solve an impasse Veronica's response was not to impose any one point of view, not even her own. Instead she called for compromise between all points of view.

Second, when asked to respond to another difficult situation (concerning the potential unemployment that would arise from her position) Veronica reduced the problem by simply assuming the availability of employment elsewhere.

Third, Veronica created alternatives to solve difficulties: 1) as she found the scientists' report wanting (thought it was conducted by students) she proposed that an expert be called in to conduct a report with proper equipment; 2) to avoid additional oil spill accidents (Valdez cited) she invented two operational maneuvers to increase the safety and efficiency of oil transportation (However, she did not choose between these, she cited the problems that would occur.); and 3) when challenged with the water dilemma she suggested drinking juices not made with that water.

Fourth, although not until the issue was at a more personal level, Veronica sought evidence. She looked for symptoms to enable her to make a decision. Yet, her already
existing evidence pertaining to the longevity of chemicals and the potential toxicity of small doses was not used to inform her response to the salient issue (would drink only one glass, wouldn’t drink a lot).

Veronica was quite assertive in the expression of her points of view: she did not hesitate to articulate her reluctance to decide and took the time to deliberate her own and others’ points of view. She was even open to exploring the possibility that something might be able to change her own point of view. (However, this did not occur.) Yet, when Veronica did assume a position she upheld it. Even though she insisted that no solution, including her own, would completely rectify the chemical problem she chose the major clean-up and upheld that position in the face of challenges. While she displayed a particular ability to denote limitations, even within her own point of view, she typically entertained only negative consequences (community suffers either way, workers worried and miffed, management would be hard on workers, they would loophole a way through). Positive consequences arising from a particular position were only noted with respect to her own point of view. As such, there were no benefits from others’ points of view considered. Hence, her consideration of consequences was only partially balanced.

Overall, Veronica’s strength lay in delaying positioning herself and drawing continual attention to the complexity of resolving such issues: that solutions are not quick and easy and that any solution has negative consequences.

(d) Who the most legitimate spokespersons were?

Veronica legitimated a range of people in her associations. Concerns for self were downplayed in her deliberations concerning her own employment and health, yet she did consider the safety of her own health when the issue became more personally relevant. Her personal experiences were noted and valued (her visitation of a mill with a lot of chemical
problems and a love for chemistry which allowed her to see the concrete applicability of science).

Her depiction of the media was mixed. On the one hand she said they were the ones who could go and get information from the company (they could demand access) and on the other hand Veronica did not trust their information (they blow things quite out of proportion and she would not base her decision about drinking the water solely on information provided by the media).

Overall, Veronica did trust companies but noted that mistakes do occur. She upheld the Exxon Valdez company for their efforts to rectify their mistakes and depicted such mistakes as anomalies, not as representative of companies’ performances writ large ("Most of them yes, are running according to schedule, it’s just the 1% that are trying to get away with it.") Yet, at the same time, Veronica also claimed that companies would not follow the rules because of costs and that the people who run them could not be trusted as they would try and “loophole their way out of things.” So, companies were generally trustworthy but not always, their prudential interests were to be taken into consideration. However, Veronica never questioned whether the company in question in this issue was indeed at fault, she simply assumed that they were responsible.

The government’s role was to set standards, very high standards. However, it was not their job to enforce them. She was unsure as to who should enforce the regulations.

Friends (knows a lot of people in the navy) are valued for their experiences and opinions, especially when the issue became more personal. Family was not considered as they “just don’t talk about those kinds of things.” Citizens she would take seriously as they are not just a “bunch of fanatics.” Students (she thinks the report was conducted by them) are OK, but
she did question their authority and would prefer someone else to do the testing, preferably an expert. This may explain why she thought that their reports (those conducted by students) contained "elements of truth."

Not all opinions were equal for Veronica, some information was more valuable than others. (Information obtained via friends was more trustworthy than information presented by the media.)

Experts, such as scientists, were considered legitimate because they have "proper" equipment and experience.

Reports are valid, they contain "elements of truth" but it depends who they are conducted by (see above). Books, newspapers, magazines, libraries and archives were also legitimate sources of information.

Veronica showed an unusual sensitivity (for someone of her age and expected working experience) to workers potential resistance to the enforcement of management rules. She quickly put herself in their position and tried to imagine how supervision would affect them:

I think it would be nice to have someone check up on them...but it would probably cause a lot of hostility...because the workers would feel someone was looking over their shoulders thinking that they weren’t doing their job and the management would get pretty hard on the workers, you know, to look good. So I think that there should be someone checking up but I don’t know what the repercussions of someone checking up would be.

Bias was attributed to company managers and the media and was always negative.
(e) How all these elements were modified during the controversy?

When Veronica began the interview she depicted no controversy until she was asked to. Indeed, she typically refrained from making a decision until she was forced to. Over the course of the interview she denoted a greater and greater sense of the complexities involved in decision-making. Also, as the interview progressed, she articulated a greater number of points of view. It was when the issue became more personal that Veronica moved away from depicting the difficulties of difference and began to search for things that would enable her to make a decision (she sought two things: evidence of a problem and the opinion of others).

Discussion of this Mapping (Veronica)

Sociologies mapped Veronica’s resistance to taking a point of view on the issue. She would typically articulate a point of view only after questioning. This was not an uncommon phenomenon in students’ discourse. Indeed, as pointed out in Chapter 3, many students only articulated any sense of difference between points of view after having been specifically asked to do so. This raises an interesting question, how did the research context help produce and/or reduce students’ associations? More specifically, how did the protocol questions enhance and constrain students’ associations and how did the associations used to construct the issue invite and prevent associations?

To respond to such questions sociologies can be applied in a self-reflexive turn. That is, the analytical framework can be applied to the associations upheld in the research context. For example, when all the interviews concerning the toxic waste issue had been analyzed it became apparent that students tended to frame the issue in terms of several binary juxtapositions: clean-up or not, health or jobs, believe scientists report or not, etc. However, an analysis of the associations used in the research context (versions of the issue as well as the protocol) showed that these same binary oppositions were repeatedly upheld and reinforced. As such, sociologies can be used to examine the associations upheld in the research context to
see (at least to begin examining) how they both enhance and constrain the production of student discourse. How this self-reflexive turn can be explicitly included in the framework is outlined in the final chapter.

Section Two: An Evaluation of The Framework

In the previous section I showed how the framework could be used to analyze four different interviews. In this section I discuss the strengths and weaknesses of the framework both in terms of these four analyses and the analysis of the other 56 toxic waste interviews.

Overall, the questions posed in sociologies attempted to describe the construction, accumulation, and mobilization of knowledge in the face of controversy. Each question played a specific role in this depiction of knowledge production. While associations in response to each question were generally heterogeneous, certain attributions were more and less common. What follows is a presentation of some of the common responses to each question.

Question One attempted to describe the construction of knowledge (as evidenced in discourse) in the face of controversy. It mapped students’ attributions of cause and effect: the portrayal of cause and effect, how the link between cause and effect was made, and the purposes the attribution served. Some common attributes of discourse across the 60 interviews pertaining to Question One were as follows:

• cause was often depicted as singular (not a complex phenomenon).

• effects cited were typically negative (positive effects were rarely depicted).

• the link between cause and effect was rarely substantiated or queried: it was most often simply assumed.
• the attribution of cause and effect served several purposes: sometimes it established or queried evidence of a problem and sometimes it supported or undermined a proposed response to the problem.

• the attribution of cause and effect was not always stable. Links that seemed solid often wavered in different contexts. For example, associations that initially linked the chemicals in question to the rash were sometimes queried when asked specifically about the legitimacy of the scientist’s report that was to have presumably established this link. So, what at first seemed a clear and solid link often became problematic as the discourse continued.

• there were no notable gender differences in the attribution of causes and effects.

Question Two attempted to delineate the construction of knowledge in the face of controversy. It mapped the heterogeneous associations constructed in the unit of analysis, “a point of view”. Any and all associations linked to a position (first element of a point of view) were accommodated. However, this mapping showed that students associated many more elements in their points of view than in the original unit of analysis (position and support for that position). Elements of a point of view were more numerous than had been anticipated and accounted for. For example, students commonly attempted to create solutions to the problem or to obstacles arising from their proposed form of action. They also tended to consider alternative points of view but only partially, that is, they only considered the negative aspects of other possible perspectives. The consideration of other perspectives (negative sides only) typically served as a means to uphold their own point of view.

The most common point of view (for both males and females) consisted of the position “clean-up” (differentiating between a major or a minor clean-up was not typical) and the support that “health was more important than jobs.” While all students were forced to consider
the economic consequences that might ensue from a clean-up position (embedded in the protocol questions) most responded to the economic obstacles by appealing to very simplistic notions of economic availability elsewhere. However, a few students (typically in the older grades) did attempt to address economic obstacles by considering other employment possibilities and by proposing long-term rehiring practices the company might consider.

Question Three attempted to describe the accumulation of knowledge in the face of controversy: it mapped how students endeavoured to render their claims credible when challenged. Two elements in the analysis stood out. First, by and large students’ associations in support of their claim (position) were not large. Typically one or two points supported their positions. However, more associations were constructed when:

- they were specifically asked to produce them (specifically asked to explain difference).

- they deliberated a problem (as evidenced when they considered a problem concerning storage regulations or when describing a similar issue of interest to them).

- the issue was of personal interest to them (i.e., comments about the Rain Forest in Brazil or other issues that had touched their lives).

- the issue became more personal (their own job or the salient event).

Second, students rarely modified their position on the issue. To maintain their position when challenged they created a variety of constructions. The most common constructions were:

- reiterated values (especially the health of people and the environment),
• refuted alternative proposals,

• attempted to rectify the problem by creating alternatives.

Question Four attempted to describe the legitimation of knowledge in the face of controversy. It mapped who and what students legitimated in their associations. In this analysis students did discriminate between who and what they would and would not consider legitimate. Sometimes the selectivity of people or things was depicted, other times it was not. When bias was depicted it was typically either negative or positive. It was rarely portrayed as having both negative and positive aspects. Authority figures (scientists and government) were often depicted as positively biased (altruistic interests) and companies and the media were often portrayed as negatively biased (prudential interests). To help alleviate bias, groups with multiple representatives were proposed, that is, more perspectives were better than one. Evidence was typically upheld as apolitical, bias therein was rarely noted. However, some associations did problematize evidence, linking it to who produced it and why. Typically though, evidence was portrayed as unproblematic.

Question Five attempted to describe the mobilization of knowledge in the face of controversy. This question upheld a dynamic view of discourse: it assumed that associations often change within and across contexts. It also foregrounded the contextuality of discourse by mapping where associations alter, in what context. In this analysis students modified their associations the most when the issue became more personal. This occurred primarily in the salient event although associations also modified (increased in size and strength) when the economic consequences of a clean up were pushed. Associations were also modified when the student openly deliberated a point. Often this arose as a result of questioning from the interviewer but it also seemed to “naturally” occur as the interview progressed and students took the time to express and explore associations.
The above questions and their answers mapped knowledge construction, accumulation, and mobilization in the face of controversy. Each question also constrained knowledge production. Five areas were identified as in need of development:

1) Students expressed their associations with varying degrees of assertiveness. Sociologics did not take this into consideration. Yet, the certainty with which associations were expressed affected the credibility of their associations.

2) Students associated many elements within their points of view. Sociologics, while capable of mapping these additional elements, did not explicitly value these other elements in a point of view. Hence, the definition of a point of view needs to be expanded to accommodate these and other potential elements attributed to points of view.

3) Students problematized evidence in their discourse. Sociologics allowed for the mapping of these associations but did not foreground them in anyway. However, given that socioscientific issues exist partially because what constitutes evidence is controvertible sociologics ought to highlight associations that query and politicize associations concerning evidence.

4) Students’ associations took place in a particular context. The issue and the protocol question upheld certain associations. How these associations may have enabled the reproduction of associations in students’ discourse needs to be examined. Sociologics needs to be applied to the research context itself to see how associations therein enable and constrain the production of discourse.
5) Sociologies mapped what associations were constructed in the face of controversy. However, sociologies had no place to consider the unmentioned and/or unimagined associations in discourse. The framework needs to point towards what, and perhaps even more importantly, who’s associations are not mentioned, noticed, or imagined.

Summary

This chapter applied the framework of sociologies to four purposefully-selected interviews to demonstrate how the framework could be used to analyze various forms of discourse on socioscientific issues. While the framework assumed that associations were heterogeneous the second section presented some of the more common associations articulated across the 60 interviews. This chapter concluded by noting five concerns of the framework that need to be addressed:

1) mapping how associations are expressed: issues of credibility,

2) expanding the definition of a point of view,

3) exploring evidence,

4) applying the framework to associations upheld in the research context,

5) foregrounding the unassociated (who and what was not mentioned).

Each of these concerns is responded to in the final chapter.
CHAPTER 7

THE STRENGTHS AND WEAKNESSES OF SOCIOLOGICS

Overview

This chapter reviews the strengths and weaknesses of sociologies as a framework to analyze students' discourse about socioscientific issues, develops the framework to take account of the noted concerns, then evaluates the framework in light of critiques of science discussed in Chapter Two and analytical frameworks described in Chapter Three. Implications for education in terms of instruction and assessment are discussed and implications for further research are outlined.

Review of Results

Sociologies was designed to follow controversies in science by tracking the alliances that scientists mobilize as they go about producing scientific knowledge. In this thesis sociologies was adapted to map students' discourse pertaining to socioscientific issues in STS education. The framework was then applied to 60 interviews concerning a socioscientific issue related to toxic waste. To demonstrate the strengths and weaknesses of the framework four interviews were analyzed in Chapter Six. In terms of strength, it was demonstrated that the framework did:

1) provide a means of mapping the heterogeneous associations students constructed in their discourse;

2) emphasize the highly employed and esteemed attribution of cause and effect;

3) foreground the complexity of associations by emphasizing their heterogeneity as well as their homogeneity,
their strength (non-negotiability) as well as their weaknesses (what gives way), and
their contradictions as well as their consistencies;
4) highlight the legitimation of knowledge production by politicizing and contextualizing associations (recognizing and locating subjectivities); and
5) accentuate the dynamics and situatedness (contextual variability) of discourse.

In terms of weaknesses, five areas were identified as being in need of development:

1) mapping how associations are expressed: issues of credibility,
2) expanding the definition of a point of view,
3) exploring evidence,
4) applying the framework to associations upheld in the research context,
5) foregrounding the unassociated (who and what was not mentioned).

The following section looks at each of these weaknesses and proposes how sociologies might be developed to respond to these concerns. The newly-developed framework is then presented and considered in light of the critiques to science articulated in Chapter Two and in light of the analytical frameworks described in Chapter Three.

Developing Sociologies: Five Concerns

While sociologies foregrounds the heterogeneous construction of associations and provides a means to begin examining the potential complexity of knowledge production and legitimation, the framework has several limitations which need to be addressed. Five
limitations are outlined then addressed in terms of how the framework could be developed to ameliorate them.

1) Mapping How Associations are Expressed: Issues of Credibility

In sociologies the goal is to render one’s claims more credible than others. The metaphor used is military, scientists engaged in a “proof” war. Latour said that he brought this military metaphor to “pure peaceful science” to show that even in what was supposed to be reason, force was at work (Berreby, 1994). At present this “force” is mapped in terms of size and strength of associations, primarily how many associations are constructed and how these resist challenge. Yet, how these associations were expressed varied greatly. For example, many associations advocated a clean-up for health reasons but these associations were constructed differently. They may have been similar in content, but not in form. Very similar associations (in terms of the points linked) were expressed with greater and lesser degrees of certainty. Varying degrees of certainty created varying intensities of force: some of which were stronger than others. (See the sociologies of Natasha in Chapter Six.) Sociologies needs to take this force, as evidenced in the certainty with which associations are expressed, into account. As such, in addition to the notions of size and strength, sociologies needs to map how associations are expressed in terms of the certainty with which they are expressed.

However, what constitutes “force” in one context may not constitute force in another; it depends, partially, on the goal of the discourse. For example, if the military model is upheld then it follows then that associations expressed assertively and with conviction would be more forceful and thus more credible than those expressed unassertively or tentatively. However, if the military model was replaced by a model in which claims were to be created, explored, and developed (rather than tested for their strength) then associations that created more openings (via uncertainty and tentativeness for example) might be considered more forceful. Indeed, these two models (proof and development) need not be juxtaposed. For use as an instructional
analytical framework sociologies might foreground the exploratory aspects of constructing associations, to develop points of view. As an assessment framework it might highlight the ability of associations to withstand challenges, to prove points of view. What is important is that the goal of the discourse be kept in mind and made as explicit as possible.

As a first step towards mapping how associations are expressed and the context dependability of what constitutes “force” two questions are added to the framework. As these two questions both concern the strength of associations they will be included in question three:

3) [Credibility] What size and strength these links have?

Size:

- number of associations
- range of associations (appeal to values, evidence, rhetoric etc.)

Strength: (to prove and/or explore)

- negotiability (openness and closure)
- assertiveness (certainty and uncertainty)

In this way “arguments and explanations are seen to be discursive and rhetorical as well as analytic and logical” (Cherryholmes, 1988, p. 101). The re-developed framework in its entirety is presented after all five concerns have been addressed.

2) Expanding the Definition of a Point of View

While Latour maps the claims of professionals in technoscience this study attempts to map the claims of students in socioscientific issues. Latour’s participants in technoscience are
somewhat familiar with the competition game, some play better than others. However, students may have had little or no exposure in making and defending claims. They may have few or no ideas about elements that enable and weaken a point of view. Students may have had little orientation and/or practice about formulating and testing their claims. Consequently, students may know little about what elements enable and weaken a point of view. Indeed, from this research and others (Gaskell et al. 1992; Solomon, 1988) students tend to need probing to explicate their reasoning. In other words, students may not articulate very strong points of view (tie many elements to the claim) because they do not know how to formulate them and/or express them.

In education the introduction of controversial issues into the classroom is typically justified on the grounds that discussing such issues will enable students to think more critically about, and thus become better decision-makers concerning societal issues. This “critical thinking/decision-making” objective is then warranted as part of a larger goal of education concerned with the enhancement of participation within and towards democracy. While these liberal objectives have been a constitutive part of social studies and current affairs classrooms, they are just beginning to be an integral component of science education classes. In the critical thinking movement there are two pervasive questions: 1) what constitutes critical thinking; and 2) is this thinking context dependent or generalizable. Both questions are addressed in light of this research and suggestions are made to develop the framework accordingly.

Thinking Critically in Socioscientific Issues: What is a “Strong” Point of View?

With respect to what constitutes critical thinking in STS, researchers have just begun to denote what it means to think critically about a socioscientific issue. Researchers in large-scale

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16 Traditionally, physics has been considered the epitome of critical thinking followed by other fields of science, such as genetics and chemistry. Biology is situated at the lower end of the pole (Siegal, 1988).
STS (See Chapter Three) have increasingly called for students to have “reasoned” arguments, that is, that students provide or select reasons for their positions on socioscientific issues. In such a case the principle unit of analysis is a position and a reason for that position. Other research, principally this work and that of Solomon (1992), document many more elements (Solomon calls them characteristics) in students’ points of view than have typically been upheld in STS analysis. To accommodate these additional elements in students’ discourse I argue that STS needs to enhance its central unit of analysis by expanding the number and kind of elements that ought to constitute a point of view in the analytical frameworks used in socioscientific issues research. To develop sociologies in a way that would accommodate and valorize the additional associations students constructed in their points of view (in this study as well as in Solomon’s 1992 study) I turn to work done in the critical thinking literature.

There are many definitions of critical thinking. Typically, critical thinking is defined as reasonable, reflective thinking focused on deciding what to believe or do (Ennis, 1962). The term thinking (or reasoning) is typically qualified. For example, one can be "appropriately" moved by reasons (Siegal, 1988, p. 32), have an understanding of what constitutes “good” reasons (McPeck, 1981, p. 22), or think “rationally” about what to do or believe (Norris, 1985).\(^{17}\) In short, a reason-able person is one who thinks “well” and “appropriately.” Often this “well” or “appropriately” is detailed in terms of a thinker’s abilities and dispositions (Ennis, 1989, 1990; McPeck, 1981, 1990).\(^{18}\) Generally though, and for the purposes of this

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18 However, value positions with respect to what constitutes well, appropriately, and rationally, and who ought to determine such criteria, often remain implicit or unquestioned in the literature. For example, Elizabeth Ellsworth cautions us on such enforcement of rationalism. She claims that in schools “rational deliberation, reflection, and consideration of all viewpoints has become a vehicle for regulating conflict and the power to speak, for transforming conflict into rational argument by means of universalized capacities for language and reason.” (1989:301). Felicity Haynes (1991), in her article “Towards an Archaeology of Critical Thinking”, provides a post-structuralist critique of the metanarrative of critical thinking, stressing the importance of the conditions of power which “critical” thinking both undermines and privileges.
thesis, critical thinking is defined as “normative thinking”, i.e., it is concerned with the quality of thinking. Thus, “A critical thinker is someone who is prepared to make reasoned judgments about the quality of what he has seen, heard or thought about” (Splitter, 1991, p. 91). While many have described criteria for such reasoned judgments, Richard Paul (1993) in my opinion, provides the most explicit depiction of elements of a point of view.

Paul (1993) argues that coming to a justifiable conclusion (what STS refers to as a position) on the basis of good reasons is,

...more complex than it appears, for drawing a conclusion is always the tip of an intellectual iceberg. There is much more that is implicit than is explicit in reasoning, more components that we do not express than what we do. To become skilled in good reasoning we must practice making what is implicit explicit so that we can ‘check out’ what’s going on “beneath the surface” of our thought. When you draw a conclusion, you do so in some circumstances, making some inferences (that have implications and consequences) based on some reasons or information (and assumptions) using some concepts, in trying to settle some question (or solve some problem) for some purpose within some point of view. (his emphasis)

Consequently Paul defines the elements of reasoning within a point of view as:

• the conclusion, solution, interpretation (what I call position),

• the evidence, data, reasons, information supporting a conclusion,

• the assumptions within a point of view,

• the concepts/constructs within a point of view,
• the other points of view considered,

• the implications of a conclusion,

• the consequences from a conclusion.

The analysis in the previous Chapter showed that students are already linking such elements to support their point of view. That is, students are already linking more elements in a point of view than are typically being valued in socioscientific research analysis. Expanding the definition of a point of view to include these elements would certainly reflect some of the associations that students are already constructing in their points of view. However, based on this research, I would argue that one additional element needs to be added to this list, a creative element in which imagination of alternative possibilities (solutions) is upheld. Thus, the principle unit of analysis (a point of view) would consist of eight elements:

Position:

• assumes a position?

• defers taking a position?

Support for position, appeals to:

• data, information, evidence?

• reasons (economic, political, ethical, historical etc.)?

Assumptions:

• identified?

• queried?
Terminology:

- understanding of?
- contextually appropriate use of?

Other points of view considered:

- number?
- whose are not included? (those potentially affected)
- strengths and weaknesses considered?

Consequences:

- number?
- kind: positive and negative?
- for whom?

Implications:

- consistency and inconsistency (consequences accepted)?

Alternatives:

- feasibility?
- obstacles overcome and generated?
- who do they serve and not serve?
Certainly, this redefinition invites other problems, such as how these elements are themselves to be evaluated. Paul suggests universal standards for evaluating better and worse elements of a point of view:

<table>
<thead>
<tr>
<th>Fundamental Standards</th>
<th>Defects in Point of View</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) flexibility in point of view</td>
<td>1) unclear</td>
</tr>
<tr>
<td>2) fairness of point of view</td>
<td>2) restricted</td>
</tr>
<tr>
<td>3) clarity of point of view,</td>
<td>3) biased</td>
</tr>
<tr>
<td>4) breadth of point of view</td>
<td>4) narrow</td>
</tr>
</tbody>
</table>

While I agree with Paul’s elements of reasoning within a point of view I find his accompanying universal, intellectual standards problematic. This is not to say that I do not agree with appeals to openness, flexibility, fairness, clarity, and breadth. Rather, it is the depiction of decontextualized standards that I would argue analysis in socioscientific issues should not accept. Such appeals to universals undermine the historicity and politicization of knowledge production, i.e., what is to count as knowledge. Normative claims of ir/relevancy, un/fairness, un/clarity, and ir/rationality are made by people in particular historical contexts with particular agendas in mind. What counts is contextually contingent: what is fair to one may not be fair to another, what counts as flexibility for one person may not count for another. So, while such standards are appealing they too are contextually dependent. Consequently, sociologies not only needs to expand the elements of a point of view, it also needs to link any standards associated with them (notably what constitutes “strong”) to the contextual demands in which the framework is being applied. (See Concern Number One in this Chapter.)

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19 Note also that the role of emotion (posed by Solomon, 1992) is still not addressed.  
20 Paul mentions “circumstances” in his definition of good reasoning yet this elements plays no further role.
The expanded definition of a point of view is included in question two of the framework and highlighting the contextualization of standards is included in question three. As previously noted, the re-developed framework in its entirety is presented after all five concerns have been addressed.

Thinking Critically Across Issues

While many researchers can come to some agreement upon what does or ought to constitute critical thinking, they differ dramatically concerning whether the ability to think critically in one issue means that one will necessarily be able to think critically in others, i.e., the transferability of that thinking. This radical division is usually exemplified in a debate between John McPeck, who advocates the context dependency of critical thinking, and Robert Ennis, who advocates the generalizability of critical thinking. Each position presents research to warrant their position: some research indicates that critical thinking does transfer across knowledge domains and some research indicates that critical thinking does not transfer across knowledge domains, that each knowledge domain creates specific criteria as to what constitutes problems, evidence, and solutions in that area (Barrow, 1991; Mishler, 1979; McPeck, 1981, 1990; Norris, 1985). While this debate continues to produce finer distinctions and more elaborate understandings of the quality and transferability of thinking, some researchers are beginning to question the mutually exclusivity of these points of view. (To

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21 Critical thinking is conventionally discussed in terms of cognitive skills and abilities. To my knowledge, and within the confines of the literature reviewed in this thesis, only McPeck (1990) has begun to talk about critical thinking as a linguistic event. From his all-too-brief discussion of the importance of language regarding critical thinking it is difficult to know whether McPeck conceptualizes language from a structuralist or a post-structuralist perspective. (Note that Splitter, 1991, offers an additional perspective on critical thinking outside of the cognitive model: critical thinking "a la Kant." From this perspective critical thinking is discussed in terms of meaning and sense-making.)

22 This research is primarily from those in the Informal Logic Movement (Siegal, 1991). Data are obtained from specifically designed critical thinking tests and classes. (For example, the 1980 Watson-Glaser Critical Thinking Appraisal and the 1985 Cornell Critical Thinking tests.)
explore this ontological and epistemological debate see the 1991 special issue on critical thinking in Educational Philosophy and Theory, 23(1), 121-140.)

One response to this dichotomy of contextuality and generalizability is the suggestion that upholding such a dichotomy oversimplifies the complexity of interaction between generalized and specialized knowledge. Describing this oversimplification as a "tale of neglected complexities" Perkins and Salomon respond by suggesting a synthesis in which generalized skills do exist, but they always are related to a context, and as such, function in contextualized ways (1989, p. 22). Such a synthesis allows for coherency between structures of argument across, and heterogeneity of criteria within, knowledge domains. However, while this synthesis does accommodate and sanction more complex relationships between generalizable and contextualized knowledge, the conditions of power within those interrelationships continue to remain unaddressed.

While this analysis did not look at students' associations across socioscientific issues I would argue that within an issue the same question pertaining to context dependency can be posed and responded to. Students constructed various points of view within a issue: their constructions shifted with the context. Indeed within an issue common associations (e.g. refute the alternative action proposal by citing dire consequences) were used across contexts (salient event, regulatory issues, similar issues of interest articulated by students). Yet, these associations were also context dependent: students offered different kinds of points and more of them in some contexts than in others (typically more when the issue became more personal).23 As such, even within issues certain structures of argument (or elements of a point of view) are generalizable and context dependent. Associations are complex

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(homogeneous and heterogeneous) even within issues. This ambiguity is especially evident in socioscientific issues where boundaries between specialized knowledge are typically blurred.

In terms of the framework eight elements of a point of view would be considered for analysis within and across issues but the degree to which these elements need to be considered would be determined by the research context, that is dependent on the goals of the discourse (to prove or explore).

(3) Exploring Evidence: Query, Substantiate, Politicize

Socioscientific issues can involve complicated networks of evidence and counter-evidence, of claims and counter claims (McPeck, 1990). As was noted in the first chapter evidence can arise from multiple sources and is often inconclusive (Wessel, 1980). Hence,

...the difficult part of making choices is not the compilation and assessment of incontrovertible scientific evidence. Rather it is the weighing of inconclusive and ambiguous evidence in the context of a variety of political, economic, social, and ethical considerations. (Nelkin in Trachtman, 1981, p. 12)

While evidence in socioscientific issues is problematic it is not specifically highlighted in sociologies: it is only one of any number of potential associations in a network.

Sociologies did map students’ associations pertaining to evidence. Sometimes it was called for (particularly when the issue became more personal) and sometimes it was queried (particularly with regards to establishing the problem or upon deliberation or questioning). However, if sociologies is to be used as an analytical framework in socioscientific issues (in which evidence is highlighted as problematic) then the framework needs to highlight associations that pertain to evidence and to make explicit what it does and does not value with
respect to those associations. Three elements, based on this analysis of what students are already doing in their discourse, are suggested here:

1) query evidence in the issue (what kind, how much),

2) substantiate evidence before deciding (what needs to be done),

3) politicize evidence (evidence according to whom, positive and negative bias).

The first element values the disposition to query evidence in the issue. While this disposition to query is highlighted in question number one (the attribution of cause and effect) it needs to be explicitly valued. The framework would thus explicitly privilege associations that highlight and query evidence (notably what kind of evidence and how much) used to construct and solve the problem. These associations are incorporated in Question Two.

The second element foregrounds the role of evidence in the point of view of the student. At present, sociologics highlights the strength of a point of view when challenged. However, deferring one’s point of view until one has accumulated and evaluated evidence is also valuable. As was previously mentioned, it may be more credible to defer one’s point of view on an issue and denote what it would take to form a ‘better’ point of view than to immediately assume a point of view without having explored the issue. In other words, instead of proving one’s point of view it would be better to recognize that it is in need of development. Again, certainly the two are interrelated: it is much easier to defend a well-developed point of view. As an instructional tool sociologics could be used to highlight the formation of a point of view. For example, it could value associations that call for and evaluate additional evidence. As an assessment tool sociologics could be used as it was initially intended, to map how a point of view withstands challenges, how its claims are rendered credible. Either way sociologics needs to highlight the role of evidence in a point of view,
specifically when does it need to be substantiated and when does it needs to be queried. This role of evidence is highlighted in Question Four (in bold):

4) Legitimacy: Who and what is and is not selected?

Who and what is legitimated? (emphasize evidence)

• what is assumed?

Who and what is not legitimated: (emphasize evidence)

• what is queried, discredited, marginalized, ignored, excluded?

Is bias (prudential interests) delineated? If so how? (emphasize evidence)

• negatively?

• positively?

The third concern highlights the social construction of evidence, that is, what counts as evidence will vary according to individuals, communities, and/or cultures. For some seeing is believing, for others, evidence must withstand tests of falsification. Evidence is selective, it is normative. This normativity needs to be acknowledged and highlighted in sociologies. Two questions will be asked of any evidence: 1) evidence according to whom?; and 2) what are their potential positive and negative biases? These concerns with respect to evidence are incorporated into Question Four (in bold):

4) [Legitimacy] Who and what is and is not selected?

Who and what is legitimated? (emphasize evidence)
• what is assumed?

Who and what is not legitimated: (emphasize evidence)

• what is queried, discredited, marginalized, ignored, excluded?

Is bias delineated? If so how? (emphasize evidence)

• negatively?

• positively?

Again, the re-developed framework in its entirety is presented only after all five concerns have been addressed.

(4) Applying the Framework to Associations Upheld in the Research Context

An additional aspect of this rubric is its potential application to invoke a self reflexive turn, that is, to analyze the associations constructed, accumulated, and mobilized in the research context. In other words, what selections have researchers already made that constrain and enhance the students’ responses? For example, in this study, students repeatedly constructed the issue in terms of an either/or juxtaposition, to clean-up or not. There were typically only two options to any decision, this or that. This binary rendition of problems was very striking throughout the analysis until I realized that the issue itself and the protocol question upheld these binary versions of the problem at almost every turn. That is, it would have been very difficult for students to have framed the issue in a more complex way, such as multiple points of view, given how it was presented and reinforced by the discourse in the research context.
Sociologies can be used to examine the research context in two ways. The first element concerns where to look. Sociologies can map which associations are employed to present the issue (its representation) and the associations used to produce discourse (i.e., the interview protocol). The second element concerns how to look at these associations (for to map them all would be a horrendous task). I suggest, as a first step, that the associations in the research context (framing of the issue and questioning therein) be examined in terms of what options are being made available to student. That is, how are the associations in the research context enabling and constraining points of view? Are multiple points of view being upheld? Whose point of view are not being upheld? In this way students points of view can begin to be interpreted in light of the context in which they are produced. Such a self-reflexive turn enables a mapping of both the productive and reproductive aspects of the social construction of knowledge (as evidence in discourse). This is an additional question created for sociologics. It is added on as question number six:

6) [Reflexivity] What associations are privileged in the research context? (issue as presented and protocol questions

Options:

• singular, multiple, binary?

Representation:

• who is not represented? (those potentially affected)

• to what degree is representation “equal”??

Reproducers:

• who selected the issue? why them? (positive & negative biases)
The five questions of sociologics map what associations are articulated. However, there are no questions to probe what associations are not mentioned and, perhaps even more importantly, whose associations are not mentioned. In other words, sociologics does not actively highlight the selectivity, the necessary bias, of knowledge construction, accumulation, and mobilization in its questions. It only looks at who and what have been selected, rallied, and mobilized, not at who and what have been discredited, marginalized, or unmentioned. Sociologics needs to look at not only what is mentioned, but also what is not mentioned. Highlighting the unspoken in addition to the spoken enables the awareness of, and the possibility to challenge, the selectivity concerning what and whose associations are and are not included in discourse (consciously or otherwise). Highlighting the unspoken calls attention to associations as yet unimagined, it foregrounds both the partiality and the potential in associations, and it reifys images of reality, scientific or not, that are always open-ended in principle. In this way “there is always a “field of possibilities” for alternative accounts, curtailed and counteracted by established cognitive styles and groups” (Brante et al., 1993, p. 180). This foregrounding of the unmentioned is (more or less) embedded in each question in the developed framework.
The Newly-Developed Framework

The proposed changes to the analytical framework of sociologies are in response to the associations that students are already constructing in their discourse. The result is the following set of questions:

1) How cause and effect is attributed (in the issue as presented and in the person’s own point of view)?

   How is cause portrayed?

   • singular, multiple?

   • whom or what is deemed the responsible agent?

   How is effect portrayed?

   • positive and negative?

   • long term/short term?

   • inevitable, controllable?

   Are the links between cause and effects:

   • assumed?

   • substantiated?,

   • queried?
What purposes do these attributions serve?

• do they establish the problem?

• support an action?

Do these attributions alter? If so, when?

2) What points are linked to which other? (Elements of a point of view)

Positionality:

• assumes a position?

• defers a taking a position?

Support for position:

• data, information?

• evidence (what kind of evidence, how much)?

• reasons (economic, political, ethical, historical etc.)?

Assumptions:

• identified?

• queried?

• substantiated?
Terminology:

- understanding of?

- contextually appropriate use of?

Other points of view considered:

- number?

- whose are not included?

- strengths and weaknesses considered?

Consequences:

- number?

- kind: positive and negative?

- for whom?

Implications:

- consistency and inconsistency (consequences accepted)?

Alternatives:

- feasibility?

- obstacles overcome and generated?

- who do they serve and not serve?
3) What size and strength these links have?

Size:

• number of associations?

• range of associations (appeal to values, evidence, rhetoric etc.)?

Strength: (in relation to goal: to prove and/or explore)

• negotiability (openness and closure)?

• assertiveness (certainty and uncertainty)?

4) Who and what are and are not selected?

Who and what are legitimated? (emphasize evidence)

• what is assumed?

Who and what (those potentially affected) are not legitimated: (emphasize evidence)

• what is queried, discredited, marginalized, ignored, excluded?

Is bias delineated? If so how? (emphasize evidence)

• negatively?

• positively?
5) How all these elements are/are not modified during the controversy?

What is and is not modified and when:

• within a given issue (noting differing contexts therein)?

• across contexts?

6) What associations are upheld in the research context? (issue as presented and protocol questions

Options:

• singular, multiple, binary?

Representation:

• who is not represented?

• to what degree is representation “equal”?

Reproducers:

• who selected the issue? why them? (positive & negative biases)

• who produced the issue? why them? (positive & negative biases)

• who produced the questions? why them? (positive & negative biases)

• what did the questions enable and constrain?
The next sections look at this new framework in terms of the critiques to science (Chapter Two) and in terms of earlier analytical frameworks (Chapter Three).

The Newly-Developed Framework and Challenges to Science

In Chapter Two I argued that challenges to a separate, privileged viewpoint for science established important points to consider with regards to socioscientific issues. In particular I emphasized three points to be considered: 1) that science is situated and socially constructed; 2) that knowledge and power are interrelated; and 3) that this point of view need not lead to relativism. The newly-developed framework responds to these three points with varying degrees of success. Each point is discussed in turn.

In terms of highlighting that science is situated and socially constructed the framework fares quite well. First, sociologies emphasizes the construction process itself: what constructions are made (associations) and how they are made (points and links). Second, sociologies maps all constructions in the same manner, that is, constructions are not separated into different domains (i.e., scientific or otherwise). Constructions, deemed scientific in nature, are not treated differently than other constructions. The scientific is not subsumed in the social nor the social subsumed in the scientific. Rather, constructions are distinguished by how well they withstand certain tests and not others. Third, all constructions (scientific or otherwise) are situated: 1) in an overall sense constructions are seen as serving prudential interests (they are seen as being made by those wishing to make their claims more credible than others’ claims); and 2) local subjectivities are brought to the foreground (who and what is and is not privileged in a particular discourse). However, while the strength of sociologies is that it

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24 This construction process is necessarily social as sociologies is premised on the fact that it is when challenged (in the course of some social interaction) that associations are typically articulated. As well, by definition as a form of discourse analysis, sociologies sees language itself as a social construction.
no longer upholds a priori distinctions between the scientific and the social (nor the
technological) this strength may also be its weakness. By not focusing on the social
construction of scientific claims (de-emphasizing science) the framework may undermine one
of the central points it is trying to make (to see science as socially constructed, to not treat
scientific claims differently). As such, the theoretical underpinnings of the framework (the
oppositions it tries to undo) need to be emphasized before the framework is used.

In terms of its portrayal of knowledge, sociologies portrays knowledge claims as
contested and established through the application of power: people make claims and they
endeavour to make them stronger. In sociologies knowledge production is what Fraser (1989)
calls “a shifting field of relations.” In this field of relations power is everywhere and in
everyone: it is capillary and operates in everyday social practices. Some practices strengthen
and reinforce one another, whereas others weaken and dismantle one another. Practices are
both productive and prohibitive; they necessarily include and exclude. Sociologies attempts to
map and interrogate the normativity of these practices (in this instance, discourse pertaining to
socioscientific issues). It is successful in this endeavour in that it brings attention to
normativity: bias is unavoidable, it needs to be examined, and it has both negative and positive
aspects. It may be unsuccessful in that highlighting normativity may prove to be disconcerting
for student use as it enables a greater awareness of “the depth and radical instabilities” involved
in making judgments (Bernstein, 1991).

In terms of a response to relativism, the framework sees all claims as valuable though
not as equally credible. Indeed, the framework was designed to account for difference.
However, what distinguishes between claims is not a particular rationality or logic. Rather,
what distinguishes claims is how strong and weak they are in the face of challenge: what resists
and what gives way, what obstacles are overcome and remain. Sociologies attempts to map
this legitimation process, this “struggle for truth” (Rouse, 1993) in various ways. Certainly,
sociologies both succeeds and fails in its endeavours to account for difference in credibility. It succeeds by: 1) outlining some elements that make points of view "stronger" according to some of the most recent work in critical thinking; 2) expanding the notion of strength in the framework to include more open, dialogical discourse, with the view of developing discourse that explores as well as proves and defends claims (depending on the purpose of the discourse); and 3) foregrounding the notion that things (i.e., evidence, inscriptions, etc.), as well as people, are more and less credible. Sociologies falls down in that mapping difference in terms of credibility may prove to be too cumbersome a task: it may be too time-consuming or complex, especially for student use.

The Newly-Developed Framework and Earlier Analytical Frameworks

In Chapter Three I suggested that STS researchers begin to develop analytical frameworks that: 1) insist upon a diversity and depth of justification for choice; 2) consider all forms of discourse as equally rational, though not as equally credible; 3) portray knowledge in terms of Rouse's (following Foucault) power/knowledge construct, highlighting the inextricable interrelationship between power and knowledge; and 4) include a reflexive component to examine how analytical frameworks both enable and constrain students' responses. The empirical component of this study demonstrated that the framework of sociologics did begin to address these concerns but did so in limited ways.

With respect to the first concern (insist upon a diversity and depth of justification for choice) this analysis showed that students' points of view do include a greater diversity and depth of justification than had been documented in previous research on socioscientific issues. In terms of diversity, students linked many more elements to their points of view than had been previously documented. In terms of depth of justification, students often articulated more than
one support for their position, especially as the issue became more personal or was of prior personal interest. While this depth of justification was not extensive (typically one to two supporting associations for a position) sociologies accommodated additional associations (it did not force the unit of one position, one reason). However, sociologies did not insist upon a diversity and depth of justification: it only mapped them. The developed framework begins to insist upon a diversity and depth of justification by making explicit some of the elements to consider when developing, exploring, critiquing, or defending a point of view.

Sociologies also extended the analysis concerning the dynamic nature of students’ discourse: it sees discourse as a dynamic phenomenon. It followed the modification of associations throughout the entire interview, not just how students’ points of view changed in the salient event (Fleming, 1986a, 1986b). For example, students often modified their attribution of cause and effect. Or, regulatory decisions that were initially firm often became inconsistent and sometimes contradictory. Such inconsistency of associations had not been previously highlighted in socioscientific analysis. While the Socioscientific Issues Component of the British Columbia Provincial Science Assessment (Gaskell et al., 1992) challenged students’ points of view for their consistency to a greater degree than previous research, the report mentioned little about the dynamics of student discourse in the interview as a whole. (Only parts of the interview were analyzed for consistency and inconsistency.) The developed framework tries to offer some specific elements to enable a more detailed mapping of discourse dynamics.

With respect to the second concern (to consider all forms of discourse as equally rational, though not as equally credible), sociologies goes much further than previous analytical framework in socioscientific issues in accepting all kinds and forms of associations and in distinguishing between those associations (more complex notions of strength). It does not uphold binary categories that privilege the scientific (symbolic, non-social, abstract), yet not all
associations are seen as equal. Extending Solomon's work (See the DISS project in Chapter Three.) the framework examines what associations students are already using in their discourse. This analysis showed that students' associations varied in size and strength: some were strong because they rallied more associations (offered more reasons), others were strong because they delayed assuming a position on the issue until they felt more informed, others were strong because they queried central assumptions in the issue, others were strong because their point of view remained consistent even when they were made to personally face the consequences of their position, etc. What is important is that the framework begins to present different ways of assessing credibility without appealing to predetermined categories or forms of reasoning, rationales or logic (typically affiliated with science). Instead, it begins to examine what associations are particularly powerful in discourse pertaining to these issues. It introduces the analysis of one association in particular, that of cause and effect. As this study indicated students already use this association on a regular basis. However, how and why they attribute cause and effect varied. Sometimes causes and effects were assumed, sometimes they were queried, sometimes they were refuted. Sometimes they served different purposes and sometimes all these changed across contexts. What is important is that sociologies provides a different way of looking and accounting for difference than previous analytical frameworks, one that no longer appeals to dichotomies.

With respect to the third concern for frameworks (highlighting the inextricable interrelationship between power and knowledge), this analysis showed that students often do describe knowledge production as political: knowledge serves prudential interests and is partial. Students say that decisions are better when made in a group, i.e., with a variety of perspectives, because people tend to put their own interests ahead of others. Sociologics is the first analytical framework to highlight at least one aspect of how knowledge is legitimated (Question Four). Other studies had explored what and who students legitimated in terms of regulatory practices and sources of information (Gaskell et al., 1992; Solomon, 1992). Yet,
who and what was legitimated was not an implicit part of the analytical framework whereas in sociologies it is.

With respect to the fourth concern for analytical frameworks (to include a reflexive component to examine how analytical frameworks both enable and constrain students’ responses), this analysis showed that while students’ associations were indeed heterogeneous, they were also homogeneous. This homogeneity was surprising given Latour’s insistence upon heterogeneity. A closer look at the context in which students’ associations were produced indicated that students’ associations were indeed similar to associations made in the discourse of the actual issues and in the protocol. In this regard students not only seemed to produce knowledge, but also to reproduce knowledge. While this “reproductive” aspect of students’ discourse was not an integral component of the original framework it has been, as a result of this analysis, built into the new framework. It should be noted that previous researchers in socioscientific research were concerned about how the questions posed to students and the research context itself influenced students’ responses. Both Aikenhead, Fleming, and Ryan and Solomon in her research continually reflected upon about how the research context influenced students’ responses. As such, sociologies is not new in addressing this concern. However, it is the first analytical framework to build in a reflexive component in a formalized manner.

In addition to the four concerns mentioned above there are several other aspects of analytical frameworks in socioscientific that should be noted. Four are highlighted here. The first aspect concerns the portrayal of evidence in socioscientific discourse. In this analysis some students did problematize and politicize the production of evidence. Focusing on and problematizing of evidence have not been part of analytical frameworks in socioscientific issues to date. Yet, it is evidence that is one of the most highly controversial elements in a socioscientific issue: it is often inconclusive and ambiguous. Accordingly, and again as a
result of what students are already doing in their discourse, the framework has been developed to highlight how evidence is portrayed and legitimized in discourse. The second aspect concerns the role of emotions in socioscientific discourse. In this analysis students also often appealed to emotions. Typically emotions were cited to support a particular position or refute a particular position. However, the framework does not address the role of emotions in these issues. Solomon (1992) was the first to question what role emotions might play in socioscientific discourse. Yet, the issue of emotions remains unaddressed. As such, it still needs to be addressed as associations of emotional significance are hard to change, even when faced with a barrage of “facts” or “evidence” (Cronbach in Eisner & Vallance, 1974). The third aspect concerns students’ dispositions to seek out and act upon knowledge about socioscientific issues. Solomon (1992) began to value these dispositions as evidenced by their inclusion in her 12 characteristics of discourse. The Socioscientific Issues component (Gaskell et al., 1992) also foregrounded whether and where students would acquire additional knowledge and whether this might affect their points of view. Sociologies too, in its analysis of what constitutes formulating a point of view, attempts to uphold the importance of querying information presented and seeking additional information before assuming a position. Indeed, this disposition becomes another way of increasing the strength of one’s point of view. The fourth aspect concerns the modality of associations (how knowledge is articulated). Again, this was explored by Solomon (1992) and included as one of her 12 characteristics of discourse. The new framework of sociologies aims to extend this concern for modality by drawing attention to certain qualities of discourse (i.e., assertiveness, tentativeness, openness and closure) and by introducing the idea that the appropriate use of certain modalities may be context dependent, that is, more or less beneficial (increase credibility) depending on the purpose of the discourse.

25 It should be noted that at the 1992 American Educational research meeting in Atlanta, Georgia that “dispositions” were the leading topic in sessions pertaining to critical thinking.
The next section presents some of the implications arising from this research. The first section looks at implications for curriculum and instruction. The second section presents some implications for further research.

Implications

Implications for Curriculum and Instruction

Sociologies has implications for curriculum and instruction concerning socioscientific issues in STS education. In terms of curriculum, sociologies calls for curriculum that offers a new way of foregrounding, accounting for, and relating to difference (as evidenced in socioscientific discourse). First, difference is central: we do not all share the same beliefs. Indeed, our beliefs are most often revealed because we encounter difference. If there is no difference associations often remain unarticulated, there is no need to articulate them. Second, sociologies does not account for difference by deficit-model accusations that privilege grandiose dichotomies such as “rational/irrational”, “logical/illogical”, or “scientific/non-scientific”. Rather, sociologies sees difference as due to interests: people have different goals. Hence, debates about reasons shift to disputes about people’s different worlds: how can they achieve their goals; what obstacles stand in their way; which resources do they rally to help remove those obstacles (Latour, 1987, p. 198). Third, in its assumption that all associations are equally valuable, the framework upholds the position that all beliefs are worthy of respect and consideration. While the framework cannot create the disposition to recognize and respect “otherness” it does attempt to encourage it.

The framework also has curricular implications in that it calls for socially constructed versions of science. The framework recognizes but does not innately privilege the “scientific” in socioscientific issues. Science is not upheld as a neutral arbitrator by which to reconcile
difference. Rather science, like all forms of knowledge production, is constructed and perspectival. It is dynamic. It is not innocent. It has both strengths and weaknesses in that it both enables and constrains knowledge production, that is, it has a major impact on the production and distribution of knowledge and power in society.

Perhaps the largest implication that the newly-developed framework of sociologies has for STS education pertaining to socioscientific issues is its expansion of the unit of analysis, a "point of view". Perhaps including these additional elements (guidelines as to what, at least in the Occident, constitutes a more in-depth point of view) within the framework will, hopefully, enhance students' propensity to produce them. Or, at least, to reproduce them.

In terms of instruction, sociologies introduces a simplified form of discourse analysis. This form of discourse analysis can be used for instruction as well as assessment. As an instructional tool the six questions can be used to begin exploring how knowledge is produced and reproduced in discourse: what constructions are made, what they include and exclude, what purposes they do and do not serve. The discourse can be oral and/or written. The discourse can be that of students or of others. It can be found in many formats: interviews, newspapers, magazine and journal articles, documentaries, television and radio broadcasts, Infonet, etc. The discourse pertaining to an issue can be analyzed over a short period of time (i.e., one instance) or over a longer period of time (follow an issue along). As students and educators become more and more familiar with analyzing their own and others discourse pertaining to socioscientific issues the framework can be used as an assessment tool. Students would be asked to apply the framework to their own and/or others discourse. For example, students would be presented with a new issue, one they had not previously encountered in STS curriculum, and asked to analyze the points of view therein. Or, students might be asked to engage with an issue and then to use the framework to analyze the strengths and weaknesses of their own point of view. The students are assessed on their ability to apply the framework, to
follow and evaluate socioscientific issue discourse at the personal level (self and others), in
STS curriculum, and in society at large (media depictions). Eventually, once students are quite
comfortable with using sociologies to follow controversies of both shorter and longer duration,
part of the assessment might entail their critique of the framework (its strengths and
weaknesses) as a mapping tool.

Yet, while the framework, as described above, holds great promise for introducing new
elements to curriculum and instruction in STS education, it also has its problems. There are
two that concern me the most. First, in terms of curricular scope, the framework avoids the
area of ethics. Nowhere is the word ethics to be found. Questions of what is harmful and
helpful, right and wrong, good and bad are absent. Second, in terms of curricular sequence,
the proficiency and perhaps the productivity of the analysis is constrained and enhanced by the
language competencies of the analyst. Thus, this type of language-based analysis may prove to
be a particularly large stumbling block for some students and even some educators.

**Implications for Further Research**

This framework of sociologics needs to tested at different levels and contexts. I outline
three suggestions for further research. First, the framework needs to be brought into the
classroom: students and educators need to work with the framework to see how it: 1) helps
develop and hinders student’s discourse, particularly their points of view with respect to
socioscientific issues; and 2) does and does not work for them as a framework to analyze
discourse writ large in these issues. The framework should be brought into the classroom at
several levels. Given its complexity I would argue that the earliest level at which it could be
brought into the classroom is at Grade 7. I believe this is justifiable as this analysis already
demonstrated that the framework can easily be applied to students’ discourse at this level.
Whether students at this level can actually apply the framework themselves needs to be
examined. I would also argue that the framework needs to be brought into the classroom at the Grade 10 level. I suggest this level primarily because it is the most advanced level that new curricular ideas can be introduced into the classroom without disrupting already tight curricular time demands required to cover material for provincial exams. At both classroom levels students discourse on these issues would have to be evaluated in both a formative and summative manner to see how their discourse began to portray science as socially constructed, knowledge production as political, and difference as devised.

Second, the framework needs to be tested as a research assessment tool. As the framework is somewhat complex, its application on either a small or large research scale is not a simple matter. Researchers would have to be introduced to the framework both theoretically and practically. While this may seem a cumbersome task researchers in the Socioscientific Issues Component of the 1991 British Columbia Provincial Science Assessment (Gaskell et al., 1992) trained teams of educators to analyze open-ended students’ responses (in 5000 booklets) with an extensively detailed framework that was as, if not more complicated than the framework of sociologies. However, the difficulty of applying the framework of sociologies is that it requires the analysts to examine the text in its entirety which, with respect to interview transcripts can be very long, thus requiring several readings. As such, I would recommend that initial research to examine the new framework be conducted on a small-scale. Two elements need to be researched. The first concerns the revised framework. It needs to be applied to students’ responses to see the degree to which it meets the five concerns that were outlined in Chapter Six. Second, the framework needs to be assessed in terms of how it works for analysts. In particular, what difficulties, practical as well as theoretical, does the framework pose for them?

Third, the framework needs to be tested on different socioscientific issues and on different textual formats. Perhaps more importantly the framework needs to be tested on
discourse (in this case points of view) that has had some time to be considered, that is, students have had some time to think about their point of view on the issue and to reflect on that point of view. I highlight this concern because one of the principal problems with this analysis is that it analyzes students’ points of view that were derived “out-of-the-blue” from a single interview that lasted 30-40 minutes in duration and that covered a wide range of questions, i.e., multiple points of view were explored, not any one point of view in any depth or duration.

Summary

This framework was brought into STS education as a way of mapping the social construction of knowledge as evidenced in discourse pertaining to socioscientific issues. Obviously the framework of sociologies did not analyze all aspects of the social construction of knowledge. In limited ways it foregrounded that knowledge as socially constructed, mediated, and situated (that socioscientific issues continue to be issues because they are complex and what constitutes evidence therein is a question of what is and is not considered legitimate by particular people in a particular historical period) and that knowledge is re-produced (often constrained by the contexts in which it is produced) and necessarily partial (constrained by what remains unspoken or unimagined). The framework attempts to move discourse in STS analysis away from a rhetoric of conclusions (Schwab, 1960), through a rhetoric of constructions (Gaskell, 1994), towards a rhetoric of contentions.
REFERENCES


APPENDIX A

Interview Transcript of Natasha

I. Can you just tell me what you think this story is about?
S. Well, it is about a boy and he gets a rash 'cause of some toxic materials or something and the doctors and the mom think it's spreading, or that it can spread, and then they argue whether the plant should clean up all their material and um, then this one guy, the vote is even and then this one guy decides it.
I. Okay. Do you think, or do people think differently about the issue in this story? Does everyone think the same way?
S. No.
I. Can you tell me about those different ways?
S. Um...
I. You just sort of did.
S. Um, well, someone thinks they should do a major clean-up and someone just thinks well they should just clean the top layer.
I. Why do you suppose some people think differently about that? Can you think of any reasons that they might have to think one way?
S. They don't want to spend as much money.
I. Okay. What about the other side?
S. Um, 'cause they don't want the company to close.
I. Okay. You mentioned about the person at the end having to decide what to do since there is a sort of split vote. What do you think he'll do?
S. Um, I think he'll go for a major clean-up.
I. Okay. Can you tell me about that?
S. Um...
I. Any idea about how, what makes you think he’ll go that way, anything come to mind?
S. I just think it’s the right thing to do.
I. Okay. Well, tell me about how, what you think is the right thing to do.
S. I just think it’s right to clean up all the mess ’cause if you just clean up the top layer then it might come back, or, I don’t know.
I. So you think they should do a major clean-up is that right?
S. Uh huh.
I. Okay. Um, now do you think they should so major clean-up even if it means losing jobs?
S. Um, I guess so.
I. Okay. Can you tell me why you think that way?
S. Um, well, the people can always get jobs somewhere else or...
I. Okay. Now, if you were working there, would you be prepared to give up your job do you think? I’m pushing you, right, this is just an...
S. Um, probably, yeah, ’cause, well, everybody would just get mad and the issue would get bigger and bigger and I guess finally everybody would lose their job there if they didn’t clean it up.
I. So you think if you didn’t deal with the problem, it would just get bigger anyway?
S. Yeah.
I. So you would like to, even if it meant losing your job, they should clean it up to make it safe. Have I got that right?
S. Yeah.
I. Okay. Um, can you think, Natasha, of any particular experiences that you’ve had in your life that might influence the way you think about this? Has anything happened to you that might, that you can think of that, you know how you think one way or another?
S. No, nothing.
I. Have you ever talked abut anything like this in school?
S. Um, I guess. I don’t remember any, but...
I. Any general ideas about the kind of things you talked about or how you went about that or anything?
S. I don’t, we don’t talk about toxic waste.
I. Okay. What about the environment stuff? Does anything seem related to this at all?
S. I guess so in a way. They don’t want all the stuff to get around the trees ‘cause it could kill them.
I. What kind of stuff?
S. Um...
I. Are you doing something with trees?
S. Yeah, um, well, we’re just doing reforestation, so it doesn’t....
I. Can you tell me about that? You mentioned about stuff around the trees. Was there some kind of chemical or something?
S. Around some trees, yeah, in some areas there are chemicals, like from plants and they’re coming towards the trees ‘cause it just got bigger and bigger and then it killed the trees.
I. Oh, I see. So they wanted to stop that.
S. Yeah.
I. Okay. So to protect the trees, yeah. Um, have you ever talked about anything like this or any kind of issue with any teachers, or...
S. No.
I. Anyone else?
S. Not really.
I. Outside of school, friends, family?
S. No.
I. Okay. Um, have you ever seen anything that seems like this on TV, or the news, radio, anything come to mind about that?
S. Stuff I’ve heard stuff but I don’t remember it.
I. Okay. Anything about that stuff come to mind? No? Okay. You’re doing great. Um, suppose you wanted to know more about this issue, Natasha. What else would you want to know, what would help you understand this better.

S. Um, if you talked to some people that deal with the chemical plants or something.

I. What do you think they would be able to tell you, just more information?

S. Yeah.

I. Okay. Um, do you think, depending on what kind of information that you got, can you think of any kind of information that would change your earlier idea, that would make you switch to the other side? No?

S. No.

I. So you’re pretty firm on that position?

S. Yeah.

I. Okay. Um, we have these rules, Natasha, about where we store these chemicals, where we try to keep them safe. Who do you think should make those rules?

S. Um, I guess the people who do the clean-up. I don’t know.

I. Now there’s a lot of different groups. We have people who work for the company, we have people who are in the community, we have government, we have scientists and experts, and just whole kinds of different groups of people. Who do you think you’d feel most comfortable with making those rules? Who would you trust the most?

S. I guess the government.

I. Okay. Can you tell me a little bit about that?

S. ‘Cause like if you let the company workers, um, they might, since it’s their own company, they might just turn around and do something else with it.

I. So they might not follow the rules?

S. And the government, I guess you, pretty much has to do the right thing, or whatever he thinks is right.

I. The government person?
S. Yeah, I don’t know.

I. Well, do you think the people who have these companies would follow those rules if someone wasn’t checking up on them? What’s your feeling about that?

S. It depends the way like other people react to it and the company too because if they want the co-workers to do something else with it or like other people might say go put it somewhere else.

I. So you think the people might think differently in the company?

S. Yeah. Some people might not wanna lose their jobs I guess.

I. Oh, okay. So they would be protecting themselves to keep their jobs?

S. Yeah.

I. Okay. Um, do you think there should be, well, just a second, do you think, like if we’re going to have someone check up on these people, right, we talked about those different groups before, who would you like to be sort of going in and checking up on these people? Who would be the best for you?

S. Um, I don’t know. Um, I don’t really have any idea.

I. Um, if you were living in that community and you knew the storage of chemicals was going on, you’d probably want someone to come out and say this is safe. Now, if that was a person from the company, would you believe them?

S. Um, well, I don’t know. I might and I guess if I went there myself and saw, then I’d know.

I. So you’d like to see it yourself?

S. Yeah.

S. Okay. Um, we have different rules, or I don’t know, when we store these chemicals, do you think there should be different rules depending on whether we store them close to where a lot of people live, or should there be different rules if they’re far away form people, or should there be the same rules?
S. Um, I think it should be the same rules because more people may move to where that other place was where there are lots of environmental things around there, and if something happened and it came out, then it would ruin that and then those people would getworried.

I. So there might be a future concern if people move there?

S. Un huh.

I. Okay. Do you think there should be different rules depending on how dangerous the chemical is?

S. Um, I guess 'cause some chemicals might not do really that much harm and some might, just-like destroy everything.

I. Right. So what would you like to see happen with that, the most dangerous ones would be...

S. Um, I guess put away, like further away and then if people do move closer, then, they can warn the people.

I. Okay. Do you think there should be stricter rules for the more dangerous chemicals?

S. Un huh.

I. Okay. I just wasn’t sure. I could assume that but I’m not sure if that’s what you mean, so if it’s a more dangerous chemical, they should have stricter rules than if it’s less dangerous. Have I got that right?

S. Yeah.

I. Okay. Un, do you think scientists, like, the university scientists in there found some evidence of chemicals in the water and the citizens committee in there took that report really seriously, but Ralph in the union meeting, one of the guys, said, well, those university people you know, they’re just a bunch of do-gooders, that means they’re just kind of fanatics, you know. When you think about that university scientists’ report, like they did, how seriously do you take that?

S. Um, I guess I’d take it pretty seriously ‘cause it might be in your drinking water, or water you swim in or something like that.
I. Would you tend to believe a report that came from the university?
S. It depends if there are like other scientists with them or it was just them themselves.
I. Okay. What would other scientists do?
S. Well, they'd probably know better and they could probably do tests or something.
I. So you'd like a group of scientists?
S. Um, I guess, if there was just like one scientist, they could do a test.
I. So you'd like one or a group?
S. I don't have any idea.
I. You wouldn't care?
S. No.
I. Does it make, it doesn't make a difference?
S. No.
I. So, okay, so if there is one scientist...
S. Actually, I guess a group 'cause, um, one might just say, oh, no there's nothing there and then a group they might have different ideas, some might say it's safe and then they can make a decision as a group, but one they can't really, they just make a decision for themselves.
I. So there might be a problem in, just with one person?
S. Yeah.
I. So, having a group, somehow you get more variety, have I got that, is that sort of what you were thinking?
S. Yeah.
I. Okay. Um, how do you think scientists should react, like you have these scientists and let's say you and I don't agree with what they find out, okay, they say it's safe. But you and I have a different kind of feeling about it, okay? Now do you think they should listen to us, I mean we're not scientists, right? Should they listen to us?
S. Um, I guess so because more people in the community might trust you better than the scientists if they know you better and I guess they want the community to trust the scientists more than like other people’s judgments, they can go, other people’s judgments.

I. So, if I, if you know someone in the community, you’d trust them more?

S. Yeah.

I. Now is that because, why would that be?

S. Um, I don’t know, you just know them for a while, family members or something like that.

I. So you’re more familiar with them, so you know them. Okay. Um, now do you think, okay, so scientists should listen to those judgments.

S. Uh huh.

I. Okay. Now, do you think that is how scientists do react?

S. Um, I don’t know. I guess not. I haven’t heard much.

I. Yeah. We don’t often come in contact directly do we? In your mind Natasha, is there a difference between an environmentalist and a scientist?

S. Um, yeah, I guess. A scientist, I guess, creates things to do with science and doing things like that, but environmentalists, they do all these different matters just to do with the environment.

I. So the environmentalist is more limited in focusing on one particular area and the scientist could do a variety of things?

S. Um, yeah, I guess.

I. Does that seem right to you, or is that what you were thinking?

S. No. I was thinking that environmentalists can do like, lots of things to do with the environment, the scientists just might work on one little area.

I. Okay. So I had it backwards actually?

S. Yeah.
I. Okay, that’s good. I want you to, ‘cause what I’m interested in is what you think, so I’m just saying it back to you to make sure I’ve got it right, cause it’s very easy to misinterpret these things. Um, most people, Natasha, when we store these kinds of chemicals, they want them to be completely safe. What does completely safe mean to you?

S. Um, I guess no way of them spilling or being able to get out, the chemicals to get out, or give off anything.

I. Now do you think something being completely safe, is that possible? Is anything ever completely safe?

S. I guess not. Um, because one day there might be, the chemicals might be put into a container and everybody might say it’s completely safe, but then they might not know like that the chemical does something else and it might go through the thing, or burn a hole.

I. You don’t know.

S. Yeah.

I. So there are things that we can’t see that will happen, from one day to the next, you’re not sure.

S. Yeah.

I. Um, if I was to tell you that, let’s say we’re talking about these stored chemicals and I said well, Natasha they’re 90% safe. Would that be okay for you?

S. Well, I don’t know. I guess it would be, but I’d want somebody to like keep me up to date to see what’s happening.

I. So you’d want more information?

S. Yeah.

I. Now what if I said it was 80%?

S. Um, I guess I’d want something else to be done.

I. Okay. I’m just trying to see where your limits are right? So, 90% would be okay?

S. Yeah.

I. And how would 80% be?
S. I'd want something to be done, to be put in a different place or a different container.
I. What about 85%?
S. That's kind of in-between. Um, I guess I think both.
I. What do you mean both?
S. I think, well, they can either put it in another container and or just like keep me really up to date, like somebody could check in everyday and then I guess if something does happen, then to be put in a different container.
I. Then you'd act on it differently.
S. Yeah. So I think kind of both.
I. Okay. Now, who would you like to check up on that? Who are you going to trust that is going come back and say well...
S. I guess the same person that's just watching it or um the person that put it there.
I. So who do you think would be the person that might put it there? I don't expect you to know this, I'm just wondering when you think of things, what comes to mind right? I mean how does this all work?
S. I guess the city workers.
I. So if a city worker came back and said that you, that would be okay for you, I mean is that the most, the person that you would trust the most? I'm trying or create a kind of ideal thing. If you could have anyone go in there and come back and report to you, who would you want that to be?
S. Um, well I guess a specialist in chemicals.
I. Okay. Now why them?
S. Because they probably know more about it 'cause I guess they just work with that topic and then the city people, they just do all sorts of jobs.
I. So they wouldn't know as much?
S. Yeah.
I. So you'd feel the most comfortable with someone who had the most information?
S. The most experience with chemicals.

I. Okay. I have a little thing I want you to just imagine here. For one week you are visiting a friend who lives in the town that has the chemical plant mentioned in that story. You are there for a week. You have heard about the controversy over these leaking barrels. Now you’ve wondered about drinking the water from the taps in your friend’s house. Now your friend offers you a glass of tap water, this is that water. Would you drink the water?

S. Um, I don’t know, it depends, like what it looks like. If it is a weird colour or it smells.

I. Okay, so if it looks or smells funny.

S. Yeah, or if I heard something about the water on the news, or, not to drink it.

I. So if you heard some kind of warning, or if it looked funny or smelled funny, you wouldn’t drink the water.

S. Yeah.

I. Okay, now, well you have heard about the controversy. But let’s say, so you’ve heard about that, but it doesn’t look funny and it doesn’t smell funny. Would you drink it?

S. I’d buy bottled water.

I. Okay, alright. Now would you just say to your friend, would you feel comfortable enough to say, I mean what would you say to them?

S. Well, like are you sure it’s okay to drink? I’d let them drink it first and see what happens to them?

I. Okay, alright. I am asking because some people feel quite comfortable saying I’m not comfortable with this and maybe there’s something the matter with this, and some people don’t, they’re afraid to hurt their friend or something you know, and so I am just wondering where that works for you. Some people are quite comfortable and they say well I am not gonna drink that stuff, it could hurt me. So, how does this work for you?

S. I guess I’d say I’m not gonna drink it.
Okay. Now just let me make sure I’ve got this straight. You feel quite strongly that um there should be a major clean-up, you wouldn’t feel comfortable drinking the water, um, and you’re willing to do the major clean-up even if it means losing a few jobs and maybe even your own because you think you could get a job somewhere else or people could get a job somewhere else.

S. Or, once the clean-up is done and the company gets more money then they can hire more.

I. Well, that is interesting. Um, I haven’t heard that one before.

S. They could like keep you off for awhile and then I guess you’d be like first priority.

I. So have some kind of list or something.

S. Yeah.

I. Oh, good idea. Those are all the questions I have. Thanks very much.