SEARCHING FOR SCIENTIFIC LITERACY AND CRITICAL PEDAGOGY IN SOCIOSCIENTIFIC CURRICULA: A CRITICAL DISCOURSE ANALYSIS

By

KRISTINA M. CUMMINGS

A Dissertation Submitted to the Faculty in the Curriculum and Instruction Program of Tift College of Education at Mercer University in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

Macon, GA

2017
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Approved:

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<td>Sharon Murphy Augustine, Ph.D.</td>
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<tr>
<td></td>
<td>Chair of Teacher Education, Tift College of Education</td>
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<tr>
<td>Kelly Reffitt, Ph.D.</td>
<td>Dissertation Committee Member</td>
<td></td>
</tr>
<tr>
<td>Colleen P. Stapleton, Ph.D.</td>
<td>Dissertation Committee Member</td>
<td></td>
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<tr>
<td>Jane West, Ed.D.</td>
<td>Director of Doctoral Studies, Tift College of Education</td>
<td></td>
</tr>
<tr>
<td>Keith Howard, Ph.D.</td>
<td>Interim Director of Graduate Programs, Mercer University</td>
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DEDICATION

This dissertation is dedicated to

My best friend and husband, Kevin, who loves me more, even though that’s preposterous.

My children, Kelsey and Scott, who inspire and amaze me every day.

My dad, Allan Scott, who taught me to work hard and laugh often.

My mom, Kathryn Scott, who instilled in me the value of education and family.

Who I am and all I do is because of them.

I love you all!
ACKNOWLEDGEMENTS

This dissertation is the culmination of three years of work, and it would not have been possible without the support, intellect, and guidance of every one of the professors with whom I worked. Every class and paper was a stepping stone toward this dissertation, and I greatly appreciate all their assistance.

Specifically, I must acknowledge the role of Dr. Anne Hathaway. From leading the process that created this doctoral program, to encouraging me in my interview, and to expecting nothing but my best work, she played a part in every step. She was the quintessential educator who made me perform better than I knew I could.

I greatly appreciate the detailed feedback and guidance of my committee members, Dr. Kelly Reffitt and Dr. Colleen Stapleton. Their questions and advice were invaluable.

Finally, this dissertation would not have been possible without the constant direction and support of my chair, Dr. Sharon Murphy Augustine. Her insight and intelligence drove this work, and her positivity, enthusiasm, and kindness kept me going.
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ABSTRACT

KRISTINA M. CUMMINGS
SEARCHING FOR CRITICAL PEDAGOGY AND SCIENTIFIC LITERACY IN
SOCIOSCIENTIFIC CURRICULUM: A CRITICAL DISCOURSE ANALYSIS
Under the direction of SHARON MURPHY AUGUSTINE, Ph.D.

The omnipresence of science and technology in our society require the
development of a critical and scientifically literate citizenry. However, the inclusion of
socioscientific issues, which are open-ended controversial issues informed by both
science and societal factors such as politics, economics, and ethics, do not guarantee the
development of these skills. The purpose of this critical discourse analysis is to identify
and analyze the discursive strategies used in intermediate science texts and curricula that
address socioscientific topics and the extent to which the discourses are designed to
promote or suppress the development of scientific literacy and a critical pedagogy.

Three curricula that address the issue of energy and climate change were analyzed
using Gee’s (2011) building tasks and inquiry tools. The curricula were written by an
education organization entitled PreSEES, a corporate-sponsored group called NEED, and
a non-profit organization named Oxfam. The analysis found that the PreSEES and
Oxfam curricula elevated the significance of climate change and the NEED curriculum
demphasized the issue. The PreSEES and Oxfam curricula promoted the development
of scientific literacy while the NEED curricula suppressed its development. The
PreSEES and Oxfam curricula both promoted the development of the critical pedagogy; however, only the Oxfam curricula provided authentic opportunities to enact sociopolitical change. The NEED curricula suppressed the development of critical pedagogy.

From these findings, the following conclusions were drawn. When socioscientific issues are presented with the development of scientific literacy and critical pedagogy, the curricula allow students to develop fact-based opinions about the issue. However, curricula that address socioscientific issues without the inclusion of these skills minimize the significance of the issue and normalize the hegemonic worldview promoted by the curricula’s authors. Based on these findings, additional research is necessary to confirm the connection between the way curricula address a socioscientific issue and develop or suppress scientific literacy. Additionally, further analysis is necessary to confirm the connection between corporate-sponsored curricula and the suppression of socioscientific issues, scientific literacy, and critical pedagogy. Finally, this study addressed only the intended results of the curricula. Further research is necessary to measure the actual impacts of these curricula on students.
CHAPTER 1

INTRODUCTION TO THE STUDY

As a nation, many of the policy decisions our leaders enact require an understanding of scientific phenomenon. Based on the complex nature of science, many would anticipate that the level of education and the amount of science knowledge one possesses has the greatest impact on the views an individual holds about important science-related issues such as the human impact on global warming, the need for emission limitations, and decisions regarding offshore drilling, fracking, the development of alternative energy, and the role of the government in funding science research. However, when analyzing the factors that had the greatest impact on United States citizens’ opinions on those topics, a 2015 Pew Research Survey found that the ideology or political party affiliation of an individual had a greater influence than education or science knowledge (Funk and Rainie, 2015a).

Additionally, the survey found that regarding how policies should be changed to deal with these and other science-related issues, a large gap exists between the opinions of the general public and members of the scientific community (Funk and Rainie, 2015b). This difference of opinion is concerning for two reasons. First, it demonstrates that the factual information shared by the scientific community about these topics is not enough to sway individual opinions. Second, Funk and Rainie (2015a) reported that 60% of those surveyed thought public opinion should play a role in establishing policies about these issues, and the groups most likely to believe that “public opinion should play an
important role included conservatives, those without a college degree and several groups of religious believers” (para. 3). The 35% who felt public opinion should not play a role in policies due to the complex nature of the issues “included postgraduate degree holders, moderates and liberals, and those unaffiliated with religious groups” (para.3). These stark differences in sub-populations demonstrates that even one’s opinion regarding the role of the average citizen in decision making about these policies is split based on ideology and party affiliation.

Essentially, a majority of Americans believe their opinion should be considered when our leaders make decisions about science-related issues even though those opinions are more influenced by ideology and political affiliation than scientific knowledge and in spite of the fact that those opinions vary greatly from ones held by the scientists with the greatest understanding of the issues. In a representative democracy, this data would be less troublesome if those who sought or held office demonstrated a greater understanding of important science issues. However, a review of the policy stances of the 2016 presidential primary candidates, several of whom already hold high positions of power, found that many held misconceptions or harmful beliefs about science issues. Some of the misinformation held by and disseminated by these candidates during the campaign include: links between vaccinations and autism; the belief that fetal tissue, which is vital to research in disease control and medicine, is obtained illegally; finding a causal relationship between mental illness and gun violence; and a disbelief in global warming or a failure to connect human actions to global warming (Borel, 2015).

Exacerbating this issue is the ever-greater presence of science and technology in our society and the policy decisions that must be made regarding them. Therefore, as
early as the 1950s, science educators began to argue for the need for science education to develop a citizenry that understands basic scientific concepts (Cohen & Watson, 1952). However, in the 1970s, the conversation turned to the importance of developing citizens prepared to deal with the ways in which science and technology impact our society (Gallagher, 1971). Hodson (2003) summarizes a major concern voiced in the literature about scientific literacy: “What is clear is that ordinary citizens will increasingly be asked to make judgements about matters underpinned by science knowledge or technological capability, but overlaid with much wider considerations” (p.650).

The wider considerations Hodson refers to include the ethical, cultural, economic, and social ramifications regarding issues such as cloning, stem cells, genome projects, global warming, and alternative fuels. Referring to these issues, Sadler (2004) argues: Regardless of society’s reluctance or enthusiasm towards the advent of these issues or its preparedness to deal with them, scientific issues with social ramifications undoubtedly will continue to arise and evolve. Advances in medical science and molecular genetics coupled with the environmental challenges produced by a burgeoning human population guarantee the prominence of these kinds of issues in the present and the future. (p. 513)

Sadler accurately points out that as science and technology advance and have an even greater presence in daily life and as the expanding global population places greater demands on the planet, science-related policies will become more numerous and complicated. Dealing with such issues requires not only a scientifically literate citizenry but one that is able to consider science issues within their own worldviews.
Alan Leshner (2015), the former CEO of the American Association for the Advancement of Science, argued that the gap between the opinions of scientists and the general population regarding the policies about science-related issues cannot be closed simply by having a citizenry that trusts scientists or that understands science concepts. He contends that those things are “compromised whenever information confronts people’s personal, religious, or political views, and whenever scientific facts provoke fear or make people feel that they have no control over a situation. The only recourse is to have genuine, respectful dialogues with people” (p. 459). In education, spaces for such a dialogue have been recommended since the 1970s with the advent of a science education movement called Science, Technology, and Society (STS) (Zeidler, et al, 2005). STS education provided opportunities for students to engage in dialogues about science and its impact on society as well as society’s impact on science. From STS education another movement, referred to as socioscientific issues science (SSI), emerged as a way to prepare future citizens to engage in conversations regarding policy decisions impacted by science and technology. This dissertation considers the ways in which such socioscientific issues are presented in the curriculum.

Socioscientific issues are open-ended, controversial issues informed by both science and societal factors such as politics, economics, and ethics, which are deliberated by both scientists and the general public (Kolsto, 2001; Sadler, 2004a; Sadler, 2011). When using socioscientific issues in the classrooms, the goal is to empower students “to consider how science-based issues reflect, in part, moral principles and elements of virtue that encompass their own lives, as well as the physical and social world around them” (Zeidler, Sadler, Simmons, & Howe, 2005). In order to fully engage with socioscientific
issues, Sadler, Barab, and Scott (2007) argue that students should have opportunities to apply and practice reasoning skills, which include recognizing complexity, multiple perspectives, ongoing inquiry, and skepticism.

Early in the development of SSI, Driver, Newton, and Osborne (2000) also advocated for an approach to science education that understood science as social practice. Due to the role of argumentation in science and in order to understand the nature of science, they maintained science educators needed to improve their own understanding of argumentation and dialogue and provide opportunities for students to develop skills in these areas as well.

Given that, for good or for ill, science and technology have ascended to a position of cultural dominance, studying the role of argument in science offers a means of prying open the black box that is science. Such an effort would seem well advised—both for science and its relationship with the public, and the public and its relationship with science. (p. 309)

Argumentation is just one aspect of the nature of science, and a connection has been established between the development of one’s understanding of the nature of science and socioscientific issues (Bell & Lederman, 2003; Sadler, 2004a; Zeidler, et al., 2002).

It is important to acknowledge that Sadler’s (2004a) review of literature regarding the effectiveness of using socioscientific issues in the classroom found that SSI do not automatically improve the scientific literacy skills needed by an engaged citizen: reasoning, argumentation, information evaluation, science content, and understanding of the nature of science. However, “they can provide a powerful vehicle for teachers to help stimulate the intellectual and social growth of their students. If we want students to think
for themselves, then they need opportunities to engage in informal reasoning, including the contemplation of evidence and data, and express themselves through argumentation” (p. 533). Therefore, in an optimal situation, engagement with a socioscientific issue would provide students with the practice needed to consider the political and policy implications intertwined with the use of science and technology in our society.

This study is approached from the belief that a healthy democracy needs citizens that understand the impact of science and who can challenge and transform existing structures and institutions, rather than blindly serve dominant interests. “As a number of theorists from Antonio Gramsci and Raymond Williams to Paulo Freire and Stanley Aronowitz have argued for the last fifty years, education is crucial to the development of any radical political formation” (Giroux, 2015, p. 109-110). While the use of socioscientific issues in science education is intended to develop scientifically literate individuals prepared to critically challenge the policies in our society, it is possible that socioscientific issues could be included in a curriculum that does not work toward either of those goals. In fact, they could be used to suppress the development of both scientific literacy and critical stances on how to engage students and teachers in those issues.

Religious, political, and corporate factors influencing curriculum in American schools could result in the suppressive use of socioscientific issues in science classrooms. The increase in the charter school movement has legalized the use of public for schools that promote religious agendas (Saiger, 2013). Reviews of textbooks have found that many states have adopted biased and politicized texts (Strauss, 2014). State legislatures have passed bills and laws to influence science standards. For example, a West Virginia law removed information about the human impact on global warming from the standards.
(Branch, 2016). In Louisiana, despite repeated efforts at repel, the state still has an unconstitutional law that allows equal time for the teaching of creationism and evolution (Forrest, 2014). Additionally, corporate involvement in education has quietly expanded. Watkins (2012) explains that educational reform is now accomplished by corporations through think tanks and foundations. One such group, the National Center on Education and the Economy (NCEE) is funded by the foundations of the wealthy such as Gates, Rockefeller, Carnegie, and Kodak as well as corporations like Boeing and Xerox.

Simultaneously, American education is in an era of unprecedented accountability, which, among other things, has led to a narrowing of the curriculum and the deprofessionalization of teaching resulting in the relaxing of professional qualifications of teachers in many states. Teaching in such an environment impacts the pedagogical performance of educators and results in a greater use of the textbook and curriculum as the authority in the classroom. These texts are particularly positioned to influence both teachers and students. Depending on the strength of the instructor, the science textbook ranges from being a resource to being the driving force in both content and pacing of curriculum (Kelly, 2007). As an elementary science teacher, my experience is that in intermediate elementary classrooms, where most teachers have completed only one or two college-level science classes, the texts of the curriculum wield prominence and authority. Due to this greater level of text and curriculum dependency in elementary science classrooms, this study is concerned with the discourse found in those texts.

This study is also approached from the perspective that texts that address socioscientific issues in a vacuum without teaching scientific habits of mind through a critical pedagogy are engaged in indoctrination and not education. Conversely, texts that
present socioscientific issues in a manner that increases scientific literacy and empowers the ideas and experiences of students provide opportunities for children to learn how to question and challenge oppressive ideologies. Therefore, the discourses used in these texts play a significant role in science education.

Kelly (2007) argues that the language and social processes used in science education construct student experiences and therefore need to be analyzed. Roberts (2007) concurs by asserting that discourse, which includes verbal discourse as well as the written discourse from texts, curriculum, and assessment, develops scientific literacy in the classroom. He also identifies the need for further research in this area: “Clearly, more research is warranted about the development of SL [scientific literacy] and PUS [public understanding of science] through an examination of how discourse is understood, enacted by teachers and students, taken up in student learning, measured, and discussed in the science education community and beyond” (p. 775). The goal of this research is to partially address the need identified by Kelly.

Researcher Positionality

From a critical theory perspective, all curricula, indeed all actions, serve a political agenda. Every decision made, from the identification of the problem to the selected methodology and the theoretical lens through which it is applied, was influenced by the politics of the researcher. Based on the foundations of critical theory, the political stance from which this work is approached is significant, openly acknowledged, and applied. The intention of positioning the researcher at this point is to concede the political stance that is foundational to this study. Therefore, before fully outlining this
work, it is important to acknowledge how the researcher’s worldview, including ontological, epistemological, and human nature assumptions, influences this study.

The researcher conducting this analysis is an upper middle-class, heterosexual woman who politically identifies as a progressive liberal. She is a veteran elementary science teacher who has taught science and other content areas to students in Kindergarten through eighth grade in Texas, Colorado, and Georgia. She believes institutional prejudice functions to suppress the advancement of marginalized groups and feels science education has been negatively impacted by political and religious ideology.

This study is inextricably linked with the ontological worldview of the researcher. The entire topic of this research rests on the assumption that curricula are designed to maintain the existing balance of power in our country. The researcher acknowledges the social reality that our educational system perpetuates classism, racism, xenophobia, sexism, heteronormativity, and all general prejudices. The elements of our system that contribute to the hegemonic role of education include the teachers and administrators, school structures, standards, assessment practices, and instructional materials. These elements are designed to marginalize students based on their otherness or deviation from the normative white, middle class, heterosexist world view.

Epistemologically, the researcher assumes that knowledge is built through all experiences, both intentional and unintentional. Therefore, all curricula have a political agenda and develop in students the concepts that preserve the status quo. Specifically, the researcher has 21 years of experience in teaching elementary science and providing science pedagogy instruction to both pre- and in-service teachers. She has witnessed corporate and religious encroachment into the presentation of science instruction, and the
refusal on the part of many educators to provide experiences that allow students to engage with science in a way that develops critical thinking and analytical skills. The researcher assumes that these actions are purposefully used to maintain the existing power structures in our country and that these actions can only be countered with a critical pedagogy that encourages students and teachers to question and challenge normalized ideas. This study intends to contribute to the disruption of existing power structures by analyzing and challenging how they operate in science curricula.

Statement of the Problem

In order to develop a scientifically literate citizenry capable of critically interacting with the numerous and complicated science-related policy issues in the world, science education needs to provide opportunities for students to engage with socioscientific issues in the classroom. However, the inclusion of socioscientific issues may or may not embrace a focus on scientific literacy and critical pedagogy skills and could therefore result in two very different outcomes for both teachers and students: the teaching of politicized or non-secular science resulting in a voiceless and subjugated citizenry or the teaching of an ideologically-free science in order to develop emancipated and empowered citizens. The goal of this study is to identify and critique the discursive tools employed in both types of science texts. The focus of this study is the intentional impacts of these curricula. The actual or realized effects these texts have on teachers and students are outside the parameters of the research.

Purpose of the Study

The purpose of this critical discourse analysis is to identify and analyze the discursive strategies used in intermediate science texts and curricula that address
socioscientific topics and the extent to which the discourses are designed to promote or suppress the development of scientific literacy and a critical pedagogy.

Research Questions

1. In intermediate science curricula and texts, how is discourse employed to present socioscientific issues?

2. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy?

3. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy?

Methodology

This study applies the methodology of critical discourse analysis, which is a type of discourse analysis that aims to use theory and analysis in support of a political cause, in this case the promotion of science education that provides ideologically-free science and develops scientifically literate, critically empowered citizens (van Dijk, 1993). The goal of critical discourse analysis is to explore the interactions of power, language, and ideology and to expose hidden agendas in discourses (Fairclough, 1989). This study analyzes a sampling of intermediate science curricula published in the past 10 years that mention or directly engage students with socioscientific issues. Based on Gee’s (2011a) theories, the texts were selected from diverse positions. Specifically, three curricula that have been produced by corporate, educational, and non-governmental or non-profit entities were analyzed.
Van Dijk (2001) explains that critical discourse analysis is not a step-by-step methodology. While the analysis of the texts in this study were influenced by French discourse analysis, sociocultural and discursive change analysis, and socio-cognitive studies; the analysis was based most heavily on Gee’s (2011a) approach to discourse analysis which considers the ways in which any discourse works to achieve seven tasks: significance, practices, identities, relationships, politics, connections, and sign systems and knowledge. To analyze how texts achieve each of these tasks, referred to by Gee as building tasks, this study used Gee’s six inquiry tools. The analysis was accomplished by applying questions posed by the six inquiry tools to each of the seven building tools identified by Gee. The validity of the analysis was based on the convergence of the answers, the coverage of the analysis from one part of the discourse to another, and the connection between the analysis and the linguistic structures used in the texts.

Theoretical Framework

This study is conducted through a transformative paradigm and is concerned with issues of asymmetrical power relations, politics, and injustice (Creswell, 2014; Mertens, 2015). Based on this paradigm, the goal is to expose the discursive practices that reproduce inequalities and hegemony and to analyze those that challenge normative processes and empower individuals with critical skills. Therefore, this study is built on the theories of critical discourse analysis and critical pedagogy.

Critical Discourse Analysis

Critical discourse analysis (CDA) as a methodology has been described in the previous section, however it also functions as a critical theory that aims to identify the connections among language, power, and ideology (Fairclough, 1989). Based on the
theories of Althusser (2010) and Foucault (1979, 1994), the theory of critical discourse analysis asserts that all discourses function to influence individuals and are used to normalize and reproduce the agendas of those in power (Fairclough and Wodak, 1997; Gee, 2011a). CDA strives to identify the ways in which discourses do so as well as their intentions and impacts. Critical discourse analysis is built on several philosophical assumptions: a relationship exists between discourse and power, discourse is used to establish a normalized *truth*, and those who engage in critical discourse analysis take a political stance (Fairclough, 1989; Gee, 2011a; Riggins, 1997; van Dijk, 2001; Wodak, 2001). The goal of critical discourse analysis is to consider social problems and the way discourses are used to produce and reproduce abusive or liberating forces that either exacerbate or alleviate societal ills (van Dijk, 2001).

Critical Pedagogy

Critical pedagogy compliments critical discourse analysis in that the latter’s purpose is to expose power abuses in discourse while the former’s goal is to use discourse and action to challenge power structures. Critical pedagogy theory, based on the foundational works of Pablo Freire (2004), aims to educate “students to become critical agents who actively question and negotiate the relationships between theory and practice, critical analysis and common sense, and learning and social change” (Giroux, 2007, p.1). It is a framework through which the goal of learning is service to all over the dominant interests of a few. Critical pedagogy theory advocates for a symmetrical relationship between students and teachers (Freire, 1994, 2004). Additionally, it calls for opportunities for both teachers and students to challenge curriculum texts and goals, question the epistemological assumptions of curriculum, work as co-learners, experience
transformational change, and engage with the pedagogy as advocates for themselves and others (Freire, 1994, 2004; Harraway, 1988; hooks, 1994; Kincheloe & McLaren, 2002; West, 1999). Critical pedagogy is an active endeavor. Unfortunately, the actual impacts on students and teachers who engage with elements of a critical pedagogy are beyond the parameters of this study. However, this CDA will analyze curriculum for the ways in which its discourses work to advance or neglect the development of critical pedagogy in the curricula used by both teachers and students.

Conceptual Framework

The goal of this research is to analyze the way in which science education approaches the presentation and teaching of socioscientific issues. Based on the transformative paradigm that is at the foundation of this study, each layer through which the texts were analyzed considered how the texts worked to either solidify or challenge existing power relations. A visual representation to accompany the discussion of the conceptual framework for this study is found in Figure 1.

The rectangle at the bottom of the figure represents the critical foundation of the study. The process for analysis of the texts, Critical Discourse Analysis, supports the transformative goals of the research. The two circles supported by the foundation of critical theory represent critical pedagogy and scientific literacy, which are the two criteria the study will use to analyze the science texts.

The circle on the left represents critical pedagogy. However, it also references Santo’s (2009) model of critical pedagogy in science education. His model of Freirean science education is fully explored in the literature review; but to understand the conceptual framework, it is important to acknowledge that the uses of socioscientific
issues are considered through both a pure critical pedagogy framework as well as the specific application of the theory in science education. The circle on the right represents a specific concept of scientific literacy, identified by Roberts (2007) as Vision II. A full discussion of the history and definitions of scientific literacy is included in chapter 2. To understand the conceptual framework, it is sufficient to identify Vision II scientific literacy as being aligned with critical pedagogy, whereas Roberts’ Vision I scientific literacy would be identified by Freire as a banking model of science education.

Figure 1. Conceptual Framework: Theorizing the Uses of Socioscientific Issues

Balanced on top of and overlapping with critical pedagogy and Vision II scientific literacy is the concept of socioscientific issues. The goal of this study asserts that the use
of socioscientific issues in science education is not in and of itself a critical process. Instead, this study argues that the use of socioscientific issues can actually function to normalize asymmetrical power relations. The circle representing socioscientific issues is not directly supported by the base of critical theory. The model is intended to demonstrate that the use of SSI can only be critical if it is anchored to either critical pedagogy, Vision II scientific literacy, or both. Without the presence of either one, the circle of socioscientific issues falls off the critical foundation and becomes another process for the reproduction of existing power structures. This region of the figure, labeled 4, and represents curriculum that mentions socioscientific issues without also giving students the opportunities to build Vision II scientific literacy or critical pedagogy. Such curriculum promotes the reproduction of ideology either actively or through indifference.

However, it is important to understand that socioscientific issues can be an effective pedagogy and address student and societal needs to varying degrees. The region of the figure labeled 1, represents curriculum that uses socioscientific issues and promotes a critical pedagogy. Such a curriculum would certainly meet the goals of critical theory, but it would fail to focus on the building of all the skills needed by a scientifically literate citizenry. Region 2 curriculum would use socioscientific issues to build critical scientific literacy, but it would fail to serve the community and advocate for marginalized populations. The region labeled X represents curriculum that does not address socioscientific issues, and as such falls out of the parameters of this study. Finally, Region 3 represents curriculum that presents socioscientific issues as a way to develop both critical pedagogy and scientific literacy. Such curriculum would fully
embrace a transformative paradigm and would fall at the opposite end of the spectrum from the curriculum placed in region 4. The research will analyze the discourse used in curricula that fall into any of the four regions.

A foundational assumption of this study is that the curricula presented in instructional texts influences the epistemology of both teachers and students. Those influences may be intentional or unintentional. The analysis of the discourses in this study are designed to identify the tasks accomplished and the ideologies normalized by each text. According to Bové (1990), it is the everyday presence of discourse that allows it to “have the privilege of unnoticed power, and this power produces instruments of control” (p. 54). He argues for the need to question the function, presence, production, regulation, and social effects of discourse, and explains that the analysis of discourse functions to “trace the systems of power which have come to constitute human being in our world. It does this to stand in opposition to them and to provide the results of its work to whomever would like to use them in their struggles against the forms of power they are trying to resist” (p. 62). This study is not designed to measure or consider the actual impacts these curricula have on students or teachers. Instead, its goal is to create the type of work, referred to by Bové, that can be used to resist suppressive curricula and promote those that are empowering.

Definitions of Key Terms

The most relevant concepts discussed in this research are defined throughout the text. However, this section provides the definitions of the most vital terms that are foundational to this study. Those terms and their definitions are provided below in a scaffold order that matches the conceptual framework discussed in the previous section.
A *transformative paradigm* is oriented toward questions of power, justice, and politics and focuses on the lives of marginalized groups, the inequalities that occur due to asymmetrical power relations, and the political and social structures that perpetuate disparity in our world (Creswell, 2014; Mertens, 2015). It is the foundation for all critical theories.

The theoretical framework of *critical discourse analysis*. *Discourse* is any written, spoken, or graphic language that is communicated. As a theoretical framework, critical discourse analysis holds that language is used to maintain unbalanced power relationships, and critical analysis of language discourses, either written or spoken, can unveil the ways in which they are being used to do so (Fairclough, 1989).

As a methodology, *Critical Discourse Analysis* (CDA), is conducted as a way to identify how power, language, and ideology interact. By its nature, CDA does not follow one specific method of analysis (Fairclough, 1989).

*Critical pedagogy* is a teaching method for developing student skills that encourage them to question societal norms, develop their own voice and advocacy, and work toward social justice. (Freire, 2004; Giroux, 2007).

*Scientific Literacy* refers to the knowledge and skills an average, non-scientist should possess in order to be an effective citizen. It has also been used a catch-all term for the purpose of science education. Roberts (2007) identified two ends to a continuum of scientific literacy with *Vision I* at one end and *Vision II* at the other. *Vision I scientific literacy* focuses on science content and the scientific knowledge that should be understood by all. It would be identified by critical pedagogy theorists as a banking model of education. *Vision II scientific literacy* begins by considering the situations in
which citizens may encounter and therefore need to be able to understand science and develops the necessary skills from that viewpoint (Bybee, 1997; Roberts, 2011).

**Socioscientific issues** are open-ended, controversial issues informed by both science and societal factors such as politics, economics, and ethics, which are deliberated by both scientists and the general public (Kolsto, 2001; Sadler, 2004a; Sadler, 2011).

**Summary**

In order to situate the reader within this research, Chapter 1 began by outlining the societal issues that have led to the problem addressed by this study: the tendency of the general public in the United States to rely more on their political party affiliation or their ideology as the basis for science-related policy decisions. The history of the problem then went on to weave in other issues, the possible use of socioscientific issues (SSI) to address these problems, and the argument that the use of socioscientific issues in a vacuum, with the exclusion of developing scientific literacy and critical pedagogy, is tantamount to indoctrination.

The chapter went on to identify the goal of this critical discourse analysis which is to examine the ways in which intermediate science texts present socioscientific issues. Next, the chapter identified the research questions that this study aims to answer and the methodology it employs. Finally, the chapter concluded with a discussion of the theoretical framework at the foundation of this work, a presentation of a conceptual framework that ties together the theoretical elements of the study, and the definitions of key terms used in this research.

Chapter 2 presents a review of the foundational literature for this study. After placing this study within the existing literature, the chapter identifies and defines the
theoretical frameworks through which this research was conducted: critical discourse analysis and critical pedagogy. Since both critical pedagogy and scientific literacy are the lenses through which the texts in this study were analyzed, the chapter goes on to define scientific literacy and its application to a critical science pedagogy. Finally, the literature review funnels down to a discussion of socioscientific issues and their role in science education.

Chapter 3 identifies the methodology for this study. The history, unique aspects, and goals of critical discourse analysis are first discussed. They are followed by a rationale for using critical discourse analysis in this research, and a specific application of critical discourse analysis to the field of education. The setting, sampling, and data coding are then described, and the chapter concludes by describing how the curricula will be analyzed and how validity will be documented.

The fourth, fifth, and sixth chapters of this study present the findings of the analysis of the three curricula. Chapter four details the analysis for the first research question. Chapter five addresses the second, and chapter six presents the findings for the third question. In chapter seven, the conclusions that were validated through the analysis of the texts are presented, and those findings are used to answer the research questions for this study. Finally, chapter seven concludes with a discussion of the implications of the findings and possible future research to be completed in this area.
CHAPTER 2

REVIEW OF LITERATURE

In *Taking Science to School*, Duschl, Schweingruber, and Shouse (2007) argue that science is omnipresent in our lives and that the “pressing issues of today – global warming, pandemics, alternative fuels, use of biometric information to fight terrorism-require a scientifically informed citizenry as never before in the nation’s history” (p. 354). This demand on our citizenry merges dangerously with other concerns: the narrowing of the curriculum and abandonment of effective pedagogy due to high stakes testing, cultural forces leading to civil illiteracy, corporate and non-secular involvement in the creation of curriculum and texts, and large portions of the citizenry relying more heavily on ideology and political affiliation than on scientific knowledge when deliberating about science related issues (Branch, 2016; Forrest, 2014; Funk and Rainie, 2015a; Giroux, 2014; Polesel, et al., 2012; Saiger, 2013; Strauss, 2014; Watkins 2012).

In order to develop an electorate that can contend with the pervasive presence of science and technology issues in our society, science education must provide classroom opportunities in which students consider, argue, and question socioscientific issues. *Socioscientific Issues* are open-ended, controversial social issues that are informed by science but also impacted by politics, economics, and ethics (Sadler, 2011). Examples of socioscientific issues are the human impact on global warming, genetically modified foods, and conservation efforts for endangered species. For example, the content knowledge students need to learn about the carbon cycle can be taught through a
socioscientific unit that requires the students to apply their understanding of carbon and its cycle through living things and our environment to the question of the impact humans have on the cycle when they burn fossil fuels.

Statement of the Problem

To develop a scientifically literate citizenry capable of critically interacting with the numerous and complicated science-related policy issues in the world, science education needs to provide opportunities for students to engage with socioscientific issues in the classroom. However, the inclusion of socioscientific issues may or may not embrace a focus on scientific literacy and critical pedagogy skills and could therefore result in two very different outcomes for both teachers and students: the teaching of politicized or non-secular science resulting in a voiceless and subjugated citizenry or the teaching of an ideologically-free science in order to develop emancipated and empowered citizens. The goal of this study is to identify and critique the discursive tools employed in both types of texts, those that discuss socioscientific issues with or without the presence of opportunities for building scientific literacy or critical pedagogy skills.

Purpose and Research Questions

The purpose of this study is to conduct a critical discourse analysis of intermediate elementary (grades 3-5) science texts and curricula that address socioscientific topics. Specifically, the analysis will identify the ways in which texts that engage socioscientific topics present scientific literacy and critical pedagogy, two skill sets needed by an effective citizenry. The analysis will consider how these skills are either advanced or atrophied in both teachers and students. This critical discourse analysis aims to answer the following research questions:
1. In intermediate science curricula and texts, how does discourse function to present socioscientific issues?

2. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy?

3. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy?

As discussed fully in chapter one, the need for this study is grounded in science curriculum research. The prominent role of the textbook and curricula to determine content in the science classroom demonstrates the need to carefully analyze the discourse contained in those texts (Kelly, 2007). Additionally, while science instruction has the ability to develop the skills needed by individuals to question and challenge suppressive structures in our society, such as inequality, famine, voter suppression and inadequate health care, science can also be presented as a codified set of knowledge that is held by experts and bestowed upon students (Bazzul, 2013). Since science discourse can be used toward either emancipatory or oppressive ends, it is important that it be analyzed in order to determine the ways in which it impacts students. Finally, Roberts (2007) identifies the need for researchers to analyze exactly how scientific literacy is being developed in the classroom, and he argues for more research of what he refers to as fine-grained documentation of the discourse being used toward that end.

Within the literature concerning scientific literacy, there are a plethora of views regarding its definition and purpose, its effectiveness in combating misconceptions and pseudoscience, and the use of socioscientific issues as a pedagogical tool in the
development of scientific literacy. My study is placed within that discussion, and this literature review presents the theories and research that are the foundation for my work. To support the conceptual framework presented in Chapter 1, this literature review discusses the foundation of my transformative paradigm and its connection to both critical discourse analysis and critical pedagogy. Finally, this review narrows to the topic of scientific literacy and the role of using socioscientific issues as a transformative pedagogical tool.

Identification and Description of Theoretical Framework

This research is approached through a transformative paradigm that is oriented toward questions of power, justice, and politics and that focuses on the lives of marginalized groups, the inequalities that occur due to asymmetrical power relations, and the political and social structures that perpetuate disparity in our world (Creswell, 2014; Mertens, 2015). This transformative worldview drives critical scholarship in education that aims to either unmask the hidden curricula that support the reproduction of a hegemonic order or that works to enable individuals to resist subjugating forces (Pinar, et al., 1996). Critical discourse analysis and critical pedagogy are the two transformational theories scaffolding my research.

Critical discourse analysis is both a process and a theoretical framework that aims to help all people see the ways in which discourse is used to maintain power structures. In his first edition of Language and Power, Fairclough (1989) referred to the new field as critical language study (CLS), and explained that the term critical indicated the process’ aim to expose the connections among language, power, and ideology.
CLS analyses social interactions in a way which focuses upon their linguistic elements, and which sets out to show up their generally hidden determinants in the system of social relationships, as well as hidden effects they may have upon that system. (p. 5)

Many people have an interest in understanding and recognizing the ways in which language is used to prop up the agendas of those in power, and Fairclough established the role of CDA to both demonstrate the hidden messages as well as the impacts of those messages on individuals. Critical discourse scholars (Fairclough, 1989; Fairclough and Wodak, 1997; Gee, 2011a) would assert that both the informal and formal learning of students is shaped daily by the discourses of teachers, peers, school structures, and textbooks. For the purposes of this research, the theoretical foundation of critical discourse analysis supports the need to consider the intentions and potential impacts of the discourses of educational science texts.

This study is also approached through the theory of critical pedagogy. Originating from the pioneering work of Freire (2004), critical pedagogy is a movement in education inspired by critical theory that breaks with the conventional conceptions of learning. Traditional education is organized around teachers providing students with knowledge in an asymmetrical relationship of authority where knowledge is transmitted from teacher to pupil, referred to by Freire (2004) as a banking model of education. In contrast, critical pedagogy is based on the idea that knowledge and education need to be invested in a radically democratic process where knowledge is shared between students and teachers for the purpose of exposing inequality and promoting justice. From a critical pedagogy perspective, the teaching of scientific literacy is not driven by a need to
create workers for a capitalistic society but from a desire to ensure that all citizens are equipped to deal with issues such as global warming, genetically modified foods, and world pollution. Within this study, texts will be analyzed for the ways in which they employ the praxis of critical pedagogy. Freire (2004) explains that through praxis, students identify and understand suppressive structures and their impacts, and take action to transform them. In order to more fully understand the theoretical role of these two critical theories on my study, this review will next discuss the foundations of both critical discourse analysis and critical pedagogy.

Critical Discourse Analysis

Critical Discourse Analysis (CDA) emerged as a consolidated theory in the 1990s when the foundational scholars of the theory, van Dijk, Fairclough, Kress, Leeuwen, and Wodak united to discuss discourse theories, their use in critical scholarship, and the various approaches taken to critically analyze discourse (Wodak 2001). The foundational writings regarding critical discourse analysis (CDA) strive to establish its theoretical base by including defining sections that delineate its processes and purposes from those of text analysis (Fairclough and Wodak, 1997; van Dijk, 2001; Riggins, 1997). While many research methodologies approach text analysis as a process, CDA is a critical theory that can be used as a lens through which discourse may be analyzed. To more fully understand the theory of critical discourse analysis, this discussion will consider its theoretical foundations, philosophical assumptions, and purpose.

Theoretical Foundations

The theories of both Althusser (2010) and Foucault (1979, 1994) are foundational for critical discourse analysis in that each author provides ideas regarding the subjugation
of the individual and the role language plays in that process. A primary argument of this study is that the discourses used in educational science materials have the ability to subjugate students. The theoretical foundation for this idea can first be traced back to the writings of Althusser. In *Ideology and Ideological State Apparatuses*, Althusser (2010) takes up the issue of people as subjects and the role that family, religion, and, most importantly, education play in the reproduction of social structures. Althusser refers to these structures, which include school, family, religion, and any organization, as *ideological state apparatuses (ISAs)*. Within his argument, he states that a person is “always-already a subject, even before he (sic) is born” (p.1357). As early as infancy, babies are seen as a subject to their family. Without choice, a child is given a name, a gender identity, and ideology. Each of these identities is forced on a child even before the socialization of the family’s rearing begins.

For Althusser, people are always already subjects who are hailed or interpolated into subject positions. This thesis, the idea that subjects are inserted or recruited into positions that support the dominant ideology, is especially useful to CDA because it advances the notion that discourse and text are essential to understanding subjectivity, or how individuals are constituted as subjects. In an educational setting, students have little or no voice regarding the content and skills they are taught. The texts used for their instruction are therefore one additional tool used to form them into subjects. As this study analyzes science texts, it will return to this foundational theory and question the extent to which the tests are tools of subjugation or emancipation.

Foucault, a student of Althusser, substantially advanced the thesis that discourse produces subjects in his book *Discipline and Punish: The Birth of Prison*, a book that
traced modes of physical and mental punishments as a way to control the individual.

Foucault (1979) writes,

The modelling (sic) of the body produces a knowledge of the individual, the apprenticeship of the techniques induces modes of behaviour and the acquisition of skills is inextricably linked with the establishment of power relations: strong, skilled agricultural workers are produced; in this very work, provided it is technically supervised, submissive subjects are produced and a dependable body of knowledge built up about them. This disciplinary technique exercised upon the body had a double effect: a ‘soul’ to be known and a subjection to be maintained. (pp. 294-295)

While these approaches are similar in the ways the subject is connected to discourse, Foucault’s understanding explores the techniques of power and the technologies associated with subject formation and what they may achieve. These discourses function to create *docile bodies*, individuals who are not only controlled but who are controlled in a way that increases their usefulness. As they become more obedient, they become more useful. As their usefulness increases, they become more obedient (1977, p. 138).

Althusser’s emphasis on ideology is helpful for diagnosing problems as they appear in discourse, and Foucault’s arguments support the belief of CDA that language is a tool to assert ideology, whether subtle or blunt, and warrants analysis.

Additionally, Foucault (as cited in Bazzul, 2014) provides a final and substantial foundation to support the purpose and significance of this research. He describes a more nuanced understanding of how power is exercised and how resistance may be approached:
Under no circumstances should one pay attention to those who tell one: ‘Don’t criticize, since you’re not capable of carrying out the reform’. That’s ministerial cabinet talk. Critique doesn’t have to be the premise of a deduction that concludes, ‘this, then, is what needs to be done’. It should be an instrument for those who fight, those who resist and refuse what is. Its use should be in the process of conflict and confrontation, essays in refusal. It doesn’t have to lay down the law for the law. It isn’t a stage in a programming. It is a challenge directed to what is. (p. 426)

Based on his theory, all educational discourses, including texts and curricula, should be critically analyzed as a means of determining the ways in which they exert power. Such criticism need not draw conclusions, solve, or create. It is designed to analyze, question, and compare the existing text as a way of providing ammunition for challenging any hegemonic structures propped up by the discourse. Therefore, this study aims to use analysis of curricula to identify, expose, and challenge the ways in which power structures attempt to oppress students, teachers, and in turn, our society at large.

Philosophical Assumptions

Critical Discourse Analysis is built on these foundational arguments of Althusser and Foucault: specifically, that societal structures function to turn individuals into subjects who follow the dominant ideology; that discourse is a primary tool used in that subjugation and ideological reproduction; and finally that the analysis of such discourse can be used as a tool of resistance against hegemony. Their theories establish the power of language and the need to criticize and resist suppressive uses of language. The very act of analyzing texts is steeped in the method for analyzing ideology and resistance in
discursive texts. Building from their work, the theory of Critical Discourse Analysis can be analyzed by considering the philosophical assumptions upon which it is built.

Relationship of power and discourse. As a theory, critical discourse analysis is built on several philosophical assumptions. First, it presupposes a relationship between discourse and power. Van Dijk (1993) asserts that all critical discourse analysis “should deal primarily with the discourse dimensions of power abuse and the injustice and inequality that result from it” (p. 252). He goes on to stress that CDA is primarily interested in understanding societal ills through the analysis of the discourses that attempt to sustain inequality and existing power structures. In order for science curricula to fit within this assumption, the texts used to teach science and socio-scientific issues need to demonstrate the assertion of power, its abuse, or actions being taken to challenge that abuse. Regardless of the aim of a science text, whether it is to expand scientific literacy or advance an ideology, the authors of all curricula influence power relations. The knowledge provided by the curricula is what Gee (2011a) refers to as a social good and the authority to share or covet scientific literacy and skills resides in the authors of the discourse. Demonstrating the abuse of that power is the goal of critical discourse analysis.

In science curricula, the primary abuse is of ideological power. Fairclough (1989) identifies ideological power as “the power to project one’s practices as universal and ‘common sense’” (p. 33). Ideological power may be exercised through coercion or through the much subtler process of consent. Ideologies that are exerted through discourses are abuses of power in that their goal is to cause the listener to accept, without question, the ideology. According to van Dijk (1997), “ideology serves to coordinate the
social practices of dominant group members so as to perpetuate their dominant position as a group” (p. 26). They manage and control the members’ practices in such a way as to create a cohesive group that can be perpetually reproduced. Similarly, Fairclough and Wodak (1997), argue that discourse is “constitutive both in the sense that it helps to sustain and reproduce the status quo, and in the sense that it contributes to transforming it” (p. 258). Based on this limited description, it can be argued that both science and religion are ideologies in that both areas expect new members to understand, utilize, and build from an existing body of ideas.

However, van Dijk (1997) stresses that ideologies control not only knowledge but also the “evaluative belief systems (attitudes) groups share about certain social issues” (p. 29). In the case of science, the standards of the American Association for the Advancement of Science (2009) demonstrate the value that the science community places on group members evaluating and questioning the quality of information.

Individuals who are science literate can make some judgments based on its character. The use or misuse of supporting evidence, the language used, and the logic of the argument presented are important considerations in judging how seriously to take some claim or proposition. These critical response skills can be learned and with practice can become a lifelong habit of mind. (E. Critical-Response Skills, para. 2)

Based on this goal, science, as an ideology, encourages individuals to question, reflect, and engage productivity which makes it a power that places it in the service of the individual as opposed to a subjugating ideology. However, Bazzul (2013) argues that science education can be suppressive in many of its existing models. Absent
opportunities to engage with science critically, as described in the above standard, Bazzul views science education as an entrenched system of traditional hierarchies of information where the teacher and scientists hold the knowledge and bestow it upon the students. Furthermore, he suggests that the very action of defining science and identifying what needs to be learned in science can be a way to maintain a power structure and create “the conditions for incapacity and the control of (student) creative powers” (p. 247).

To better understand the difference between these two uses of power, empowerment or subjugation, it is helpful to consider Foucault’s (1994) distinctions regarding power. He argued for an analysis of power relations over power. For Foucault, there is not a need to attack institutions or groups but rather their techniques for exerting power, those actions that impose a truth on individuals in such a way as to make them recognizable to others or cause them to be subjugated to others. The techniques of science cause it to have very different power relations than those of other ideologies. Through its own processes, science encourages the individual to challenge ideas and be skeptical. In order to develop critical skills and to enhance the emancipatory power of science, Bazzul (2013) makes the case that science educators need to build opportunities for students to engage in value-laden discourses in ways that respect their intellect and give them voice. The specifics of this view of science education and how it is achieved will be addressed fully below. However, for the purposes of questioning the ways in which power is exerted in science education, it is sufficient to acknowledge the current stance of the scientific community regarding the importance of empowering individuals with scientific habits of mind and to juxtapose that with the alternative, ideologies designed to influence or dominant individuals.
Use of discourse to establish truth. In addition to believing that the discourse of those in power maintains the status quo, CDA scholars argue that discourse is used by power structures to establish what is considered to be common sense or truth. This status quo discourse builds on Foucault’s (1994) concepts of power previously mentioned. Wodak (2001) explains that “dominant structures stabilize conventions and naturalize them, that is, the effects of power and ideology in the production of meaning are obscured and acquire stable and natural forms: they are taken as ‘given’” (p. 3). Bloome, Power Carter, Christian, Madrid, Otto, Shuart-Faris, and Smith (2008) extend this idea when they claim that language is used to create groups and privileges those groups’ ways of knowing. The idea that the discourse of those in power establishes societal norms demonstrates the connection between power and language and leads to an additional foundational assumption of CDA.

Critical discourse analysis proposes that discourse is both constructed by and constructs society. A relationship exists between events in society and the discourse that is created within specific times and places, and that relationship has influence in both directions. “As well as being determined by social structures, discourse has effects upon social structures and contributes to the achievement of social continuity or social change” (Fairclough, 1989, p. 37). This is referred to as reflexivity by Gee (2011a), who suggests that many aspects of discourse both influence and are in turn impacted by one another. For example, language is impacted by the context in which it is spoken or written, but it also affects that context. In science education, students may learn the terminology used as they conduct inquiry experiments such as experiment, data, or conclude. The use of
these terms shapes their actions and they in turn eventually use them to describe their actions.

Additionally, people use their discourses “when they try to make visible to others (and to themselves, as well) who they are and what they are doing” (p. 37). Gee calls this recognition work. However, the role being acted out by the person then, in turn, influences the discourse. Gee argues that language and context are like “mirrors facing each other and constantly and endlessly reflecting their own images back and forth between each other” (p. 101). Based on this idea, critical discourse analysis can bring to light ways in which discourse is used to oppress groups and individuals as well as the ways in which they are used to challenge dominant power structures. For example, teachers engage in actions and use terminology that function to align their pedagogy with specific theories. Constructivist teachers self-identify and recognize others through both pedagogical choices and the ways they discuss teaching and learning. However, teachers who do not believe in the effectiveness of constructivist theories but who know they are popular with their administration may interject constructivist terminology into their conversation but then describe contradictory practices. A critical discourse analysis aims to identify the ways individuals use their discourse.

Critical Discourse Analysis scholars take a political stance. The final assumption of CDA is also based on Foucault’s ideas regarding the power in society. Foucault (1994) argued that a society without power relations is impossible and that one could only be considered in an abstract way. For Foucault, the omnipresence of power relations in society necessitates scholars who study how those power relations formed, their strengths and weaknesses, and how they can be transformed or eliminated.
...I would say that the analysis, elaboration, and bringing into question of power relations and the “agonism” between power relations and the intransitivity of freedom is an increasingly political task—even, the political task that is inherent in all social existence. (p. 343)

Therefore the final assumption of critical discourse analysis is that those scholars who engage in it take and announce a political stance.

Critical Discourse Analysis scholars provide a voice for “…those who lack the institutional levers to produce counterdiscourses, and their ultimate motivation appears to be the hope that their work will contribute to social emancipation” (Riggins, 1997, pp.2-3). Van Dijk (2001) takes his stance a step further by unapologetically writing, “…CDA is biased – and proud of it” (p. 96). CDA is not unique when compared with other transformational theories or paradigms that attempt to advance the causes of disenfranchised groups. However, Fairclough and Wodak (1997) explain that CDA is distinctive in that it “…intervenes on the side of dominated and oppressed groups and against dominating groups, and that it openly declares the emancipatory interests that motivate it” (p. 259). Through using this voice, scholars who engage in Critical Discourse Analysis identify the ways in which discourse is functioning as an oppressive force, and they use that analysis to expose and transform those negative forces.

Gee (2011a) takes the political nature of critical discourse analysis a step further. He identifies social goods as those things the members of a society find desirable. They may include knowledge, rights, or position. For Gee, politics is any action that impacts the distribution of these social goods, and all language is engaged in that process. Politics is about the distribution of the social goods that are available in any society.
Since the rules for determining who receives social goods are always being set with language, Gee argues that all language is political. Therefore, Gee’s definition of political is much broader than its common definition. A lay person thinks of politics as a process that results in the passing of laws and the administration of a group of people. For Gee, labeling a person a scientist is a political action because they are being given a position within a community and the title suggests they have a specialized body of knowledge. Therefore, an educator who bestows that title on all the students in an elementary classroom is using language to give a social good to the students. For Gee, that is a conscious political action.

Purpose of Critical Discourse Analysis. Finally, the theoretical foundation of CDA can be analyzed through a consideration of the purpose of the scholarship approached through this theory. Van Dijk (2001) explained that CDA “…focuses on social problems, and especially on the role of discourse in the production and reproduction of power abuse or domination” (p. 96). He argued that CDA scholars work to use the experiences of oppressed groups to help them oppose those who use discourse to “establish, confirm or legitimate their abuse of power” (p. 96). In both of the goals outlined by van Dijk, the need to consider the discourse of science textbooks is evident. The discourse of science textbooks is positioned to either confirm or question the uses of science in our culture and to either promote or disregard the building of scientific literacy. In the event that a text is abusing its power through either included or excluded discourse, CDA gives voice to marginalized students and reveals the hidden assumptions and ideologies being taught. These goals of CDA align with the second theory that structures my research, Critical Pedagogy.
Critical Pedagogy

Theorists who approach research from a transformational paradigm seek to help marginalized groups, give a voice to the individuals being studied, and challenge hegemonic norms (Martens, 2015). In the field of education, critical theorists such as Giroux (1981, 2014, 2015), Kincheloe (2002, 2012, 2014), and McLaren (2002, 2014), view curriculum as a political device of cultural reproduction, and argue that teachers, students, and parents need to resist the structures of education that perpetuate the marginalization of certain groups. From this work and, most importantly, the influence of Freire (2004), the theory of critical pedagogy has emerged (Pinar et al., 1996). Since the goal of my research is to analyze the discourse used in science texts to determine the ways socioscientific topics are approached, it is important to connect the instructional texts being analyzed with both critical pedagogy and Critical Discourse Analysis.

As previously explained, taking a political stance is an essential element of Critical Discourse Analysis. For this work, the political stance is influenced by the political beliefs that are foundational in critical pedagogy. Based on the essential ideals of critical pedagogy, texts that include socioscientific issues without giving teachers and students the opportunity to critically work with the issues are reproducing, intentionally or unintentionally, the norms of that issue. Science materials that provide opportunities for both students and teachers to critically engage issues using science habits of mind are aligned with the theoretical foundations of critical pedagogy. Therefore, when the texts are analyzed for their effectiveness of engaging with a critical pedagogy, the fundamental beliefs described below will be considered. To fully examine critical pedagogy and the way in which it applies to my research, the theory can be analyzed by considering its
foundational arguments regarding the role of the researcher/teacher, epistemology, the teacher/student relationship, and the role of the learner.

Role of the Researcher/Teacher

Freire’s methodology requires a partnership with oppressed people where both the researcher and those being studied work together to investigate and think on a more critical level (Kincheloe, McLaren, and Steinberg, 2014). For Freire, simply studying an oppressed group and working to improve the condition of others is at best ineffective and at worse a perpetuation of hegemony. Freire (2004) explains that “political action on the side of the oppressed must be pedagogical action in the authentic sense of the word, and, therefore, action with the oppressed” (p.66). This argument has several implications for educators.

Provide opportunities for co-learning. Standing with the oppressed, according to Freire, entails giving supports and assistance, what Freire refers to as true generosity. The role of the teacher is to provide opportunities for students to gain their own humanization. The very action, or praxis, of fighting for liberation allows the oppressed to understand the need for the fight, gain a love for it, and use that love to counter the lovelessness demonstrated by the oppressor’s blatant violence or subversive false generosity.

Similarly, Giroux (1981) argues that changing the pedagogy used in critical research could result in successful challenges to oppressive institutions. “At the core of any radical pedagogy must be the aim of empowering people to work for a change in the social, political, and economic structure that constitutes the ultimate source of class-based power and domination” (p. 24). Instead of being institutions of cultural reproduction,
Giroux contends that schools could be sites that aid transformational research, and he maintains that teachers and students should become critical researchers of their own experiences.

To accomplish this, teachers can apply various processes applied by critical pedagogy scholars. Freire (1994, 2004) created a process through which teachers and learners became the co-creators of knowledge through identifying the culture of the students, connecting it to the world, and then engaging the students in the process of actively changing the world. Kincheloe (2012) promotes developing individualism while simultaneously connecting it with society and issues of power. Giroux (2014) recommends the development of critique and critical inquiry to “revitalize the conditions for individual and social agency” (p. 113). Finally, Westheimer (2015) suggests schools use controversial issues as a way to allow students to mentally wrestle with controversy and ideology and prepared them to be citizens who can understand, dialogue about, and solve policy issues. Programs that develop what he refers to as social justice-oriented citizens are based on the assumption that “citizens must question and change established systems and structures when they reproduce patterns of injustice over time” (p. 39).

Therefore, to help students build a sense of agency for themselves and others and to understand their transformational role in the world, educators must engage students in authentic, controversial issues that allow them to critique and challenge the existing structures that perpetuate oppression for themselves and others. It is in this critical nexus that critical pedagogy, scientific literacy development, and the practice of socioscientific issues function together to develop vital citizenry skills.
In science education, many structures could be considered reproductive and oppressive. Kincheloe, McLaren, and Steinberg (2014) argue that the practices dictated by mainstream paradigms actually, even if unintentionally, sustain the structures of hegemony. As previously discussed, science is an ideology with cultural norms and expectations, and the processes used in science could easily be unintentional reproducers of hegemonic norms (Bazzul, 2013). However, science education also values the critical reasoning skills vital to good science and science literacy. Therefore, a science curriculum that empowers both teachers and students to engage personally with science rests firmly within the theory of critical pedagogy and is one lens through which the discourses in this study will be analyzed.

Remove suppressive structures. In addition to providing opportunities for personal engagement and co-learning, teachers and scholars working toward radical political change must also investigate the structural mechanisms that control the educational experiences. According to Kincheloe and McLaren (2002), language is not a part of the world but actually something that constructs it, and “criticalists begin to study the way language in the form of discourses serves as a form of regulation and domination” (p. 94). This connection between the discourses in education and the impact of their power is a fundamental element of investigating science materials. The empirical processes involved in science dictate specific steps for research and for understanding the discourse of science; however, those same processes also demand the application of the reasoning and questioning involved in critical pedagogy. As discussed above, the science presented in textbooks is the representation of a structured group influencing the conversation about the process of a particular field of science. In texts that present
science mixed with faith-based or personal beliefs, additional hegemonic forces influence the text and therefore the student. These texts are, in every way, examples of the regulation and domination written about by Kincheloe and McLaren and represent another way in which science texts can be analyzed.

Challenge curriculum goals. Finally, teachers and researchers need to be sensitive to the ways curriculum is organized to privilege some student populations at the expense of others. The previous section considered the impacts on a teacher’s pedagogy and the curriculum based on one’s vision of the best type of citizen for a healthy democracy. A critical pedagogy requires teachers to challenge the goals of curriculum and the impact those goals have on students. In the case of science instruction, Roberts (2011) argues that some visions of scientific literacy view “school science as if its major purpose is to develop a potential scientists pool” (p.13). Such a goal places science education as a creator of docile bodies as described by Foucault and sees its aim as being the production of manageable and well-behaved students who are prepared to work for others in low wage occupations. Huerta-Charles (2007) argues that “new global and dehumanized capitalism” has moved our society even beyond seeing humans as docile bodies of utility. Low wages, fewer full time jobs, and attacks on unions have made individuals expendable; while at the same time, the discourses in our society have convinced us to “accept as a ‘given’ reality this kind of capitalism, along with its social inequalities” (p. 251). To counter this, teachers applying critical pedagogy in the science curriculum need to engage students in questions regarding the economic and political uses of science, place science in the service of the community, and value scientific literacy and an informed citizenry. Therefore, teachers and researchers must analyze science curricula to
determine the extent to which it allows students to use critical approaches to engage with socioscientific issues such as global warming, pollution, sexuality, and disease. The specifics of the goals of science education and how they apply to a critical pedagogy are more fully discussed below; however, it is important to state that the way in which science texts present the goals of science education is another area of analysis in science texts.

Epistemology

Critical pedagogy is also concerned with the way in which education can be used to define knowledge. Mertens (2015) explains that the epistemological beliefs of a transformational paradigm such as critical pedagogy hold that knowledge is situated in the knower’s social and historical experience, what he refers to as one’s cultural lens, and that positions of power impact “the determination of what is considered legitimate knowledge” (p. 32). Therefore, researchers must be aware of how positions of power and cultural structures influence what is valued as knowledge. This view of epistemology is illustrated by Cornel West’s (1999) description of the “new cultural politics of difference” (p. 119) in which he addresses the ways critical scholars must approach and analyze the impact of their own life experiences and past oppressions, deepen their understanding of multiculturalism, continue to critique structures of Western and white privilege, and refrain from actions that attempt to argue the superiority of any group.

Bernal (2002) furthers this argument by explaining that those who view the world through a privileged, Western lens believe their knowledge is indeed fact when in fact a critical epistemology would see “the production of knowledge as situated” (p. 120). Haraway (1988) specifically refers to this concept as situated knowledges, and she argues
that the idea of being objective when studying science is “an illusion, a god trick” (p. 582). Instead, she proposes that we strive to see the world from another person’s viewpoint, specifically those who are subjugated, without “romanticizing and/or appropriating the vision of the less powerful while claiming to see from their positions” (p. 584). This is accomplished by practicing an “objectivity that privileges contestation, deconstruction, passionate construction, webbed connections, and hope for transformation of systems of knowledge and ways of seeing” (p. 585). Haraway envisions these practices as ways to break out of one’s fixed worldviews. Specifically, in the study of science curricula, the goal is to question those things that are taken for granted, the processes and terminology that are assumed to be accepted by all cultures and viewpoints.

The ability to accept that all knowledge is subjective and that no single viewpoint as absolute is vital to a critical pedagogy. However, Ladson-Billings (2000) explains how challenging it is to do so. Due to the reciprocal influence one’s knowledge and worldview have on each other, Ladson-Billings argues:

The process of developing a worldview that differs from the dominant worldview requires active intellectual work on the part of the knower, because schools, society, and the structure and production of knowledge are designed to create individuals who internalize the dominant worldview and knowledge production and acquisition processes. The hegemony of the dominant paradigm makes it more than just another way to view the world – it claims to be the only legitimate way to view the world. (p. 258)
Ladson-Billings hones in on schools as one of the structures that creates these hegemonic worldviews. When the curriculum and pedagogy in science classrooms reinforce the idea of a god-view of objectivity instead of considering objectivity from different perspectives; or worse, when the instruction confirms the ideas that such objectivity is even possible, then the instruction legitimizes the dominant worldview of science and does not use Critical pedagogy to present the content, process, or epistemology of science. The role of the teacher is to give students opportunities to engage in the intellectual work necessary to break free of the dominant worldview.

Critical pedagogy is a process through which individuals can analyze their worldview and its epistemological influences. Certainly one’s worldview impacts one’s knowledge as well as the knowledge one values and passes on to others. For example, through a synthesis of multiple studies, Westheimer (2015) found that most curricula aimed at developing citizenship skills focused on voluntarism and obedience and did not require students to grapple with social issues. The aim of such teaching is to reproduce docile, unquestioning citizens. As a critical theorist, Giroux (2014) argues instead for a citizenry that “embraces a culture of questioning and puts into question society’s commanding institutions” (p. 24). Critical pedagogy allows teachers and students to question the goals of instruction and therefore the knowledge being taught.

The significance of this understanding of knowledge on my research is that everyone’s worldview can be impacted through critical pedagogy. Educational processes for students may be altered so that, in lieu of hegemonic views, the skills necessary to help them understand that there is no single legitimate system of knowledge may be internalized. This study aims to analyze the discourses used in science materials and the
extent to which they help students and teachers question these very epistemological assumptions.

Teacher and Student Relationship

In order to resist being an instrument of ideology, as described below by Althusser, and instead to work toward transformation, as demanded by Freire, science educators must develop a balanced relationship with their students. Critical pedagogy theory is concerned with the dynamics between teachers and students. At the heart of Paulo Freire’s critical pedagogy is the belief that the relationship between instructor and student should not be asymmetrical. Althusser (2010) identifies the teacher who attempts to fight against the ideology of the system as a hero. However, in his opinion, there are not many, and most “do not even begin to suspect the ‘work’ the system (which is bigger than they are and crushes them) forces them to do, or worse, put all their heart and ingenuity into performing it with the most advanced awareness…” (p. 1348). In Pedagogy of the Oppressed, Freire (2004) argues that the aim for the oppressed and their allies is to “unveil the world of oppression and through the praxis commit themselves to its transformation” (p. 54).

Therefore, to be a part of a transformational process instead of an aggregator of hegemony, teachers must work with students in critical lessons that question the ways in which science either oppresses or liberates marginalized groups. Part of a critical pedagogy is allowing students to generate their own questions, search for their own answers, and feel ownership of the knowledge they produce. These elements of a critical pedagogy support the development of scientific literacy, which is increased when student learning focuses on the processes and critical thinking involved in science instead of the
rote memorization of science facts. Therefore, teachers and students must work together to create opportunities to find their agency and voice. The goal of this study to analyze the ways science texts present socioscientific issues is fueled by the belief that both teachers and students can be oppressed by texts marbled with pseudoscience and ideology. The intention is to analyze texts that successfully present socioscientific issues in a way that empowers both students and teachers. Finding and duplicating those discursive devices would increase the presence of critical pedagogy in science education. Ultimately, doing so would positively impact the quality of life for students from marginalized groups by widening their exposure to different worldviews, increasing their scientific literacy, and impacting their ability to join a common community of scientists.

Role of Learner

Finally, critical pedagogy considers the learners, each of whom arrives to school with capacities and a schema. Based on Freire’s (2004) theory, students must be advocates for themselves, engage in the dialogue that transforms and humanizes the world, and demand a voice in that process. When writing about diverse populations, bell hooks (1994) explains that the fixed ideas about pedagogy are challenged. She calls for an engaged pedagogy. Student backgrounds, such as economical, racial, and social variety, are a vital component that impact student learning and influence our actions as educators. In *Teaching to Transgress*, hooks shares her practice of addressing the needs of marginalized students by using “pedagogical strategies that affirm their presence, their right to speak, in multiple ways on diverse topics” (p. 84). Curriculum and pedagogical tools such as textbooks allow for students to voice their opinions and engage with a variety of ideas.
Textbooks that present socioscientific issues from a non-critical framework promote specific ideologies and engage in pedagogical practices that defy hooks’ view of education. Such texts manipulate the relationship between teacher and student and not only dismiss but also silence student views by dictating the knowledge students gain. Additionally, such texts demonstrate disrespect for students’ cognitive and critical abilities by depriving them the opportunity to engage with the foundational knowledge that is the entry way for students into the conversation about any given field of science.

In their synoptic text, Pinar, Reynolds, Slattery, and Taubman (1996) synthesize studies that assert that curriculum research has been geared toward getting teachers to do what others want them to do while teaching has been focused on getting students to learn what has been dictated. Critical pedagogy challenges educators and students to question these structures. Structures such as textbooks that specifically work to entrench a single worldview need to be identified, examined, and analyzed. In Teachers as Researchers, Kincheloe (2012) wrote, “This democratic reconceptualization of education embraces a vision which takes seriously notions of social justice, racial, gender, and class equality, and alternative ways of seeing the world borrowed from people who have traditionally been ignored” (p. 2). The production and sharing of knowledge is a political and ideological act. Critical pedagogy provides a framework for theorizing a new kind of relationship between students and educators that draws from the unique insights and knowledge of each to reconceptualize learning in the service of others rather than in service of dominant interests.

The foundations of critical pedagogy provide one of the political stances applied in this analysis. All education serves the function of liberating or suppressing students.
Through using the elements of critical pedagogy to analyze science texts that discuss socioscientific issues, this study applies a political stance that believes in the importance of developing a critical pedagogy and cultivating the type of citizen that results from that process. Furthermore, the problem addressed by this study involves the skills needed by citizens to deal with complex socioscientific issues. The skills developed through a critical pedagogy, which are summarized in Table 1, play a vital role in cultivating such a citizenry.

Table 1

**Critical Pedagogy Indicators**

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<th>Presence of:</th>
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<tr>
<td>Co-learning: engage personally, connect, challenge and change</td>
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<tr>
<td>Non-capitalistic, pro-community goals of science education</td>
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<tr>
<td>Opportunities to challenge dominant worldviews</td>
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<td>Transformational experiences for teachers and students</td>
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<td>Connection of instruction to the service of all not just special interests</td>
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<tr>
<th>Absence of:</th>
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<tbody>
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<td>Suppressive structures</td>
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**Scientific Literacy**

One of the goals of this study it to determine the extent to which science texts that mention socioscientific issues use discourse to promote or suppress scientific literacy. In order to outline the framework through which the presentation of scientific literacy in these texts will be evaluated, this literature review will next define scientific literacy.
through a discussion of the history and conceptual understandings of scientific literacy and then identify the definition of scientific literacy applicable to this critical study.

Scientific Literacy Defined

In science education, the Sisyphean question, according to Bybee (1997), is “What should the scientifically literate person know, value, and do – as a citizen?” (p. 46). He goes on to argue that since the 1950s, when the term scientific literacy first appeared in the literature, science education reform movements have been driven by the answers different scholars have for this question. While a full history of the various incarnations of scientific literacy is outside the purpose of this review, it is helpful to understand that early definitions of scientific literacy focused primarily on the factual, applied science information an average citizen would need in order to judge and question information presented by scientific experts (Cohen & Watson, 1952). The term became little more than a slogan or a catch-all for the purpose of science education, and science educators spent decades attempting to finalize a definition. (Bybee, 1997; Roberts, 2011)

In 2007, Roberts argued all views on the definition of scientific literacy, or the purpose and primary content of science education, could be placed on a continuum with camps at each extreme. He referred to each as Vision I and Vision II. Vision I scientific literacy focuses on science content and the scientific knowledge that should be understood by all. Vision II scientific literacy begins by considering the situations in which citizens may encounter and therefore need to understand science. The former starts with the science and considers what should be taught while the later begins with real-world applications and questions the science knowledge is needed in those situations. Vision I is promoted by those in the scientific community who view science instruction’s
main goal as being the creation of a pool of future scientists, while Vision II advocates a science education in which “students comprehend and cope with a variety of science-related situations that confront adults as parents and citizens” (Roberts, 2011, p. 13).

The broader conceptualization of science education, identified by Roberts as Vision II, was first proposed nearly half a century ago when Gallagher (1971) argued for the importance of a science curriculum that not only addressed science concepts and process but also considered their relationship to technology and society. During the 1970s and 1980s, science education shifted to a focus on science, technology, and society which is referred to as STS education (Zeidler, et al., 2005). Aikenhead (1994) explained that STS science teaching focused on the content and processes of science by integrating them “into science and technological contexts meaningful to students” (p. 59). By the early 1980s, this shift in science education was evident in the National Science Teachers Association’s (1982) description of a scientifically literate person as one who understood the connections between science, technology, and society.

Critical Application of Scientific Literacy

Over the past quarter century, the elements of Vision II scientific literacy have been integrated into major science standards written in the United States, including Benchmarks for Science Literacy (1993), Next Generation Science Standards (2013), and A Framework for K-12 Science Education (2012). Zeidler, et al. (2005) synthesized the elements of scientific literacy found in these standards by explaining that being scientifically literate requires individuals who can understand socioscientific issues through making decisions, analyzing information, and applying moral and ethical reasoning. They continue by arguing that to be scientifically literate requires one to be
exposed to and to practice habits of mind such as “acquiring skepticism, maintaining open-mindedness, evoking critical thinking, recognizing multiple forms of inquiry, accepting ambiguity, and searching for data-driven knowledge” (p. 358). Finally, they argue that scientifically literate individuals can only make decisions about socioscientific issues if they understand the epistemology of science and use it to evaluate “scientific claims by discerning connections among evidence, inferences, and conclusions” (p. 358). A summary of these elements of scientific literacy is found in table 2 and can be used to analyze the ways in which the texts in this study promote or suppress scientific literacy.

Table 2

Descriptors of Scientific Literacy

Understand Socioscientific Issues by
- making decisions
- analyzing information
- applying moral and ethical reasoning

Exposure to and practice of habits of mind such as:
- being skeptical
- accepting ambiguity
- expecting data-driven knowledge

Know and use epistemology of science
to judge scientific claims through
- evidence
- inference
- conclusions

While many descriptions of scientific literacy call for opportunities for students to apply science content to authentic decision making, the one advanced in this research,
and described above, promotes a specific *Vision II* definition which requires individuals to negotiate socioscientific issues (Sadler, 2004a). This concept of scientific literacy is promoted by curriculum referred to as *Socioscientific Issues (SSI)* instruction which is a pedagogical process that emerged from the Science-Technology-Society (STS) movement.

**Socioscientific Issues**

To understand the role SSI can play in a critical pedagogy, this literature review will next examine socioscientific issues science education by defining it, considering how it is different from Science-Technology-Society (STS), and presenting the ways in which it can be used to promote critical pedagogy and develop scientific literacy.

**Socioscientific Issues Defined**

Socioscientific issues are scientific issues that require public input, as opposed to those discussed only in the scientific community (Kolsto, 2001). Sadler (2004a) identifies socioscientific issues as those that have scientific and social factors at their core, and he argues that science and society are not separate issues. In fact, all science is tied to the society from which it originates, but the term *socioscientific issues* is used to describe those topics that “display a unique degree of societal interest, effect, and consequence” (p. 513). These issues are open-ended, controversial social issues that are informed by science but also impacted by politics, economics, and ethics (Sadler, 2011). Examples of socioscientific issues are the human impact on global warming, genetically modified foods, cloning, stem cell research, alternative fuels, and conservation efforts for endangered species. For example, students learning about the carbon cycle can improve
their content understanding by applying the information to a socioscientific unit regarding the impact humans have on global warming.

Science-Technology-Society (STS) Compared to Socioscientific Issues Education

In the previous section regarding the definition of scientific literacy, this review discussed the role Science-Technology-Society education played in supporting Vision II scientific literacy. Socioscientific Issues education stems from STS in that both movements have shared principles, visions, and pedagogies. Predretti and Nazir (2011) explain that both STS and SSI share a broad understanding of scientific literacy which includes informed decision making, information analysis, and an understanding of the nature of science (NOS). Most importantly, they argue that both movements include a “coupling of science, ethics, and moral reasoning; and agency” (p. 604). However, it is in this final area, which is further discussed below, that SSI distinguishes itself as a movement separate from STS.

Socioscientific Issues education places special focus on the psychological and epistemological growth of students. In a foundational definition, Zeidler, Walker, Ackett, and Simmons (2002), defined Socioscientific Issues as a movement that incorporated all the goals of STS education “while also considering the ethical dimensions of science, the moral reasoning of the child, and the emotional development of the student” (p. 344). Sadler and Zeidler (2005) later specified that while STS focuses on the effect of science and technology on society, it does not consider the “moral and ethical implications that underlies these issues. In contrast, the socioscientific issue movement arises from a conceptual framework that unifies the development of moral and epistemological orientations of students and considers the role of emotions and character as key
components of science education” (p. 113). Pedretti and Nazir (2011) identify SSI as a value-centered current of STS that challenges the idea that science is value free. For example, the issue of fracking understood through a Science Technology and Society lens considers the science and technology of fracking and how it impacts people. But from a socioscientific issue perspective, all of those elements would be considered along with the ethical issues of engaging in fracking. Students would learn about and discuss the ethics of providing natural gas to heat homes against the negative impacts of fracking, such as the accidental release of natural gas into the atmosphere and the contamination of drinking water. Engaging in exercises that require students to consider the decision to conduct fracking allows them to develop the skills needed to consider multi-faceted issues. Additionally, it involves them in opportunities for true agency to address those issues, and to understand that the choices regarding the use of science and technology are anything but value free.

This evolution of SSI from STS is outlined by Sadler (2004b) who argued that a definition of scientific literacy that strives to build the aptitudes needed to deal with socioscientific issues requires students who can find and understand the ever-changing information about science, understand the nature of science, and “have an appreciation for the moral and ethical dimensions associated with these issues” (p.41). The STS movement does not address the moral and ethical aspects of decision making and therefore restricts student experiences. To create opportunities for students to fully engage in informed decision making about socioscientific issues, Sadler goes on to advocate for science classrooms that allow students to express their ideas and value
systems in a tolerant community where dissenting opinions and belief systems can be explored through debates, role-plays, and writing.

In support of the inclusion of ethics and morality in science education, Sadler (2004b) contends:

Ethics and morality are unavoidable in the contemplation of socioscientific issues and it is better to pay explicit attention to these aspects than to leave a major facet of socioscientific decision-making to chance. Rather than overlooking or actively ignoring the ethical implications of socioscientific issues, educators have a responsibility to address them. If the promotion of scientific literacy is an important aim of science education, and socioscientific decision-making occupies a seminal place in scientific literacy, then attention to morality and ethics must be included in science curricula. (p. 46)

Sadler’s argument places the goal of science education squarely in line with Vision II scientific literacy and connects socioscientific issues, as well as their moral and ethical aspects, within science education. By doing so, he also connects science education within the critical framework previously discussed in this review. As a pedagogical practice, socioscientific issues allow students to question the normative or reproductive powers of science and technology, develop a voice within the discussions of the issues, and apply scientific data and evidence to challenge their own and others’ worldviews.

A summary of the ways in which engagement with a socioscientific issues in the classroom would achieve these goals was provided by Zeidler and Kahn (2014). They argued that units that address socioscientific issues should include opportunities for students to argue and debate as well as discuss. Additionally, the students should practice
critical thinking through assignments that require analysis, inference, explanation, evaluation, interpretation, or self-regulation. Another essential requirement is that students evaluate the sources of information they encounter for characteristics such as credibility, accuracy, reasonableness, and support from other sources. Finally, they argue that SSI units should include cooperative learning and both teacher and self-assessment.

Table 3 summarizes the elements found in curricula that address socioscientific issues.

Table 3

*Elements of Socioscientific Curricula*

- Students express their ideas and value systems in a tolerant community
- Dissenting opinions.belief systems explored - Role-plays, Writing, Debates
- Discussions
- Arguments and Debates
- Critical Thinking – Analysis, Inference, Explanation, Evaluation, Interpretations
- Evaluation of Sources of Information - Credibility, Accuracy, Reasonableness,
- Consensus
- Cooperative Learning
- Assessment – Teacher and Self
- Neither negation nor affirmation of student belief systems

The Role of Socioscientific Issues in Scientific Literacy and Critical Pedagogy

This literature review has discussed the definition of Vision II scientific literacy and socioscientific issues education in order to highlight they ways in which they align
with the transformational goals of a critical pedagogy. In the forward that Shaull (2004) wrote for *Pedagogy of the Oppressed*, he argued:

> There is no such thing as a neutral educational process. Education either functions as an instrument that is used to facilitate the integration of the younger generation into the logic of the present system and bring about conformity to it, or it becomes “the practice of freedom,” the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world. (location 420-421)

Science education is not an exception to this claim, so it necessary to understand the ways in which science education can develop students who are ready to engage critically to challenge and transform their communities while simultaneously developing the scientific literacy needed by an informed citizenry.

Science education that promotes *Vision I scientific literacy* functions to reproduce oppressions in our society and does not focus on the development of citizens. It isolates science to the service of job training and capitalism, and applies a *technocratic perspective* to the definition of what it means to possess functional scientific literacy (Zeidler, et al., 2005). Santos (2009) argues that for Freire, “scientific literacy in its practical aspect could be regarded as banking education” (p. 371). On the other end of the spectrum, *Vision II scientific literacy* builds the skills and thought processes needed by citizens in all decision-making while at the same time providing opportunities that develops a scientific foundation that enables them to be life-long and thoughtful consumers of science.
Since so many issues in our society involve the integration of science and technology, informed citizens need a level of literacy that allows them to successfully engage with ever-changing concepts. The understanding of such issues does not require a specific set of science knowledge because that information is mercurial. Therefore, it is more important that an engaged citizen understand how to question and gain science information as opposed to memorize and learn specific concepts. While an SSI pedagogy cannot automatically develop all science skills, Sadler’s (2004) review of the literature did find that SSI did “provide a forum for working on informal reasoning and argumentation skills, NOS conceptualizations, the evaluation of information, and the development of conceptual understanding of science content” (p. 533). Sadler and Zeidler (2005) identified four practices for decision-making that are taught within the context of socioscientific issues: recognizing the complexity of socioscientific issues, examining issues from multiple perspectives, understanding that these issues involve ongoing inquiry, and exhibiting skepticism when potentially biased information is read.

Hodson (2003) actually argues that those who do not have this “basic understanding of the ways in which science and technology are impacted by, and impact upon, the physical and the sociopolitical environment will effectively be disempowered and susceptible to being seriously misled in exercising their rights within a democratic, technologically-dependent society” (p. 650-651). Therefore, engaging with socioscientific issues not only builds life-long skills but also ensures a citizenry that is empowered by those skills to participate with societal issues that involve science and technology. According to Huff and Bybee (2013), socioscientific issues pedagogy also requires students to practice argumentation, conversation, and critical discourse all of
which “enhance conceptual understanding and strengthen students’ scientific reasoning capabilities” (p. 30). Their findings support the argument that practice with socioscientific issues establishes a reciprocal relationship between the development of scientific and civil literacy. Therefore, working with socioscientific issues not only empowers students to be better consumers of science but also increases their understanding of scientific concepts and develops skills they can use when considering other societal issues.

Additionally, the development of Vision II scientific literacy builds other skills needed by a transformational electorate. In a synthesis of findings, Sadler and Zeidler (2005) found that dealing with the decision-making integral to socioscientific issues provided opportunities for students to consider the inherent complexity in such dilemmas, to examine issues from multiple perspectives, to appreciate the ways in which such issues are on-going, and to be skeptical about the potential bias found in information given to the public. While such skills are vital to addressing these socioscientific issues, they are also the habits of mind that all citizens should possess. The potential for transferability from socioscientific issues to all societal concerns is another massive benefit of building this type of scientific literacy in citizens.

Engaging with socioscientific issues also allows students to challenge science and technology; and through that process, it prevents scientific knowledge from being another hegemonic structure in our society. Citizens who are taught the established science content as a codified set of knowledge, fail to understand the fluid nature of science and the role argumentation plays in the scientific method. When students have opportunities to engage in their own arguments, they build an understanding of the nature and structure
of debate. Driver, Newton, and Osborne (2000) argue that doing so not only builds transferable argumentation skills in citizens but also encourages them to effectively understand and question science. They suggest that average citizens have placed science and technology into a position of dominance and that engaging in science-based debates is a way of demystifying science.

Finally, citizens who develop a level of scientific literacy that enables them to wrestle with socioscientific issues also requires individuals to consider the moral and ethical implications of decisions. The role of moral and ethical aspects of socioscientific issues were fully discussed in the comparison of STS and SSI; however, it is worth repeating the importance of using science education as a way to develop the personal character. The real issues faced by the members of a democratic society require individuals who can consider the needs of others before themselves and who can weigh immediate gratification against future gains. A scientific literacy that develops an altruistic citizenry is far better than one that only develops science content and process knowledge.

While the above review of the literature connects socioscientific issues with the development of Vision II scientific literacy, civic literacy, and a critical perspective, it stops short of directly connecting socioscientific issues with a critical pedagogy. In the literature, that connection is established by Santos (2009) who created a Freirean perspective of science education that incorporates SSI. He suggests that to engage science topics with a critical pedagogy would require three aspects: “1. discussion of socially relevant themes by socioscientific issues (SSI), 2. establishment of a dialogical process in classroom, and 3. engagement of students in sociopolitical actions” (p. 373).
He argues that to move the discussion of socioscientific issues past a naïve application and toward true critical engagement with the human condition requires applying socioscientific issues as well as creating opportunities for the dialogical processes identified as part of civic and scientific literacy discussed above, such as argumentation and analysis of information.

However, it is most important to acknowledge that application of socioscientific issues and dialogue alone are not enough to establish a critical pedagogy. In order to make that connection, the curriculum must also require students and teachers to take action. Santos (2009) argues that a Freirean perspective must be applied in science education in order for both poor and rich students to engage in transformative practices that apply science and technology to equality and social justice.

Summary

This literature review discussed the fundamental theories on which this study is constructed. At its core, this critical discourse analysis, as do all CDAs, aims to analyze the interconnectedness of language, power, and ideology. The specific goal of this study is to analyze the ways in which intermediate science curriculum present socioscientific issues and use those issues as a way to develop scientific literacy and critical pedagogy. By starting with a discussion on the transformative paradigm, this literature review was able to examine the theoretical and critical foundations of not only critical discourse analysis and critical pedagogy, but also of science education, specifically Vision II scientific literacy and socioscientific issues pedagogy. These critical theories and practices are connected and dedicated to challenging and transforming normative processes and discourses. However, the review of socioscientific issues and scientific
literacy revealed the ways in which both concepts can be used to solidify hegemony and work against a transformative paradigm. The specific goal of this study is to analyze texts that may use socioscientific issues toward these very different ends and to determine the ways in which discourse is being used to accomplish both. The next chapter of this study will explain how a critical discourse analysis will be conducted in order to achieve this aim.
CHAPTER 3
METHODOLOGY

Socioscientific issues are open-ended, controversial social issues that are informed by science but also impacted by politics, economics, and ethics (Sadler, 2011). Such issues could include additives and hormones in foods, the value of vaccinations, or soil and water management. Students who are learning about the water cycle could apply their content knowledge to a socioscientific unit regarding water usage and the human rights aspects of obtaining clean water. The research findings in this study aim to contribute to the academic conversation regarding the uses of socioscientific issues in intermediate elementary science education.

As discussed in the literature review, national standards, including *Benchmarks for Science Literacy* (1993), *Next Generation Science Standards* (2013), and *A Framework for K-12 Science Education* (2012), contain standards regarding the building of scientific literacy and the inclusion of controversial science topics. Additionally, connections have been made between the use of socioscientific issues and their impact on the development of students’ scientific habits of mind and their understanding of the nature of science. However, the definition of scientific literacy spans a wide margin and the use of socioscientific issues extend along a continuum from a mere mentioning of the topics to an application of the issues for political action (Hodson, 2010; Sadler, 2004; Santos, 2009).
Since all learning takes place with either written or spoken texts, which include both words and symbols, all of the discourses used in education are open to analysis. Furthermore, Gee (2011a) argues that “since Discourses and their interactions in time and space are inherently about the distribution of social goods (i.e., kinds of people and their places in society), discourse analysis is or should be inherently critical and even political” (p. 43). Gee (2011c) refers to politics as “any situation where the distribution of social goods is at stake,” and to Gee a social good is “anything a social group or society as a whole takes as a good worth having” (p. 96). Based on Gee’s description, materials that present socioscientific issues move beyond just discussing or using the issues as a pedagogical choice. The authors of those science texts are engaged in the political act of denying or providing scientific literacy skills and critical pedagogy processes, two vital social goods of value to an informed citizenry.

Gee argues that all language is political in that it all functions to establish the distribution of social goods, of which education is one. In the case of the texts to be analyzed in this study, Gee would argue that they either provide or withhold a social good, namely a transformative education that develops in students a Vision II scientific literacy and a voice through a critical pedagogy. If the texts engage the socioscientific issue without also providing students with the critical tools to consider those issues, then the texts are withholding the social good of a critical education and are using science education to solidify science as a hegemonic power. Because these texts are engaged in the distribution of a social good, then Gee would consider them political texts.

Therefore, Gee’s (2011a) approach to discourse analysis “looks at meaning as an integration of ways of saying (informing), doing (action), and being (identity), and
grammar as a set of tools to bring about integration” (p. 8). Through considering the way in which the writer uses grammar, for example the vernacular or placement of a phrase or word to make it more or less dominant, discourse analysis results in deeper understanding of the being and doing of the speaker. This study intends to use Gee’s process to determine the intentions of the authors who include the use of socioscientific issues in intermediate science instruction.

The intention of this methodology is to fully explore the way in which this study was completed. To do so, this methodological chapter includes an outline of the background and statement of the problem; the purpose of this study and the research questions; a description of the methodology of critical discourse analysis (CDA) and the rationale for utilizing it in this research; and an explanation of how data will be identified and analyzed. Finally, it will conclude by establishing how validity will be established.

Statement of the Problem

In order to develop a scientifically literate citizenry capable of critically interacting with the numerous and complicated science-related policy issues in the world, science education needs to provide opportunities for students to engage with socioscientific issues in the classroom. However, the inclusion of socioscientific issues may or may not embrace a focus on scientific literacy and/or critical pedagogy skills and could therefore result in very different outcomes for both teachers and students: the teaching of politicized or non-secular science resulting in a voiceless and subjugated citizenry or the teaching of science in a way that develops emancipated and empowered citizens. The goal of this study is to identify and critique the discursive tools employed in both types of science texts.
Purpose Statement

The purpose of this critical discourse analysis is to identify and analyze the discursive strategies used in intermediate science texts and curricula that address socioscientific topics and the extent to which the discourses are designed to promote or suppress the development of scientific literacy and a critical pedagogy.

Research Questions

1. In intermediate science curricula and texts, how is discourse employed to present socioscientific issues?

2. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy?

3. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy?

Methodological Framework

Critical discourse analysis as a theory was previously considered in this research; however, in this section, it is used as a methodology. In considering its unique qualities and its goals, critical discourse analysis as a methodology can be better understood by contrasting it with other types of discourse analysis.

Definition of Critical Discourse Analysis

The first major difference involves the aims of discourse analysis. Other types of discourse analysis work toward making a contribution to a field or a theory. By contrast, critical discourse analysis utilizes a theory or method based on the way in which it can further the social or political goals of the researcher (van Dijk, 1993). In this way, CDA...
is supported by the researcher’s goal rather than supporting any single theory. The goal is always to use the theory and analysis to move forward a political cause. For the purposes of this study, the theory of critical pedagogy will be used as a lens through which to conduct the analysis. Politically, this study aims to use the basic tenants of critical pedagogy as the basis for the analysis of how socioscientific issues are presented to students. Analysis of the discursive practices, which are described below, will be used to identify suppressive as well as empowering discourse with the intention of eliminating the former and reproducing and promoting the latter.

Critical discourse analysis is also different in that it is not a part of a specific field nor is it a step-by-step methodology. Critical discourse studies engage in a variety of processes and are found in many different fields of study. Van Dijk (2001) stresses that there is no set method or scholar to follow in critical discourse analysis: “CDA should be essentially diverse and multidisciplinary” (p. 96). Van Dijk goes on to explain that CDA is not aligned with a specific field in the same way as discourse or conversation analysis and it is not a set method like Chromsky’s transformational generative grammar or systemic linguistics.

One final difference between critical discourse analysis and other types of discourse analysis is that CDA is concerned with the implied messages that are working to influence the reader or listener (Riggins, 1997). Fairclough and Wodak (1997) argue that the sense of self of each person is being continually shaped and altered by discourse, and therefore CDA is first a part of social life and second an academic process. CDA examines the connection between the individuals in a society and the discourse that helps shape them. In school cultures, discourse is a constant force shaping both students and
teachers. This unique feature and CDA’s flexibility make it stand out from other types of discourse analysis; however, the sociopolitical goals of CDA are most significant when applying them to school text studies, and it is these objectives of critical discourse analysis that will be examined next.

The theoretical goals of critical discourse analysis were previously discussed in the theoretical framework; however, the goals of the methodology align with the theory. Fairclough (1989) asserts that the process of critically analyzing discourses is designed to uncover the ways in which power, language, and ideology interact. Van Dijk builds on this by explaining that CDA “…focuses on social problems, and especially on the role of discourse in the production and reproduction of power abuse or domination” (2001, p. 96). He argues that CDA scholars work to use the experiences of oppressed groups to help them oppose those who use discourse to “establish, confirm or legitimate their abuse of power” (p. 96). In these objectives, the need to consider the discourse of science curricula is evident. Science textbooks and curricula are positioned to either confirm or question the uses of science in our culture and to either promote or disregard the building of scientific literacy in the citizenry. In the event that a text is abusing its power through either inclusive or exclusive discourse, CDA gives voice to marginalized students and reveals the hidden assumptions and ideologies being taught.

Rationale for Critical Discourse Analysis

To establish the rationale for using critical discourse analysis in this study, this methodology first considers the study through the lens of the eight basic principles of CDA outlined by Fairclough and Wodak (1997) and then situates it within Rogers’ (2011) framework for the use of CDA in educational research. Each of the principles and
pertinent aspects argued by these foundational works are considered in turn and their application to the goals of this research are explained.

Alignment with the eight principles of CDA. As the first principle of CDA, Fairclough and Wodak (1997) argue that this methodology addresses social problems. The authors explain that “major social and political process and movements…have a partly linguistic-discursive character” (Fairclough and Wodak, 1997, p. 271). In the case of the curricula analyzed in this research, power is exerted by multiple social and political processes, including the beliefs, pedagogical theories, and political interests of the authors and organizations that published them. Science texts can propagate incomplete information or neglect the development of science habits of mind completely by simply leaving out experiences that develop them. On the other hand, they may include defendable science content, nurture the skills necessary for engaging in science, and connect science knowledge to the improvement of the human condition. This research argues that the former type of science curriculum deprives students of the knowledge and experiences necessary to become scientifically literate members of society. Ultimately, a citizenry with limited scientific knowledge exacerbates societal issues through actions such as denying climate change or refusing to vaccinate children. Conversely, science curriculum could function as a vehicle to enrich students’ understandings of societal issues and the structures that propagate them. This research directly aligns with the first principle of critical discourse analysis in that it aims to address the social problems that occur with a citizenry deprived of the highest quality of science instruction.

Secondly, power relations are discursive. In the case of a textbook or a curriculum, the discourse provided is assumed as authoritative by not only the students
and parents, but also by teachers and administrators. The discourse of the text holds power over the students and dictates what will and will not be learned. The analysis conducted by this study examines two ways in which the discourses may exert power. First, the discourse may either value and teach or devalue and neglect the habits of mind used in science. Second, the discourses used in these texts and curricula may ignore or engage in a critical pedagogy. Regardless of the way it is achieved, the science discourses in this research do exert power relations; therefore, their discourses can be critically analyzed.

The third principle of CDA is that discourse has a dialectical relationship with society and culture in which it is both constituted by them and constitutes them. This assumption was discussed previously when critical discourse analysis was considered as a theoretical framework. In the case of textbooks and curricula, the discourse being used is constructed based on the political and social interests of the authors. At the same time, the discourse of the texts shapes the society that is formed by students using the textbooks. The discourses are a part of a cycle of ideological reproduction.

In the fourth principle, Fairclough and Wodak (1997) explain the way in which discourses engage in ideological work. They define ideologies as “particular ways of representing and constructing society which produce unequal relations of power, relations of domination and exploitation” (p. 275). Then the authors explain that ideologies create reality and collective identities. When considering this principle within the context of my study, it is helpful to return to the discussion regarding ideology from my theoretical framework. Based on the foundational arguments of critical discourse analysis, all science curricula are capable of abusively exerting ideological power over those using the
texts. However as previously discussed, Foucault’s (1994) description of the differences between empowerment and subjugation provide the basis for considering the goals of the ideologies found in science materials. Regardless of the goals of the discourses, the science texts and materials used in this study do engage in ideological work. The intention of this study is to analyze the ideological intentions of texts that engage students with socioscientific issues.

The fifth principle of CDA asserts that discourse is historical. It always takes place within a certain time and culture, and it is always impacted by other discourses. Gee (2011a) identifies this historical positioning as the Conversation that the discourse is a part of. “Conversations are public debates, arguments, motifs, issues, or themes that large numbers of people in a society or social group know about” (p. 112). In the case of the texts being studied in this research, the discourse is impacted by any number of past discourses including those about energy and the human impact on the environment.

Fairclough and Wodak’s (1997) sixth principle holds that the link between text and what is happening in the society is mediated by the analysis. This complex process involves looking beyond just the discourse and considering the societal impact on it. Gee (2011a) identifies these areas as some of the building tasks of language. All seven building tasks will be discussed more fully below, but two of them have a specific connection to Fairclough and Wodak’s principle. For Gee, language is a part of and also influenced by politics. By his definition, politics include all the decisions regarding the distribution of social goods. Therefore, all discourses are impacted by the way that social goods are shared and they also play a role in how they are shared. In addition to its ability to build politics, Gee argues that language can connect or disconnect ideas in
society. The science texts being analyzed in this research could be and have been impacted by any number of religious, political, or ethical issues of the society in which they were written. Through two of Gee’s building blocks of language, conversations and connections, a CDA can analyze the connection between society and the text.

In a related idea, the seventh principle says that discourse analysis is interpretative and explanatory. The text cannot possibly be analyzed in a vacuum. Analysis is impacted by the reader’s class, gender, age, beliefs, emotions, attitudes, and knowledge. The result is that the analysis of the textbooks requires a “…systematic methodology and a thorough investigation of the context” (Fairclough and Wodak, 1997, p. 279). The analyst must consider all interpretations. Based on Gee’s (2011a) work, this can be accomplished through a method of determining how well the answers to all levels of analysis converge to reach the same conclusion. The way in which validity is documented in critical discourse analysis is more fully considered later in this methodology.

The final principle of CDA aligns with its goal. Discourse is social action, and the goal of CDA is to expose the hidden agendas in the discourse of those with power. In the case of texts and curricula that engage students with socioscientific issues, the students are a largely voiceless group that is exposed to the discourse of those who write the texts. An analysis of these materials can expose discourse being used to produce and reproduce political power structures. Alternately, the analysis can be used to identify characteristics of socioscientific curricula that promote a critical pedagogy. Such analysis could be used to eliminate the presence of reproductive texts and increase the use of texts that positively engage students.
Alignment with Rogers. In addition to aligning this study with the CDA approaches identified by Fairclough and Wodak, the justification for using this methodology can be considered through an educational research lens. A framework argued by Rogers, Malancharuvil-Berkes, Mosley, Hui, and Joseph (2005) provides the support to examine why critical discourse analysis is an appropriate fit for examining instructional materials used in the teaching of socioscientific issues. First, Rogers et al. assert that all educational practices are communicative events and can therefore be analyzed. In the area of socioscientific issues, discourses available for analysis include textbooks, teaching support materials, prepared units, and the websites of curriculum-writing organizations or companies. All of these written texts, as well as the pictures and symbols used within them, constitute communicative events to which critical discourse analysis may be applied.

Secondly, Rogers et al. contend that the commensurability of critical discourse analysis and educational research is supported by the role education plays in both shaping and being shaped by society. As previously discussed, a major assumption of critical discourse analysis proposes that discourse is both constructed by and constructs society. According to Fairclough and Wodak (1997), discourse is “constitutive both in the sense that it helps to sustain and reproduce the status quo, and in the sense that it contributes to transforming it” (p. 258). Based on this assumption, the discourses related to the teaching of socioscientific issues play this dual role. They have been influenced by the society in which they were created and in turn they have an influence on the students, parents, and educators who engage with them. This reflexive nature supports the argument for the use of critical discourse analysis.
Finally, the framework proposed by Rogers, et al. argues that both educational research and critical discourse analysis share the common goal of addressing social inequalities. Critical discourse analysis is a process that identifies the ways in which discourse is being used to grant or deny power; therefore, it is an appropriate tool for educators who seek to narrow and identify the ways in which educational discourses are being used to limit access to students. As with all discourse, those written regarding socioscientific issues wield power and may be used to either expand or narrow the scientific literacy of the students who encounter them. In a review of critical discourse analysis studies done in the field of education, Rogers et al. (2005) also found that most CDA was approached from a critical framework, and she suggested the need for studies that identify productive and constructive educational processes. By analyzing socioscientific texts through both a critical and productive lens, an analysis can lead to a greater understanding of the role these discourses play in either alleviating or increasing inequality.

Rationale

The curricula analyzed in this study was collected from science materials created within the past ten years, available on the internet, designed to be used in intermediate (grades 3-5, ages 8-11) science instruction, and mentioning or directly involving the socioscientific issue of climate change. This study was limited to this range of curricula for many reasons.

1. The researcher works with students in this age level and participates in professional development for intermediate elementary teachers. The decision to focus on intermediate elementary materials was also supported by Rogers,
et al. (2005) findings that only 15% of all educational CDA studies have been completed with elementary level discourses. “Ideologies are reproduced and transformed at very young ages. Therefore, descriptions and explanations of how this occurs and, more important, how the acquisition of counterproductive ideologies is interrupted, are necessary” (p. 385).

2. Since the study was designed to analyze the discourse of curricula that involve socioscientific issues, any level of inclusion or mentioning of the socioscientific issue of climate change qualified a text as appropriate for the study.

3. The setting was based on curricula that were electronically available because many organizations design and distribute individual units that address climate change, and they publish those instructional units electronically. Additionally, most state standards, including those of my own state, Georgia, do not require the teaching of climate change and instead only require the teaching of energy concepts. Therefore, curricula in textbooks may not mention either energy or climate change. As more states adopt the Next Generation Science Standards, which include climate change standards, teachers will need new curricula. Therefore, it was appropriate to analyze the existing materials.

4. The political and economic nature of the socioscientific issue of climate change is such that the statistics, policies, and even depth of the issue may change significantly with time. Therefore, only current materials that may be effectively used in an instructional setting were considered.
5. Finally, keeping in alignment with the assertions that the selection of the texts to be analyzed is part of the theoretical judgment of the researcher (Gee 2011a), climate change was selected over other topics based on two factors. First, recent research found that middle and high school teachers in the U.S. dedicate only one to two hours per year to the topic, and the educational experience being provided by the teachers is impacted by their own political and cultural ideologies (Plutzer, McCaffrey, Lee Hannah, Rosenau, Berbeco, & Reid, 2016). Lambert and Bleicher (2017) found that pre-service teachers gained a greater understanding of climate change and developed perceptions that aligned more closely with climate scientists when scientific argumentation was incorporated into their instruction on the topic. These studies demonstrate the need for curricula that teach the issue of climate change while simultaneously addressing the worldviews of the students as well as the teachers.

Sample

The sampling of curricula was based on the principles of convenience and criterion sampling (Mertens, 2015). For the sake of convenience, the texts considered for the study were found by following the process an intermediate science teacher may use to search for and find curricula materials for the classroom. Based on its documented use by an estimated 1.6 billion monthly visitors, Google is the most popular search engine (ebizmba.com, 2016). Due to the higher likelihood of a teacher using it, Google was used as the search engine for this study.
To design search phrases for identifying the curricula to consider for this analysis, key terms that may be used by teachers interested in finding curricula to use in their classroom were identified and organized into twelve search phrases. The terms energy, climate change, and global warming were selected as the subject terms. Since the curricula are designed to be used by intermediate elementary science teachers, the term intermediate elementary was included. The terms curriculum or lesson plans were also considered. Finally, teachers may not use the term socioscientific issues when searching, but they may search for curricula by identifying the subject matter as an issue or everyday science issue. Therefore, that term was added as well. By combining those terms, twelve phrases were designed that were used in Google to search for potential curricula to analyze for this research (see Table 4). For purposes replicating this study, a Google search of these phrases will not yield the same results each time. The intention of sharing the search criteria process is to fully explain how the researcher identified the curricula.

After using those phrases, the top ten results from each search were considered for the study, for a total of 120 potential curricula. Each result was categorized based on the type of content found at each linked site. The categories included: journal or news articles (A), blogs (B), direct links to curricula or lesson plans (C), information and research (I), links to other sources or websites that include curriculum resources (L), standards (S), and textbooks (T). The results of the searches as well as the narrowing of the curricula to those used in this research are found in Appendix A. Since the intention of the search was to find curricula, all non-curricula links, labeled A, B, I, S, and T, were first eliminated. Additionally, those sites that only provided links to other sites that may or may not have curricula, labeled L, were also eliminated. This decision was supported
by the concept of convenience sampling in that these sites led to too many possible curricula to consider and in many cases led to curricula that did not meet the criteria for the study.

Table 4

*Search Phrases Used in Google to Search for Curricula*

| Search 1: “intermediate elementary energy curriculum” |
| Search 2: “intermediate elementary energy lesson plans” |
| Search 3: “intermediate elementary climate change curriculum” |
| Search 4: “intermediate elementary climate change lesson plans” |
| Search 5: “intermediate elementary global warming curriculum” |
| Search 6: “intermediate elementary global warming lesson plans” |
| Search 7: “everyday science issues global warming elementary curriculum” |
| Search 8: “everyday science issues global warming elementary lesson plans” |
| Search 9: “everyday science issues climate change elementary curriculum” |
| Search 10: “everyday science issues climate change elementary lesson plans” |
| Search 11: “everyday science issues energy elementary curriculum” |
| Search 12: “everyday science issues energy elementary lesson plans” |

Of the 120 results obtained through the searches, 52 led to sites that provided curricula. Next, those curricula that fell outside of the criteria for the study were eliminated. Examples include curricula designed for other grade levels or that did not address global warming. In Appendix A, these search results are followed by the label
wrong content or level. Removal of those sites narrowed the list to 21. Additionally, one site was repeated four times. That site was combined and the number of times it appeared in the searchers was recorded. The removal of duplicate and non-criteria meeting materials resulted in a list of 18 curricula. Finally, many of the resulting curricula were written by the same organization or entity, so the resulting curricula were organized based on their source.

The ultimate selection of the curricula analyzed was based on Gee’s (2011a) theories regarding text selections. He argues that the selection of texts to be analyzed is one part of the theoretical judgment of the researcher. For Gee, the text selected to be analyzed is itself a theoretical entity that “does not stand outside an analysis, but, rather, is part of it” (p.117). An essential argument of this study is that the ideology of an individual influences his or her understanding of science, and that argument impacts the curricula created by organizations with different political and ideological worldviews. Therefore, the sources of materials were also labeled and organized based on the essential identification of the group that wrote them. Categories included: corporate, education, government, and not for profit. According to Gee (2011a), the purpose for selecting from diverse positions is not to construct a simple binary but to “get ideas about what the poles of a continuum may look like. We get ideas that can then inform the collection of new data out of which emerges a much more nuanced and complex picture” (p. 150). Table 5 presents the final list of curricula considered for this study.

Gee also maintains that any discourse analysis should be based on writings that are “deemed relevant in the context and that are relevant to the arguments the analysis is attempting to make” (p. 117). Since this research examines the ways in which materials
that mention the socioscientific issue of global warming either develop or neglect scientific literacy and critical pedagogy, Gee’s scholarship suggests the need to search for texts specifically designed to result in either of those outcomes. Conversely, curricula could also be selected based on their neglect of the development of scientific literacy or critical pedagogy. Evidence of a heavy commitment to critical pedagogy was based on Santos’ (2009) Freirean perspective for science education in which students engage in socioscientific issues and follow their instruction with dialogical processes and sociopolitical engagement. To evaluate the level of commitment the texts demonstrated to increasing student scientific literacy, the curricula were evaluated for the presence of experiences that demonstrate a commitment to Robert’s (2007) Vision II scientific literacy.

Table 5

Curricula Categorized by Organization Type and Frequency in Searches

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Organization</th>
<th>Name of Curriculum (times found)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate</td>
<td>Society of Petroleum Engineers</td>
<td>Energy4Me: Download Lesson Plans and Activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The NEED Project Elementary Curriculum Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Efficiency &amp; Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy Education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free Energy Curriculum and Lesson Plans</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Climate Change</td>
</tr>
</tbody>
</table>
Table 5 - continued

<table>
<thead>
<tr>
<th>Education</th>
<th>American Federation</th>
<th>Physical Science Lesson Plans: Intermediate of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio State University</td>
<td>Hands-On Science and Literacy Lessons</td>
<td></td>
</tr>
<tr>
<td>Preparing</td>
<td>About Weather and Climate</td>
<td></td>
</tr>
<tr>
<td>Elementary and</td>
<td>Why everyday science?</td>
<td></td>
</tr>
<tr>
<td>Secondary Pre-Service</td>
<td>Teach Engineering</td>
<td>What is Energy?</td>
</tr>
<tr>
<td>Teachers for Everyday</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>Teach Engineering</td>
<td>NASA</td>
<td>Lesson Plans-Elementary: My NASA Data</td>
</tr>
<tr>
<td></td>
<td>National Renewable Energy Laboratory</td>
<td>Workforce Development and Education</td>
</tr>
<tr>
<td></td>
<td>Public Broadcasting</td>
<td>Programs</td>
</tr>
<tr>
<td></td>
<td>Climate Change: Vital Signs of Planet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and NASA</td>
<td></td>
</tr>
<tr>
<td>Texas State Energy</td>
<td>Renewable Energy Lesson Plans</td>
<td></td>
</tr>
<tr>
<td>Information Admin.</td>
<td>(site acknowledges NEED as the source for</td>
<td>the lessons available)</td>
</tr>
<tr>
<td>NFP</td>
<td>Earthwatch Institute</td>
<td>Education Lesson Plans for Teachers</td>
</tr>
</tbody>
</table>
Grounded in Gee’s theories, the final decision regarding the selection of the texts to be analyzed was based on the judgment of the researcher. Ultimately, three curricula were selected for analysis, each one originating from a different authoring organization type including business, education, and non-government organization or non-profit agency. Final selection of each curricula was in part based on its frequency in the Google searches. This decision was based on the assumption that curricula with a higher frequency are more likely to be used in an elementary classroom setting and therefore increase the significance of this study. Additionally, the cursory impressions of the curricula’s treatments of scientific literacy and critical pedagogy were considered. While government-authored lessons were identified through the search, the resulting curricula were inadequate for this study. For example, the My NASA Data site had only one climate or energy related lesson that was designed for upper elementary, and the Vital Signs of the Planet site consisted of an excellent website for students but it did not include lesson plans or activities. Based on these issues, the study does not include any government-authored curricula. A full description of the three curricula selected for this study, their authoring organization, and the rationale for their inclusion in this study is fully discussed in the following section.
Curricula to Be Analyzed

The following section introduces each of the pieces of curriculum analyzed in this study and their authoring organizations.

PreSEES Global Warming Socioscientific Unit

PreSEES, Preparing Elementary and Secondary Pre-Service Teachers for Everyday Science, is a consortium made up of representatives from Cyprus, Denmark, Spain, Turkey, France, Romania, and the United Kingdom. Based on a gap found in the literature regarding the ways in which elementary and secondary teachers approach the teaching of socioscientific issues, PreSEES was established with the goal to “engage pre-service teachers in critical discussions of everyday science through socioscientific issues, and prepare them to teach SSI” (Evagorou, Guven, & Mugaloglu, 2014, p. 69). Toward that aim, the consortium designed three modules that teach the nature, pedagogy, and assessment of SSI. The first of those modules is a stand-alone SSI unit designed to take students through a socioscientific issue unit on global warming (PreSEES, 2014). Since the unit is taught to elementary and secondary teachers and is designed based on the framework being taught for SSI instruction, it can be considered an appropriate unit for use with elementary students, and is therefore appropriate for this study.

This module by PreSEES, which is a representation of a curriculum created by educators, was ultimately selected over the other curricula for several reasons. First, the specific curriculum only appeared one time from the 120 searches conducted; however, different materials from PreSEES, including connections to academic articles and materials, were the results of 6 of the 120 searches. Based on the relatively high frequency of 5% of the searches, the likelihood of an elementary teacher finding and
using the curriculum is higher than that of others found with the searches. Additionally, when compared with the other curricula written by educators, this unit was the most comprehensive.

This curriculum was also selected based on the authoring group’s ideological attachment to the importance of teaching science through the use of socioscientific issues as well as its belief that doing so increases the scientific literacy of students. This ideological stance is evident in the organization’s website, purpose, and publications, all three of which reference foundational works in SSI pedagogy by scholars such as Sadler and Zeidler (Evagorou, Guven, & Mugaloglu, 2014; PreSEES, 2014).

While the same materials do not specifically reference critical pedagogy, there are three aspects of the group’s informational literature that indicate the presence of a critical pedagogy may be found in the materials. First, Evagorou, Guven, & Mugaloglu (2014) refer to the need for dialogical processes in the science classroom. Additionally, one goal of the training works toward “empowering teachers to understand the connections of science to everyday life and the implications of their decisions” (p. 69). Finally, the authors discuss the need for science instruction to enable students to understand the interconnected nature of socioscientific issues. While there is no guarantee that the SSI module being analyzed will show the same heightened commitment to a critical pedagogy, its authors show evidence of a commitment to some elements of critical pedagogy. Therefore, this text meets Gee’s (2011a) requirement of aligning with the goals of the research.

The global warming SSI module is composed of six tasks, but only the first four pertain to this analysis. The final two tasks of the lesson are designed to be used with
pre-service teachers. They consider the pedagogical aspects of using SSI and the nature of socioscientific issues. Since this study is only interested in the application of this unit in grades 3-5, this analysis will not consider any of the information from the fifth and sixth tasks. The unit has two portions that are being considered in this analysis: a Power Point that guides students and teachers through the unit, with slides 1-26 pertaining to the first four tasks, and four student worksheets.

NEED Elementary Energy Infobook and Elementary Energy Infobook Activities

The second curriculum analyzed was written by the NEED Project. NEED is an acronym for National Energy Education Development Project. NEED identifies as an organization, and its website mentions the collaborative work achieved by students, educators, business members, government and community leaders without specifying its contributors. However, NEED’s list of approximately 120 partners and sponsors includes over 85 oil, petroleum and energy companies. The only non-profit partners are cooperating school districts and government agencies such as the U.S. Department of Energy (National Energy Education Development Project, 2016f). Due to the overwhelming majority of corporate sponsors, this curriculum was categorized as being authored from a business perspective.

The mission statement of NEED, which has been designing energy curricula for 35 years, says its goal is to promote energy conscious and educated members of society. According to NEED, this is accomplished through the creation of “networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs” (National Energy Education Development Program, 2016a, Para. 6). In reference to the type of program the organization aims to
deliver to classrooms, the mission statement includes the terms *objective*, *multi-sided*, and *balanced*. Those themes are also found in the letter from the group’s chairman, Wendy J. Wiedenbeck (2015), in which she argues that the curricula created by the group plays a vital role by providing “comprehensive, objective curriculum about all forms of energy” by “keeping the dialogue balanced and based on science” (Para. 1).

NEED has designed curriculum for all grade levels and a plethora of energy topics. The links that were supplied through the Google searchers conducted for this research let to a page of the NEED site identified as *Curriculum Resources*. It includes thirty-one links to curriculum. The links are based on grade level (*elementary*, *intermediate* [which includes grades 6-7], and *secondary* [high school]), as well as specific energy subject areas, such as *energy sources*, *coal*, and *uranium*, and content areas, such as *language arts*, *social studies*, and *technology*. There is no charge for the curricula, and each one can be downloaded directly from the site.

Curricula designed by NEED were selected for analysis for multiple reasons. First, the frequency with which curricula from NEED appeared in the Google searches conducted make it highly likely that the materials would be found and used by elementary teachers. NEED was the authoring organization of 5 of the final 18 pieces of curricula identified for this study, and it appeared twelve times in Google searches conducted, meaning that it accounted for 10% of the curricula found by these searches, more than any other authoring organization. Additionally, curricula written by NEED appeared in the materials of other groups found through the searches. Second, specific pieces of the curriculum were selected over others because the *Elementary Energy*
*Infobook* was the only NEED curriculum written for elementary students that mentioned climate change in its description.

Finally, several aspects of the NEED website suggest the curriculum may demonstrate a commitment to at least some aspects of critical pedagogy and building scientific literacy. First, information in this section indicates that a goal of the program is to be action oriented toward reducing fossil fuel dependence, and increasing renewable energy technologies and energy efficiency. Additionally, this section indicates that the program uses “Kids Teaching Kids” as one of its major philosophies, “encouraging students to explore, experiment, and engage, and encouraging teachers to embrace student leadership in the classroom” (National Energy Education Development Program, 2016a, Para. 1). This section also argues that students and teachers who receive NEED training understand energy and are “local experts and leaders in community discussions on energy use, energy efficiency and new energy technologies” (Para. 3). These commitments align with several foundations of critical pedagogy, specifically co-learning, transformational experiences, and a connection of instruction in service to all. Finally, the website suggests a commitment to the building of scientific literacy by explaining that students use hands-on, inquiry based lessons to meet Next Generation Science Standards.

Of the curricula designed by NEED, two specific pieces were analyzed for this study: *Elementary Energy Infobook (e-publication)* and *Elementary Energy Infobook Activities (e-publication)*. Each of the twelve links found through the Google searches that led to the NEED site essentially ended up at the same menu. Under the *Elementary*
search, the first curricula offered was the *Elementary Energy Infobook (e-publication)*. The description for the curriculum reads:

> Energy Infobooks are the resource for many NEED activities and include an introduction to energy, information on major sources of energy, new technologies, energy conservation, electricity, climate change, and other energy information. They are available on four reading levels and are revised and updated annually.

(National Energy Education Development Program, Para 1)

The seventh curriculum resource on this level is *Elementary Energy Infobook Activities (e-publication)*. The descriptor for this curriculum explains that it provides companion activities for the Energy Infobook.

**Oxfam Climate Challenge**

Oxfam International is a group of independent non-governmental organizations. Their goal is to work internationally to reduce poverty and injustice. Their name originated with the Oxford Committee for Famine Relief, which collected money and worked politically in order to get food and supplies through a blockade and into occupied Greece during World War II. In addition to providing emergency relief and development programs to struggling countries, Oxfam is actively engaged in efforts “to end unfair trade rules, demand better health and education services for all, and to combat climate change” (Oxfam International, 2016, Para. 3).

Oxfam Education is one of the many projects undertaken by Oxfam, and its goal is to provide ideas, curricula, and educator development for schools and teachers that want to provide a global learning experience. Their initiative, Education for Global Citizenship, provides curricula for grades K-12 on topics ranging from human rights
issues to guidance and counseling to environmental education. In addition to over 93 lesson plans, Oxfam has created assemblies, case studies, simulation games, and entire learning days that can be used school-wide (Oxfam Education, 2016d).

The Oxfam Climate Challenge curriculum was selected for this study for several reasons. In addition to meeting all of the criteria for this research, including grade level and the addressing of the socioscientific issue of energy use and global warming, the Oxfam Climate Challenge presented an entire, cohesive unit on the topic. The other two non-governmental authored curricula provided either single worksheets or individual lesson plans that were tangentially connected with climate change. Additionally, the information provided on the Oxfam website indicates a commitment to the issues of interest in their research, scientific literacy and critical pedagogy. In their discussion of “Global Citizenship,” Oxfam invokes many applications and elements of critical pedagogy, including social justice, community, and a process they reference as Learn-Think-Act. This process references the role of understanding power and applying new knowledge about an issue to individual and collective action. Additionally, Oxfam connects global citizenship education with authentic experiences that challenge misinformation and inequality (Oxfam Education, 2016c).

The site for Oxfam Education also suggests a commitment to building scientific literacy skills. The Learn-Think-Act process of global citizenship education stresses skills such as considering issues from different viewpoints, applying cause and effect reasoning, and critical thinking (Oxfam Education, 2016c). The Climate Challenge Teacher’s Overview (2016k) includes requirements for students to experiment, explain, share knowledge, consider cause and effect, and differentiate among science concepts.
The specific Oxfam curriculum selected for this study is *Climate Challenge for 7-11 Years*. The curriculum description explains that its focus is on the human impact of climate change as well as how humans are impacted and adapting. The unit includes a teacher’s overview, six sessions, and two slide shows that accompany the lessons. It is designed for students between the ages of 7 and 11, and provides options for differentiation. The materials cover standards in science, English language arts, and geography (Oxfam Education, 2016k).

Data Coding

Once the curricula were identified, they were separated and coded based on their connection to the three research questions:

1. In intermediate science curricula and texts, how is discourse employed to present socioscientific issues?
2. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy?
3. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy?

Textual portions of each curriculum were identified as being connected to one or more of the research questions. For example, a portion of the curricula that discussed the human use of energy was coded to be a part of the analysis for research question one, an excerpt that discussed decision making or evidence was coded for the second research question, and portions that addressed transformation or challenging norms were coded for analysis for the third research question. In the literature review, the indicators and
descriptors for socioscientific issues, critical pedagogy, and scientific literacy were summarized in Tables 1, 2, and 3. Those terms and concepts were used as guides for locating and coding each of the parts of the curricula. Table 6 below contains a compilation of the terms and concepts and their matching research question.

Table 6

*Key Terms or Concepts Used to Identify Text Related to Research Questions*

**Question 1**

Students express ideas and value systems in a tolerant community

Dissenting opinions/belief systems explored: Role-plays, Writing, Debates, Discussions

Arguments and Debate

Critical Thinking: Analysis, Inference, Explanation, Evaluation, Interpretations

Evaluation of Sources of Information: Credibility, Accuracy, Reasonableness, Consensus

Cooperative Learning

Assessment: Teacher and Self

Neither negation nor affirmation of student belief systems

Subject terms such as energy, electricity, global warming, climate change

**Question 2**

Understand Socioscientific Issues by making decisions, analyzing information, applying moral and ethical reasoning

Exposure to and practice of habits of mind such as being skeptical, accepting ambiguity, and expecting data-driven knowledge
Table 6 - continued

Know and use epistemology of science to judge scientific claims through evidence, inference, conclusions

**Question 3**

Presence of:  Co-learning: engage personally, connect, challenge and change

Non-capitalistic, pro-community goals of science education

Opportunities to challenge dominant worldviews

Transformational experiences for teachers and students

Connect instruction to serve all; not just special interests

Absence of:  Suppressive structures

Not all portions of the texts were applicable to one of the research questions, so some portions of each curriculum were not coded at all. The three curricula analyzed represented a great volume of material, and for an analysis of a text to be most effective, Denzin and Lincoln (2003) recommend that researchers limit the number of texts they use as well as the parts of the texts analyzed. Therefore, the study analyzed three pieces of curriculum and only relevant portions of those texts.

**Data Analysis**

As evidenced by the defining principles and assumptions, critical discourse analysis stems from a theoretical foundation that discourages hegemonic structures. Therefore, the approaches to conducting CDA are individualistic, and major scholars in the field discourage researchers from believing there is one best process. In fact, doing so is counter to the foundational theories of the methodology.
Approaches to CDA

The various approaches that either philosophically or practically influence the methodology of this research are briefly described below.

French Discourse Analysis. This type of critical discourse analysis is based on the theories of discourse by both Althusser and Foucault. Based on their theories, Pêcheux argues that ideological discourse defines the social positions of people and that they are not even aware of the ways in which discourses shape them (Fairclough and Wodak, 1997). He also asserts that texts that present information as being implicit or taken for granted are by definition ideological (as cited in Carbo, 1997). These theories, built on Foucault’s (1994) philosophical foundations regarding the power of language, which were previously discussed in the theoretical framework, will be thread through the questions asked as the texts are analyzed. Specifically, the analysis will look for the presence of discourse that presents some ideas as being assumed by all, and therefore suggests other ideas are rejected or unacceptable. French discourse analysis has been used to examine school textbooks, and is therefore an appropriate approach for this research. (Fairclough and Wodak, 1997).

Sociocultural Change and Discursive Change. This type of analysis pays special attention to the connections between the discourse being analyzed and the social and cultural changes taking place. In analyzing the discourse of texts, it is useful to consider how changes in political or religious discourses impact the changes found in textbooks and curricula. Fairclough studies the importance of using CDA to increase students’ critical language awareness. He argues that top-down mandates on language use that do not include teaching critical language skills to students result in the legitimizing of
certain language (Fairclough, 2013). The same argument will be used against the
codification of language used in science instruction. Dictating content instead of
teaching the process skills of questioning and analysis will result in the same structural
limitations on students as those mentioned by Fairclough. Based on Fairclough’s critical
language awareness, the texts in this study will be analyzed for the manner in which they
codify science language or allow for the development of critical thinking.

Socio-cognitive Studies. Van Dijk’s approach to CDA focuses on how
“…societal structures influence discourse structures and precisely how societal structures
are in turn enacted, instituted, legitimated, confirmed or challenged by text and talk”
(Fairclough and Wodak, 1997, p. 266). In classrooms, the social structures impact the
learning of students, and the instructional materials are a quintessential example of a
structure that both presents text and directs the class discourse in ways that solidify and
legitimize cultural structures. However, critical pedagogy processes that encourage
students to analytically engage with science content could also function to establish
norms that empower students and teachers. Van Dijk also asserts that we all possess and
are shaped by socially shared cognitive representations. “Social representations are
largely acquired, used and changed, through text and talk” (van Dijk, 1990, p. 165).

Based on van Dijk’s approach, this analysis will ask questions designed to analyze the
manner in which the texts are used to socially reconstruct or challenge cultural at large
and, in effect, the cognitive representations of the students.

Gee’s approach. Gee (2011b) asserts that language is always a part of the social
practices that impact political actions such as “status, solidarity, the distribution of social
goods, and power” (p. 28). In that way, language performs actions that have the ability to
both build and destroy. In fact, Gee (2011a) argues that “language has meaning only in and through social practices” (p.12). Because of the political nature of all language, any analysis of it must be critical. If it is not, then the analysis is taking place for no reason. For Gee, the method of critical discourse analysis can either 1) provide evidence to support theories that explain how and why language works the way it does, or 2) it can “contribute, in terms of understanding and intervention, to important issues and problems in some area that interests and motivates us as global citizens” (p.12). This study aligns with the second role identified by Gee.

The only way to fully understand any discourse, according to Gee (2011a), is to first know what the speaker is doing and what role they fill when they speak. He refers to these as doing and being. A text is meaningless without knowing the speaker and the motivation. Gee argues that language, referred to as saying, is only necessary because there is a person fulfilling a role and accomplishing a task. “Saying follows, in language, from doing and being” (p.5). Based on this description, discourse is only needed to accomplish a specific task. Additionally, all our discourses are impacted by the role of the speaker or writer. It is not the specific meanings of the words used in a discourse, but rather what we are doing and who we are as we do it that give meaning to what we say. Part of the analysis completed in this study considers what the texts are accomplishing in regards to the development of liberation for the students.

Gee (2011b) uses the term social good to identify the recognitions or social positions people desire. Regardless of what type of identity one wishes to have, there are socially constructed conventions that define social goods, and the definitions and requirements for being granted a social good constantly change. Gee compares social
goods to a game where the requirements for receiving recognition are the rules. Those who receive the social good are the winners and those who do not are the losers. Since these rules are established by society, they are argued over and changed. In the case of science discourses, there are rules regarding the processes and presentation of information and the way in which one documents and supports assertions. Being acknowledged as a member of the scientific community or being recognized as a scientifically literate citizen could be considered social goods. Gee would argue that texts need to be critically analyzed to evaluate their inclusive or exclusive nature regarding the distribution of science as a social good.

Process of Data Analysis

The texts in this study were analyzed based on the discursive tasks identified by Gee (2011a). He isolates seven **building tasks** that are used simultaneously in all discourses and asserts, “Essentially a discourse analysis involves asking questions about how language, at a given time and place, is used to engage in the seven building tasks…” (p. 121). A discourse analysis is conducted by considering what a text achieves in regard to each task. Since all discourses are working to accomplish each of the building tasks, the question is not if they are engaged in the task, but *how*. To analyze the discourse, a researcher asks how the discourse is accomplishing each task and how it is using grammar and language to do so. Gee’s seven building tasks are summarized in Table 7.

It may be helpful to think of the building tasks as parts of a house. The discourse is a house that has been built by the author. Different parts of the house are designed for different purposes. The roof keeps out the elements, the foundation maintains the structure, and the plumbing brings in fresh water and takes out waste. In the same way,
discourse accomplishes different tasks. While all houses have a way of keeping out the cold and rain, the roof may be made of shingles, straw, or plastic. Similarly, all discourses function to make some things more significant than others. But like the roof, what is made significant is completely different from one discourse to another. In the application of Gee’s theories, the first step of CDA is knowing each of the tasks being accomplished by all discourses.

Table 7

Name and Description of Gee’s Seven Building Tasks

<table>
<thead>
<tr>
<th>Gee’s Building Tasks</th>
<th>Impact/Question Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significance</td>
<td>How does the text deem some things more important than others?</td>
</tr>
<tr>
<td>Practices</td>
<td>How does the text solidify social practices or norms?</td>
</tr>
<tr>
<td>Identities</td>
<td>How does the text assign an identity to the writer or ascribe an identity to others?</td>
</tr>
<tr>
<td>Relationships</td>
<td>How does the text connect or distance the writer and the audience?</td>
</tr>
<tr>
<td>Politics</td>
<td>How does the text give or withhold social good?</td>
</tr>
<tr>
<td>Connections</td>
<td>How does the text attach objects, individuals, or concepts to one another?</td>
</tr>
<tr>
<td>Sign Systems and Knowledge</td>
<td>How does the text legitimize the terms, style, grammar, and even signals and symbols of a group?</td>
</tr>
</tbody>
</table>
The first building task is significance. Discourse is used to establish the importance of the subject being discussed. This building task aligns with French discourse analysis and considers how the text is functioning to establish what is considered assumed or taken for granted. An analyst would ask, “How is this piece of language being used to make certain things significant or not and in what ways?” (p. 17).

The second task is identifying the practices or activities achieved by the discourse. By a practice, Gee means a social, institutional, or cultural activity that combines actions in a certain way. The language we use is determined by the practice, and the practice is defined and established by the language. In this way, Gee says, “Language and practices ‘boot strap’ each other into existence in a reciprocal process through time. We cannot have one without the other” (p. 18). During critical discourse analysis, this building task requires the researcher to consider what practices are being accomplished by the discourse.

The next two building tasks identified by Gee are identities and relationships. Both align with van Dijk’s (1990) socio-cognitive analysis processes. Individuals build their own identities through the process of building the identities of those around them. As an example, individuals would identify themselves as being Evangelical Christians by placing the identity of non-Evangelical Christian on others. So, a CDA would question how the discourse is being used to enact a specific identity for the writer and what identities it is ascribing to others as a way of better defining the writer’s identity. The building task of relationships establishes the actual relationship, or hoped for relationship, between the writer and reader. This building task leads the researcher to consider the type of relationship the discourse is trying to establish with others.
Gee’s (2011a) fifth building task of politics seeks to analyze the way in which the discourse works to bestow or distribute social goods. Any time language is used, the discourse plays a role in granting or depriving social goods. The question to ask for this building task is, “What perspective on social goods in this piece of language communicating (i.e. what is being communicated as to what is taken to be ‘normal,’ ‘right,’ ‘good,’ ‘correct,’ ‘proper,’ ‘appropriate,’ ‘valuable,’ ‘the ways things are,’ ‘the way things ought to be,’ ‘high status or low status,’ ‘like me or not like me,’ and so forth)?” (p. 19).

The building task of connections demonstrates how language forms connections between objects, groups of people, or ideas. The way in which a discourse addresses the connections either strengthens or weakens them. During a critical discourse analysis, Gee suggests that researchers examine how the discourse connects or disconnects things and makes them relevant or irrelevant to one another.

Gee’s final building block is sign systems and knowledge. A sign system can be a specific language, the terms and phrases used by a specialty group such as a profession or hobby, or the non-language images and graphs that are a part of a discourse. One sign system may be more privileged than another in a discourse. Fairclough’s (2013) theories regarding the privileging of language align with this building block. Gee (2011a) suggests asking, “How does this piece of language privilege or dis privilege specific sign systems (e.g., Spanish vs. English, technical language vs. everyday language, words vs. images, words vs. equations, etc.) or different ways of knowing and believing or claims to knowledge and belief (e.g., science vs. the Humanities, science vs. ‘common sense,’ biology vs. ‘creation science’)?” (p. 20).
Gee (2011a) identifies six tools of inquiry, which he calls theoretical tools, that can be used to analyze each of these building tasks. Using the previously discussed analogy of the house, think of the tools one could use to learn more about the structures of a house. The blueprints, the electrical or plumbing schematics, or a visual inspection are all tools one could use to analyze any given part of a structure. The important thing to remember is that each tool can be used to look at vastly different portions of the home. In the same way, these inquiry tools can be used to analyze different tasks in a discourse. One of these tools is not better than another. They are all just different. Additionally, some tools may be better for looking at certain types of structures. Also, it’s important to understand that to analyze part of a home, one or all of the tools could be used. These decisions are up to the discretion of the individual.

The six inquiry tools Gee recommends are situated meanings, social languages, figured worlds, intertextuality, Discourses, and Conversations. See Table 8 below. Before outlining how these questions are used to conduct an analysis, each of the six tools are briefly discussed below.

The first tool of situated meanings allows the analyst to question the contexts of the texts and to consider both how context impacts the meaning and how the text impacts the context. From a validity standpoint, the analyst must contend with what Gee refers to as the *frame problem*. The context of a text can infinitely expand; however, the researcher must use the tool of context to ever-expanding levels until it can be argued that considering a greater level of context makes no difference in the interpretation.
Table 8

*Gee’s Six Tools of Inquiry or Theoretical Tools*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Question It Asks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situated Meanings</td>
<td>What meaning is given to the text based on context?</td>
</tr>
<tr>
<td></td>
<td>What is the impact of context?</td>
</tr>
<tr>
<td>Social Languages</td>
<td>How does the language style or vocabulary connect the discourse with a specific style?</td>
</tr>
<tr>
<td>Intertextuality</td>
<td>What other texts or social languages does the discourse connect itself to?</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Which socially or culturally constructed mental community does the discourse assume or invite the reader to assume?</td>
</tr>
<tr>
<td>Discourse</td>
<td>How are the text, interactions, actions, values, etc. of the discourse being used to establish a socially recognizable activity?</td>
</tr>
<tr>
<td>Conversations</td>
<td>What social issue, debate, or discussion does the text assume the reader is aware of?</td>
</tr>
</tbody>
</table>

Gee’s second inquiry tool is social languages, which are the styles of language used by individuals for different purposes. Social languages can be vernacular or technical language. A third related tool is intertextuality. This tool refers to the ways in which the discourse alludes to other texts. For the purpose of this study, science and critical pedagogy have specific languages. However, texts can borrow the social language of another group in order to disguise themselves, their ideologies, or their intentions. Gee’s fourth tool is based on the writings of Holland, Skinner, Lachicotte,
and Cain (1998). They identify figured worlds as “those cultural realms peopled by characters from collective imaginings” (p. 51). These are socially and culturally constructed mental communities that constitute simplified worlds.

Discourses, with a capital D, is the term used by Gee (2011a) to identify all the aspects of communication that are not an actual part of the language used by a speaker or writer. Gee identifies it as the “ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing, and using various symbols, tools, and objects to enact a particular sort of socially recognizable identity” (p. 29). His final tool is Conversations, with a capital C. They are the discussions that have taken place in a society around a specific issue. In the case of the texts being analyzed in this study, the texts are considered through the lens of the Conversations that have taken place around the socioscientific issue of energy and climate change. For example, our society has Conversations regarding evolution and the human impact on the environment.

Ultimately, each building task could be analyzed using each of the six tools, which would result in a total of 42 specific areas of analysis. For example, to analyze the task of significance, a CDA could ask, “How does this discourse assign significance to an idea by connecting itself with Conversations? Discourses? Figured Worlds? Intertextuality? Social Languages? Or Situated Meanings?” That could be asked about every building task. Considering the analogy of a house, each structure of the home could be analyzed with every tool available. The function of the roof could be analyzed with the blueprints, the semantics, a visual inspection, and three other tools. Then the same tools could be used to look at the plumbing, the foundation, and so on. However, it would probably not be necessary to use every tool to look at every part of the house. A
basic idea of the function of the roof could probably be determined by using just a few of the tools. Gee (2011a) argues that an analysis that asked and answered all 42 questions would be unreasonably long and that, in reality, a critical discourse analysis is only going to deal with some questions. “Actual analyses, of course, usually develop in detail only a small part of the full picture. However, any discourse analysis needs, at least, to give some consideration, if only as background, to the whole picture” (p. 121).

Before detailing how the curricula in this study were analyzed, it is necessary to consider one more set of tools that were used. As previously explained, Critical Discourse Analysis differs from textual analysis, which relies solely on linguistic structures; however, the validity of the CDA is in part established by showing a link between the analysis and the grammatical structures and linguistic choices made in the text. For this research, those tools are identified as grammatical and contextual tools. Considering the house analogy, think of the visual inspection of the roof. The use of a camera, magnifying glass, or flashlight would help during a visual inspection to validate the conclusions that were drawn about the function of the roof. Grammatical and contextual tools work in the same way to connect the answers found in the analysis to the actual text and the choices the author made. Gee (2011a) identifies six contextual tools and nine grammatical tools. They are listed in Table 9. In the analysis, each is fully explained the first time it is used.

In this analysis, Gee’s theories were applied in the following way:

1. Coded excerpts of texts that applied to the first research question were read from the first curriculum.
2. One of the building tasks was selected for analysis. For example, how is this curriculum presenting the socioscientific issue of energy and global warming by connecting it to other concepts?

Table 9

_Gee’s Contextual and Grammatical Tools_

<table>
<thead>
<tr>
<th>Contextual Tools</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Why This Way and Not That Way Tool</td>
<td>Fill In Tool</td>
</tr>
<tr>
<td>Frame Tool</td>
<td>Making Strange Tool</td>
</tr>
<tr>
<td>Context is Reflexive Tool</td>
<td>Doing and Not Just Saying Tool</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grammatical Tools</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intonation Tool</td>
<td>Cohesion Tool</td>
</tr>
<tr>
<td>Topic Flow or Topic Chaining Tool</td>
<td>Stanza Tool</td>
</tr>
<tr>
<td>Diexis Tool</td>
<td>Vocabulary Tool</td>
</tr>
<tr>
<td>Subject Tool</td>
<td>Topic and Theme Tool</td>
</tr>
<tr>
<td>Integration Tool</td>
<td></td>
</tr>
</tbody>
</table>

3. A tool was selected to help answer that question: Through the use of social languages, like the style and the vocabulary the author used, how is this curriculum presenting the socioscientific issue of energy and global warming by connecting it to other concepts? Once an answer was found by the researcher, contextual or linguistic tools were used to show how the structure of the discourse supported the analysis.
4. Next, another tool was selected to help answer the question: By referencing or sounding like other texts, *Intertextuality*, how is this curriculum presenting the issue of energy and global warming by *connecting* it with other concepts? Again, a contextual or linguistic tool was used to connect the text with the analysis.

5. Tools continued to be used to analyze the *connections* being made by the text until a hypothesis could be established regarding how the curriculum was using connections to present the issue of energy or global warming. This process forms a tentative answer to the research question that will be confirmed or disproved through analysis of the entire collection of data.

6. Then steps 2-5 were repeated for the same curricula and the same research question but for a new building task. For example, how is this curriculum presenting the issue of energy or global warming by establishing relationships between or among groups of people? Different tools were used to consider that question. How are social languages being used to establish those relationships? How are situated meanings being used to establish those relationships?

7. By repeating steps 2-5 with a new building task, the original hypothesis that was established by analyzing the first building task was built upon, changed, or revised. The answer for the research question continued to be formed through the repetition of these steps.

8. Steps 1-7 were then completed on the second and third piece of curricula for the same research question.

9. Then all eight steps were repeated on all three curricula to formulate an answer for the second and third research questions.
Based on Gee’s (2011a; 2011b), the specific building tasks, inquiry tools, and contextual and linguistic tools selected for the analysis were entirely dependent upon the texts. Since the tools used for each portion of the text varied, the analysis includes tables that summarize the building tasks and inquiry tools used in the formation of each hypothesis. The analysis continued until specific themes and recurring concepts converged to support answers for the research questions.

To demonstrate the analysis process, the following section describes the way in which one portion of text from the NEED curriculum was analyzed. It reads, “The coal we use today took millions of years to form. We can’t make more in a short time. That is why it is called nonrenewable” (National Energy Education Development Program, 2016d, p. 13). This section can be analyzed for the way it connects or disconnects ideas and concepts. To consider how it does so, the social languages used in this text were analyzed. Social languages are the ways the style or vocabulary are used to communicate with a specific manner. The social languages used are analyzed with grammatical and contextual tools.

First, the integration tool is a grammatical tool that considers what words or phrases have been integrated into the sentence and function to change the social language. In this case, if you remove the phrase “in a short time,” the second sentence would just say, “We can’t make more.” The integration of the phrase “in a short time” mixes the social language of the scientific idea of nonrenewable with a child’s concept of time. By doing so, the sentence mixes a technical and casual vernacular.

Next, the Vocabulary tool was used to analyze the sentence. The use of the pronoun “we” includes the child, the scientists writing the text, and all humans. The verb
“make” disconnects the formation of coal from the natural process involved in its creation and instead places its creation within the abilities of humans.

The Making Strange tool was next used to analyze this section. The making strange tool asks the analyst to think of the sentence from a different point of view and substitute in a new idea to see if the sentence then seems strange or out of place. In this case, the sentence can be made strange by putting any other natural phenomena into the place of coal. For example, a text would not say we cannot make more rain or more mountains. Those are naturally occurring events that humans cannot control. When the sentence is considered with this tool, the misconception perpetuated by the text, that humans can make more coal but not quickly, is exposed.

Finally, the Fill In tool was used to consider what assumptions the reader, in this case a child, would fill in to the text. Based on the findings of the first three tools, the analysis can fill in that a child would assume that people (we) can make coal. Therefore, it must not be a natural process. It must be something humans can do. A child would also fill in that it can be done but it takes a while. Based on a child’s concept of time, “a short time” can be a month or a year.

These four tools help analyze the Social Languages used in the text. First, a mixture of technical and casual vernacular are presented. Second, the mixture of those languages functions to inappropriately connect concepts for the reader. As a final step, these social languages are used to consider what concepts the text disconnects in the mind of the reader. Through the use of social languages, the text disconnects fossil fuels from the process that created them. Doing so disconnects fossil fuels from the once living things that made them. Thus, they are disconnected from the carbon that makes them up
and that is released when they are burned and from their impact on climate change. Additionally, the social languages disconnect the fossil fuels from their finite amounts.

Achieving Validity

Just as in an empirical investigation, the tentative answer or hypothesis can never be fully proven, but it can be strengthened through finding more support for it in additional pieces of discourse. Of course, it is possible that analysis of further discourse disproves a hypothesis. Gee argues that “our hypotheses make predictions about what we expect to find in further data or in a closer look at our original data” (p. 25).

Validity was documented in this analysis in three ways. First, the analysis demonstrated what Gee (2011a) refers to as convergence. This occurs when the answers established by the analysis are compatible and convincing. The data from the text began to lead to similar conclusions. According to Gee (2011a), “ideas from new parts of the database continue to support ideas we have gotten from other parts of the database” (p. 175). This was accomplished by analyzing the text with different building tools and ending up with the same conclusions.

Second, validity was established through coverage. This occurs when “ideas inspired by one part of the data extend to and illuminate other parts” (p. 175). An idea that was inspired by one part of the data was applied to another portion. In this case, the themes that began to emerge in the hypotheses were applied to other areas in the text and to the other two curricula. In this manner, the analysis became predictive of the data. This was accomplished by using the analysis to demonstrate the repetitive presence of central themes.
Finally, validity was demonstrated through the connections that were made between the analysis and the linguistic details found in the texts. As previously discussed, Gee (2011b) contends that validity is in part established when the analyst can “argue that the communicative functions being uncovered in the analysis are linked to grammatical devices that manifestly can, and do, serve these functions” (p. 123-124). According to Gee, the convergence of all of these elements in an analysis indicate validity, and he argues that it is highly unlikely that an inaccurate or untrustworthy analysis would result in the joining of all three elements.

Summary

The purpose of this critical discourse analysis is to identify and analyze the discursive strategies used in intermediate science texts and curricula that address the socioscientific topic of global warming and the degree to which they support or undermine the development of scientific literacy and a critical pedagogy.

Through a criterion and convenience sampling of texts, curricula that are readily available to elementary school teachers were identified, and three curricula from different types of authoring organizations, business, non-governmental, and educational, were selected based in part on their apparent commitment to critical pedagogy and scientific literacy. The process for analysis of the texts relied on the building tasks of discourse identified by Gee that are influenced by the theories of French discourse analysis, Fairclough, and van Dijk. Through this analysis the study answers questions regarding the use of discourse to present socioscientific issues and to promote or suppress the development of scientific literacy and critical pedagogy.
CHAPTER 4

RESEARCH QUESTION ONE FINDINGS: TREATMENT OF SSI

The purpose of this critical discourse analysis is to identify and analyze the discursive strategies used in intermediate science curricula that address the socioscientific topic of climate change and the extent to which these discourses are designed to promote or suppress the development of scientific literacy and a critical pedagogy. Toward that goal, the analysis presented in the next three chapters presents the findings of this study’s three research questions. This chapter details the analysis completed to develop a hypothesis for the first research question: In intermediate science curricula and texts, how is discourse employed to present socioscientific issues?

The answer to this research question evolved through analysis of each of the three curricula described in chapter 3: PreSEES Global Warming Socioscientific Unit, NEED Elementary Energy Infobook and Elementary Energy Infobook Activities, and Oxfam Education Climate Challenge. The Significance that each curricula developed for the issue of climate change was analyzed along with the Connections each one made and they ways those connections developed the socioscientific issue. Additionally, the Practices or Activities that the curricula engaged in along with the relationships they developed among the readers and writers were considered. Based on this analysis, all three curricula were found to elevate or de-emphasize the issue of climate change by presenting it with a narrowed, specific worldview and by developing a reader identity that
engages with that worldview. The development of this analysis and the discursive tools used to conduct it are detailed in this chapter.

PreSEES Global Warming Socioscientific Unit

The following section details the analysis of the PreSEES unit based on significance, identities, connections, and practices (activities).

Significance

To determine how discourse is used to present this socioscientific issue, the text was first analyzed by considering the question of how it stresses or deemphasizes the significance of global warming. Gee’s (2011b) Big “C” Conversation Tool can be used to consider all the claims the discourse assumes the students and teachers have heard. This is accomplished by asking which issues, sides, debates, or claims the authors of the text assume the readers know. The text functions in several ways to elevate the significance of global warming by making several assumptions regarding the knowledge students possess about the topic. For example, the introductory activity assumes the students can define and have heard of global warming, and asks a series of questions that the students are expected to answer. The text from that portion of the curriculum is presented in Table 10.

Slide 4 on the Power Point and student worksheet 1.1 have the same questions (PreSEES, 2014). The title question on slide 4 asks, “What do you think about global warming?” The use of the word think elevates the significance of global warming by suggesting that the students already have and should have an opinion to share. Question 2A asks, “What do you know about the issue of Global warming?” This question raises the significance of the issue of global warming through the assumption that the students
know about the issue and have enough knowledge to share what they have already learned. Question 4 A and B function in the same way by asking the students’ opinions and what they are based on. Gee’s Fill In Tool can be used to consider the assumptions made by the text. With this tool, the text is approached by asking what is not being overtly said or what the reader has to fill in. To make the content of this lesson clear, students must provide answers to these questions. An inability to do so implies a deficit of knowledge on the part of the student. By expecting students to provide knowledge and opinions about global warming, the text is elevating its significance.

Table 10

PreSEES Global Warming SSI Unit: Content of Slides 3 and 4

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**Slide 3**

“The topic of Global Warming” and a collage of 13 images

**Slide 4**

Title Question: “What do you think of Global Warming?”

Question 1: “What do you think about the images, movies, articles, etc. you have seen?”

(reference to the images on slide 3)

Question 2A: “What do you know about the issue of Global warming?”

Question 2B: “What famous people or groups have you heard talking about it?”

Question 2C: “What videos/news/documents have you seen before on this?”

Question 4A: “What is your personal opinion about the causes of climate change?”

Question 4B: “What do you base it on?”
The *Conversation Tool* can also be applied to Slide 3 to understand how the text places itself in the broader societal conversation about global warming. The specific images presented on this slide are fully discussed in a later portion of this analysis, but for the purposes of analyzing their role in stressing the significance of the issue of global warming, they are now viewed as a mass of images. Through the application of Gee’s *Cohesion Tool*, the presentation of the images in one group functions to connect them all and to indicate that many groups and individuals engage in the conversation about global warming. The specific images are fully described later when they are individually analyzed.

Instead of explaining or even identifying the images, the curriculum assumes the student is already aware of and a part of the societal conversation regarding global warming. The *Fill In Tool* was applied to question the knowledge the text expects the students and teachers to supply. Since the curriculum materials do not provide a script for or description of the images, the dialogical portion of the lesson will vary each time, therefore the extent to which famous people are recognized in the images will vary as well. Regardless, the large number and variety of the pictures contribute to raising the significance of global warming in the mind of the reader. They are expected to fill in this knowledge. If they can, the text functions to remind them of the significance of the issue of global warming. If they cannot, it functions to imply that there is a whole conversation they are not a part of. Effectively, this choice in the discourse, to show and imply that global warming is discussed and present in various media, communicates to both the teacher and the student that the issue of global warming is significant.
The significance this curriculum places on the issue of global warming was next analyzed with the *Discourse Inquiry Tool*, which asks what socially recognizable identity or activity is taken on by the text. The following analysis demonstrates that the text engages in the discourse of concern and engagement with the topic of global warming. In question 2A, students are asked: “What do you know about the issue of global warming?”

The word *issue* is placed in front of the term *global warming*. Before considering the way this vocabulary choice functions in the question, it is important to briefly address Gee’s *vocabulary tool*, which will be used throughout this analysis. The most common words in the core of the English language are Germanic words. In addition to being used with a higher level of frequency, they are considered informal or common styles of communication. More formal or specialized styles of English communication use words from other languages at a higher frequency (Jackson & Amvela, 2007). Specifically, the presence of Latinate words indicates a more formal tone.

Additionally, Gee (2011b) argues that the formality of words can be analyzed through the three tier word distinctions identified by Beck, McKeown, and Kucan (2013). Tier 1 words are commonly used by students, tier 2 words are not commonly used by students but are used by mature language users, and tier 3 words are not found commonly and are specific to content areas. The word *issue* marks a change from the informal to the formal in that the word has Latinate origins and is identified as a tier 3 domain-specific word (Marzano Research, 2013). Apart from the specialized term *global warming*, the other words used in these questions are more common, Germanic, Tier 1 words. The text’s shift to the more formal term *issue* right before the mention of global warming functions to elevate the significance of the SSI topic.
Slide 4 and worksheet 1.1 also pose question 2B, “What famous people or groups have you heard talking about it?” and question 2C, “What videos/news/documents have you seen before on this?” Two grammatical tools can be used to analyze these two sentences. The Cohesion Tool asks how ideas are lexically assumed to be connected. In this case, the use of the slash connects and equates videos, news, and documents. Additionally, by placing famous people or groups in the same position as the videos, news, and documents, the repeated sentence structure creates cohesion between the two topics. These questions are also placed together on the same slide and on the same bullet. Therefore, the text functions to connect them with Gee’s Stanza Tool, which indicates connections of concepts that are grouped or clustered tougher. By grouping and connecting these topics, the text heightens the significance of the issue of global warming. It implies that famous people and groups are engaged in a discourse about global warming and that the students should have previously heard and read others talking about the issue. By asking about an array of sources, including videos, news, and documents, the text elevates the issue and suggests that global warming is part of a discourse that has been and is discussed in all manner of media.

A summary of the analysis tools applied to determine the significance this text places on the soicoscientific issue of global warming is presented in Table 11. After analyzing the text with the Significance Building Task, an initial hypothesis can be written to answer the first research question. In intermediate science curricula and texts, discourse is employed to elevate the significance of the socioscientific issue.
Table 11

**PreSEES: Analysis Tools Applied and Findings: Significance**

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversations</td>
<td>Fill In Tool</td>
<td>Elevated significance by assuming</td>
</tr>
<tr>
<td></td>
<td>Cohesion Tool</td>
<td>reader aware of and involved in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>conversation about global warming</td>
</tr>
<tr>
<td>Discourse</td>
<td>Vocabulary</td>
<td>Elevated significance by being</td>
</tr>
<tr>
<td></td>
<td>Cohesion</td>
<td>concerned and engaged with the</td>
</tr>
<tr>
<td></td>
<td>Stanza</td>
<td>discourse of global warming by</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sharing interactions of it with media</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and famous people</td>
</tr>
</tbody>
</table>

Identities

Gee (2011a) explains that discourses can be analyzed by considering the ways in which they construct an identity for the author or the reader. In this section, the analysis will consider how the curriculum functions to enact an identity for the authors, students, and teachers. In the above analysis regarding the Significance, discourse was analyzed by considering the Conversation it evokes and the Discourse it uses when discussing global warming. These same sections function to invite the reader to take on the identity of an individual involved in the Conversation and using the Discourse of global warming. The ways in which the text does this can be considered with Gee’s (2011a) *Doing and Not Just Saying Tool*, which is used to consider what the author is doing and not just saying. The entire introductory slide is engaged in pulling the students and teachers into
the *Conversation*. This is accomplished through the repeated use of the pronoun *you*. By using the plural pronoun *we* in question 3A, the text ties the identity of all of the students and teachers with that of the author and involves the author in the activity of viewing the images. This slide constructs an identity for the reader as one engaged in the *Conversation* of global warming. By asking what the student thinks, has seen, can identify, and can construct an opinion about, the text also requires the student to use the activities, values, and objects that make up the *Discourse* of the socioscientific issue.

The identity formed for the reader can also be analyzed by considering how the discourse nurtures and invites the reader to become part of a *Figured World*, a socially and culturally constructed mental community. On slide 4, the title question, question 1, and question 2A have the same sentence structure, where the topic of each question is *you*, the student. “What do you think about Global Warming?” “What do you think about the images, movies, articles, etc. you have seen?” “What do you know about the issue of Global warming?” That repeated sentence structure is broken in sentence 2B, “What famous people or groups have you heard talking about it?” Gee’s contextual tool of *Why This Way and Not That Way* can be used to ask how grammar was used to make readers become part of the *Figured World*. If the previous structure had been kept, the resulting sentence would ask, “What have you heard famous people or groups say about it?”

By changing the structure of the sentence, the discourse functions to emphasize the significance of global warming. *Famous people* have now become both the topic and the theme of the sentence. Based on Halliday’s (1973) theories regarding functional linguistics, this change in pattern is a motivated change in prominence, which he calls *foregrounding* (p. 104). According to Gee (2011b), the theme of the sentence is any part
of the sentence that comes before the topic. In a sentence, such as this one, where nothing comes before the topic, the topic is also the theme. The theme of the sentence “orients the listener to what is about to be communicated” (p. 72). Therefore, this structural change functions to move the reader from the focus of themselves, you, to individuals who are famous. The impact is that famous people are given a place of prominence and their interest in the topic increases the significance of global warming.

Regarding Identities, it functions to group the reader with the Figured World of famous people who are engaged in thinking and talking about the issue of global warming.

Table 12

*PreSEES: Analysis Tools Applied and Findings: Identities*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversations</td>
<td>Subject Tool</td>
<td>Tied the identity of the reader to</td>
</tr>
<tr>
<td></td>
<td>Doing and Not Just Saying</td>
<td>the Conversation about global warming</td>
</tr>
<tr>
<td>Discourse</td>
<td>Doing and Not Just Saying</td>
<td>Required the reader to take on an</td>
</tr>
<tr>
<td></td>
<td></td>
<td>identity that used the Discourse of global warming</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Why This Way/Not That</td>
<td>Tied identity of the reader with</td>
</tr>
<tr>
<td></td>
<td>Topic Flow or Topic Chain</td>
<td>famous people engaged in the Conversation and Discourse</td>
</tr>
</tbody>
</table>
Table 12 summarizes the tools used to analyze the Identities that the discourse builds for the students and the teachers and summarizes the analysis. Based on the analysis of the Identities Building Task, the hypothesis for the first research question is solidified and built upon: In intermediate science curricula and texts, discourse is employed to elevate the significance of the socioscientific issue by developing an identity for the reader as an individual engaged with the issue.

Connections

The PreSEES curriculum was next analyzed for the connections it makes among the issue of global warming and other relevant or irrelevant issues. Even though one goal of a socioscientific issue unit is to maintain impartiality and accept all student viewpoints, the Situated Meanings inquiry tool can be used to demonstrate that the discourse of this curriculum connects the socioscientific issue with the argument that global warming exists and is impacted by human actions. First, question 4A is the first time the students are asked to share their opinion. The question does not ask them to share their opinion about just global warming, but about “the causes of climate change.” Gee (2011a) argues that context and discourse shape one another in that the context impacts the way in which a discourse is presented and the discourse changes the context.

The Situated Meanings tool asks the analysis to consider how the context impacts the meaning of the text. Using this tool, the discursive choice to switch readers from thinking of just global warming to thinking about the causes of global warming works to prepare the students for the actions that the curriculum wants them to engage in. Namely, the students will be asked to research the arguments of those who contend that human activity impacts global warming and those who argue that it is a natural process of the
earth. Question 4A connects the ideas of students with the viewpoint that global warming is being caused and is not simply happening. The Vocabulary and Why This Way and Not That Way tools were used to support this analysis. The text used the term causes, which places the question within the Social Language of science, and pairs it with effect. This discourse presents global warming as the effect and therefore aligns itself with the idea that there are actions that are causing it. If the text had used other options, such as reasons, origins, or sources, it would have made a weaker connection or no connection at all between global warming and human actions.

The Situated Meanings tool demonstrates how the context around the issue of global warming and the human impact on global warming has influenced the authors and therefore the text and the reader. By asking how the context impacts the meaning, the curriculum is understood to have a point of view that wants to lead the reader to the understanding that there are causes of global warming. Additionally, it can be used to identify the Connection that is not being made in this discourse. Specifically, the discourse removes itself from a context that does not accept that global warming is happening at all. On slide 3, two of the images reference global warming as fraud or hoax, and the open questions on slide 4 could lead to a class discussion that there are some individuals who do not believe global warming is occurring; however, the discourse itself does not address it. Instead, the curriculum immediately moves students and teachers from discussion varying opinions to being divided up into research groups.

Slide 5, which is detailed in Table 13, divides the students into groups based on being “In favor of global warming as caused by human activity” or “In favor of global warming as a natural process.”
Table 13

*PreSEES Global Warming SSI Unit: Content of Slide 5 and Worksheet 1.2*

**Slide 5**

**Title:** “Let’s look for info about the topic”

**Bullet 1:** “Divide the class in 2 groups. Each group should find the following information on the Internet:”

**Sub-Bullet 1:** “Group 1: In favor of global warming as caused by human activity”

**2nd Bullet under Group 1:** “Data or arguments in favor of global warming as caused by human activity.”

**Sub-Bullet 2:** “Group 2: In favor of global warming as a natural process”

**2nd Bullet under Group 2:** “Data or arguments against global warming as caused by human activity.”

**Sub-bullets under both groups:** “General data regarding global warming: what is it? Is the planet warming or not?” and “Data or arguments from different sources (scientists, ecologists, politicians, industrialists,…) etc.”

**Worksheet 1.2**

**Question 1:** “With the information you have found, how do you explain what is global warming? Is the planet warming or not?”

Slide 5 does ask both groups to collect “General data regarding global warming: what is it? Is the planet warming or not?” Additionally, question 1 on Worksheet 1.2 asks the students to explain what global warming is and to answer the question, “Is the planet warming or not?” However, the reader views both questions through the context
Worksheet 1.2 asks students to respond to three additional questions that are dependent upon them accepting that global warming is occurring. Based on the Situated Meanings that the teachers and students must fill in, namely that there are other assignments to complete and arguments to research, the discourse functions to detach the socioscientific issue of global warming from the idea or Conversation that the existence of climate change could possibly be a non-issue.

The text functions in another way to connect the socioscientific issue of global warming within the binary that is explored throughout the curriculum. That binary is a part of the Conversation regarding global warming, asking whether it occurs naturally or is impacted by human actions. Gee (2011b) argues that individual sections of a text can be analyzed to question why the writer built and designed with the grammar that they did as opposed to writing in a different way (the Why This Way and Not That Way tool). This tool can be used to analyze how questions 3A and 3B on slide 4 work to frame global warming within the context used in the curriculum. After stating that the images showed many views on global warming, question 3A asked “What are these views?” and 3B asked, “Can you identify different opinions on the issue of global warming?” Question 3B is not asking if they can identify opinions as question 3A does. Question 3B asks students to classify those opinions. Asking for a classification sets up a binary that moves the students to the next activity. The second activity in the curriculum assumes that question 3B led the students to discover that there are two views on global warming, that it is caused by human activity or that it is a natural process of the earth.
Additionally, the splitting of the class into two research groups on slide 5 and the organization of the questions that students answer on Worksheet 1.2, discussed above, supports the connection between the issue of global warming and ideas about the actions that impact it. After analyzing the Connections built by the discourse, several aspects of the hypothesis for the first research question have been solidified. Table 14 summarizes the tools used to analyze the Connections and the findings.

Table 14

*PreSEES: Analysis Tools Applied and Findings: Connections*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situated Meanings</td>
<td>Vocabulary</td>
<td>Connects itself with stance that global warming is happening and is impacted by human action</td>
</tr>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>Connects itself with science detached from option of global warming being a non-issue</td>
</tr>
<tr>
<td>Conversations</td>
<td>Why This Way/Not That</td>
<td>Connects issue with binary views on causes</td>
</tr>
</tbody>
</table>

The Connections made continued to elevate the significance of the socioscientific issue and to develop in the reader an identity of one engaged with the issue. Through analyzing the Connections made by this curriculum, the discourse was found to connect both the significance and the engaged identity of the reader to a specific viewpoint.
regarding the socioscientific issue, specifically that global warming is happening and is caused by human actions. In intermediate science curricula and texts, discourse is employed to elevate the significance of the socioscientific issue by narrowing it to a specific topic and developing an identity for the reader as an individual engaged with the issue.

Practices (Activities)

To understand the activities that the text is achieving, the curriculum was next analyzed for the ways in which it gets the reader to recognize accomplished activities and the groups that support or normalize those activities. Gee’s (2011b) tool of figured worlds can be applied here. Figured Worlds are “theories or models or pictures that people hold about how things work in the world when they are ‘typical’ or ‘normal’” (p.178). He recommends analyzing a discourse by asking what the writer assumes about the world. Often a figured world can be used to perpetuate a hegemonic norm, but it is also possible for the discourse to function as a way to challenge or disrupt norms. In the case of this curriculum, the analysis tool demonstrates that the authors are assuming a Figured World where global warming is assumed to be caused by human activity. Before analyzing the ways in which this figured world is evident in the discourse, it is important to acknowledge that scientific research supports the assumption of the authors. However, future analysis of other science curricula that mention socioscientific issues may present a curriculum through a figured world that is not based on accepted scientific evidence. Therefore, it is important to analyze all figured worlds of the discourses and consider the assumptions presented.
The third slide of the Power Point contains a collection of images. The same or very similar images are also included at the top of worksheet 1.1, however they vary slightly. The worksheet images include some Spanish language items. For the analysis, only the pictures used on the Power Point were considered. The reason for this decision is that the Power Point images are the ones the students see as they engage in a whole group discussion. Additionally, those pictures are in color, more detailed, larger, and are written in English.

The images are arranged somewhat in rows, so they are numbered from one to thirteen starting at the top left and going from left to right and from top to bottom. First the images can be analyzed with Gee’s (2011b) Intertextuality tool. This analysis tool is used to consider the other texts alluded to by the discourse and to question why the authors used them. The other texts alluded to in the image include the following texts that assert that global warming is caused by human activity. Image 2 is the front cover of the book *The Economics of Climate Change* by Nicholas Stern. The front cover of the book shows a picture of the earth. Image 4 is the front cover of the book *An Inconvenient Truth* by Al Gore. A picture of former Vice President Al Gore is on the front cover of the book. Image 5 is the movie poster for *The Day After Tomorrow*. The cover shows two characters from the film dressed for artic weather in the foreground and the frozen-over skyline of the city of New York in the background. Image 8 is the cover of the August 13, 2007 issue of Newsweek. A photograph of the burning sun with solar flares is covered with the title *Global Warming Is A Hoax.* In the bottom left of the image in much smaller point, the footnote for the asterisk says, “Or so claim well-funded naysayers who still reject the overwhelming evidence of climate change. Inside the
denial machine. By Sharon Begley.” Image 9 is a picture of Sir Nicholas Stern, who wrote *The Economics of Climate Change* (Image 2) (Stern, 2006). In the picture, the reader can see his face. He appears to be presenting on a stage and the screen behind him says, “Review on the Economics of Climate Change.” Image 12 is a poster created by the World Wildlife Fund. It shows a man’s body with a human head that has developed the mouth and eyes of a fish. The poster says, “STOP CLIMATE CHANGE BEFORE IT CHANGES YOU.” It also has the WWF logo at the bottom.

Only one of the thirteen images references a text that supports the viewpoint that global warming is a naturally occurring phenomenon. Image 11 is an image of a power plant with the words “Climategate: Global Warming Fraud” over the top. *Climategate* refers to the leak of emails sent among scientists who were a part of the Intergovernmental Panel on Climate Change (IPCC). They included emails that requested the deletion of scientific data and that suggested the scientists were not objectively reporting on the issue of global warming (Jowit, 2011). In addition to the uneven inclusion of images to represent the two sides presented in this curriculum, there is a difference in the reorganizability of the images. The texts aligned with the human activity cause for global warming are connected to higher profile individuals and groups such as a former vice-president, a prominent news magazine, and a movie. By comparison, the *Climategate* text alludes to a news story the students may or may not be aware of.

To analyze the *Figured Worlds* propagated by the curriculum, the images used in the Power Point were analyzed with the *Making Strange* tool, which asks what would seem strange to an outsider or what is taken for granted by an insider. Someone
unfamiliar with the individuals and groups presented in the images would not be able to
distinguish between those who are on both sides of the issue. Even the one image that
originates from a group that does not believe global warming is impacted by human
activity uses the visual of a power plant. Therefore, the images would not be viewed by
an outsider in a way that would help them understand that there are differing views about
the causes of global warming.

Using the *Cohesion Tool*, the images can be seen as one object that is functioning
to connect these cultural images with global warming, and the discrepancy in number and
quality works to build a relationship between the discourse and the argument that global
warming is caused by human actions. With the *Fill In Tool*, the images can be analyzed
by asking what they are not overtly saying. The presentation of these images indicates
that there are not many cultural images that support the idea that global warming is
naturally occurring, and those that do exist are not highly recognizable to the reader.
Through *Intertextuality*, the ways in which the discourse refers to other texts, the images
accomplish two activities. They function to get the reader to recognize other prominent
groups that support the idea of global warming being impacted by human actions. By
showing many prominent sources, the images also function to norm that viewpoint.

Gee (2011a) also argues that images can be analyzed by considering “how the
elements you have found fit together – form a pattern – to create a certain sort of style for
the whole image” (p. 195). The general pattern found in the pictures communicates a
*Social Language* that can be used to further analyze the *Practices or Activities* built by
the curriculum. The textless images in the collection of pictures can be analyzed in this
way. Image 1 is a vibrantly colored, computer generated image that shows a field of
cracked, dry earth on the left and the same field covered in grasses on the right. Image 3 is an illustrated earth where half of the planet is frozen and melting and the other half is burning. Image 6 is a computer-generated image of a major city flooded after sea levels have risen. The city buildings rise out of the water. Image 7 is a nuclear power plant. Image 10 is a picture of a polar bear who has climbed up onto a piece of ice that is too small to hold it. The polar bear’s back legs are moved up so that they can dig into the ice and keep it from falling off.

The images can be analyzed with the Why This Way and Not That Way tool. The authors chose to include visualizations of the impacts of global warming. They certainly could have shared images of the existing impacts such as eroded beaches or drought impacted rivers. Instead of showing a polar bear, they could have selected a cold-water fish or salmon. By selecting images that dramatize global warming and connect its impact to a large mammal, the images as a whole invoke a feeling of dread regarding the consequences of global warming.

Together, these images present the issue of global warming as being dire and imminent. As a social language, they function to build in the reader a sense of urgency to improve the situation, and improvement can only take place when one’s actions have an impact and make a difference. If the discourse approached global warming from the assumption that it was a naturally occurring activity, there would be no need to consider its serious effects because they would be an unstoppable certainty. Instead the discourse presents the collection of images to the reader in order to make them feel as though they can impact the situation. That is only possible if the issue is approached through the assumption that global warming is caused by human activity.
Image 13 is a poster with a drawing of the earth with a face. The earth is sweating and has its tongue stuck out like a panting animal. Above the image are the words, “The Truth About Global Warming.” Under the image, it says, “It’s About Politics Not The Planet…It’s About Control Not Concern!!” This final image is the second of the thirteen images that are aligned with those who argue that global warming is a natural process; however, the image with the message invokes the same feelings as the non-text images above. Since the text with the image is not well known, its image of the earth just blends in with the style of the non-text images around it, and it contributes to the overall social language that they communicate.

Finally, the views of the authors are evident in an analysis of question 4 A on slide 4, which says, “What is your personal opinion about the causes of climate change?” This is the first time the materials have replaced the term *global warming* with *climate change*. The way in which the terms are used interchangeably indicates that authors assume the student has been exposed to the general conversation regarding global warming. However, since it is the first time the authors have used the term and it is the first time they ask the students to record their initial opinion about global warming, the change in term also functions as a way for the authors to attempt impartiality on the issue. The term *climate change* can be localized and variable, while the term *global warming* indicates a wide-spread and specific impact.

Table 15 summarizes the tools used to analyze the activities accomplished by the PreSEES Global Warming unit in regard to its treatment of the socioscientific issue of global warming. Primarily through its selections of intertextual references, the text functioned within a figured world and used a social language that stressed the role of
human activities on global warming, the threats it poses to our planet, and the role of action to address the socioscientific issue.

Table 15

PreSEES: Analysis Tools Applied and Findings: Practices

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured Worlds</td>
<td>Making Strange</td>
<td>Normalizes a socially constructed community that accepts the human impact on global warming and invites the reader to do the same</td>
</tr>
<tr>
<td>Intertextuality</td>
<td>Cohesion Tool</td>
<td>Norms the belief that global warming is impacted by human activities</td>
</tr>
<tr>
<td></td>
<td>Fill In Tool</td>
<td></td>
</tr>
<tr>
<td>Social Languages</td>
<td>Why This Way/Not That</td>
<td>Impacts of global warming are dire, imminent, and can be changed with action</td>
</tr>
</tbody>
</table>

After analyzing the curriculum with this fourth building task, the hypothesis for the first research question is supported and narrowed: In intermediate science curricula and texts, discourse is employed to elevate the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with the specific worldview. Based on the analysis of four building
tasks, the treatment of the socioscientific topic of global warming was consistent and changed only in so much as the worldview of the authors became more evident. To challenge, build upon, or alter this hypothesis, the second curriculum was analyzed.

NEED Elementary Energy Infobook and Elementary Energy Infobook Activities

Despite the fact that the description for the Energy Infobook specifically indicates that it presents information about climate change, the issue of global warming or climate change is not approached at any time in the curriculum. The Energy Infobook does discuss issues that lead up to the issue, but it does not then continue to the topic of global warming. By not discussing climate change, the NEED curriculum is still engaged with the issue in that it makes the choice to treat it as a non-issue. Therefore, this analysis considers the portions of the curriculum that move toward the issue of global warming but do not discuss it. Specifically, this analysis focuses on the pieces of the curriculum that approach and then ignore the issue of global warming and the building tasks used by the curriculum to present global warming as a non-issue.

Practices (Activities)

To begin the analysis of the Elementary Energy Infobook, its introduction was read and analyzed through Gee’s Practices question: What activities or practices is the curricula building and enacting and getting the readers to recognize as accomplished and normed activities? To form an initial hypothesis for this question, Gee’s Figured World tool was applied. It asks what socially and culturally constructed mental community is evoked by the text in order to build an understanding of a simplified and accepted world. The introduction says, “What is Energy? Energy helps us do things. It gives us light. It warms our bodies and homes. It bakes cakes and keeps milk cold. It runs our TVs and
our cars” (p.6). First, the grammar can be analyzed to determine how *Cohesion, Topics, and Diexis*, which is the use of pointing words, is used to strengthen a *Figured World* through a shared and specific concept of *energy*.

The pronoun *it* is used to represent *energy*, and it is applied in four consecutive sentences to detail the things energy helps us do. The repetition also makes *it* or *energy* the topic of all five sentences and therefore chains the topics together to create the overall theme of *energy* for this section. The grammatical use of chaining the sentences builds an argument that introduces energy and the things it provides. Finally, by keeping energy and its pronoun in the theme position of the sentence, the structure also functions to maintain the importance of energy in this stanza.

The grammatical focus on energy can be analyzed further with Gee’s *Context is Reflexive* tool, which analyzes the text by asking how it is creating, shaping, or manipulating what the listener considers to be relevant. The energy examples included in this introduction begin to build a context for the reader that energy is primarily available through human interventions such as heaters, light bulbs, refrigerators, and machines. Natural examples, such as sunlight or wind, are excluded. To continue to build a context for the reader that makes them think of energy primarily as a force manipulated through human intervention, the two pages that follow show six pictures: a light bulb, a camp fire, a tree, a motorcycle, a computer, and a gas station.

Ultimately, the grammatical structure equalizes all the ways that energy *helps us*. Therefore, the text functions to equate the importance of getting light and having warmth for our bodies and homes with needs such as baking cakes, chilling milk, and running our televisions and cars. The text creates a mental community in which all readers are helped
by energy in the same way. Additionally, that community understands that all our needs are equally significant and worthy of being met.

The practices being accomplished by the curricula were next approached by considering the Discourses used. This analysis questions how the text enacts a socially recognizable identity and engages in a socially recognizable activity. Two discourses, consumption and the importance of capitalistic economics, were identified and are analyzed below. The presence of a discourse that values consumption was initially identified on page 9, where the text applied the need for energy to televisions, computers, video games, toys, electronics, and microwaves; however, they were found throughout the Energy Infobook. A full list of the quotations that contribute to this discourse is found below in Table 16.

The discourse regarding consumption in the United States as compared to other countries is addressed by Turner (2010), who argues that the current American discourses regarding consumption seem “to appeal to self-interest as the best, most important, or only value, and do not hesitate to commodify others, especially nonhumans and the land” (p. 2295). The Elementary Energy Infobook often joins the consumption discourse as described by Turner, and in doing so engages in the practice of normalizing consumption and encouraging the audience to unquestioningly focus on their own energy needs. Consumption as self-interest is evident in that the technology examples presented in the text are all used for individual gains. Applying Gee’s context tool of Why This Way and Not That Way, the text can be analyzed by considering why the author used these examples and not others. To illustrate, the text could have included ways in which energy is used for the common good, such as water and waste processing or scientific
experimentation. The authors could have replaced recreational uses of energy, such as video games and television, with vital uses of energy such as public emergency systems and public transit. By not making those choices, the authors use the text to normalize the importance of individual energy consumption for personal and recreational purposes.

Table 16

**NEED: Quotations Contributing to the Discourse of Consumptionism**

“It takes energy to run our TVs, computers, and video games…” (p. 9).

“We use electricity many times every day. It gives us light and heat, it makes things move, and it runs our toys, electronics, and microwaves. Imagine what your life would be like without electricity” (p. 9).

“Energy is Needed for a Growing Country.” “People needed more energy.” “Today, electricity is a part of almost everything we do. We use more every year” (p. 10).

“Factories burn natural gas to make products…” (p. 20).

“The United States doesn’t produce enough oil to meet our needs” (p. 21).

“We Use Petroleum Every Day” “What would we do without petroleum? Our country would come to a stop” (p. 22).

“Propane is the gas we use to fuel our backyard grills” (p. 23).

“Electricity does a lot of work for us. We use it many times each day. It lights our homes, warms and cools our rooms, and helps us keep them clean. It runs our TVs, DVD players, video games, computers, and fax machines. It cooks our food and washes the dishes. It can power our lawn mowers and leaf blowers. It can even run our cars. We use a lot of electricity every year.” (p. 34)
Turner’s second argument regarding the discourse of consumption in the U.S. is that it views others, specifically nonhumans and the environment, as commodities. The text positions energy as a product by emphasizing the vital need for energy. Readers are told that we need it every day, do not have enough, and use more every year. Gee’s grammar tool of *Intonation* can be used to see how the text stresses the importance of energy as a commodity. By reading aloud sentences such as “Imagine what your life would be like without electricity” and “What would we do without petroleum? Our country would come to a stop,” the intonation demonstrates the finality and importance being placed on electricity and petroleum. The text does not elaborate on either of the thoughts it asks students to consider because the intonation makes it clear that such a thing is inconceivable.

The curriculum also engages in the social discourse regarding the importance of a capitalistic economy. Examples of times when the text engages in, and therefore normalizes, the importance of connecting energy use with the economy are included in Table 17. These examples function to place the curriculum in a *Discourse* that links economic growth with resource exploitation and holds the economic measure of a country in greater esteem than any other indicators such as health, resources, or equality (Genus, A. & Thorpe, A., 2016). To demonstrate how these examples are placed within this Discourse, Gee’s *Making Strange Tool* was applied. Using this tool requires the reader to consider the text as an outsider and to question which aspects may appear odd or out of place. When discussing the use of energy sources that result in less or no pollution, an outsider would find the inclusion of the cost benefits to be odd. Why would the financial savings of using less power or working during the day be included in a
discussion of energy use? Why would cost be a consideration when using a cleaner energy source? Reading these texts through a non-capitalistic lens and thinking beyond the economic health of the consumer makes the text’s normalization of a capitalistic economic discourse apparent.

Table 17

**NEED: Quotations Contributing to the Discourse of Economics**

“Engines must be changed to use propane though, and that is expensive” (p. 34).

“When you save energy, you save money, too. You have more money to spend on other things” (p. 38).

“Working during the day saves money because sunlight is free” (p. 6).

“And geothermal energy is cheap—once a new power plant is built, it can make electricity for less cost than a coal or natural gas plant” (p. 15).

“[Hydropower] is the cheapest source of electricity because the water is free to use” (p. 17).

Through the analysis of the consumptionist and economic discourse that the curriculum is engaged in, the hypotheses of the practices of the text are validated and elaborated. When approaching the topic of energy use and the impact it may have on climate change, the Elementary Energy Infobook conducts activities designed to convince the reader that the use/consumption of energy is not only right and necessary but also an essential component of individual comfort and recreation and should only be
questioned in ways that do not have negative financial consequences. The tools used to analyze the Practices (Activities) of the task are summarized in Table 18.

Table 18

*NEED: Analysis Tools Applied and Findings: Practices*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured Worlds</td>
<td>Cohesion</td>
<td>Creation of a common world in Topics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>which energy is right and necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to meet our needs</td>
</tr>
<tr>
<td>Discourses</td>
<td>Why This Way/Not That</td>
<td>Normalization of Consumptionism Intonation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and Capitalism as primary</td>
</tr>
<tr>
<td></td>
<td>Making Strange</td>
<td>importance with energy use</td>
</tr>
</tbody>
</table>

After analyzing the first curriculum, the hypothesis for the first research question was: In intermediate science curricula and texts, discourse is employed to elevate the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with the specific worldview. After the analysis of one task, the second curriculum appears to validate the hypothesis with the single exception that the second curriculum functions to deemphasize the significance of the socioscientific issue. The modified hypothesis is now: In intermediate science curricula and texts, discourse is employed to elevate or deemphasize the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with the specific worldview.
Connections

The NEED curriculum was next analyzed for the ways in which it connects or disconnects issues, ignores connections, makes things relevant or irrelevant, or ignores the relevance between topics. Specifically, the discourse was analyzed for the connections it made in relation to the socioscientific topic of global warming. Again, because the text does not mention climate change or global warming, the analysis focused on the ways in which it disconnected global warming from energy use or made the connection irrelevant. To do so, the text was first analyzed by considering the Conversations engaged in by the curriculum.

One debate or Conversation regarding global warming and energy use is the role of human impact. The question of increased carbon and its part in global warming focuses on the increased use of fossil fuels over the past 200 years. In several areas, the Energy Infobook makes the impact of fossil fuels irrelevant by suggesting they have always been used. “Early Egyptians collected oil that floated to the top of ponds. They burned the oil for light. Native Americans burned coal to bake clay pots. Ancient Chinese people used natural gas to heat sea water for salt” (p. 9). Using Gee’s Subject Tool, the text can be analyzed to ask why the author choose to use ancient people as the subject in these three sentences. Additionally, Gee’s Topic Flow or Topic Chaining Tool can be used to consider how the topic flows through all four sentences by using an ancient culture or a pronoun to represent them as the topic in all four sentences. Both grammatical choices place the group using these fossil fuels as the most prominent aspect of the paragraph. However, this portion of the text can also be analyzed with Gee’s Cohesion tool. The text creates cohesion among the groups through their placement as
topics, but then the authors use a bold type with each of the fossil fuels used by these groups. The bold type acts to connect all of the fuels into one group. The effect is to disengage from the Conversation that connects the human use of fossil fuels with climate change by stressing the fact that people have used all varieties of fossil fuels for thousands of years.

Phrases that continue to take place in a Conversation that normalizes the use of fossil fuels and deemphasizes its role on climate change are repeated throughout the Energy Infobook. See Table 19 below. By failing to compare the fractional use of these fuels to a much smaller population, Gee’s Doing and Not Just Saying tool demonstrates that the authors are not just sharing energy history but are building the argument that fossil fuels have been burned for millennia without obvious harm; therefore, they could not be causing harm now.

Table 19

NEED: References to Uses of Fossil Fuels Before 1800

“Many years ago, Native Americans burned coal to make pots” (p. 12).
“The early Chinese burned natural gas for heat to separate salt from sea water” (p. 18).
“People have burned oil for a long time. Long ago, they didn’t dig for it. They gathered oil that seeped from under the ground into ponds. It floated on top of the water” (p. 20).

One additional part of the Conversation regarding the impact of energy use on climate change regards the finite amount of fossil fuels available on our planet. Within that Conversation, one can either discuss the reality of fossil fuels as a limited resource
and embrace the technological changes necessary to convert to renewable energy resources, or one can negate the need to do so. The text discusses a total of ten energy sources in alphabetical order: biomass, coal, geothermal, hydropower, natural gas, petroleum, propane, solar, uranium, and wind. The selection of these topics functions as one way to elevate the importance of fossil fuels and deemphasize concerns about them running out. Gee’s *Making Strange* tool helps to analyze this choice. Approached from the perspective of an outsider who views this text as a presentation of all the energy sources available on our planet, the assumption would be that all fossil fuel energy is one type of energy. Assuming this would reduce the list to only six sources, of which fossil fuels would be one. As approached by the authors, fossil fuel-based energy appears to make up four of our ten sources.

The text also engages in a *Social Language* that disconnects the finite nature of fossil fuels from the text. By using Gee’s *Social Language* tool, the text can be analyzed to ask how the vernacular or technical languages are being used or mixed. Specifically, how is the discourse being used to disconnect fossil fuels from the reality of their limited availability? In the Energy Infobook, as each energy source is discussed, the issue of its renewability is addressed. Table 20 presents quotations regarding nonrenewable sources of energy.

These sections of the text mix the technical language of science with the common vernacular of the students in a way that improperly connects the scientific definition of *nonrenewable* with student concepts of time as well as their understanding of natural processes and human creations.
Table 20

*NEED: Quotations Addressing Nonrenewable Sources of Energy*

“The coal we use today took millions of years to form. We can’t make more in a short time. That is why it is called nonrenewable” (p. 13).

“The natural gas we use today took hundreds of millions of years to form. That’s why we call it a nonrenewable energy source. We can’t make more in a short time” (p. 18).

“The petroleum we use today was made hundreds of millions of years ago. We can’t make more in a short time. That’s why we call petroleum nonrenewable” (p. 20).

“The propane we burn today was made a long time ago. It took hundreds of millions of years to from. We can’t make more propane in a short time. It is a nonrenewable source of energy” (p. 22).

“Uranium is a mineral found in rocks in the ground. Uranium is nonrenewable. We can’t make more” (p. 26).

Using Gee’s *Integration* tool, the text can be analyzed for the way in which the clause *in a short time* functions. If that clause is left out, as it is on page 26 when the text discusses Uranium, then the sentences for each fossil fuel source would read: *We can’t make more.* By including the clause *in a short time*, the text suggests that we can make more, but it cannot be done quickly. By using the student vernacular as opposed to repeating the amount of time needed for fossil fuels to form, or as opposed to addressing the rate of use of fossil fuels, the text has used a clause that mixes the social language in a way that does not fully develop students’ understanding of the impossibility of acquiring
more fossil fuels. The scientific term *nonrenewable* is mixed with a child’s perception of time so that its concept is not fully developed.

Gee’s *Vocabulary* tool also addresses the style of language and its impact. The text repeatedly uses the collective pronoun *we*. For the students, that could indicate the author, scientists, or energy specialists, but it certainly includes themselves. Therefore, the social language includes the student in the group. The casual verb *make* removes the creation of fossil fuels from the technical terminology of the processes involved in their natural formation and moves it into the casual register of the student. The casual use of the term *make* also suggests a purposeful action as opposed to a naturally occurring process that falls outside the ability of people. With Gee’s *Making Strange* tool, the misconception created by this part of the text is evident if the sentence is related to rain or mountains. A science text would not suggest to students that humans cannot make rain or a mountain in a short time. Instead, a science text would make it clear that humans, *we*, cannot ever achieve those natural processes.

Using Gee’s *Fill In* tool, this mixed *Social Language* can be analyzed to consider what assumptions the listener will bring to the text. Since the author refers to the formation of fossil fuels as something *we* can make, and since students identify themselves as part of that group, the reader assumes that fossil fuels can be made by people. They just cannot be made in a short time. The text functions to disconnect fossil fuels from their finite amounts, and in doing so, also disconnects them from concerns regarding climate change.

After considering the building task of *Connections*, the analysis supported the previous findings that the NEED texts functions to deemphasize connections, or in effect
disconnect elements of the socioscientific topic. Therefore, the hypothesis is supported:

In intermediate science curricula and texts, discourse is employed to elevate or
deemphasize the significance of the socioscientific issue by narrowing it to a specific
worldview and developing an identity for the reader that engages him or her with the
specific worldview.

Table 21

**NEED: Analysis Tools Applied and Findings: Connections**

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversations</td>
<td>Subject Tool</td>
<td>The text normalizes human use of fossil fuels, disconnects them from climate change, and identifies them as four of ten of our energy sources.</td>
</tr>
<tr>
<td></td>
<td>Topic Flow or Chaining</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cohesion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doing/Not Just Saying</td>
<td></td>
</tr>
<tr>
<td>Social Languages</td>
<td>Integration</td>
<td>The text deemphasizes the finite amount of fossil fuels and detaches them from climate change.</td>
</tr>
<tr>
<td></td>
<td>Vocabulary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Making Strange</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fill In</td>
<td></td>
</tr>
</tbody>
</table>

Significance

Finally, the NEED curriculum was analyzed for the ways in which it built up or
lessened the importance of specific ideas regarding the socioscientific issue and the way
in which it worked to establish that some things regarding the socioscientific topic were
assumed or taken for granted. The text was analyzed for the ways in which it addressed
the significance of energy use on the environment, the issue of pollution, and the balance of earth’s carbon budget. First, the text functions to lessen the importance of the impact energy needs have on the environment. Table 22 shares excerpts used.

Table 22

NEED: Quotations on Environmental Impacts

Regarding biomass: “We can always grow more plants” (p. 10).

“We should plant new trees when we cut down old ones for wood. We also need to take care of the soil in which our crops grow” (p. 10).

“After the coal is mined, they put back the dirt and rock. They plant trees and grass. The land can be used again” (p. 13).

“When dams are built, the reservoirs flood a lot of land. They change the flow of the rivers. Sometimes, fish can’t swim up the rivers and lay their eggs like they could before, so dams have fish ladders, elevators, and other devices…” (p. 17).

“We move natural gas from one place to another in pipelines” (p. 19).

“Oil companies work hard to drill and ship oil as safely as possible. They try to clean up any oil that spills” (p. 21).

“Large amounts of radiation can kill our cells and poison our food and water. Power plants are very careful to keep radiation from escaping. The power plants in the United States are required to follow rules…” (p. 27).

Gee’s Figured Worlds inquiry tool asks what type of community that constitutes a simplified world is being built by the text, and in this case, how that simplification works
to minimalize the significance of environmental impacts. In each example, only two environmental problems are specifically stated, that fish may not be able to lay eggs and radiation can kill. In the other instances, the environmental issues that are alluded to are not specifically addressed, including soil old growth versus new growth forests, soil depletion, effects of strip mining, and impacts on the ecosystem in dammed areas and when pipelines and oil rigs have accidents. However, in each case, the solution for an undefined problem is provided: plant new trees, take care of soil, reclaim land after strip mining, provide fish ladders, clean up spills, be very careful, and follow rules.

Applying Gee’s *Intonation* tool, these sentences can be read aloud to understand which points are made salient and which are backgrounded. The specific environmental impacts are removed completely and therefore in the background, and the solutions are simplified and presented with a tone of finality. The land can be used again, there are new trees, the oil is cleaned, and the fish can lay eggs. The *Fill In Tool* also supports the way in which the environmental impacts are being lessened. By considering what knowledge the reader is assumed to possess, these segments expect the elementary student population to already have an understanding of these potential environmental hazards. By focusing on the solutions and presenting them with a simplified and finite tone, the text creates a Figured World in which the readers are invited to accept that the problems caused by acquiring energy are so insignificant that they do not need to be discussed and the solutions to those problems, should they exist, are simple and definite.

The text also diminishes the Significance of pollution through presenting it as a taken for granted presence and narrowing or negating its impact. The Elementary Energy Info book references the burning of wood, plants, coal, natural gas, trash/garbage, and
biomass a total of 42 times. Each time, these discussions are accompanied by the ways in which the energy or process is beneficial: cooling food, heating homes, making products to sell, making electricity, heating furnaces, and even saving landfill space. The sheer volume of references demonstrates the way in which the text diminishes the significance of burning things in order to acquire energy. Through the number of ways and purposes for burning things, the text makes it a taken-for-granted action and therefore diminishes its significance.

Table 23

*NEED: Quotations About Pollution*

“Waste-to-energy plants work to scrub the air from the burning waste to reduce pollution and smells” (p. 11).

“When coal is burned, it can pollute the air. Power plants and factories work hard to keep the pollution from getting into the air. They clean the coal before they burn it. They use scrubbers to clean the smoke before it goes into the air” (p. 13).

“Petroleum keeps us going, but it can damage our environment. Burning fuels made from oil can pollute the air. Pollution from cars is a big problem in many parts of the country. Oil companies are making cleaner gasoline and diesel fuel every year” (p. 21).

The word pollution is only found six times in the text of the curriculum, and two of those are found in a picture caption and in a section that explains it is not created by geothermal energy. The other four times are found above in Table 23. Considered through Gee’s Discourse tool, these segments are engaged in the social Discourse that
energy can be clean and the energy industry is a responsible entity focused on reducing its amount and effects, cleaning and scrubbing it, and designing it to be cleaner. Gee’s grammar tool of Cohesion demonstrates how pollution is negated or minimalized by having the term pollution always discussed with the same Stanza as the ways in which it is being reduced. Additionally, the Topics found in these stanzas demonstrate the text’s commitment to a Discourse that minimalizes pollution. Each of the sentences that provide solutions begin with the topic of the industry that is solving the problem: waste-to-energy plants, power plants and factories, pronouns referring to those plants, and oil companies.

Engagement with this Discourse is also evident by examining the curriculum with Gee’s Social Languages inquiry tool, which analyzes the text for the ways in which it mixes technical language and other vernaculars. Outside the limited discussion about pollution previously analyzed, the text only suggests a connection between pollution and burning fuels in one other way. The curriculum references other energy sources, such as solar, wind, and hydro, as being clean. However, it also uses the terms clean, cleaner, and cleanest when referring to the burning of some bio and fossil fuels. Analyzing with Gee’s Vocabulary tool, the terms clean, cleaner, scrubbed, and scrubbers are found to reside in two very different registers. The students reading the curriculum understand those terms in a common, social register. Clean and cleaner are compliments and good things. Scrubbed, based on its connotation, suggests an action that requires lots of work and results in something being amazingly clean. However, the text is using specialized terms that have specific meanings to scientists and those in the energy industry. By not delineating those meanings, the text mixes the Social Languages, which communicates
the idea that the pollution created is actually cleaned and scrubbed and therefore less significant.

Finally, the text was analyzed for the way in which it addresses the significance of Earth’s carbon budget. While the text does directly discuss environmental impacts and pollution, the issue of greenhouse gases is never addressed in the curriculum. However, there are areas in which the curriculum has opportunities to address the carbon released through the burning of biomass and fossil fuels but does not do so. One example is the many references to burning fuels for energy, which were discussed above. Additionally, the curriculum describes the formation of each fossil fuel. In doing so, the text points out that the sun was the original source of energy for the prehistoric plants and animals that ultimately formed the fuels we use (p. 12-24). To question why the test did not move to the natural next step of teaching about the presence of carbon in those once living things or even in biofuels, Gee’s Sign Systems and Knowledge task was applied. It considers what knowledge or ways of knowing are being privileged or deprivileged. Since places have been identified were the curriculum could have included a discussion of the carbon cycle, the analysis next questions why it did not engage in that specific Conversation. Two of Gee’s context tools can be used to justify questioning why this curriculum does not engage in the Conversation about the role of energy and climate change.

Applying the Making Strange tool, the curriculum can be read through the lens of an outsider. If someone from another country, industry, or viewpoint read this curriculum, would they find it surprising that the issue of climate change was not addressed? Since pollution and clean energy are addressed and the need to conserve
energy is taught in one section, then it would seem strange that the curriculum did not engage with the *Conversation* of climate change.

Next Gee’s *Why This Way and Not That Way* tool was used to question the developmental appropriateness of teaching the carbon cycle and the earth’s carbon budget with intermediate elementary students. That question can be answered by considering the scientific topics the curriculum deemed appropriate for inclusion. The Elementary Energy Infobook includes discussions of fossil fuel formation and collection, the process of nuclear fission and fusion, the role of convection currents in the wind cycle, electricity, and electromagnetism. Based on the complexity of those concepts, climate change was not excluded based on the belief that it was too difficult. The ultimate deemphasis of the socioscientific issue of global warming in this curriculum is evident through its purposeful exclusion.

By applying Gee’s *Significance* Task, the NEED curriculum was found to deemphasize the significance of the impact of meeting energy demand on the environment. The text functioned to lessen the significance of the impact on the environment by using discursive practices that suggested those issues were easily and permanently resolved. Similarly, pollution was presented as an issue of less significance because either little pollution was being created or the pollution was being handled by the energy industry. Finally, the text removed all significance of the issue of global warming by excluding it from the curriculum. Through the process of analyzing the NEED curriculum for the way in which it presents the socioscientific issue of global warming, the hypothesis was further supported. Indeed, the text functioned to present the socioscientific issue in the narrowest terms by minimalizing its significance to the extent
of making it a non-issue. The hypothesis for the first research question was confirmed: In intermediate science curricula and texts, discourse is employed to elevate or deemphasize the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with the specific worldview.

Table 24

*NEED: Analysis Tools Applied and Findings: Significance*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured Worlds</td>
<td>Intonation</td>
<td>The significance of the environmental consequences of meeting energy needs are minimized by suggesting they are easily and permanently solved.</td>
</tr>
<tr>
<td></td>
<td>Fill In</td>
<td></td>
</tr>
<tr>
<td>Discourse</td>
<td>Cohesion</td>
<td>The text uses a Discourse that suggests any pollution created is being addressed and solved by the energy industry.</td>
</tr>
<tr>
<td></td>
<td>Stanzas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Topics</td>
<td></td>
</tr>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>The text makes the issue of pollution less significant.</td>
</tr>
<tr>
<td>Conversations</td>
<td>Making Strange</td>
<td>The text deprivileges the socioscientific issue of global warming through purposeful exclusion.</td>
</tr>
</tbody>
</table>
Oxfam Education Climate Challenge

Since the first two curricula confirmed the hypothesis and further analysis functioned to demonstrate an even greater degree of narrowing and elevating or deemphasizing the issue, the third curriculum was analyzed specifically for further confirmation or disproving of this hypothesis.

Significance

Gee’s *Significance* tool was applied to confirm or disprove a hyper-elevated or hyper-deflated presentation of the socioscientific issue. Analysis conducted on the Oxfam Education Climate Challenge demonstrated an elevated presentation of the importance of global warming in multiple ways. Like the PreSEES curriculum, the ways in which the text elevates the *Significance* of the issue can be seen by analyzing the *Conversation* that the authors assume the students are both aware of and involved in. The activity 1.1 requires students to complete a board race where they are expected to work as a team, relay style, to pass a pen and run to the board to write as many ideas as they can about the topic of *climate change* (Oxfam Education, 2016e, p. 2). This activity assumes the students are engaged in the social issue and debate to the extent that they know what climate change is and that they possess enough information to participate in a formative assessment of their existing knowledge. Gee’s *Vocabulary* tool supports this analysis. By using the less common and more formal and technical term of *climate change* over *global warming*, the text assumes the students are steeped in the Conversation to the extent that they can discuss it in a more formal and technical register.

Activity 1.3 in the first session continues to engage the students and teachers with the social *Discourse* that climate change is a proven issue currently impacting our world.
The students are encouraged to create and research their own questions about climate change. However, unlike the PreSEES curriculum, which encouraged the students to research both sides of that Discourse, and the NEED curriculum, which did not engage with the issue at all, the Oxfam curriculum refers the students to specific websites dedicated to teaching children about climate science. The directions specify, “Explain that the learners should focus on the science around climate change. Tell them that they will be finding out more about the causes and impacts of climate change, as well as potential solutions, in subsequent sessions” (Oxfam Education, 2016e, p. 4). This sentence demonstrates the curriculum’s valuing of the science-based Discourse regarding the topic of climate change. Gee’s Cohesion Tool demonstrates how the sentence structure works to connect climate change with science, causes, impacts, and solutions. Additionally, the Cohesion Tool can be applied to this entire lesson. The three activities in this session connect the students’ existing knowledge to their original questions and ultimately to the research of other scientists. With the Intonation Tool, the text can be read aloud in order to hear the matter-of-fact tone with which this direction is given to teachers. The idea that climate change may not be happening is treated as a non-issue and backgrounded by the tone of this direction.

Additionally, the Discourse is evident in the title slide of the Power Point that accompanies the unit. It reads, “The Human Impact of Climate Change” (Oxfam Education, 2016a). Gee’s Fill In tool can be used to ask what assumption is being made by the text. Since the focus of this unit is on the ways in which climate change is affecting communities around the earth, the title properly identifies the theme. However, it assumes the students are aware of the Discourse surrounding the human impact on
climate change. It assumes they have heard discussions regarding the impact humans have on climate change. The creative twist of turning the word on to of is only understood and appreciated by a reader who is aware of the Discourse surrounding the socioscientific issue. By including this lexiconic twist, the authors elevate the significance of climate change and assume students understand the play on words.

Finally, the curriculum elevates the process of working productively with the socioscientific issue. As summarized in Table 3 in Chapter 2, Zeidler and Kahn (2014) identified the elements present in the teaching of a socioscientific issue. Some that are present in the Oxfam curriculum include: evaluation of sources of information, critical thinking, dissecting opinions, and expressing ideas and value systems. In the research assignment described above, activity 1.3, the curriculum tells the teacher to discuss what information sources students could use; and as previously mentioned, the students are directed to focus on the science of climate change. Using Gee’s Making Strange Tool, one could ask what else, besides science, one might find about climate change. Even through this curriculum is not acknowledging or taking part in the Conversation about climate change that may include information shared by climate change deniers or those who do not acknowledge the human impact on climate change, this direction makes it clear that the writers are aware of the Conversation students may encounter when they research. Through the simple direction of telling students to focus on the science of climate change, the curriculum makes such aspects of the climate change Conversation a non-issue. By doing so, it is de-emphasizing the Significance of climate change denial.

The other aspects of teaching a socioscientific issue that are elevated in Significance by the curriculum are detailed below. The text functions to engage the
students in a socially and culturally constructed mental community that values and utilizes elements of an SSI pedagogy. The curriculum elevates the importance of critical thinking with multiple activities, such as comparing the importance of the per-person emissions and per-country emissions (Oxfam Education, 2016f, p. 3), identifying cause and effect of climate change (Oxfam Education, 2016g, p. 2), and ranking the impact of different actions against their effect on carbon emissions (Oxfam Education, 2016j, p. 2-3). Students are also asked to share and express opinions, ideas, and value systems in activities. Students are encouraged to write to their representative with a personal message asking the government to cut carbon emissions (Oxfam Education, 2016g, p. 4). They are also asked to determine their opinion and justify it in relation to statements such as, “Climate change won’t really affect people,” “Everyone is equally responsible for climate change,” and “Everyone will be impacted by climate change in the same way” (Oxfam Education, 2016h, p. 2). Gee’s grammatical Stanza Tool can be used to examine the ways in which each activity clusters terms such as position, opinion, and share why. These clusters strengthen the importance of engaging in each type of activity.

Table 25 summarizes the Oxfam curriculum analysis for how it elevates or minimalizes the Significance of the socioscientific topic. By increasing the significance of climate change and negating the idea of climate change denial, Oxfam supports the existing hypothesis. Additionally, by engaging the activities present in socioscientific issue pedagogy, it further emphasizes the significance of both the issue and the way students engage with it. The Oxfam curriculum narrows the view of climate change by negating the idea that there is a debate regarding its existence or its causes.
Table 25

*Oxfam: Analysis Tools Applied and Findings: Significance*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversations</td>
<td>Vocabulary</td>
<td>Significance of climate change is emphasized through assumption that students can discuss the issue at a technical and formal level.</td>
</tr>
<tr>
<td>Discourse</td>
<td>Cohesion</td>
<td>Text elevates climate change by normalizing it with science-based Discourse and negating climate change denial, making it a non-issue.</td>
</tr>
<tr>
<td>Conversation</td>
<td>Making Strange</td>
<td>Elevates significance by assuming readers are aware of climate change Conversation</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Stanza Tool</td>
<td>Elevates importance of engaging with the pedagogical elements of a socioscientific issue lesson</td>
</tr>
</tbody>
</table>

Furthermore, it elevates the significance of student interaction with the topic by using an SSI pedagogy. The curriculum allows students and teachers to personally engage with the topic and therefore create a specific worldview. After evaluating for *Significance*, the existing hypothesis was strengthened: In intermediate science curricula and texts, discourse is employed to elevate or deemphasize the significance of the
socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with the specific worldview.

Relationships

Part of the way in which the curriculum functions to develop a specific worldview toward the socioscientific issue for the students and teachers is by building *relationships* among the readers, Oxfam, government agencies, and those people most impacted by climate change. First, the curriculum built these relationships by creating a *Figured World* constructed to form a community concerned and engaged with the consequences of climate change. The relationships with Oxfam and those impacted by climate change are strengthened through this common *Figured World*. Quotations from the text that demonstrate *Cohesion* among these groups and ideas are listed in Table 26.

By analyzing these statements for the ways they lexically assume ideas are connected, the text can be seen to build the *Figured World* in which the reader is invited to assume climate change is tied with permanent impacts. This is viewed through the temporal *Vocabulary* selected: *forever* and *now and in the future*. The text also ties the impacts to specific groups and by doing so, builds a relationship between the reader and those groups. This can be seen by applying the *Integration Tool* and the *Topic and Theme Tool*. The text referenced details about the individuals impacted by climate change by *integrating* specific phrases. Instead of referring to those impacted by a simple subject such as *people*, adjective phrases were added so that the individuals referenced became: *people around the world, people in poorer countries, people living in the most food-insecure regions of the world,* and *people who contribute the least to climate change*. Additionally, the identity of those impacted was placed as the *Theme* in
the causal sentences given in the examples of the impacts of climate change. By doing so, those impacted, children, people, and farmers became more significant than the consequences, miss out on an education, have nowhere to live, go hungry, and aren’t able to grow crops to sell or feed their families. By creating a Figured World in which the most significant consequence of climate change is the toll on humans, the text builds a relationship of concern between the reader and those most affected by climate change.

Table 26

Oxfam: Quotations Connecting Climate Change and Consequences

“…many things that are important to our lives and the lives of others could be changed forever by climate change” (Oxfam Education, 2016g, p. 2).

“…share and discuss some examples of ways in which people around the world are being affected by climate change, both now and in the future” (Oxfam Education, 2016g, p. 2).

Sample examples of consequences: “Children miss out on an education,” “People have nowhere to live,” “People go hungry,” “Farmers aren’t able to grow crops to sell or feed their families” (Oxfam Education, 2016g, p. 3).

“Explain that climate change affects everyone, but many people in poorer countries will be hit harder than many people in wealthier ones, and people living in the most food-insecure regions of the world will be hit the hardest. Ironically (and unfairly), the people who contribute the least to climate change are the ones who suffer the most” (Oxfam Education, 2016h, p. 2).
The relationships between the reader, those impacted by climate change, and the Oxfam organization are also strengthened through sections of the curriculum that function to engage the reader in the *Conversation* about climate change and the ways in which individuals can encourage governments to take on the large-scale changes needed to slow carbon emissions. A societal *Conversation* exists regarding the small steps individuals can take to limit or eliminate their carbon footprints, and this *Conversation* is often present in elementary energy curriculum. However, that discussion is a boutique solution in comparison to the large-scale changes that can be made with international, governmental agreements. At the end of the third session, which teaches students about the impacts of climate change, the curriculum invites students to engage in the *Conversation* regarding the need for governmental action.

Oxfam’s For the Love Of postcard campaign is calling on the UK government to be more ambitious and take a lead in cutting carbon emissions. Young people are encouraged to get active by learning more about the issue, writing or drawing personal messages to their MP and holding an MP meeting. (Oxfam Education, 2016h, p. 4)

Using the *Fill In Tool*, several things are assumed by the curriculum through this invitation, including the reader’s agreement that governments are influenced when citizens ask them to act, that the impact on governments is greater when citizens unite in their actions, and that the readers want to join their voice with the actions of Oxfam. The request also assumes that the reader has internalized the link between not only climate change and carbon emissions but also climate change and its effects. The *Cohesion Tool* can be used to see how several ideas are grouped and linked causally in this small
invitation: Oxfam’s campaign, the UK’s need and ability to take a lead in limiting carbon emissions, the reader, and the actions that students and teachers can take. By inviting the reader into this Conversation, the students and teachers solidify their relationship with both Oxfam and their government through the assumption that combined efforts can impact the effects of climate change.

Finally, the curriculum functions to develop a Relationship of empathy between the readers and those living in the countries that are most impacted by the effects of climate change. This is accomplished by engaging the students with Climate Change Stories, four stories of real people from different locations and the ways in which their lives have been impacted by the effects of climate change. These stories include images of and direct quotations from the individuals. Table 27 includes the sections of the curriculum to be analyzed.

Through these activities, the curriculum uses a specific Discourse to build the Relationship between the reader and those impacted by climate change. The text describing these activities uses specific actions, tools, and values to engage the students and teachers with a socially recognizable identity of empathetic individuals. Specifically, the text functions to put them in the place of others by using tools such as questioning, acting, and interviewing. By doing so, climate change is connected to the effects, the effects are connected to others, and those others are connected to the readers. The relationship built through these activities is later used to move the students and teachers toward action. The Topic and Theme Tool demonstrates that each of these phrases places the student as the focus: ask learners, learners can act, learners could create. In sentences where an implied topic would make the directions clear, the authors added the
As a whole group,” so that the focus of that sentence once again became the students. Focus on the student is necessary to build their empathy.

Table 27

_Oxfam: Quotations Building Empathy_

“…profiles are of real people who are affected by climate change. Ask learners to read their story and think about how they would introduce this person to others in the class” (Oxfam Education, 2016h, p. 2).

“As a whole group, discuss possible questions that you could ask the people featured in the stories (such as questions beginning with Why, What, Where, Why, When and How)” (p. 2).

“…learners can act in role, using their own ideas based on other aspects of what they know or have read. Emphasize that this is an activity in empathizing and imagining rather than scientific fact finding” (p. 3).

“Learners could create a short story, newspaper article, diary entry, cartoon strip or poem to describe the feelings and opinions of a person affected by climate change” (p.3).

“Ask learners to list further questions they would like to ask the people featured in the Climate change stories. Although they will not be able to find out the answers, the questioning process in itself develops empathy” (p. 3).

The text also uses specific clauses to move the teacher and the students from facts and research toward activities to build empathy. With the *Integration Tool*, those sentences can be analyzed to consider why specific phrases were integrated and what the
impact would have been if they were excluded. “Although they will not be able to find out the answers” and “…rather than scientific fact finding” are both phrases that impact the text. By including those phrases, the authors are acknowledging the argument that the previous sessions have focused on the science and facts of climate change but that the purpose of this session is to specifically build the empathy of the student. Removing those clauses distances the discourse from the previous commitment to the science of climate change. By including them, the authors maintain their connection with science while simultaneously emphasizing the importance of building empathy in the students.

Ultimately, these sections of text and the activities they encourage can best be analyzed with the Doing and Not Just Saying Tool. Clearly, the text is engaged in the activity of building student empathy for a specific group of individuals. The authors specifically acknowledge that action by asking teachers to “Emphasize that this is an activity in empathizing and imagining…” and by explaining that “the questioning process in itself develops empathy” (Oxfam Education, 2016h, p. 3). Beyond this overt and stated activity, the text also functions to build that empathy through the presentation of the impacts that climate change has had on four individual lives. The lives of the individuals profiled in session 4 could also be impacted by a multitude of issues including war, health, and natural events unrelated to climate change. However, by focusing on the impact of climate change, the text functions to attach the reader’s empathy with the socioscientific issue being addressed by the curriculum.

By analyzing the text for the ways in which it builds Relationships between the reader and other individuals, in this case the readers, Oxfam, government, and those being the most impacted by climate change, the Oxfam curriculum functioned to
strengthen the hypothesis. It continued to elevate the significance of climate change and
narrowed the socioscientific issue toward an even more specific worldview that connects
climate change with its impacts and specifically with those people who are most affected.
Furthermore, analysis of the curriculum confirmed the hypothesis by demonstrating
continued actions to build the identity of the reader within the narrowed worldview.

Table 28

*Oxfam: Analysis Tools Applied and Findings: Relationships*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured World</td>
<td>Cohesion</td>
<td>Creates a Figured World concerned with the consequences of climate change. By doing so, builds a relationship among readers, Oxfam, government, and those impacted.</td>
</tr>
<tr>
<td></td>
<td>Vocabulary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integration Tool</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Topic and Theme</td>
<td>relationship among readers, Oxfam, government, and those impacted.</td>
</tr>
<tr>
<td>Conversations</td>
<td>Fill In</td>
<td>Builds relationships by involving students, government, and Oxfam in Common Conversation about the role of government and civic engagement in climate change.</td>
</tr>
<tr>
<td></td>
<td>Cohesion</td>
<td></td>
</tr>
<tr>
<td>Discourse</td>
<td>Topic and Theme</td>
<td>Uses Discourse to build empathy and solidify relationships among victims of climate change and the readers who are moved to action.</td>
</tr>
<tr>
<td></td>
<td>Integration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doing/Not Just Saying</td>
<td></td>
</tr>
</tbody>
</table>
Therefore, the hypothesis was confirmed: In intermediate science curricula and texts, discourse is employed to elevate or deemphasize the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with the specific worldview.

Connections

The Oxfam curriculum functions to form *connections* between the socioscientific issue of climate change and its causes and consequences in order to further narrow the topic to a specific worldview. This is accomplished by outlining the argument that developed countries, of which the student is presumed to be a citizen, are responsible for climate change, climate change causes extreme weather events, and the individuals in developing countries are most impacted. The parts of the curriculum involved in that argument can be analyzed for their *Intertextuality*, the ways they use styles of language and the ways they allude to other *texts*, which in this case are the images that accompany the text.

The focus on the human aspect of climate change is first evident with the selected titles of sessions two and three: *Who is responsible?* and *Who is affected?* By selecting *Who* instead of *What* as the *Topic and Theme* of the questions, the curriculum places the focus of climate change on the actions of humans as well as the impacts on humans. Additionally, the images in both sessions visually connect the human actions in developed countries with the causes of climate.

Slide 10, which accompanies the second session, entitled *Who is Responsible*, has the title *What is Responsible?* The remainder of the screen is filled with six images. They show a ten-lane highway filled with cars, a grocery store produce department,
industrial farming, large power lines, a city skyline, and a jet. The curriculum instructs the teacher to show the slide while reminding the students “that the burning of fossil fuels such as coal, gas and oil have increased the amounts of greenhouse gases, such as carbon dioxide, in the Earth’s atmosphere” (Oxfam Education, 2016f, p.2). The curriculum immediately starts its argument about who is responsible by connecting the text with images that show what developed countries are doing to contribute to climate change.

The Cohesion Tool can be used to consider the ideas that are presented together in this part of the curriculum. First, all the images are not only common images from developed countries; but also, they show examples of massive energy use. Second, the accompanying text functions to make connections that are sometimes opaque to students. For instance, by combining the text with the images of the electrical power lines and the city lights, the students are reminded that coal is often used to generate electricity. The image of the copious amounts of fruit in the produce department as well as the image of industrial farming accompanied by the reminder of the role of gas and oil in climate change functions to connect food production and transportation with the food that is consumed by those living in developed countries. Finally, none of the images include humans in them. For each image, the Subject seen by the students are the actions of humans such as flying, driving, using lights, and industrial farming. By eliminating humans, the focus is on the actions of only those who live in developed countries that have the technologies shown. By referring to the images, the text successfully connects the actions of developed countries with climate change.

Intertextuality was used to consider the ways the curriculum ties the question of Who is affected? with specific individuals. In the slides that accompany the third session,
the first slide works in partnership with the slide described above. While the slide for session 2 is entitled *What is responsible?* and shows images of six human actions, the first slide for session 3 is entitled *Effects of Climate Change* and again shows six images. However, the *Subjects* of each of the images is a human dealing with the impacts of climate change. These images are included in small versions on slide 17, in full images on slides 18 through 23 (Oxfam Education 2016a) and in small images on the student handout (Oxfam Education, 2016g, p. 5-6). They are described in Table 29.

The table includes quotations that connect the impacts of extreme weather conditions that have increased in frequency along with the increase of carbon emissions. With *Intertextuality*, these images connect climate change with impacts and individuals. Both the *Cohesion Tool* and the *Topic Chaining Tool* show how this is accomplished by the text. Without using cohesion words such as *therefore* and *because*, the text creates cohesion by chaining together the topics in the sentences and the subjects in the images.

The captions begin with the topic, which is the person impacted, and the images themselves hold the topic of the individual being impacted and show the impact. Then the surrounding text discusses further impacts that chain on ideas and terms such as *climate change*, *rising sea waters*, and *the typhoon*. Using Gee’s *Context is Reflexive Tool*, the text was considered for how it creates, shapes, and manipulates what the listener takes as relevant context. Similar quotations, captions, and images are presented six times in the session. Within that context, the text stresses the relevance of the extreme weather events with their effects and ultimately with individuals who are impacted. In contrast with the images of the causes of climate change, these new pictures put a human face on those impacted. By asking what the text is *Doing and Not Just Saying*, the
curriculum functions to remove the student, who is in the position of activist and empathizer, from the images of causing climate change while simultaneously providing an image and personality for the millions of people impacted the most by climate change.

Table 29

*Oxfam: Quotations Connecting Climate Change, Impacts, and Individuals*

Image descriptions and captions as well as accompanying text:

Women traveling with donkeys across a desert: “Women collecting water with their donkeys in the Somali region of Ethiopia. Many people in this area have to walk for up to half a day to find water.” “Climate change is likely to affect freshwater supplies in many parts of the world” (Oxfam Education, 2016g, p. 5).

A woman wading through waist-high water with stick and plastic wrapped shelters flooded in the background. “A woman walks through flooded land in Bangladesh to get back to her home.” “Many places in the world are at risk from rising sea levels. Bangladesh is particularly vulnerable. It regularly experiences severe tropical storms and large areas of the country are low-lying” (p. 5).

A young man standing in thigh-high water holding rope and metal in gloved hands: “Joel used to be a fisherman. He lost his home, boat and fishing equipment to Typhoon Haiyan. Now he earns a living selling scrap metal he finds along the shore.” Following Typhoon Haiyan, “Nearly three quarters of fishing communities have been severely affected, with 30,000 boats damaged or destroyed. The typhoon also damaged mangrove forests and coral reefs which are important fish spawning grounds.” (p. 6).
By conducting an analysis of the *connections* made by the Oxfam curriculum, the text was found to further confirm the hypothesis formed by analyzing the PreSEES and NEED curriculums and other aspects of the Oxfam curriculum. Based on the connections made by the Oxfam curriculum, it was found to elevate the significance of a specific aspect of the socioscientific topic of climate change. Namely, the connections made function to narrow the topic to its impacts, and specifically, to ways they affect the individuals living in developing countries. The connections also influenced the reader’s worldview regarding the various actions of developed countries that most impact climate change.

Table 30

*Oxfam: Analysis Tools Applied and Findings: Connections*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intertextuality</td>
<td>Topic and Theme</td>
<td>Connects climate change with human actions and impacts on humans.</td>
</tr>
<tr>
<td></td>
<td>Cohesion</td>
<td>Connects climate change with actions of developed countries</td>
</tr>
<tr>
<td></td>
<td>Subject</td>
<td>including those not commonly identified by students such as electricity and food production.</td>
</tr>
<tr>
<td>Reflexive Tool</td>
<td>Doing/Not Just Saying</td>
<td>Connects climate change with extreme weather, its impacts, and individuals in developing countries.</td>
</tr>
</tbody>
</table>
Based on the analysis of all three curricula, a final hypothesis was found and confirmed for the first research question: In intermediate science curricula and texts, how does discourse function to present socioscientific issues? The final hypothesis is: In intermediate science curricula and texts, discourse is employed to elevate or deemphasize the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with that specific worldview. A summary of the findings of the three critical discourse analyses conducted on the PreSEES, NEED, and Oxfam curricula to answer the first research question are fully considered in chapter 7.
CHAPTER 5

RESEARCH QUESTION TWO FINDINGS:
TREATMENT OF SCIENTIFIC LITERACY

The second research question considered by this dissertation was: In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy? The following analysis considers how each of the three curricula present and develop Vision II scientific literacy. The descriptors of a Vision II scientific literacy were originally presented in chapter 2, but they are found again in Table 31. To find areas of analysis in each of the three curricula, the texts were searched for opportunities for the development of these skills, missed opportunities for their development, or the development of opposite skills. All three were analyzed for the Practices (Activities) they engage in. Additionally, each was analyzed for the Significance they place on scientific literacy. Finally, the PreSEES and Oxfam curricula were both analyzed for the Identity they develop for the reader and the NEED curriculum was analyzed for the connections or disconnections it makes.

The two curricula that elevated the significance of the socioscientific issue of climate change were found to promote the development of Vision II scientific literacy by elevating its significance, engaging students with its practices, and developing a student identity engaged with its terminology and activities. Conversely, the NEED curriculum, which deemphasized the socioscientific issue of climate change was found to suppress the development of Vision II scientific literacy by elevating the significance of the
curriculum as expert, disconnecting scientific literacy skills from the instruction, and by developing a student worldview that does not expect to engage in scientific literacy skills.

Table 31

Descriptive of Vision II Scientific Literacy

<table>
<thead>
<tr>
<th>Understand Socioscientific Issues by</th>
<th>making decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>analyzing information</td>
</tr>
<tr>
<td></td>
<td>applying moral and ethical reasoning</td>
</tr>
<tr>
<td>Exposure to and practice of habits of mind such as:</td>
<td>being skeptical</td>
</tr>
<tr>
<td></td>
<td>accepting ambiguity</td>
</tr>
<tr>
<td></td>
<td>expecting data-driven knowledge</td>
</tr>
<tr>
<td>Know and use epistemology of science to judge scientific claims through</td>
<td>evidence</td>
</tr>
<tr>
<td></td>
<td>inference</td>
</tr>
<tr>
<td></td>
<td>conclusions</td>
</tr>
</tbody>
</table>

PreSEES Global Warming Socioscientific Unit

The following section includes the analysis of the PreSEES unit based on practices (activities), significance, and identity.

Practices (Activities)

The first way to analyze how the discourse of the PreSEES Global Warming unit presents scientific literacy is to consider how it engages with the practice of scientific literacy. Gee (2011a) explains that a practice is a “socially recognized and institutionally or culturally supported endeavor that usually involves sequencing or combining actions
in certain specified ways” (p. 17). Based on his definition, the process of teaching *Vision II* scientific literacy is a practice, and there are several ways to analyze the text and determine the extent to which it promotes or downplays the teaching of scientific literacy.

The analysis first uses Gee’s (2011a) *Discourse Tool*. Gee uses the term *Discourses*, with a capital D to analyze “the ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing, and using various symbols, tools, and objects to enact a particular sort of socially recognizable identity” (p. 29). This tool can be used to analyze a text for the presence of the specific ways in which scientific literacy is discussed. In other words, the tool asks what is used to promote scientific literacy, which is made up of vocabulary, phrases, and styles of discussion. This analysis will first consider which terms and processes commonly used in the Discourse of scientific literacy are present in this curriculum.

First, the terminology used by the curriculum aligns with the *Discourse of scientific literacy*. Prior to slide 5, the curriculum does not use vocabulary specifically aligned with the scientific habits of mind mentioned above. Then at slide 5, the *Vocabulary* suddenly changes to include the terms: *information, data, arguments, sources,* and *documents* (PreSEES, 2014b). On slides 6 and 7 and the worksheet 1.2, the terms *analyze, explain, source type, analysis, evidence,* and *conclusion* are added (PreSEES, 2014c). These terms function to demonstrate that the curriculum is engaged in the practice of building scientific literacy.

However, these terms could be used to mimic the *Discourse of Vision II* scientific literacy, if they were not accompanied by opportunities for students to actually practice them. Therefore, it is important that the *Discourse* of the curriculum also demonstrates
its alignment with the practices of scientific literacy through the activities the students are
asked to complete. The ways in which these activities are highlighted can be analyzed
with Gee’s *Integration Tool* and *Topic and Theme Tool*. The first activity that builds
*Vision II* scientific literacy is found on the Power Point that accompanies the lesson
(PreSEES, 2014b, slide 5). The text is presented in Table 32.

Table 32

*PreSEES Global Warming SSI Unit: Content of Slide 5*

<table>
<thead>
<tr>
<th>Title Question: “Let’s look for info about the topic”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directions: “Divide the class in 2 groups. Each group should find the following information on the internet:”</td>
</tr>
<tr>
<td>Point 1: “Group 1: In favor of global warming as caused by human activity”</td>
</tr>
<tr>
<td>Point 2: Same as above with the ending “…as a natural process”</td>
</tr>
<tr>
<td>Sub-point 1 and 2 A: “General data regarding global warming: what is it? Is the planet warming or not?” (same for both groups)</td>
</tr>
<tr>
<td>Sub-point 1 and 2 B: “Data or arguments in favor of global warming as caused by human activity.” (same for both groups except that <em>in favor</em> is replaced with <em>against</em>)</td>
</tr>
<tr>
<td>Sub-point 1 and 2 C: “Data or arguments from different sources (scientists, ecologists, politicians, industrialists,… etc.)” (same for both groups)</td>
</tr>
<tr>
<td>Final Directions: “You will need to bring the information/documents found in order to discuss them in class.”</td>
</tr>
</tbody>
</table>
On Slide 5, the sub-points require the students to use *data or arguments* to present the research they found regarding the causes of global warming. Even though sub-points B and C are not full sentences, the clauses foreground the words *data or arguments*. Doing so makes those words the theme of the clauses and therefore the focus of the point is the collection of data and the formation of arguments. Sub-point C also requires the students to collect data from different sources. Based on the final directions, the students are required to research one of the two stances regarding the cause of global warming and then share their research and hear the research collected by others.

Worksheet 1.2 is used to collect that data, and it uses the Discourse of scientific literacy in several ways (PreSEES, 2014c, p. 2). In question two, the students must record the credentials of the authors, consider the type of source used, and classify each argument as being based on either evidence or opinion. On slide 7, which gives the directions for worksheet 1.2, the title question asks, “What have you found about global warming?” and is followed by the sub-title, which says, “Analysis of the information found” (PreSEES, 2014b). The activities on slides 5 and 7 as well as the areas for recording work found on worksheet 1.2 can be viewed as one *Stanza* of information, and therefore, those areas function as one.

By using the *Fill In Tool*, the text can be analyzed for the inferences the readers have to make in order to fully understand the directions. By being asked to include the argument as well as the author, source type, and the evidence upon which the argument is formed, the reader can fill-in the importance of analyzing and evaluating the information he or she has researched. Doing so engages the reader in *Vision II* science literacy skills. This portion of the lesson can also be analyzed by considering what the text is *Doing and*
Not Just Saying. The text is telling the readers what steps to follow, but by doing so, it is stressing the importance of engaging with research in a specific way.

On worksheet 1.2 the first question asks: “With the information you have found, how do you explain what is global warming? Is the planet warming or not?” (PreSEES, 2014c, p. 2). By placing the prepositional phrase at the beginning of the sentence into the Topic space, the sentence structure functions to prioritize the importance of using the information that has been researched. Then in question 3, students are asked to use their research data to evaluate the arguments they have researched and explain why they believe they are strong arguments.

Through the requirement of including data as well as author and sources, the curriculum creates a context in which the students can tell what they should identify as good arguments. Those things which make for a good argument will stand up to all the requirements of the assignment. The author and source will have credentials that identify them as experts, and the argument will be based on evidence as opposed to opinion. Using the Making Strange Tool, the text was analyzed from the viewpoint of what a student may think of as a good argument if they were not given the scaffolding of the tables on worksheet 1.2 that require them to consider the author, source, argument, and evidential basis. Without those guidelines, an outsider would be left wondering how they are supposed to know the parameters for a good argument. By guiding the students through the process, the text defines the elements of a good argument and gives students opportunities to consider and evaluate arguments.

One final aspect of slide 7 can also be analyzed for the way in which it engages the reader with the Practices of Vision II scientific literacy. The directions on that slide
say, “In groups of 4-5 experts, share the information (data, arguments, etc.) you have found about global warming and analyze it using Worksheet 1.2” (PreSEES, 2014b, slide 7). Using the Integration Tool, the introductory phrase can be analyzed for being placed into the Topic position. The focus of the directions is on the groups, or collaborative nature, and the experts, meaning the expertise gained by the students through engaging with data in a critical manner. Not only do the directions focus on the importance of engaging collaboratively as an expert, but the accompanying activity also requires the students to work together within a heterogeneous group filled with those who are experts on the arguments that are both for and against the idea of humans making an impact on global warming. Through both using the terminology and the activities of a specific Discourse, the PreSEES curriculum functions to engage students in the Vision II scientific literacy practices.

After analyzing the PreSEES curriculum for the ways in which it functions to engage students with the practices (activities) of Vision II science literacy, a preliminary hypothesis can be written as a response to the second research question. However, since this curriculum was found in the analysis for the first research question to elevate the significance of the socioscientific issue, the hypothesis needs to reflect that aspect. Therefore, a specific and preliminary hypothesis is formed: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of Vision II scientific literacy through the use of both applicable terminology and activities.
Table 33

*PreSEES: Analysis Tools Applied and Findings: Practices (Activities)*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Vocabulary</td>
<td>Text engages students in the practice of <em>Vision II</em> scientific literacy by integrating specialized vocabulary</td>
</tr>
<tr>
<td>Integration Tool</td>
<td></td>
<td>Engages students with practices</td>
</tr>
<tr>
<td>Topic and Theme</td>
<td></td>
<td>that focus on data and arguments.</td>
</tr>
<tr>
<td>Stanza</td>
<td></td>
<td>Ties together the scientific literacy skills of researching, analyzing, and evaluating data and arguments and provides opportunities for students to use those skills.</td>
</tr>
<tr>
<td>Making Strange</td>
<td></td>
<td>Defines the practices associated with good arguments</td>
</tr>
<tr>
<td>Integration Tool</td>
<td></td>
<td>Engages students with <em>Vision II</em> practices.</td>
</tr>
</tbody>
</table>

Significance

The way scientific literacy is presented by this socioscientific curriculum can also be analyzed by considering the ways the discourse is used to increase or decrease the significance of scientific literacy. The most obvious evidence of this text increasing its significance is through the sheer volume of ways in which it is practiced. The inclusion
of these activities creates and invites readers into a *Figured World* in which engaging
with argumentation and data in a critical manner is normalized. Those practices in which
the students are engaged in this curriculum were the focus of the last section of analysis.
Of the four activities given to the students, all but the first one engage students in
processes that build scientific literacy. Specifically, from slide 5 to the end of the
curriculum, every slide includes the *Vocabulary* of *Vision I* scientific literacy based on
Rogers’ (2007) classification. This is evident through the action verbs found in the titles
and subtitles of those slides: *look for info, analysis, seen, make recommendations, reflect, elaborate, find, do, make decisions* (*PreSEES*, 2014b). Each portion engages students in
active processes that build scientific literacy. By applying the *Doing and Not Just Saying
Tool*, the heavy use of *Vision II* scientific literacy skills demonstrates that the text is
engaged in the process of building the significance of these skills and the importance of
using them to further investigate a socioscientific issue.

Even in the first lesson, before the students are directly engaged with activities
designed to increase the skills of scientific literacy, the discourse takes on the *Social
Language of Vision II* scientific literacy and in doing so functions to increase its
significance. Early in the unit, question 4A asks the students to share their opinion about
global warming. Question 4B then asks, “What do you base it on?” (*PreSEES*, 2014b,
slide 4). Applying the *Why This Way and Not That Way Tool*, the analysis can consider
the difference between asking *what* and asking *if*. By asking *what* the opinion is based
upon, as opposed to asking *if* the opinion is based on specific information, the text
functions to build the idea that an opinion should and even must be built on some type of
information or life experience. Reading these questions aloud helps apply the *Intonation
Tool to these questions. When read aloud, the matter-of-fact, taken-for-granted tone functions to normalize the necessity of building an opinion on some type of evidential base. Therefore, even in this first activity, this question functions to promote the significance of scientific literacy by suggesting that all opinions must be accompanied with reasons. The Social Language of Vision II scientific literacy is also present in the Vocabulary, specifically action verbs, identified above, which are found throughout all four activities. As previously mentioned, the use of this social language along with the application of the skills indicates that the text is authentically adopting the social language and therefore elevating the significance of scientific literacy.

One final way to document how the discourse functions to increase the significance of scientific literacy is to use the Integration Tool and consider the times the text places a process of scientific literacy into the theme, the first section, of the sentences in the materials. For example, Worksheet 1.2, question 1 begins with the theme, “With the information you have found” (PreSEES, 2014c, p. 2). This sentence structure pulls the attention of the reader to the role the information needs to play when they write their definition of global warming. On slides 7 and 8, the directions given to the students all start by referencing the groups the students are working in: “In groups of 4-5 experts,” “Working in heterogeneous groups,” “In heterogeneous groups of four people (two from each panel),” and “In the same group of experts you have worked (sic).” Each of these sentences focuses on the group by mentioning it before the topic of the sentence. By doing so, the discourse functions to increase the significance of the group work and the role of collaboration in scientific endeavors. Doing so adopts the vernacular of scientific literacy while simultaneously connecting that language to the actions of the students and
pulling the actions to the forefront. Doing so increases the *Significance* of *Vision II* scientific literacy.

### Table 34

**PreSEES: Analysis Tools Applied and Findings: Significance**

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured Worlds</td>
<td>Vocabulary</td>
<td>Includes a large volume of activities that normalize scientific literacy skills.</td>
</tr>
<tr>
<td></td>
<td>Doing/Not Just Saying</td>
<td></td>
</tr>
<tr>
<td>Social Language</td>
<td>Why This Way/Not That</td>
<td>Elevates significance and normalizes need to have evidential basis for opinions.</td>
</tr>
<tr>
<td></td>
<td>Intonation Tool</td>
<td>Integrates social language with scientific literacy skills, which demonstrates authentic engagement with scientific literacy.</td>
</tr>
<tr>
<td>Integration</td>
<td></td>
<td>Elevates significance of collaboration as a scientific literacy skill.</td>
</tr>
</tbody>
</table>

After analyzing the PreSEES curriculum for how it elevates or deemphasizes the *significance* of *Vision II* scientific literacy, the text was found to both validate and narrow the hypothesis for the second research question. Specifically, the significance of scientific literacy was elevated through the process of normalizing the skills practiced
with *Vision II* scientific literacy. Therefore, the new hypothesis now reads: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of *Vision II* scientific literacy through the normalization and use of both applicable terminology and activities.

Identity

*Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) explains that by the end of fifth grade, students should understand that science is an activity all people can take part in, that it requires clear communication, and that scientists do not take seriously claims that are not backed up with evidence that can be confirmed. This understanding is based on the descriptors of *Vision II* scientific literacy. The final way to analyze the PreSEES curriculum for its presentation of scientific literacy is to consider the social, recognizable *Identity* the writer is trying to enact or invite the readers to take up. The identities built for the students in this discourse work to support the elements of *Vision II* scientific literacy.

First, the text invites the reader to become a part of a *Figured World* by taking up a common identity with the author and other scientists. The way the text accomplishes this can be analyzed by considering the *Diexis*, pointing words including pronouns, used and their position as the *subjects* in sentences. The sentences analyzed in this section are collected in Table 35.

When analyzing the pronouns used, the text is better understood by questioning the assumptions the author is making or the assumptions the author is inviting the reader to make. The pronouns found in title questions on slides 5, 9, 11, and 12 indicate that the work is done together as a collaborative group. The curriculum uses the pronouns *us* and
we. Additionally, the previous section analyzed the importance of the sentences that foregrounded the groups as the theme. These same clauses function to build the identity of the students as members of those groups. Through the use of plural pronouns and collaborative groups, the text builds a socially constructed community that collaboratively builds scientific literacy skills, and it invites students to assume membership in that community.

Table 35

*PreSEES Global Warming SSI Unit: Uses of Groups/Group Pronouns*

“…we can see that there are different actors…” (PreSEES, 2014b, p. 4).

“Let’s look for info about the topic” (p.4).

“In groups of 4-5 experts, share the information (data, arguments, etc) you have…” (p. 7).

“In heterogeneous groups four people (two from each panel), put together…” (p. 8).

“What have we seen in the activity” (p. 9)?

“Let’s make recommendations” (p. 11).

“You are scientific experts and you have to make recommendations” (p.11).

“In the same groups of 4 (heterogeneous groups), you have to:…” (p. 12).

In addition to building a student identity that allows them to see themselves as collaborative scientists, this discourse also functions to build identities by aligning the reader with the *Conversations* of scientific literacy. The *Conversation* regarding *Vision II* scientific literacy revolves around the issue of what skills and mind sets an individual must possess in order to be a functioning member of a democratic society. Considering
the *Doing and Not Just Saying Tool*, the PreSEES curriculum functions to place students into the *Conversation* that expects them to practice and build *Vision II* scientific literacy skills. Throughout the curriculum, students are expected to practice the skills, share their opinions, and defend their positions. By engaging them in these activities, the curriculum gives them opportunities to build *Vision II* scientific literacy, but it also teaches them to expect those opportunities. Additionally, the curriculum invites them into the *Conversation* about *Vision II* scientific literacy by referring to them as *experts* and by giving them the opportunity to make recommendations about climate change policy (PreSEES, 2014b, p. 7, 11-12). However, the students are only referred to as experts and asked for their recommendations after they have learned information through research. In this way, the discourse supports the *Conversation* regarding *Vision II* scientific literacy, and invites the students to be a part of that *Conversation*, thereby building their identity as a scientifically literate citizen.

By analyzing the *Identities* built by the curriculum, the text was found to place students within the community of and conversation about scientific literacy.

Additionally, it encourages students to adopt an identity that expects participation in scientific literacy experiences. Based on the *Identity* the curriculum forms for the students, the hypothesis can be further solidified and narrowed: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of *Vision II* scientific literacy through the normalization and use of both applicable terminology and activities and the building of a student worldview that expects future practices and applications of scientific literacy skills.
Table 36

*PreSEES: Analysis Tools Applied and Findings: Identity*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured Worlds</td>
<td>Diexis</td>
<td>Students and authors are members of a socially constructed mental Community engaged in the building of scientific literacy skills.</td>
</tr>
<tr>
<td></td>
<td>Subjects</td>
<td></td>
</tr>
<tr>
<td>Conversation</td>
<td>Doing/Not Just Saying</td>
<td>Curriculum gives students opportunities to build scientific literacy skills and teachers them to expect those opportunities.</td>
</tr>
</tbody>
</table>

**NEED Elementary Energy Infobook and Elementary Energy Infobook Activities**

In the analysis for the first research question, the NEED curriculum was found to function in the same ways as the PreSEES and Oxfam curriculum in that it narrowed the issue to a specific worldview and developed an identity for the readers that engaged them with that specific worldview. However, the NEED curriculum functioned in those ways to deemphasize the significance of the socioscientific issue of climate change, whereas the other two raised its significance. Because of this difference, the preliminary hypothesis for the second research question was specifically written in reference to a curriculum that elevated the significance of the socioscientific issue. The analysis of the NEED curriculum for its treatment of *Vision II* scientific literacy will strive to determine
if a correlation exists between the treatment of the socioscientific issue and the
development or suppression of Vision II scientific literacy skills.

Practices (Activities)

NEED’s Elementary Energy Infobook identifies itself as a resource of information regarding energy and energy sources. As such, it would not necessarily be expected to provide opportunities for the building of Vision II scientific literacy skills. However, it also says, “Infobooks can be used as a resource for many activities” (NEED, 2016d). Since NEED has created an accompanying book entitled Elementary Energy Infobook Activities, that book was considered as a part of the curriculum. The practices used to regard scientific literacy can first be analyzed by considering the Social Languages used by the texts. Both books have the same statement near the front that alludes to the function of the books to align with standards that build Vision II scientific literacy. “This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum” (NEED 2016d, p. 4; NEED 2016e, p. 4). The texts take on the social language of science education and the value it places on scientific literacy by using the vocabulary associated with the Next Generation Science Standards. By suggesting that the books meet performance expectations and science and engineering practices, the text functions to connect itself to the processes necessary to build scientific literacy. Also, by using the term activities to refer to the work present in the Elementary Energy Infobook Activities text, the authors have used a specific pedagogical term that mimics the work of science education.

Performance, practices, and activities are a part of the vernacular of science education
and signal a connection with science practices and habits of mind. Therefore, the first practice the curriculum is engaged with is one of associating itself with that social language.

Of the 23 activities in the book, only one was found to develop Vision II scientific literacy skills. Two others were identified as activities that could be adapted by the teacher in a manner that develops Vision II scientific literacy. Those will be discussed in the next section. Beyond those four activities, the others provide opportunities for students to directly apply the vocabulary learned in the Elementary Infobook with either matching, filling-in-the-blank, or completing crossword puzzle activities that only require direct recall. Before analyzing these activities, it is important to clarify that by using the lexicon of science pedagogy in the absence of those practices, Gee’s social languages tool would identify this curriculum as a mimic of the actual social language. By using the terminology without authentic opportunities for skills practice, the curriculum is trying to legitimate itself.

The activities found in the curriculum can be analyzed by considering their Intertextuality, which questions the ways in which one text refers to another or borrows a social language to disguise itself. In the case of the NEED curriculum, the Elementary Energy Infobook Activities refers solely to its companion text, and pulls sentences, terms, and definitions verbatim. An example fill-in-the-blank sentence reads, “Coal is ___________; you can’t make more in a short time” (NEED, 2016e, p. 11). One of the matching activities requires students to connect the name of the type of energy to the image of the icon used by NEED to represent it (p. 20). Finally, minute details from the
Elementary Energy Infobook are included such as, “Coal is moved by __________ and __________” (p. 11). The expected answers are trains and barges.

Using the Fill In Tool, these activities can be analyzed for what the students have to fill in or what the authors are assuming the students will fill in in order to make the text clear. In this case, and to perform well on the activity, students would quickly infer that there is only one correct answer to each question and that the answer must be found directly in the text. If the Making Strange Tool is applied, the definitions and answers to the questions would not be evident to an outsider who had not read the original text. By engaging the students with assessments that require a specific response that comes from one source, the curriculum functions to establish itself, through Intertextuality, as the sole expert on the subject. Also, because the curriculum uses the vernacular of science and science education, it functions to legitimize the knowledge it presents by mimicking the social language of science education.

The one activity that directly functions to build Vision II scientific literacy skills are some the Critical Thinking Questions (NEED, 2016e, p. 8). These 14 questions are found on one page of the Elementary Energy Infobook Activities text. Seven of the questions can be categorized as not requiring critical thinking since they are actually constructed responses that require recall or basic application. For those questions, the answer is available in the text. For example, these questions ask students to draw and label diagrams, trace the path of electricity, or add words to one of the crossword puzzles and write clues for them. Two of the questions require critical thinking, but do not have the potential to build Vision II scientific literacy, so they have been removed. The remaining questions are presented in Table 37.
Table 37  

*NEED: Critical Thinking Questions that Build Scientific Literacy Skills*

Energy does a lot for us. Which of its job do you think is the most important? Why?

Do you think people mining for coal should have to use reclamation on the land? Why or why not?

Two drops of water meet in a cloud. They start talking about their last trip to Earth. One went through a hydropower plant. The other helped provide water for wheat to grow. They got into an argument over who did a more important job. Write a dialogue between the two water droplets.

Explain how you use petroleum in your life. Can you reduce the amount of petroleum you use? How?

The radiation from nuclear fuel can be dangerous if not taken care of properly. Describe at least two other things that can be dangerous if not taken care of properly.

These questions can first be analyzed for the *practices* they normalize. By placing the critical thinking questions in one isolated area, separate from the text, the curriculum creates a *Figured World* for itself as well as the reader that identifies critical thinking as a separate activity that does not take place as an individual learns and assimilates new information. By applying the *Cohesion* tool, the isolation of these questions can be analyzed as a way of breaking a connection between the information given by the *expert* in the *Elementary Energy Infobook* and the application and manipulation of that information by the student. The curriculum functions to remove the
ideas of the student from those of the expert, and in doing so fails to provide the opportunity for the students to see themselves as scientific thinkers.

Finally, these critical thinking questions continue to promote the Discourses of Consumptionism, which was discussed previously in relation to the NEED curriculum. Phrases such as *Energy does a lot of for us* and *Can you reduce the amount of petroleum you use*, place students within a Discourse that normalizes the amount of energy they use and the many ways in which they use it. By mixing that Discourse with opportunities to consider ethical and moral issues, which is one of the Vision II scientific literacy skills, the curriculum functions to bias the reasoning of the students and to connect their energy consumption with their decision making and reasoning. This mixture will be more fully analyzed in the next section, but for purposes of Practices, the mixing of the Discourses function to dilute the opportunity to practice applying moral and ethical reasoning to a socioscientific issue.

After analyzing the NEED curriculum for the Practices it engages in with its handling of the development of Vision II scientific literacy, the curriculum was found to further confirm a mirrored version of the hypothesis. When the curriculum uses the terminology of science pedagogy for the development of scientific literacy, it is accompanied with few opportunities for authentic practice. By normalizing one right answer, creating an expert/novice hierarchy between the curriculum and the students, and mixing biased Discourses with opportunities to build scientific literacy, the NEED curriculum functions to suppresses or under develop the scientific literacy of the students.
Table 38


<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>Engages in practice of mimicking the social language of science pedagogy in order to legitimize its treatment of scientific literacy.</td>
</tr>
<tr>
<td>Intertextuality</td>
<td>Fill In Tool</td>
<td>Establishes the curriculum as the expert, normalizes questions with one right answer.</td>
</tr>
<tr>
<td>Figured World</td>
<td>Cohesion</td>
<td>Separates critical thinking from learning. Creates expert/novice dichotomy with curriculum and students and thereby fails to support students as scientific thinkers.</td>
</tr>
<tr>
<td>Discourse</td>
<td></td>
<td>Dilutes the opportunity to apply moral and ethical decision making about the socioscientific issue by mixing in bias of Discourse of Consumptionism.</td>
</tr>
</tbody>
</table>

Therefore, a second sentence has been added to the hypothesis: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse
is employed to promote the development of Vision II scientific literacy through the normalization and use of both applicable terminology and activities and the building of a student worldview that expects future practices and applications of scientific literacy skills. However, in intermediate science curricula and texts that deemphasize the significance of socioscientific issues, discourse is employed to suppress or under develop the Vision II scientific literacy through the normalization of right answers and the building of a student worldview that expects few or biased practices and applications of scientific literacy skills.

Connections

The critical thinking questions analyzed above for the way in which they helped the curriculum achieve specific Practices or Activities, can also be analyzed for the Connections found in them and the ways in which those Connections impact the curriculum’s building or suppression of students’ Vision II scientific literacy skills. These critical thinking questions can be analyzed as scientific literacy skill-building opportunities by analyzing them for the way in which they either are or are not connecting with the Conversation regarding Vision II scientific literacy. As previously detailed in chapter 2, a Conversation exists within the science and science education communities regarding the definition of scientific literacy and the skills it entails. One way to evaluate this curriculum’s treatment of scientific literacy is to evaluate the extent to which it embraces that Conversation.

For example, giving students the opportunity to understand socioscientific issues by making decisions and applying moral and ethical reasoning toward them would align the curriculum with the scientific literacy Conversation. The critical thinking questions,
listed above in Table 27, that require students to consider land reclamation after coal mining, water use for hydropower or irrigation, and petroleum use reduction all engage students in the decision-making skills mentioned above. However, the curriculum does not build in, through either directions or specifics in the questions, the Vocabulary of Vision II scientific literacy. The questions do not direct the students to use evidence or analyze and apply information to their decision making, both of which are scientific literacy skills. Since the students do not engage with any research when responding to these questions, they also do not have the chance to practice other scientific literacy skills such as expecting data-driven knowledge, being skeptical, making inferences, or drawing conclusions. By not placing suggestions of research and evidence application into the critical thinking questions, the curriculum fails to create Cohesion between the questions being asked and scientific literacy skills. Through their exclusion, the curriculum functions to create Cohesion between socioscientific issues and unsubstantiated student opinions. The failure to form a Connection between the need for research and data and decision-making about socioscientific issues is an action of the curriculum that suppresses the development of students’ scientific literacy skills.

While the critical thinking questions were the only activity that functioned in any way to build Vision II scientific literacy skills, there were two other activities that could be used to develop scientific literacy skills. The Renewable or Nonrenewable 2 activity provides a table of information from the United States Energy Information Administration that includes U.S. energy consumption based on source type for the year 2013. The sources are divided into renewable and nonrenewable source types. The students are asked to, “Calculate how much of the energy we use in the U.S. comes from
renewable energy sources. Calculate how much comes from nonrenewable sources” (NEED, 2016e, p. 24). Then the students are asked to create a pie chart with the data. The resulting work requires students to find that nonrenewable sources account for 90.5% of U.S. consumption and renewable sources make up 9.4%. The next activity, Where We Get the Energy We Use, lists the same data table, which is organized with nonrenewable sources on the left and renewable on the right (NEED, 2016e, p. 25). The sources are also listed from largest to smallest from top to bottom. In both data tables, the uses for each type of energy source are also included.

These activities can be analyzed first for the scientific literacy skills they build. While students are not required to use the information for making inferences or drawing conclusions and while they are not asked to use the data as evidence for an argument, the activities could be used in those ways. However, by not requiring students to interact with or interpret the data, the curriculum functions to develop a Figured World in which the participants, in this case students, interact with data for the sole purpose of presenting it in a graph. The Cohesion and Subject tools can be applied to understand that the focus, or subject, is the larger and more significant role of nonrenewable energy sources. By tying nonrenewable sources with the larger percentages portion of the pie graph, and taller bars on the graph, the text further constructs a Figured World in which their use is normalized. The absence of any opportunity to analyze, question, or be skeptical of the data also further disconnects data and evidence from the socioscientific issue and normalizes for students the expectation that data is not to be questioned or interpreted. Through disconnecting these concepts, the curriculum further suppresses scientific literacy development.
Table 39

NEED: Analysis Tools Applied and Findings: Connections

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversation</td>
<td>Vocabulary</td>
<td>Disconnects the curriculum from the building of scientific literacy skills, detaches the formation of opinions about socioscientific issues from the need for research and data.</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Cohesion</td>
<td>Creates connections that normalize the use of nonrenewable energy sources. Normalizes, for students, that data should not be questioned or interpreted.</td>
</tr>
</tbody>
</table>

An analysis of the Connections, which also includes disconnections, accomplished by the NEED curriculum demonstrate that the text functions to suppress the development of Vision II scientific literacy. This is accomplished by disconnecting the practices and skills of scientific literacy from engagement with opinion formation, data, and socioscientific issues. Through this analysis, the hypothesis is both confirmed and narrowed: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of Vision II scientific literacy through the normalization and use of both applicable terminology and
activities and the building of a student worldview that expects future practices and applications of scientific literacy skills. However, in intermediate science curricula and texts that deemphasize the significance of socioscientific issues, discourse is employed to suppress or underdevelop the *Vision II* scientific literacy through the normalization of *right* answers, the disconnection of scientific literacy skills and science instruction, and the building of a student worldview that expects few, biased, or non-authentic practices and applications of scientific literacy skills.

Significance

The NEED curriculum was finally analyzed for the ways in which it uses discourse to build up the *Significance* of *Vision II* scientific literacy skills. Based on the analysis of the *Elementary Energy Infobook Activities* completed in the previous sections, only one activity presents an opportunity for students to develop some scientific literacy skills. Additionally, many activities function to suppress the development of those skills. However, the absence of building scientific literacy skills is not enough evidence to demonstrate that the curriculum functions to lessen the significance of the skills. To determine if the text builds up, lessens or demonstrates indifference toward the significance of building scientific literacy skills, the text was analyzed for the ways in which the discourse had the opportunity to build those skills but did not. Based on *Vision II* scientific literacy skills, the text was first searched for places where activities could be added that allowed students to collect evidence and data and make inferences and conclusions based on that information. Several opportunities for such activities are present in the *Elementary Energy Infobook*. The discussion or direct quotation along
with the possibility of an activity that would build scientific literacy are presented in Table 40.

Table 40

**NEED: Opportunities for Activities for Building Scientific Literacy Skills**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Measurable Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>“In the winter, our jackets and blankets hold in our body heat” (NEED, 2016d, p. 6).</td>
<td>Temperature inside, outside jackets.</td>
</tr>
<tr>
<td>Discussion of how energy makes things grow and definition of photosynthesis. (p. 6)</td>
<td>Growing of plants with changing variables.</td>
</tr>
<tr>
<td>“Wind was the first energy source used for transportation” (p. 9).</td>
<td>Engineering of vehicles moved by wind.</td>
</tr>
<tr>
<td>Discussion of windmills and water wheels to pump water and run sawmills. (p. 9)</td>
<td>Experimentation with gear size and rotation ratio.</td>
</tr>
<tr>
<td>“Oil can pollute soil and water, harming the animals that live in the area. Oil companies work hard to drill and ship oil as safely as possible. They try to clean up any oil that spills” (p. 21).</td>
<td>Cleaning spilled oil.</td>
</tr>
<tr>
<td>Discussion of solar panels and solar cells. (p. 25)</td>
<td>Measurement of energy from cells.</td>
</tr>
<tr>
<td>Discussion of electromagnets and generators. (p. 32).</td>
<td>Engineering of both.</td>
</tr>
</tbody>
</table>
The Discourse of science pedagogy values specific actions and activities. The measurable activities, mentioned in Table 40, are only a few of the possible engineering and science inquiry activities that would result in measurable data that would build scientific literacy. By creating an activity book that does not include or mention the possibility of engaging in this way with the science of energy, the curriculum has not enacted the socially recognizable Discourse of science education. By applying the Context is Reflexive Tool, the text can be analyzed by asking how it is creating, shaping, or manipulating the things the reader identifies as relevant. Since opportunities for the addition of activities that build scientific literacy skills are found throughout the text, and those opportunities are never approached, the curriculum communicates to the students that engaging in such Discourse is not relevant. Additionally, by diminishing the relevance of such activities, the curriculum functions to reproduce similar contexts and normalize the absence of such activities in other science curriculum.

Similarly, the curriculum was searched for places where socioscientific issues could have been approached from a decision-making, analysis, or moral or ethical reasoning perspective. Some, but not all of the direct quotations or discussions, as well as the socioscientific opportunities they address are summarized in Table 41.

---

Table 40 - continued

“The electrons flow though the power lines to our houses. They flow through the wires in our houses and back to the power plant. Then they start their journey again” (p. 33).
Table 41

**NEED: Opportunities for Building Scientific Literacy Through SSI**

<table>
<thead>
<tr>
<th>Curriculum Discussion</th>
<th>Socioscientific Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Today, electricity is a part of almost everything we do. We use more every year” (p. 9).</td>
<td>Energy use and conservation</td>
</tr>
<tr>
<td>In discussion of biomass as a renewable source of energy: “We can always grow more plants. We should plant new trees when we cut down old ones for wood. We also need to take care of the soil in which our crops grow” (p. 10).</td>
<td>Impact on soil, water use, and old growth trees for biofuel.</td>
</tr>
<tr>
<td>In discussion of coal as nonrenewable source of energy: “There is a lot of coal in the United States. There is enough to last up to 250 years” (p. 13).</td>
<td>Impacts of coal on climate change and the environment.</td>
</tr>
<tr>
<td>Discussion of deep mining, surface mining, and land reclamation (p. 13).</td>
<td>Environmental/human costs of mining.</td>
</tr>
<tr>
<td>“They clean the coal before they burn it. They use scrubbers to clean the smoke before it goes into the air” (p. 13).</td>
<td>Pollution from coal.</td>
</tr>
<tr>
<td>Discussion of dams flooding land and need for fish ladders (p.17).</td>
<td>Impact of Hydroelectric Energy</td>
</tr>
<tr>
<td>Discussion of drilling for natural gas (p. 19).</td>
<td>Impacts of fracking.</td>
</tr>
<tr>
<td>Discussion of transporting natural gas and petroleum (p.19, 21).</td>
<td>Environmental impact of spills.</td>
</tr>
<tr>
<td>“The United States doesn’t produce enough oil to meet our needs. We import 48 percent of the oil we use from other countries”</td>
<td>Energy use and conservation.</td>
</tr>
</tbody>
</table>
Table 41 - continued (p. 20).

“Petroleum keeps us going, but it can damage our environment. “Clean” energy. Burning fuels made from oil can pollute the air. Pollution from cars is a big problem in many parts of the country. Oil companies are making cleaner gasoline and diesel fuel every year” (p. 21).

“Oil can pollute soil and water, harming the animals that live in the area. Oil companies work hard to drill and ship oil as safely as possible. They try to clean up any oil that spills” (p. 21).

“Today, solar energy provides only a tiny bit of the electricity we use. In the future, it could be a major source of energy. Scientists are looking for new ways to capture and use solar energy” (p. 25).

“Large amounts of radiation can kill our cells and poison our food and water. Power plants are very careful to keep radiation from escaping” (p. 27).

As with the previous activities, these opportunities were found throughout the curriculum. By not addressing the socioscientific issues that could be discussed in relation to each of the topics taught in the text, the curriculum ignores the societal debates related to each. By treating these Conversations as non-issues, the curriculum, based on the Context is Reflexive Tool, functions to make the issues non-relevant to the readers. Additionally, the Context of diminishing the socioscientific issues also creates a Figured World in which it is not necessary to address these issues in the science class. The
curriculum functions to deemphasize the *Significance* of building scientific literacy skills in students by failing to use the contextual opportunities to include activities that would do so.

Table 42

*NEED: Analysis Tools Applied and Findings: Significance*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Context is Reflexive</td>
<td>Communicates to students that the Discourse of integrating activities that build scientific literacy is irrelevant.</td>
</tr>
<tr>
<td>Conversations</td>
<td>Context is Reflexive</td>
<td>Makes socioscientific issues non-relevant to readers and normalizes science curriculum that does not address them.</td>
</tr>
</tbody>
</table>

By analyzing the NEED curriculum for *Significance*, the curriculum was found to deemphasize the need for building scientific literacy through inquiry and addressing socioscientific issues. By doing so, the hypothesis was further solidified: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of *Vision II* scientific literacy through the normalization and use of both applicable terminology and activities and the building of a student worldview that expects future practices and applications of scientific literacy.
skills. However, in intermediate science curricula and texts that deemphasize the significance of socioscientific issues, discourse is employed to suppress the development of *Vision II* scientific literacy by normalizing the curriculum as the expert, disconnecting scientific literacy skills from the science instruction, and building a student worldview that does not expect opportunities to build scientific literacy skills.

**Oxfam Education Climate Challenge**

The Oxfam curriculum was analyzed based on its practices (activities), identity, and significance.

**Practices (Activities)**

Because the Oxfam curriculum is aligned with the PreSEES curriculum, in that both functioned to elevate the significance of the socioscientific topic, to either confirm or disprove the hypothesis for the second research question, the Oxfam curriculum’s treatment of scientific literacy development was first analyzed for *Practices (Activities)*. Based on the hypothesis, it was expected to use practices that develop scientific literacy, and the analysis found that to be confirmed in three areas. The Oxfam curriculum develops scientific literacy by taking on and applying the *Discourse* of *Vision II* scientific literacy. The *Discourse* includes the actions, interactions, values, tools, and environments that build a socially recognizable identity. Examples of content from the first two sessions were analyzed. They are presented in Table 43.

Several tools demonstrate how these activities function to build a socially recognizable identity for the students of being a scientifically literate individual. First, phrases are *Integrated* in order to tie processes of scientific literacy with the activity. For example, the phrase *use their existing knowledge, understanding and experiences* is
embedded and reminds (or teaches) students the process needed to formulate a reasonable prediction. The same process is followed when questions are added as guides during research. The questions scaffold effective research. The integration of these actions with the development of student learning builds a context to which the Context is Reflexive Tool can be applied. By asking how this text is shaping a relevant context for the students, the curriculum is found to connect and normalize the integration of building and practicing scientific literacy skills through science lessons.

Table 43

*Oxfam: Content of Activities Building Scientific Literacy*

“Ask learners to use their existing knowledge, understanding and experiences to predict what will happen to the temperature…” (Oxfam, 2016e, p.2).

During research to answer student-generated questions about climate change, students are asked to consider: “…how learners might find out the answers to these questions,” “What information sources could you use? What support might you need,” “…use secondary sources of information…,” “focus on the science around climate change,” “existing knowledge, understanding and experiences around climate change” (p.3-4).

While going through the process of identifying all of the fossil fuels needed to make a loaf of bread or an aluminum can, students must consider production, packaging, and transportation, and link the usage to their own consumption needs (Oxfam, 2016f, p. 2-3).

Use a provided data table from *The Global Carbon Atlas* and then manipulate the database themselves to determine, by country, who is responsible of the most carbon emissions (p.3).
These samples also demonstrate how the text creates a *Figured World* in which the students are invited to value and interact in a socially constructed mental world where they practice and build scientific literacy. In the examples above, students generate their own questions, navigate a database, draw inferences and conclusions from data, and collect data and use it as evidence. Within each action, the student is an active user of the practices of scientific literacy.

Table 44


<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Integration</td>
<td>Builds an identity that develops scientific literacy by using a Discourse</td>
</tr>
<tr>
<td></td>
<td>Context is Reflexive</td>
<td>normalizes the students’ active development of scientific literacy skills.</td>
</tr>
<tr>
<td>Figured World</td>
<td>Integration</td>
<td>Normalizes the inclusion of scientific literacy activities in science curriculum.</td>
</tr>
<tr>
<td>Social Language</td>
<td>Cohesion</td>
<td></td>
</tr>
</tbody>
</table>

Finally, these examples show the curriculum has taken up the *Social Language* of scientific literacy in an authentic way that integrates words with actions. The *Vocabulary* of scientific literacy is used as students engage in the actions that build scientific literacy skills: *predict; research; answer; generate their own questions; use information; identify*
and use secondary sources of information; use their existing knowledge, understanding and experiences; identifying; link; and use and interpret data. The Cohesion of the words with the actions demonstrates how the text is engaged in the Practice of building scientific literacy skills for the students. In addition to building the skills, the curriculum functions to normalize that practice for students so that it becomes a permanent part of their science education expectations. The analysis of the Practices (Activities) accomplished by the Oxfam curriculum, further confirmed the existing hypothesis without any changes. Specifically, the text normalizes the development of scientific literacy in science curriculum.

Identity

The Oxfam curriculum was next analyzed by considering what socially recognizable identity the writers enacted or invited the readers to take up. As discussed in the previous analysis, the text couples the action verbs of scientific literacy with the practice of those words. Examples found in the text include: carry out an experiment; use their existing knowledge, understanding and experiences to predict; record their results; compare; use secondary sources; find out more; investigate; and record their results (Oxfam Education, 2016e). Further analysis of the curriculum demonstrates how the text uses vernacular and language style to connect the student and teacher with the Social Language of science and scientific literacy. This analysis was accomplished by considering the use of scientific literacy Vocabulary along with the Topic and Theme Tool when considering the ways in which the sentences in Session One build an identity for both the teachers and the students.
The directions given to the teacher in the curriculum often use the implied *you* and then place the action that needs to be taken by the teacher into the topic position.

Examples from Session One include, *Show slide 3 and explain briefly...; Tell learners...; Congratulate learners.* By using the implied *you*, the theme of the sentence, which is the focus, becomes the action verb and its direct object. A majority of the sentences in Session One, 28 of the 52 sentences, focus on the teacher, as the implied *you*, an action verb directly related to the building of scientific literacy, and the learners. Examples from Session One are included in Table 45.

Table 45

*Themes from Sentences in Session One*

“Tell learners that...” (Oxfam Education, 2016e, p. 2).

“Organize learners...” (p. 2).

“Congratulate learners...” (p.2).

“Explain that learners are...” (p. 2).

“Explain to learners...” (p. 2).

“Ask learners...” (p. 2).

“Recap on what the learners learned...” (Oxfam Education, 2016e, p. 3).

“Ask questions that learners have...” (p. 3)

“Explain that the learners...” (Oxfam Education, 2016e, p. 4).

“Learners could add...” (p. 4).

“Learners could investigate...” (p.4).
These themes combine the teacher, student, and the previously mentioned action verbs that build scientific literacy. By placing all three at the front of the sentence, the curriculum functions to move them to a place of prominence which allows the text to build an identify for both the teacher and the student. The teacher is given the guiding position in the classroom that directs students in ways that build their scientific literacy. The students are given the identity as the object of the building of the scientific literacy. As previously mentioned, the use of scientific literacy vernacular is authenticated by the expectation that students engage in the actions indicated by the terminology. The sentence structure places both teachers and students in the center of the Social Language of science, and therefore functions to build for them an identity that accepts that position and then scientific engagement that goes along with it.

In addition to building a student identity of active participation, the text functions to develop an identity for the student as someone who is engaged with others in the Discourse required for application of scientific literacy. This is accomplished with the inclusion of open-ended questions as well as the requirement that students communicate their findings with tables and graphs. Question examples include: “Do you think the temperature will always be the same on both thermometers at any given time?” (Oxfam Education, 2016e, p. 2); “What do you predict will happen to the temperature over time on each thermometer? Why do you think this?” (p. 3); and “What did you find? Why do you think this happened? Were your predictions correct?” (p. 3). In addition to these questions, the curriculum requires students to compare their findings by recording them on both a table and a graph, and it encourages the teacher to provide student appropriate
accommodations by either providing a table and graph template or by asking them to create both independently (p. 3).

The impact of these elements of the curriculum can be analyzed with the Fill In Tool. By considering what is not being overtly said by the curriculum or what it is expecting the reader to assume or infer, the text requires both the teacher and the student to engage with and embrace the Discourse of scientific literacy. The text assumes that both groups understand what a prediction is and how it needs to be supported with some type of previous scientific understanding. Additionally, through the open-ended questions and the graphing, the text assumes that the students understand and can apply graphic representations of data, discuss them, and compare their findings with others. By requiring students to compare their information with others, the text is engaging them in the collection of data from multiple trials and including them in discussions of controlling variables, evaluating outlier data, and considering the causes of the data. For this text to be clear, the student and the teacher must already possess an understanding of many scientific literacy skills. By assuming their presence in the reader, the text functions to give them opportunities to apply the Discourse of science; and by doing so, functions to develop for them an identity that normalizes their use of and inclusion in science.

The analysis of the Identity developed for the reader by the Oxfam curriculum further solidified the hypothesis without any changes. By requiring the reader to use and engage with the Social Language and Discourse of scientific literacy, the curriculum builds an Identity for both the student and the teacher that gives them a sense of belonging and normalizes their role with the application of scientific literacy skills.
## Table 46

**Oxfam: Analysis Tools Applied and Findings: Identity**

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>Text builds identity for the reader by placing them at the center of the use of scientific literacy skills and by engaging them with the Social Language of scientific literacy.</td>
</tr>
<tr>
<td></td>
<td>Topic and Theme Tool</td>
<td></td>
</tr>
<tr>
<td>Discourse</td>
<td>Fill In Tool</td>
<td>Through the assumptions made by the text regarding the prior engagement of the readers with the Discourse of scientific literacy, the text further builds and normalizes the readers’ identities and sense of belonging in scientific discussions.</td>
</tr>
</tbody>
</table>

**Significance**

The previously analyzed sections of the Oxfam curriculum can also be used to demonstrate how the text builds up the importance of scientific literacy. The *Fill In Tool* was used to demonstrate the assumptions the text’s *Discourse* made regarding the existing scientific literacy of the reader. Because of the skills the curriculum expects students to possess and use, the text establishes those abilities as assumed or taken for granted; and in doing so, it raises their *Significance.*
Additionally, the previously discussed sections of the text can also be analyzed for the ways in which they create a *Figured World* that the reader is invited to assume. The curriculum values the activities that build scientific literacy. This is present in the action verbs that engage students with scientific literacy skills, the way in which the curriculum places the students and teachers at the center of those activities, and the open-ended questions it asks them to discuss. These aspects of the curriculum use the *Vocabulary* and *Discourse* of scientific literacy to invite students to be a part of a culturally constructed community that engages in science. By engaging them with the actions of scientific literacy, the text invites them to assume a role that places *Significance* on its importance.

The ways in which the curriculum assumes the scientific literacy skills of the students and teachers as well as the ways in which it invites both groups to be a part of a community that uses scientific literacy skills to discuss science function to increase the *Significance* of scientific literacy. The findings of the analysis of the ways in which the Oxfam curriculum increases the *Significance* of scientific literacy are summarized in Table 47. By increasing the *Significance* of scientific literacy, the Oxfam curriculum further confirms the hypothesis.

Based on the analysis of all three curricula, a hypothesis was developed and confirmed for the second research question: In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy? The final hypothesis is: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of *Vision II* scientific literacy through the
normalization and use of both applicable terminology and activities and the building of a student worldview that expects future practices and applications of scientific literacy skills. However, in intermediate science curricula and texts that deemphasize the significance of socioscientific issues, discourse is employed to suppress the development of Vision II scientific literacy by normalizing the curriculum as the expert, disconnecting scientific literacy skills from the science instruction, and building a student worldview that does not expect opportunities to build scientific literacy skills.

Table 47

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Fill In Tool</td>
<td>Text increases the Significance of scientific literacy by making it an assumed skill possessed by both teachers and students.</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Vocabulary</td>
<td>Increases the Significance of scientific literacy by inviting students to be a part of a culturally constructed community engaged with science through the application of scientific literacy skills.</td>
</tr>
</tbody>
</table>
A summary of the findings of the three critical discourse analyses conducted on the PreSEES, NEED, and Oxfam curricula to answer the first research question are fully considered in chapter 7.
CHAPTER 6

RESEARCH QUESTION THREE FINDINGS:

TREATMENT OF CRITICAL PEDAGOGY

The third research question considered by this dissertation was: In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy? To consider the way in which the three curricula present and develop critical pedagogy, they were analyzed through the lens of the Freirean science education model proposed by Santos (2009). According to Santos, a Freirean science education framework combined with socioscientific education has the goal of “attaching social meaning to science contents, and of helping students understand the oppressive context of modern society” (p. 374). Santos’ (2009) applications of critical pedagogy to socioscientific issues and the descriptors of a critical pedagogy were discussed in chapter 2. The indicators of critical pedagogy have been organized into the three categories identified by Santos, and they are presented below in Table 48.

To analyze the curricula for the development of critical pedagogy, areas of each curriculum that included these indicators were analyzed along with areas where these indicators could have been developed but the curriculum failed to do so. Additionally, since the absence of suppressive structures is one of the indicators for a critical pedagogy, areas of the curricula that normalized suppressive structures were also analyzed. All three curricula were analyzed for the Practices (Activities) that were used to develop or suppress critical pedagogy as well as the Connections (or Disconnections) they made.
between the students and their connection with sociopolitical change. The Significance developed or disregarded for a critical pedagogy was also analyzed for the PreSEES and NEED curricula, and the ways the PreSEES and Oxfam curricula developed student Identities and Relationships among students and others were also analyzed. This chapter details the development for the final research question in which the PreSEES and Oxfam curricula were both found to promote a critical pedagogy even though the PreSEES curriculum did not provide authentic opportunities for sociopolitical action. The ways in which the NEED curriculum suppresses the development of a critical pedagogy is also detailed.

Table 48

_Critical Pedagogy Indicators Organized with Santos’ (2009) Three Indicators_

**Presence of:**

1. Discussion of socially relevant themes of the socioscientific issue
   - Co-learning: engage personally, connect, challenge and change
   - Non-capitalistic, pro-community goals of science education

2. Establishment of a dialogical process in the classroom
   - Opportunities to challenge dominant worldviews

3. Engagement of students in sociopolitical actions
   - Transformational experiences for teachers and students
   - Connection of instruction to the service of all not just special interests

**Absence of:**

Suppressive structures
The PreSEES curriculum was analyzed for significance, identity, practices (activities), and connections.

Significance

The SSI module on global warming highlights the connection between the readers and the issue of global warming and therefore increases the *Significance* of a critical pedagogy. First, the *Social Language* used by the text invites and encourages the students and teachers to engage with the topic. To accomplish this, the discourse uses a casual social language. According to Gee (2011a), social languages are distinguished by their level of formality and *vocabulary*. For example, the text speaks directly to the student and the teacher by asking questions and giving directives. Examples from slide 5 include: “Divide the class in 2 groups” and “You will need to bring the information/documents found in order to discuss them in class” (PreSEES, 2014b, slide 5). Another sign of the casual social language is the use of less formal sentence structures that tonally speak directly to the reader. Examples include: “What videos/news/documents have you seen before on this” and “What do you think about the images, movies, articles, etc. you have seen” (PreSEES, 2014b, slide 4)? The use of the slashes and the abbreviation for *etcetera* makes the text personal and inviting. Finally, the complexity of the words used is primarily Germanic and Tier 1 and 2. Additionally, on slide five, the text uses the abbreviation “info” for the word *information*. The casual *Social Language* used in the discourse is one way in which the text works to connect the students’ culture with the issue of global warming.
The text also creates a *Figured World* that invites the readers to be a united group involved in a discussion about the socially relevant themes of climate change. By creating opportunities for the students to interact with and value the issue, the *Figured World* functions to unite the authors, students, and teachers. This is partially accomplished with the use of plural personal pronouns such as *we* and *let’s*. Examples include the titles on several slides which say, “Let’s look for info about the topic,” “What have we seen in the activity,” and “Let’s make recommendations” (PreSEES, 2014b, slides 5, 9, 11-12). These group-building personal pronouns elevate the significance of the reader in the process and work to create cohesiveness and eliminate a hierarchy between the authors, teachers, and students.

Finally, the text increases the *Significance* of a critical pedagogy by creating a *Figured World* in which the students not only work in a united group to discuss the issue of climate change but also engage in opportunities to identify dominant worldviews and challenge them with competing ideas. The lesson scaffolds the students as they research the arguments of those who contend climate change is caused by human activities and those who argue it is a naturally occurring phenomenon (PreSEES, 2014b, slide 5). Then it requires them to discuss the evidence that supports both viewpoints (slide 7). Finally, the students are asked to consider and dialogue about the issue of climate change from various worldviews such as those of car manufacturers, environmental organizations, and consumers and propose new laws based on those viewpoints (PreSEES, 2014b, slide 11).

Using the *Fill In Tool*, this portion of the curriculum can be analyzed for the assumptions it requires students to make regarding the importance of considering this issue from various viewpoints and sharing and discussing those ideas. Without directly
telling the students, the curriculum communicates the *Significance* of the processes involved in a critical pedagogy. The *Doing and Not Just Saying Tool* can also be applied to consider what the text accomplishes. By requiring students to actually engage with the processes of critical pedagogy, the curriculum elevates its *Significance*. A summary of the findings of the ways in which the PreSEES curriculum elevates the *Significance* of a critical pedagogy is summarized in Table 49.

Table 49

*PreSEES: Analysis Tools Applied and Findings: Significance*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>The text increases the significance of critical pedagogy by using a casual social language to connect the curriculum to the reader’s culture.</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Vocabulary</td>
<td>Text unites the readers and the author into a single non-hierarchical learning group.</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td>Fill In Tool</td>
<td>Creates social community that elevates the significance of a critical pedagogy by actively engaging students with some of its processes.</td>
</tr>
</tbody>
</table>
From this analysis, a preliminary hypothesis can be formed for the third research question. However, since the PreSEES curriculum has been identified as one that elevates the significance of a socioscientific issue and promotes the development of Vision II scientific literacy, the preliminary hypothesis is approached through those descriptors and results in the following hypothesis: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop Vision II scientific literacy, discourse is employed to promote the significance of a critical pedagogy by connecting the curriculum with the readers’ culture, creating a united learning community among the authors and readers, and engaging students with the processes of a critical pedagogy.

Identity

They way in which this discourse promotes or suppresses critical pedagogy can also be analyzed by considering the Identities the discourse builds for the authors, students, and teachers. In the analysis of how the PreSEES curriculum presented the socioscientific issue of climate change, the questions on slide 4 were analyzed for the way that the sentence patterns were switched to move the focus from the student, you, to famous people (PreSEES, 2014b, slide 4). Using the Topic Chaining Tool, the sentences can be seen as a single Stanza. The previous analysis of this portion of the text argued that the switch functioned to increase the significance of the topic of global warming by suggesting that famous people were engaged with the topic. However, this discursive action also places the famous people and groups into the position held by the student, you, in the two previous sentences. The sentence structure functions to enact an identity on the students by aligning them with famous people and groups. By doing so, the
curriculum works to pull the readers into the Discourse by giving them the identities of individuals whose opinions about the issue are just as important as the opinions of famous people. This identity of the student prepares them for their place in the dialogical process that is a cornerstone of a Freirean science education.

The Identity of the student is also built with the portions of the text that engage the students in the Conversation of critical pedagogy. By expecting them to possess and share their opinions regarding global warming, the authors immediately elevate the student from observer to participant. On slide 4 and worksheet 1.1, the authors modify the word opinion with the adjective personal, which signals the opinion as unique (PreSEES, 2014b, slide 4; PreSEES, 2014c, p. 1). Through positioning themselves as the asker, the authors have also built their own identity. Therefore, the discourse has identified the student as an individual with a valuable and unique contribution to make to the Conversation and the authors as educators who value the active role of the student in the learning process. The building of these identities is necessary for the students to be engaged in a dialogical process, which is one of the elements of a Freirean science education.

Finally, the discourse works in another way to impact the student identity and engage them in the dialogical process promoted by critical pedagogy. Beginning on slide 11, the students are referred to as experts (PreSEES, 2014b, slide 11). The directions on this slide say, “You are scientific experts responsible to advise your government on a proposed new law, in the context of a dispute about global warming, with various stakeholders on this issue: Association of car manufacturers, Environmental organizations, Association of Consumers, Expert Group on Climate Change IPCC.” By
referencing the students as *experts*, the discourse recognizes the knowledge they have acquired about the topic and identifies them as individuals equipped to make policy recommendations. Analyzing this assignment with the *Cohesion Tool*, this assignment is found to connect the student identity of being *scientific experts* with the *responsibility* of influencing their *government* and *laws*. In this way, the curriculum provides an opportunity for the students to connect themselves with the issue and be a part of a dialogical process that leads to transformational change.

The findings from analyzing the PreSEES curriculum for the ways in which it builds identities that promote a critical pedagogy are summarized in Table 50.

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Topic Chaining Tool Stanza</td>
<td>Text engages students in the Discourse in a way that values their opinion and places them in the dialogical process.</td>
</tr>
<tr>
<td>Conversation</td>
<td>Vocabulary Cohesion</td>
<td>Text elevates student identity to active participant with valued opinions. Ties their knowledge with their responsibility of influencing government and laws.</td>
</tr>
</tbody>
</table>
From this analysis, the curriculum was found to further solidify and narrow the hypothesis for the third research question. Based on this analysis, the new hypothesis is: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use of a critical pedagogy by connecting the curriculum with the readers’ culture, creating valued author and reader identities that form united learning communities, and engaging students with critical pedagogy processes that require them to use their knowledge to influence government and law.

**Practices (Activities)**

Many aspects of this curriculum engage students in the practices of critical pedagogy. Freire (1994) argued that teachers should make students aware of the many different stances on an issue and allow students to form their own opinion. The dialogical process is intended to provide those opportunities for students. The PreSEES curriculum creates a *Figured World* that allows students to engage in two practices that promote this element of critical pedagogy. First, on slide 5, the students research two opposing views on the causes of global warming (PreSEES, 2014b, slide 5). Then, on slide 11, they are asked to take on the viewpoint of several different stakeholders and make policy recommendations from that point of view (slide 11).

The curriculum also uses the *Discourse* of critical pedagogy and invites students to do so as well. Students are given an opportunity to address the question, “What does ‘controversial’ mean” (slide 17)? The curriculum lists the many ways that a socioscientific issue could be controversial, and it suggests cultural differences that may influence discussion about a socioscientific issue. For example, the curriculum asks...
students to consider the “interests between different social groups” and “value systems” (slide 17). The reference to social groups provides an opportunity in the dialogue for students to use the Discourse of critical pedagogy and include the impact that socio-economic status may have on the views individuals hold about global warming.

The importance of considering and accepting several viewpoints is reinforced in other parts of the curriculum that can be analyzed with the Doing and Not Just Saying Tool. Point 1 says, “Controversy in social/ economical/ ethical/ ecological/ political aspects…There is enough scientific consensus (for now!). But there is controversy among stakeholders from different disciplines or domains (social, ethical, economic problems, etc.)” (PreSEES, 2014b, slide 18). In one of the few sections of direct instruction, the curriculum proposes three ways in which students can make decisions. They include being informed, considering all points of view, and searching for the best-reasoned decision (slide 23). By guiding the students through those processes, the curriculum communicates to the students that they need to form individual opinions based on knowledge and reason, and this practice aligns the curriculum with critical pedagogy by making the issue relevant to the students and by engaging them in a dialogue about the issue.

While the opportunities discussed above allow students to engage in practices that support the first two elements of Santos’ (2009) Freirean science education, namely connection of an issue to the student’s culture and engagement in a dialogue about the issue, the curriculum does not connect practices for the final element. According to Santos, a third aspect of the Freirean science education is opportunities for students to engage in sociopolitical actions. The discourse does function to demonstrate Cohesion
between the socioscientific issue of global warming and decision-making and policy about that issue. For example, slide 12 gives the students the opportunity to make recommendations regarding a law that their government is going to make to reduce carbon emissions. While this portion of the discourse provides a mocked-up practice of sociopolitical engagement, the recommendations made by the students are not intended for an authentic audience. The students do not get to use their recommendations to enact actual sociopolitical change. Since that is a goal of a critical pedagogy, the curriculum fails to promote that crucial element.

Table 51

*PreSEES: Analysis Tools Applied and Findings: Practices (Activities)*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured World</td>
<td>Cohesion</td>
<td>Creates a mental community where students adopt different points of view/make policy recommendations.</td>
</tr>
<tr>
<td>Discourse</td>
<td>Doing/Not Just Saying</td>
<td>Students form opinions based on knowledge and reasoning. While the text provides a mock opportunity for students to propose governmental policy, does not engage in actual sociopolitical change. Connects knowledge with responsibility of influencing government and laws.</td>
</tr>
</tbody>
</table>
Analysis of the *Practices (Activities)* accomplished by the curriculum found that the PreSEES curriculum did promote a critical pedagogy by creating opportunities for students to engage in its processes; however, opportunities for authentic sociopolitical change were not present in the curriculum. The findings are summarized above in Table 51.

These findings further developed the hypothesis for the third research question: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use of a critical pedagogy by connecting the curriculum with the readers’ culture, creating valued author and reader identities that form united learning communities, and engaging students with critical pedagogy processes that require them to form opinions based on knowledge and reasoning that can influence governmental policy. However, opportunities for students to authentically enact sociopolitical change are not present.

Connections

Gee’s (2011b) connections tool suggests that an analysis can consider how a discourse functions to connect or disconnect ideas, and in so doing, makes the ideas significant or insignificant. The practices analyzed above demonstrate that the discourse does promote at least some aspects of a critical pedagogy. By considering the *Cohesion* present in the discourse, the analysis considers how the elements of critical pedagogy are being used to promote other ideas. In the previous section, slides 17, 18, and 23 were analyzed for the ways in which they allowed students to connect their own views and form independent opinions (PreSEES, 2014b). However, it is also significant that these parts of the curriculum, which allow for opinions to be connected to *social, economic,*
ethical, ecological, and political associations, also connect that discourse with the importance of quality data and information.

In several other areas, the curriculum demonstrates Cohesion between worldviews and the factors that impact them. For example, the curriculum asks students to consider cultural differences which may impact, an individual’s “ideas, theories, prior knowledge” and “sources of data/evidence” (slide 17). It also specifies the difference between a controversy stemming from social, economic, political, ecological, or ethical differences and a scientific controversy, which occurs when “…science has not reached a consensus, because: There are several trends within the scientific community or Insufficient data/experimental capacity…” (slide 18). A final example can be found in slide 23. This slide provides answers to the question, “How can we make decisions?” While the second answer directs students to consider all viewpoints, the first answer is, “Being well-informed: looking for enough quality information, from various sources, several authors, etc.” Each of these portions of the curriculum connect the critical pedagogy element of forming one’s own opinion with the importance of basing that opinion on data, knowledge, and scientific consensus.

Finally, as previously mentioned, the curriculum fails to engage in the Practice of involving students in sociopolitical change. By providing a mock opportunity for the students to write policy (PreSEES, 2014b, slide 12), the curriculum does connect itself with the idea that instruction should function for the service of all citizens. However, because the policy ideas developed by students are not communicated outside the classroom setting, the curriculum also disconnects the learning setting from transformational experiences and authentic sociopolitical change. By doing so, the
curriculum fails to promote the most significant element of a critical pedagogy. A summary of the Connections made by the PreSEES curriculum is below in Table 52.

Table 52

*PreSEES: Analysis Tools Applied and Findings: Connections*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Cohesion</td>
<td>Connects opinion formation with cultural elements and empirical information and reasoning. Uses those distinctions to connect evidence and scientific consensus with opinion formation regarding socioscientific issues. Disconnects intermediate science curriculum from sociopolitical change.</td>
</tr>
</tbody>
</table>

Based on the final analysis of the PreSEES curriculum and the Connections it makes or fails to make, the hypothesis for research question 3 was further confirmed and solidified. After analyzing the PreSEES curriculum the hypothesis is: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use of a critical pedagogy by connecting the curriculum with the readers’ cultures, creating author and reader identities that form united learning communities, and engaging students with
critical pedagogy processes that require them to form opinions about socioscientific issues based on empirical knowledge and reasoning in order to influence governmental policy. However, opportunities for students to authentically enact sociopolitical change are not present and therefore disconnect curriculum from sociopolitical change.

NEED Elementary Energy Infobook and Elementary Energy Infobook Activities

The analysis of the NEED curriculum in the areas of significance, connections, and practices (activities) is presented in the following section.

Significance

The treatment of critical pedagogy by the NEED curriculum was first analyzed by considering how it built up or lessened the Significance of a critical pedagogy. It was searched for places where it gave students opportunities to discuss socially relevant themes, establish a dialogical process, or engage in sociopolitical actions, which are the critical pedagogy elements summarized above in Table 48. To do so, the curriculum was analyzed for how it engaged or ignored the Conversation of critical pedagogy.

Table 53

NEED: Questions and Directions

“Imagine what your life would be like without electricity” (NEED, 2016d, p.7)?
“After a long day, do you ever feel too tired to move? You’ve run out of energy” (p.7).
“What would we do without petroleum? Our country would come to a stop” (p. 21).

After explaining that solar energy is free, clean, and renewable, the curriculum asks:
“Why don’t we use the sun for all our energy needs” (p.25)?

“Have you ever held two magnets close to each other” (p. 31)?
The curriculum does not overly direct students or teachers to use a dialogical process or engage in sociopolitical activities. The few times when students are asked questions or directed to consider an issue are listed in Table 53. These questions either connect the information to the schema of the student, such as connecting personal energy needs with fuel or magnetic principles with student experiences, or they are rhetorical. Since answers are immediately provided and students and teachers are not directed to discuss these questions, they do not engage in the Conversation of critical pedagogy. Additionally, by supplying the answers to the questions, including ones that could become a socially relevant discussion, the curriculum can be analyzed with the Doing and Not Just Saying Tool. Through its limited and rhetorical use of questions, the text communicates to students that discussions do not have a place in science curriculum and therefore lessens the Significance of a critical pedagogy.

The same analysis can be applied to the critical thinking questions found in the Elementary Energy Infobook Activities. Some of those questions were previously presented in Table 37. As previously discussed, these questions are presented in isolation as one group. Three aspects of the presentation of these critical thinking questions indicate they are not intended to initiate discussions or a dialogical process. First, they are presented without any directions or scaffolding for either the students or the teachers. Second, they are presented in the activity book where other responses are expected to be written by the students. Finally, they are accompanied by an answer key, which suggests one right answer or the acceptance of many answers if they are supported by the student.

In addition to not cultivating discussion or dialogues, the questions are presented with Intonation that normalizes rather than challenges dominant worldviews. Examples
include: “Energy does a lot for us. Which of its jobs do you think is the most important? Why” (NEED, 2016e, p. 8); “When we flip a switch, our lights go on. When we plug something in, and turn it on, it works. We don’t think about where electricity comes from. Pretend you are a spark of electricity. Explain your journey from an energy resource to your game console or system” (p.8). The Discourse of critical pedagogy is not used in these sections. A discussion about differences between energy use for health and sanitation verses entertainment is ignored. Students are not asked to consider the social impacts of their responses, and the use of energy for entertainment is normalized.

Other questions and their suggested answers allow students to respond in ways that dismiss a socially relevant theme so long as they do so in a way that is justified. For example, the answer key contains the following question and answer: “Do you think people mining for coal should have to use reclamation on the land? Why or why not? Students should pick yes or no, and explain why the land should be taken care of after it has been used for mining or why not” (p. 31). In addition to bypassing a discussion about the issue of land reclamation, the curriculum lessens the significance of social relevance by defending a student’s choice to suggest that land should not be restored.

The critical thinking questions also function to dismiss societal issues by equating them with insignificant issues. One question and answer reads: “The radiation from nuclear fuel can be dangerous if not taken care of properly. Describe at least two other things that can be dangerous if not taken care of properly. Answers will vary. Students may describe things like pets, firearms, cleaning supplies, gasoline, or even light bulbs” (p. 31). Using the Cohesion and Subject tools, this question can be analyzed for the way in which it places radiation from nuclear fuel in the same subject space as at least two
other things. The question and its response tie nuclear waste with a broken light bulb or gasoline spilled in a garage and therefore equate their dangerous consequences. The relevance of nuclear waste disposal on a community is diminished to the impact of a cut foot or a potential fire. Therefore, if a teacher decided to use the critical thinking questions for a class discussion, the questions themselves diminish or dismiss socially relevant themes and therefore lessen the Significance of developing a critical pedagogy.

Table 54

**NEED: Analysis Tools Applied and Findings: Significance**

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversation</td>
<td>Doing/Not Just Saying</td>
<td>Fails to engage in the Conversation of the elements valued in a critical pedagogy by asking limited, rhetorical questions.</td>
</tr>
<tr>
<td>Discourse</td>
<td>Intonation</td>
<td>Lessens Significance of critical pedagogy by presenting isolated questions designed to be answered individually without discussion.</td>
</tr>
<tr>
<td>Discourse</td>
<td>Subject</td>
<td>Lessens Significance critical pedagogy by dismissing the importance of the socially relevant issues present in the critical thinking questions.</td>
</tr>
</tbody>
</table>
Connections

The NEED curriculum was next analyzed for the ways in which it connected or disconnected elements of a critical pedagogy. As previously mentioned, the curriculum does not engage students in the discussion of any socially relevant themes or ask them to personally connect issue to their personal experiences. Therefore, the analysis of the Connections made were based on the ways in which the curriculum disconnects discussions and dialogical process from socially relevant issues. In Table 41, the parts of the NEED text that mentioned social issues were quoted and labeled with the issue each one addressed.

Table 55

NEED: Socially Relevant Themes Mentioned

<table>
<thead>
<tr>
<th>Theme</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy consumption and conservation (NEED, 2016d, p. 9, 20)</td>
<td></td>
</tr>
<tr>
<td>Impacts on soil, water use, and old growth trees for biofuel (p. 10)</td>
<td></td>
</tr>
<tr>
<td>Impacts of coal on climate change and the environment (p. 13)</td>
<td></td>
</tr>
<tr>
<td>Environmental and human costs of mining (p. 13)</td>
<td></td>
</tr>
<tr>
<td>Pollution from coal (p. 13)</td>
<td></td>
</tr>
<tr>
<td>Impact of hydroelectric energy (p. 17)</td>
<td></td>
</tr>
<tr>
<td>Impacts of fracking (p. 19)</td>
<td></td>
</tr>
<tr>
<td>Environmental impact of oil and natural gas spills (p. 19, 21)</td>
<td></td>
</tr>
<tr>
<td>“Clean” energy and the impact of “scrubbing” pollutants (p. 21)</td>
<td></td>
</tr>
<tr>
<td>Government research funding for alternative energy sources (p. 25)</td>
<td></td>
</tr>
<tr>
<td>Nuclear energy safety (p. 27)</td>
<td></td>
</tr>
</tbody>
</table>
The socially relevant themes identified previously in Table 41 are summarized above in Table 55. At each of these points in the text, socially relevant themes are mentioned and treated in one of two ways. In some cases, the curriculum minimally addresses the issue in a manner that does not include co-learning or a personal engagement with the topic.

For example, in response to petroleum spills, the text acknowledges it as an issue by saying, “Oil can pollute soil and water, harming the animals that live in the area” (NEED, 2016d, p. 21). However, the curriculum then disconnects the social issue from a critical pedagogy by negating the need for discourse or co-learning about the issue. This is accomplished by the curriculum including in the same Stanza a solution to the issue, “Oil companies work hard to drill and ship oil as safely as possible. They try to clean up any oil that spills” (p. 21). By clustering the issue with the solution and failing to engage with student and teacher with either one, the curriculum invites the students to engage in a Figured World in which their participation is unnecessary. The problem is being handled by oil companies who work hard and as safely as possible. They also try to clean up any oil that spills. The students can Fill In that the problem is solved and not in need of discussion. Additionally, the impact is limited to soil, water, and animals that live in the area, therefore it is an isolated issue that is detached from their personal experience. The human, economic, and broader environmental issue are disconnected. Furthermore, a group is taking care of the issue, so there is no need for any sociopolitical involvement or challenging of the dominant worldview presented. In these ways, the social issue is disconnected from the building of a critical pedagogy.
The curriculum also addresses some of the issues by ignoring them or treating them as non-issues. Most issues in table 55 are not presented as issues at all. Those include: impacts of coal and all fossil fuels on climate change, human costs of mining, environmental impacts of hydroelectric energy, impacts of fracking, the concept of “clean” energy, and government research funding for alternative energy sources. Conversations that address the issues and debates about these issues are a part of society’s broader discussion about energy. By disconnecting the Conversations from the issues, the curriculum assumes that the reader does not need to know anything about those issues. Furthermore, the disconnection forms a Figured World for both the teacher and the students in which not only energy consumption is detached from those issues but also the students and teachers do not have a role in the discussions of those issues. The disconnection in the curriculum makes the elements of a critical pedagogy irrelevant.

Table 56 summarizes the findings of the analysis of the NEED curriculum’s Connections. The curriculum suppresses the formation of a critical pedagogy by disconnecting socially relevant issues from the learning experience, the input of students and teachers, and boarder cultural discussions. By doing so, the curriculum undermines the need for a critical pedagogy and suppresses its development. Based on these findings, the hypothesis for the third research question can be further developed and confirmed: In intermediate science curricula and texts that deemphasize the significance of socioscientific issues and suppress the development of Vision II scientific literacy, discourse is employed to undermine the development of a critical pedagogy by asking limited, rhetorical questions that dismiss socially relevant issues and by disconnecting the discussions and sociopolitical actions of students and teachers from those issues.
Table 56

NEED: Analysis Tools Applied and Findings: Connections

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured World</td>
<td>Stanza</td>
<td>Socially relevant issues are disconnected from a critical pedagogy by presenting them with established solutions and detaching them from discussion or the need for sociopolitical activity.</td>
</tr>
<tr>
<td></td>
<td>Fill In</td>
<td></td>
</tr>
<tr>
<td>Conversations</td>
<td>Cohesion</td>
<td>Disconnects socially relevant issues from their Conversations. In doing so, removes students and teacher from the issues and negates the need for a critical pedagogy.</td>
</tr>
<tr>
<td>Figured Worlds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Practices (Activities)

Finally, the NEED curriculum can be analyzed for the critical pedagogy practices or activities it builds or gets others to recognize and therefore normalize. As discussed in the previous analysis of the NEED curriculum, many of the elements of a critical pedagogy are missing and are therefore practices that are not being developed. However, the failure to develop such practices does not mean the curriculum suppresses their development. The ways in which critical pedagogy practices are ignored or
underdeveloped were further analyzed to determine if they simply fail to develop or actively suppress the development of a critical pedagogy.

Previous analysis has discussed how the curriculum does not engage or encourage the students and teachers to engage in discussions or in dialogical processes. Based on the limited number and quality of the questions asked, the curriculum demonstrates a failure to use practices that build a critical pedagogy. However, the ways in which the curriculum purposely disconnected socially relevant themes from the actions of the students and the teachers functioned to suppress the development of a critical pedagogy. Furthermore, the absence of discussion and personal connection with the curriculum is suppressive in that it normalizes those disconnections for the students and teachers. For learners, the NEED curriculum builds a Figured World in which learners accept that acquiring knowledge is separate from personal understanding and development, and that it is detached from sociopolitical action. Applying the Making Strange Tool, the entire curriculum can be considered from the outside and analyzed with the question of why does the curriculum not ask students more questions, ask them to apply the information to their personal experiences, or encourage them to learn more about issues that are discussed broadly in our society. These types of pedagogical elements are common, normalized practices, and their absence is odd to the point of being deliberate.

The practices of the curriculum can also be analyzed by considering its final section, entitled Saving Energy (NEED, 2016d, p.37-38). This area encourages students to conserve energy and gives ideas for how to do so which include reducing the number of items used, reusing and recycling things, and reducing energy use. The topic of one’s individual energy use and carbon footprint could be presented through practices that
develop a critical pedagogy; however, the analysis of this section demonstrates the curriculum’s active suppression.

First, this section does not engage students in a discussion of energy use, how it can be conserved, or why conservation is important. Instead, these things are told to the student by the curriculum, which is presented as the expert on the issue. This is accomplished with a *Social Language* that speaks casually and in directives to the students. The casual vernacular used includes phrases such as *get rid of; What a waste; fix old things; dig up; don’t go in and out, in and out.* The directives are accomplished by using the implied *you* so that the actions the students should do are placed as the *topic* of each of the sentences. Directives given by the text are presented in Table 57. By using this *Social Language*, the curriculum presents itself to the students as the expert that tells them what they can do to reduce energy use.

Table 57

*NEED: Directives for Saving Energy*

<table>
<thead>
<tr>
<th>Directive</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Don’t use paper plates or cups all the time”</td>
<td>37</td>
</tr>
<tr>
<td>“Write on both sides of your paper”</td>
<td>37</td>
</tr>
<tr>
<td>“Try to use things more than once – reuse them”</td>
<td>37</td>
</tr>
<tr>
<td>“Paint an old bike instead of buying a new one”</td>
<td>37</td>
</tr>
<tr>
<td>“Don’t throw away anything you can recycle”</td>
<td>37</td>
</tr>
<tr>
<td>“Turn off the TV and video games, too”</td>
<td>38</td>
</tr>
<tr>
<td>“Unplug devices you aren’t using”</td>
<td>38</td>
</tr>
<tr>
<td>“Don’t stand in the shower for a long time”</td>
<td>38</td>
</tr>
</tbody>
</table>
In addition to suppressing the development of a critical pedagogy by denying students the opportunity to discuss and make personal connections to energy use, the curriculum focuses on the need to save energy for capitalistic gains as opposed to broader pro-community purposes. This is overtly accomplished in two areas that read: “…you can save energy and money, too” (p. 37) and “When you save energy, you save money too. You have more money to spend on other things” (p. 38). By focusing on the personal, capitalistic gain to be made by saving energy, the curriculum run contrary to the goals of a critical pedagogy. In a subtler manner, the curriculum normalizes recreational energy uses; and by doing so, fails to encourage students to challenge those capitalistic norms.

Finally, this section suppresses student engagement with sociopolitical action. This is accomplished with a Discourse that focuses on the actions of the individual and detaches them from the broader political actions necessary to enact large-scale change for social issues. The curriculum says, “The things you do every day make a difference. If everyone saves just a little energy, it adds up to a lot” (p. 38). This is the final message of the curriculum. The topic of each sentence is the things you do and everyone saves just a little energy. These topics focus the students on small, individualized actions. This focus comes right after the sentences throughout the section, sampled above in Table 57, in which the topics of the sentences are the actions the students should take. These discursive choices engage in a boutique-solutions Discourse regarding the actions needed for addressing energy issues such as renewable energy, pollution, and climate change. By engaging the students with a Discourse that negates the need for sociopolitical action, the curriculum suppresses the development of that element of a critical pedagogy. It is
not just that the curriculum fails to engage the students with the large-scale issues and solutions, it distracts them from those issues by suggesting that the individual actions dictated to them by the curriculum are sufficient enough for dealing with them.

Table 58

*NEED: Analysis Tools Applied and Findings: Practices (Activities)*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured World</td>
<td>Making Strange</td>
<td>Learners accept that discussion, personal connection, and dialogical processes are detached from learning.</td>
</tr>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>Directs students in how they can address energy issues instead of allowing them to determine their own actions. Normalizes capitalism.</td>
</tr>
<tr>
<td>Discourse</td>
<td>Topic</td>
<td>Suppresses student involvement with sociopolitical action by focusing on a Discourse of small, individual action.</td>
</tr>
</tbody>
</table>

The analysis of the NEED curriculum’s Practices (Activities), found that it engages in practices that further suppress the development of a critical pedagogy. If the curriculum simply failed to include discussion, dialogue, and sociopolitical action, it would just fail to develop a critical pedagogy; however, the discourse is used to direct
students away from those actions, dismiss the need for them, and suggest students engage in opposite actions that distract them from those developed in a critical pedagogy. Through these practices, it actively suppresses the development of a critical pedagogy. The findings of the Practices (Activities) analysis of the NEED curriculum are summarized above in Table 58.

After analyzing the PreSEES and NEED curriculums, the hypothesis for the third research question was further confirmed. In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop Vision II scientific literacy, discourse is employed to promote the use of critical pedagogy by connecting curriculum with the readers’ cultures, creating valued author and reader identities that form united learning communities, and engaging students with critical pedagogy processes that require them to form opinions about socioscientific issues based on empirical knowledge and reasoning in order to influence governmental policy.

However, opportunities for students to authentically enact sociopolitical change are not present and therefore disconnect the role of curriculum from sociopolitical change. In intermediate science curricula and texts that deemphasize the significance of socioscientific issues and suppress the development of Vision II scientific literacy, discourse dismisses socially relevant issues, disconnects the discussions and sociopolitical actions of students and teachers from issues, and dictates student focus by normalizing capitalism and boutique solutions as opposed to allowing students to discover and challenge social issues. Through those actions, it functions to undermine the development of a critical pedagogy.
Oxfam Education Climate Challenge

The following section includes the analysis of the Oxfam curriculum based on its treatment of practices (activities), relationships, and connections.

Practices (Activities)

Since the Oxfam Education Climate Challenge curriculum was found to elevate the significance of the socioscientific issue of climate change and to develop Vision II scientific literacy, it was expected to align with the hypothesis formed after the analysis of the PreSEES curriculum. Therefore, it was first analyzed for the Practices (Activities) it accomplishes regarding the development of a critical pedagogy.

Throughout the Oxfam curriculum the elements of a critical pedagogy were normalized for both the students and teachers. First, the curriculum applied the Discourse of a critical pedagogy through the actions and interactions it asked students to engage in. Since elements of a critical pedagogy are present throughout the curriculum, the students are placed within its socially recognized activities.

In Table 59, the activities in the Oxfam curriculum that involve the students with each of the elements of a critical pedagogy are listed. Because the curriculum uses and expects students and teachers to complete these elements, the Doing and Not Just Saying Tool demonstrates that the curriculum is not only engaged in teaching the content regarding climate change but also the processes and values inherent in a critical pedagogy. Additionally, by giving students opportunities to practice these elements, the curriculum functions to build those skills in the students as well and normalizes a critical pedagogy for both teachers and students.
Table 59

**Oxfam: Activities that include Critical Pedagogy Indicators**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Discussion of socially relevant themes of the socioscientific issue</td>
<td>1.3, 2.1, 3.2, 4.1</td>
</tr>
<tr>
<td>Co-learning: engage personally, connect, challenge and change</td>
<td>1.1, 2.2</td>
</tr>
<tr>
<td>Non-capitalistic, pro-community goals of science education</td>
<td>2.3, 3.2, 4.2, 5.1</td>
</tr>
<tr>
<td>2. Establishment of a dialogical process in the classroom</td>
<td>2.3, 2.4</td>
</tr>
<tr>
<td>Opportunities to challenge dominant worldviews</td>
<td>3.2, 4.1, 6.2</td>
</tr>
<tr>
<td>3. Engagement of students in sociopolitical actions</td>
<td>6.1, 6.3, 6.4</td>
</tr>
<tr>
<td>Transformational experiences for teachers and students</td>
<td>5.1, 5.2, 6.3, 6.4</td>
</tr>
<tr>
<td>Connection of instruction to the service of all not just special interests</td>
<td>5.1, 5.2, 6.3, 6.4</td>
</tr>
</tbody>
</table>

In order to complete the practices associated with the development of a critical pedagogy, the curriculum also uses its *Social Language* and mixes it with the science vernacular used to teach climate change and develop scientific literacy. The text engages students in sociopolitical actions. “…we can think of taking action as doing something to help stop a situation (usually bad) from developing or continuing” (Oxfam, 2016j, p. 2), “…thinking about and planning possible actions they could take against climate change” (p.2), and “Now ask learners how they think we can and should take action against
climate change. What types of action are there? Who should take these actions” (p. 2)? Vocabulary such as action and planning demonstrate the ways in which sociopolitical action is focused on achievement. Through the use of Diexis pronouns such as they and we and the inclusion of the question of who should take these actions, the curriculum creates Cohesion between the learners and teachers as well as Oxfam and communicates the united efforts involved in the sociopolitical action.

The curriculum also guides students to challenge the worldview that change is limited to individualized action. By doing so, it engages the students in a Figured World in which change is both social and political. The curriculum does so in Session 6, which is entitled Taking Action Against Climate Change. It asks students to consider, “What does taking action mean” (Oxfam, 2016b, slide 27)? This slide shows an elementary student recycling paper as well as a large group of people assembled for a rally. The activity then requires students to decide and justify “who they think most needs to take action on climate change” (Oxfam, 2016j, p. 2). The choices given and discussed are “myself, my friends, other people, and people in power” (Oxfam, 2016b, slide 28). Additionally, the curriculum gives examples of ways to take action against climate change and categorizes them into both social and political actions which include “raising awareness, campaigning, going green, and fundraising” (slide 29).

With these choices, the curriculum Stanzas together group and individual actions as well as community, governmental, and charitable efforts. Finally, the curriculum shares with students the sociopolitical efforts that have been accomplished by other students and asks the students and teachers to plan their own actions and then share the impact of those efforts with the Oxfam organization. The entire session engages in the
practice of promoting and guiding students through sociopolitical change; and in doing so, the curriculum is engaged in the practice of normalizing critical pedagogy and building student and teacher value for all of its elements.

Table 60


<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse</td>
<td>Doing/Not Just Saying</td>
<td>Builds and normalizes critical pedagogy skills.</td>
</tr>
<tr>
<td>Social Languages</td>
<td>Vocabulary</td>
<td>Engages readers in united efforts for sociopolitical action.</td>
</tr>
<tr>
<td></td>
<td>Diexis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cohesion</td>
<td></td>
</tr>
<tr>
<td>Figured World</td>
<td>Stanza</td>
<td>Normalizes both individual and group efforts with social, charitable, and governmental actions.</td>
</tr>
</tbody>
</table>

The analysis of the *Practices (Activities)* the Oxfam curriculum is engaged in both confirmed and challenged the hypothesis for the third research question. The curriculum was found to develop a critical pedagogy; however, unlike the PreSEES curriculum, it provided authentic opportunities for sociopolitical action. The new hypothesis was further attuned: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use of a critical pedagogy by connecting the curriculum with the readers’
cultures, creating valued author and reader identities that form united learning communities, and engaging students with critical pedagogy processes that require them to form opinions about socioscientific issues based on empirical knowledge and reasoning in order to influence governmental policy. However, opportunities for students to authentically enact sociopolitical change may or may not be present and connect the curriculum with authentic sociopolitical change.

Relationships

In previous analysis of the Oxfam curriculum, the curriculum was found to establish a relationship between the teachers and students and the Oxfam organization. In addition to increasing the significance of climate change and building scientific literacy through those relationships, the curriculum also uses them to build transformational experiences for the teachers and learners. By sharing with the students the personal stories of individuals in the global community who are impacted by climate change, the curriculum creates relationships that focus on the pro-community goals of science and connects the instruction to the service of all (Oxfam, 2016i).

The curriculum also builds a relationship between Oxfam and the teachers and learners. This is accomplished by sharing the sociopolitical actions of others motivated by the Oxfam curriculum (Oxfam, 2016b, slides 30-33). The curriculum also tells students and teachers, “Oxfam Education would love to hear about any climate change activities you carry out. Please send in any pictures, reports or stories to…” (Oxfam, 2016j, p.4). Pictures and stories of others involved in transformational experiences and the invitation to share their own experiences, create a Figured World in which the students are involved in the actions of a critical pedagogy. These relationships provide
the authentic opportunities for the teachers and learners to have transformational experiences.

Table 61

**Oxfam: Analysis Tools Applied and Findings: Relationships**

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured World</td>
<td>Cohesion</td>
<td>Builds relationships between Oxfam, the readers, and others who have engaged in sociopolitical action with climate change.</td>
</tr>
</tbody>
</table>

Analysis of the relationships built by the curriculum are summarized above in Table 61 and further confirm the hypothesis: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use of a critical pedagogy by connecting the curriculum with the readers’ cultures, creating valued author and reader identities that form united learning communities, establishing relationships among the author and reader, and engaging students with critical pedagogy processes that require them to form opinions about socioscientific issues based on empirical knowledge and reasoning in order to influence governmental policy. However, opportunities for students to authentically enact sociopolitical change may or may not be present and connect the curriculum with authentic sociopolitical change.
Connections

The curriculum connects personal actions with individuals’ carbon footprints. In session 2, students are required to use data to analyze the carbon emissions of developed countries as compared with developing countries (Oxfam, 2016f). By doing so, the text personally connects the students with the issue and encourages them to confront and challenge the imbalance of responsibility for climate change.

Finally, the Oxfam curriculum can be analyzed for the ways in which it connects the issue of climate change with the need for sociopolitical change. The purpose of the first three sessions of the curriculum is to guide students as they develop an understanding of the causes and effects of climate change; however, the last three sessions tie that knowledge to a purpose.

Table 62

*Oxfam: Analysis Tools Applied and Findings: Connections*

<table>
<thead>
<tr>
<th>Inquiry Tool</th>
<th>Contextual/Grammar Tools</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversation</td>
<td>Cohesion</td>
<td>Connects individual actions with carbon emissions and connects science curriculum with critical pedagogy to address climate change.</td>
</tr>
</tbody>
</table>

By connecting the issue of climate change with both individual and group efforts to stop and alleviate the impacts of climate change, the curriculum becomes a part of the *Conversation* of critical pedagogy. The broader debate that curriculum needs to be
transformational and personal is embraced by the curriculum. As a part of that *Conversation*, the Oxfam curriculum normalizes a critical application of a science curriculum and demonstrates the ways in which socioscientific issues can be taught through a critical pedagogy. The findings regarding the connections made by the Oxfam curriculum are summarized above in Table 62.

The Oxfam curriculum also connected the socioscientific issue of climate change with the development of a critical pedagogy. This analysis further finalized and confirmed the hypothesis for the third research question: In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy? Analysis of the PreSEES, NEED, and Oxfam curricula, resulted in the final hypothesis: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use of a critical pedagogy by connecting the curriculum with the readers’ cultures, creating valued author and reader identities that form united learning communities, establishing relationships among the author and reader, and engaging students with critical pedagogy processes that require them to form opinions about socioscientific issues based on empirical knowledge and reasoning in order to influence governmental policy. However, opportunities for students to authentically enact sociopolitical change may or may not be present and connect the curriculum with authentic sociopolitical change. Intermediate science curricula and texts that deemphasize the significance of socioscientific issues and suppress the development of *Vision II* scientific literacy undermine the development of a critical pedagogy by using discourse that dismisses socially relevant issues, disconnecting the discussions and
sociopolitical actions of students and teachers from those issues, and dictating student focus by normalizing capitalism and boutique solutions as opposed to allowing students to discover and challenge social issues.

The critical discourse analysis conducted on the PreSEES, NEED, and Oxfam curricula resulted in the formations and confirmations of a hypothesis for each of the research questions addressed in this dissertation. A discussion of these findings along with a consideration of the implications and possible recommendations for further research are presented in chapter 7.
CHAPTER 7
DISCUSSION, IMPLICATIONS, RECOMMENDATIONS

The work completed in this dissertation was built on the foundational beliefs of the researcher, which hold that the omnipresence of science and technology in our society and the societal issues related to them require the development of a critical and scientifically literate citizenry. To do so, socioscientific issues, which are open-ended, controversial issues informed by both science and societal factors such as politics, economics, and ethics and deliberated by both scientists and the public, need to be included in intermediate elementary education (Kolsto, 2001; Sadler, 2004a; Sadler, 2011). However, this work was also based on the assumption that the inclusion of socioscientific issues is not in and of itself a critical process. In fact, the presentation of socioscientific issues in a vacuum without the development of scientific habits of mind and a critical pedagogy act to normalize asymmetrical power relations. Conversely, texts that present socioscientific issues in a manner that increases scientific literacy and empowers the ideas and experiences of students provide opportunities for children to learn how to question and challenge oppressive ideologies.

Therefore, the discourses used in intermediate science texts, and all curriculum, play a significant role in education. Bové (1990) argues that the mundane presence of such discourses gives them “the privilege of unnoticed power, and this power produces instruments of control” (p.54).
Overview of Study

To analyze the discourses that present socioscientific issues in intermediate science curricula, the theories and methodology of critical discourse analysis (CDA) were employed. CDA is both a theory and a methodology that identifies the connections among language, power, and ideology (Fairclough, 1989). It assumes that a relationship exists between discourse and power and that discourse is used to establish a normalized truth (Fairclough, 1989; Gee, 2011a; Riggins, 1997; van Dijk, 2001; Wodak, 2001).

Purpose of the Study

The purpose of this critical discourse analysis was to identify and analyze the discursive strategies used in intermediate science texts and curricula that address socioscientific topics and the extent to which the discourses are designed to promote or suppress the development of scientific literacy and a critical pedagogy.

Research Questions

1. In intermediate science curricula and texts, how is discourse employed to present socioscientific issues?

2. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy?

3. In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy?

Methodology

This dissertation limited its analysis to three curricula focused on energy needs and their impact on climate change. In order to consider varied sources, the curricula
selected were written by organizations with different viewpoints including corporate, educational, and non-governmental or non-profit. Gee’s (2011a; 2011b) processes for critical discourse analysis were applied in order to develop a hypothesis for each research question. The following sections provide a summary and discussion of the answers developed through this process for each research question.

Discussion of Findings: Treatment of Socioscientific Issues

The first research question addressed was: In intermediate science curricula and texts, how is discourse employed to present socioscientific issues? The analysis of all three curricula confirmed the following hypothesis: In intermediate science curricula and texts, discourse is employed to elevate or deemphasize the significance of the socioscientific issue by narrowing it to a specific worldview and developing an identity for the reader that engages him or her with that specific worldview. The findings for this research question, which were presented in the Tables 11-12, 14-15, 18, 21, 24-25, 28 and 30 in Chapter 4 and are summarized in Table 62, demonstrated that intermediate science texts present socioscientific issues in ways that affect how the reader understands their importance, the broader worldview through which the reader conceptualizes the issue, and the attachment of the reader’s identity to that worldview. In other words, the authors of the curricula present the socioscientific issue in the way they want the students and teachers to view it and try to help the reader develop an identity that views the issue in the same way.

The following section details each of these aspects, significance, worldview, and identity. Additionally, it ties the actions of the curricula back to the ways in which they
included or failed to include the elements of socioscientific curricula, as identified by Zeidler and Kahn’s (2014) and discussed in Chapter 2 and summarized in Table 3.

Table 63

Findings Supporting Research Question 1

The Significance of the socioscientific issue was elevated by the PreSEES and Oxfam curricula and deemphasized by the NEED curriculum.

The socioscientific issue was narrowed to specific worldviews by all three curricula.

A reader identity was developed that engaged the reader with that specific worldview.

First, this study found that the intermediate science texts analyzed either elevated or deemphasized the importance of the socioscientific issue under discussion. The significance of climate change was elevated by the PreSEES and Oxfam curriculums. Moreover, the discursive practices they employed functioned in the same ways. Both curricula presented the issue in a way that assumed the reader was not only aware of the Conversation regarding climate change, but was already involved in the Conversation and knowledgeable to the extent that they could discuss it on a technical and formal level. By doing so, the curricula affirm the knowledge of those who are aware of the issue and communicate to readers that are not aware of the socioscientific issue that it is significant enough that they should be. Therefore, all readers receive the message that the issue is important. In these ways, both curricula align with the following elements Zeidler and Kahn (2014) identified as necessary in a socioscientific issue curriculum: engage the students in discussions, arguments and debates, and cooperative learning.
Additionally, both PreSEES and Oxfam use discourse that connects the issue to the lives of the reader. In the case of the PreSEES curriculum, this is accomplished by connecting it with media and famous people. In the Oxfam curriculum, it is achieved by connecting the daily energy activities of the students with the issue. Finally, both curricula use discursive practices that elevate the significance by communicating the dire and imminent impacts of the socioscientific issue and the ways in which they can be addressed. These aspects of the curricula engaged several of the characteristics identified by Zeidler and Kahn (2014) including critically thinking and exploring different opinions and belief systems.

By contrast, the NEED curriculum deemphasizes the socioscientific issue; however, it does so in nearly mirrored ways. Instead of assuming knowledge of the issue, the NEED curriculum deprivileges the issue through purposeful exclusion, which communicates to students who are aware of the issue that it is either insignificant enough to not warrant discussion or that it is a separate issue from energy. For those unaware of the Conversation of climate change, the NEED curriculum fails to make them aware of the issue. Instead of connecting the socioscientific issue to the lives of the readers, the NEED curriculum disconnects the impacts of energy use by using discursive practices that make the issue of pollution less important. It also disconnects them completely from climate change. Finally, instead of using discourse to communicate the detrimental impacts of fossil fuels in energy, the NEED curriculum actually minimizes them by suggesting they are easily and permanently solved. Through these actions, the NEED curriculum also lacks the characteristics of a curriculum that teaches a socioscientific issue with the processes identified by Ziedler and Kahn (2014). The students are not
asked to express their ideas, discuss, explore opinions, argue or debate, think critically, or work cooperatively.

In addition to emphasizing or deemphasizing the significance of the socioscientific issue, all three curricula were found to narrow climate change to a specific worldview. Even though the worldviews promoted by the curricula varied, the three pieces of curriculum used the same processes for doing so. First, all three curricula used normalization to narrow the worldview used to present the issue of climate change. The PreSEES curriculum was written by educators who aimed to present the issue in a way that allowed students to construct their own beliefs regarding the existence and causes of climate change, and the Oxfam curriculum, which was written by a non-profit organization, completely negated climate change denial and questions of the causes of climate change by making both non-issues. Despite these differences, both curricula normalized the understanding that climate change is impacted by human action and does and will continue to affect humans. The NEED curriculum also used normalization to narrow the issue of climate change in the opposite direction. The discursive practices of the NEED curriculum normalized the human use of fossil fuels by presenting them as the most important sources of energy and by deemphasizing their finite amounts. Furthermore, the curriculum normalized the idea that climate change is not connected to the use of fossil fuels. Since Zeidler and Kahn (2014) indicate that socioscientific curricula should allow for dissenting opinions, the Oxfam and NEED curricula do not meet all their criteria. While the PreSEES curriculum meets this criterion, the overall analysis of the text presented a narrowed worldview favored the scientifically-supported arguments regarding climate change.
In addition to normalizing, all three curricula presented the socioscientific issue through a narrowed worldview by connecting the issue and the curricula to specific ideas and communities. In the case of both PreSEES and Oxfam, the issue of climate change was narrowed with discursive strategies, specifically the normalization of a science-based Discourse that connected the issue with the scientific community. Additionally, they both connected climate change with socially constructed communities that accept the human impact on global warming. The PreSEES curriculum also narrows the issue by connecting it with the educational processes of socioscientific science instruction, and by doing so, presents it as an issue to be discussed. In contrast, the Oxfam curriculum narrows the issue by connecting it with the specific and common actions of those living in developed countries. The NEED curriculum narrows the issue of climate change by connecting it with the energy industry. Specifically, it suggests any pollution created by fossil fuels is being addressed and solved by the energy industry. Through both normalization and connection to specific groups and ideas, the curricula analyzed in this study were found to present a narrowed worldview of the socioscientific issue.

In both the PreSEES and Oxfam curricula, engagement with these Discourses meets the criteria set by Zeidler and Kahn (2014). Students are given opportunities to express their ideas, debate, critically think, learn cooperatively, and evaluate information sources. While the curricula engage in the discourse that promotes a scientific and impact-based presentation of climate change, students are given the opportunity to share and explore other views. Conversely, the NEED curriculum does not include the elements of a socioscientific curriculum as identified by Zeidler and Kahn, and therefore limits the student thinking to the worldview it presents.
Finally, the curricula were found to develop an identity for the readers that invited them to engage with the narrowed worldview of the socioscientific issue as presented in each curriculum; and again, they were found to do so with the use of the same discursive functions. Specifically, all three curricula invited the reader to engage in the Conversation and Discourse of the worldview presented by the curriculum and invited the reader to engage in a specific community. Both the PreSEES and Oxfam curricula tied the identity of the reader to the Conversation about global warming and required them to engage in the Discourse of the issue. Additionally, the discourse of the Oxfam curriculum asked readers to adopt climate change Discourse to the extent that it moved them to act on the issue. Inclusion in the Conversation of climate change, including the actions to be taken to address the issue, invite the reader to develop an identity that engages them in the narrowed worldview of climate change presented by both curricula.

In the same vein, the NEED curriculum normalized and invited readers to engage in the Conversations of Consumptionism and Capitalism as they connected with the issue of energy usage. By doing so, the discursive practices used by the NEED curriculum further developed an identity that connected the reader with the worldview of energy use that it promoted. As previously explained, the PreSEES and Oxfam curricula did so through the practices identified by Zeidler and Kahn (2014) while the NEED curriculum did not.

All three curricula also invited the reader to engage with a community that participated in the worldview of climate change that it encouraged. The PreSEES curriculum tied students to famous people and media connected with their worldview while the Oxfam curriculum used discursive practices that built relationships among the reader, Oxfam, government agents, and those who are most victimized by the effects of
climate change. Through these practices, both curricula invited readers to join with others who share the worldview of climate change that they put forward. Similarly, the NEED curriculum invites students to join a community in which energy is a right and a necessity to meet our needs. Inclusion in such a community places the reader with those who engage with energy usage in a manner promoted by the worldview advanced by NEED.

The analysis of all three curricula regarding the ways in which they present a socioscientific issue found that they all use the same discursive practices toward very different intentions. All three curricula elevate or deemphasize the importance of the socioscientific issue by connecting or disconnecting the issue to the reader’s prior knowledge, their life, and the level to which the issue can impact them and others. They also advanced a narrowed, specific worldview of the socioscientific issue through normalization and making connection to specific issues and communities. Finally, the three curricula developed a reader identity aligned with the promoted worldview by encouraging engagement with a specific Conversation and Discourse regarding the issue as well as alignment with communities that also supported that worldview.

Most interestingly, for the implications of this study, the two curricula that elevated the significance of the socioscientific issue included the majority of the elements identified by Zeidler and Kahn. However, the curriculum that deemphasized the issue did not include the elements present in a socioscientific issues curriculum. The fact that the NEED curriculum addressed a socioscientific issue but failed to do so with any of the pedagogical characteristics identified by Zeidler and Kahn will be more fully discussed in the implications section of this chapter.
Discussion of Findings: Treatment of Scientific Literacy

The second research question for this dissertation asked: In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress the development of scientific literacy? The analysis of the three curricula used in this study resulted in the following hypothesis: In intermediate science curricula and texts that elevate the significance of socioscientific issues, discourse is employed to promote the development of \textit{Vision II} scientific literacy through the normalization and use of both applicable terminology and activities and the building of a student worldview that expects future practices and applications of scientific literacy skills. However, in intermediate science curricula and texts that deemphasize the significance of socioscientific issues, discourse is employed to suppress the development of \textit{Vision II} scientific literacy by normalizing the curriculum as the expert, disconnecting scientific literacy skills from the science instruction, and building a student worldview that does not expect opportunities to build scientific literacy skills. The findings used to build this hypothesis were originally presented in Tables 33-34, 36, 38-39, 42, 44, and 46-47 and are summarized in Table 64.

Analysis of all three curricula for the second research question resulted in findings similar to those for the first research question in that the all of the curricula used mirrored processes to achieve opposite results. These parallel findings are first found in the dichotomy of the answer to the research question. Curricula that promote the importance of the socioscientific issue also promote the development of \textit{Vision II} scientific literacy while the curriculum that suppresses the significance of the socioscientific issue also suppresses scientific literacy. These opposite results are also achieved through mirrored
actions. To develop scientific literacy, the curricula actively immerses students in its skills and connects scientific literacy with science so that students come to expect their pairing. Likewise, to suppress scientific literacy, the curriculum excludes scientific literacy skills and disconnects science and scientific literacy skills so that students do not expect them to accompany one another.

Table 64

*Findings Supporting Research Question 2*

The PreSEES and Oxfam curricula normalize and use *Vision II* scientific literacy terminology and activities.

The PreSEES and Oxfam curricula build a worldview in the students and teachers that expects science curricula to provide opportunities to practice and apply *Vision II* skills.

The NEED curriculum normalizes curricula as the expert and disconnects *Vision II* skills from science instruction.

The NEED curriculum builds a worldview in the students and teachers that does not expect science curricula to provide opportunities to practice and apply *Vision II* Skills.

In chapter 2, Roberts (2007) descriptors of *Vision II* scientific literacy were discussed, and they were summarized in Table 31. The skills referenced above include those identified by Roberts and include practices such as making decisions, analyzing information, applying moral and ethical reasoning, being skeptical, accepting ambiguity,
expecting data-driven knowledge, and judging scientific claims with evidence and inference. The remainder of this discussion will identify the specific ways in which those skills were included or excluded by the curricula.

The analysis also found that all three curricula used the same processes regardless of their building or suppression of Vision II scientific literacy. Specifically, the curricula that developed scientific literacy did so by normalizing such processes, engaging students with the processes and language of scientific literacy, and making students part of a culture that engages with those skills. Both PreSEES and Oxfam required students to understand the socioscientific issue by making decisions and analyzing information (Roberts, 2007). Through action and membership, the discourse also developed a worldview that normalized those actions. However, the curriculum that suppressed the development of scientific literacy did so by using the same methods. The curriculum and the authors were normalized as the experts and the students were established as novices. Actions that are the opposite of Vision II scientific literacy, such as isolating or eliminating critical thinking and disconnecting facts and data from opinion formation, were normalized by the curriculum. Students were not expected to engage in Vision II scientific literacy skills such as being skeptical and expecting data-driven knowledge (Roberts, 2007). Students were also immersed in vocabulary and activities that suppressed Vision II skills, such as single-answer questions, unchallenged data, and unsupported opinions. Finally, the readers were invited to join a mental community; however, it was one in which they were the receiver of information from experts. The discursive actions of all three curricula used normalization, activity and vocabulary
immersion, and the creation of mental communities as processes for either developing or suppressing *Vision II* scientific literacy.

Finally, the analysis found that all three curricula engaged in practices that built a worldview in which the students either expected the pairing of science and scientific literacy skills or anticipated science instruction isolated from those skills. The development of each worldview was accomplished with similar discursive practices. Namely, all three curricula built mental communities that either connected or disconnected science and scientific literacy. Additionally, they either assumed the absence or the presence of scientific literacy skills in the reader. Through these actions, the curricula built expectations for the students and created a worldview through which students would judge future science instruction. For the second research question, the development of scientific literacy correlated with the treatment of the socioscientific issue. Regardless of whether the curriculum built or suppressed scientific literacy, the discursive processes used were the same. This analysis supports the previous trend found with the NEED curriculum, which deemphasizes the socioscientific issue and fails to include the characteristics of a socioscientific issue curriculum. This analysis demonstrates that it also suppresses the development of *Vision II* scientific literacy skills.

**Discussion of Findings: Treatment of Critical Pedagogy**

The final research question asked: In intermediate science curricula and texts that mention socioscientific issues, how is discourse employed to promote or suppress critical pedagogy? After analyzing all three curricula, the following hypothesis was formed: In intermediate science curricula and texts that elevate the significance of socioscientific issues and develop *Vision II* scientific literacy, discourse is employed to promote the use
of a critical pedagogy by connecting the curriculum with the readers’ cultures, creating valued author and reader identities that form united learning communities, establishing relationships among the author and reader, and engaging students with critical pedagogy processes that require them to form opinions about socioscientific issues based on empirical knowledge and reasoning in order to influence government policy. However, opportunities for students to authentically enact sociopolitical change may or may not be present and connect the curriculum with authentic sociopolitical change.

Table 65

*Findings Supporting Research Question 3*

The PreSEES and Oxfam curricula:

- connect student culture with the curriculum.
- create united learning communities.
- establish relationships between the author and the reader.
- connect critical pedagogy processes in order to influence public policy.
- connect the curriculum with authentic sociopolitical change.

The NEED curriculum:

- dismisses socially relevant issues.
- disconnects issues from student and teacher discussions and sociopolitical actions.
- dictates student focus.

Intermediate science curricula and texts that deemphasize the significance of socioscientific issues and suppress the development of *Vision II* scientific literacy
undermine the development of a critical pedagogy by using discourse that dismisses socially relevant issues, disconnecting the discussions and sociopolitical actions of students and teachers from those issues, and dictating student focus by normalizing capitalism and boutique solutions rather than allowing students to discover and challenge social issues. The findings that support the third research question were originally presented in Chapter 4 in Tables 49-52, 54, 56, 58, and 60-62 and are summarized in Table 65. The critical pedagogy indicators, based on Santos’ (2009) writings, were originally discussed in chapter 2 and summarized in Table 48, and they are used in the discussion below regarding how each curriculum treats critical pedagogy.

To engage students in a critical pedagogy, both PreSEES and Oxfam made connections between the issue and the culture and individual actions of the student. Doing so engaged them personally and in the pro-community goals of science education identified by Santos (2009). Additionally, both curricula provided opportunities for the reader to participate in the practices of critical pedagogy, and by doing so, they built the relationships that are an essential component of a critical pedagogy. Those mental communities were used by the curricula as a way for the students to connect their learning to the action of influencing social policy. However, the most significant finding regarding the development of a critical pedagogy is that the two curricula differed in their connection of the curriculum to authentic sociopolitical change. Unlike the Oxfam curriculum, which actually engaged students in political and social action, the PreSEES curriculum only provided a mocked-up activity. Based on the elements of a critical pedagogy, the involvement of students in activities that challenge and change the status quo is essential. Santos (2009) details transformational experiences for teachers and
students as one of the indicators of critical pedagogy. Therefore, while the case-study activity provided by the PreSEES curriculum gives students the opportunity to practice the skills of sociopolitical change, it does not meet all of the elements of a critical pedagogy. This demonstrates that curricula can elevate the importance of a socioscientific issue and develop scientific literacy, yet still not fully develop a critical pedagogy.

The findings for the third research question are also unique in that the discursive practices of the curricula do not mirror one another. The PreSEES and Oxfam curricula developed a critical pedagogy by creating connections among the student, the issue, the curriculum, and the authoring organization. They also created a mental community to support the activities involved in a critical pedagogy. However, the discursive actions of the NEED curriculum did not use the same strategies to suppress a critical pedagogy. Essentially, building a community and making connections between the curriculum and the students are moves toward a critical pedagogy, so it is logical that the mirrored processes found for the first two research questions are missing in this case. Instead, the NEED curriculum suppressed a critical pedagogy with processes that oppose it: enforced limitations, hegemonic solutions, negation of or direct suppression of the need for a critical pedagogy, and normalization of the status quo. These actions run counter to the indicators identified by Santos (2009) including personal engagement, non-capitalistic and pro-community solutions applied to science education, challenging dominant worldviews, and providing transformational experiences that disrupt the status quo.

The findings also furthered the pattern found in the first two research questions that demonstrated that the curricula stayed aligned in all three research questions. The PreSEES and Oxfam curricula, which elevated the socioscientific issue by using the
characteristics of SSI curriculum and built scientific literacy, also engaged in a critical pedagogy. However, the NEED curriculum, which de-emphasized the socioscientific issue and suppressed the development of scientific literacy, suppressed the elements of a critical pedagogy.

In Chapter 1, a conceptual framework was proposed for this study that theorized the uses of socioscientific issues. The conceptual framework argues that a curriculum can address socioscientific issues yet fail to do so in a critical or transformational manner. Furthermore, it argued that to engage with a socioscientific issue in a critical and transformational way, the curriculum must include the development of *Vision II* scientific literacy, a critical pedagogy, or both. Based on the analysis of the three curricula, each can be placed in the conceptual framework. See Figure 2 below.

**Figure 2. Conceptual Framework with Identification of Analyzed Curricula**
Since both the PreSEES and Oxfam curricula develop scientific literacy and critical pedagogy skills, they would both be placed in the area identified with the number 3 and would be found to present a socioscientific issue in a way that is critical and transformative. The NEED curriculum, which mentions a socioscientific issue without developing either a critical pedagogy or scientific literacy, would be placed in position 4. Such placement demonstrates that the curriculum is presenting the socioscientific issue in a way detached from the processes that teach students how to engage and challenge such issues in our society.

Implications

The findings of this research provide valuable information in all three areas of education identified by the research questions: socioscientific science education, scientific literacy instruction, and critical pedagogy. Additionally, the study contributes to the field of critical discourse analysis in elementary education curriculum development. The implications for each are discussed below.

First, the study confirms one of the original arguments of this research, which is that science curricula can address socioscientific issues and yet fail to do so in a way that develops the skills needed by our citizenry to confront and deal with them. The research demonstrated the ways in which the NEED curriculum approached the issue of energy and its implications while simultaneously disregarding its social, political, economic, and environmental issues. For educators and curriculum specialists, these findings support efforts to question and challenge curriculum developers and sources. In the curriculum analyzed for this research, the interests of the petroleum and energy companies were normalized by the discourse. Additionally, they were used to dismiss the socioscientific
issue and its implications on broad societal problems. Due to perennial funding issues in education, the use of free, web-based curriculum will become more common place (Terrell, 2016). With current trends in STEM education, educators are encouraged to develop and sustain corporate relationships. The findings of the NEED curriculum indicate that educators and curriculum specialists need to be thoughtful when using curriculum designed by corporations.

The findings of this research also demonstrate the significant difference in how socioscientific issues are presented based on the ideology and political viewpoints of the authoring group. While all three curricula narrowed the curricula to their own worldview and while it is impossible to remove ideology from curriculum, the analysis did demonstrate that curriculum that include the characteristics of SSI instruction and that elevate the significance of the socioscientific issue also develop scientific literacy skills and critical pedagogy. However, the curriculum that deemphasized the importance of the issue and failed to use the characteristics of SSI instruction also suppressed the development of scientific literacy and critical pedagogy. Therefore, educators and curriculum specialists need to challenge or reject curricula that discuss socioscientific issues without utilizing the characteristics of SSI and developing scientific literacy and critical pedagogy.

The research also found a connection between the addressing of the socioscientific issues and the development of scientific literacy. Both the PreSEES and Oxfam curricula presented the socioscientific issue of climate change in an expanded fashion that allowed students to consider all social aspects and to develop their own fact-based opinion about the issue. Simultaneously, they both developed Vision II scientific
literacy. Conversely, the NEED curriculum suppressed both the socioscientific issue and scientific literacy. For educators evaluating and adopting curricula, these findings could be used as a benchmark requirement for curricula that addresses socioscientific issues. The conceptual framework for this study could be used as a tool to identify the alignment of the curriculum and its connection to or disconnection from a transformational educational experience. If future research, which is more fully discussed in the next section, confirms the correlation between the development of the socioscientific issue and scientific literacy, curricula that address socioscientific issues should only be adopted when they also build a Vision II scientific literacy for the students. In other words, they would have to align with position 2 or 3 on the conceptual framework.

The findings also have implications for those educators interested in developing and expanding the use of curricula that engage a critical pedagogy. This research demonstrates that curricula that address a socioscientific issue may stop short of providing opportunities for students to engage in authentic sociopolitical change. Therefore, these findings document the need for critical pedagogy scholars and practitioners to develop either supportive networks or further curricula that demonstrate the ways in which all socioscientific issue curricula can be altered to develop a critical pedagogy.

Additionally, the study supports the ways in which critical pedagogy, scientific literacy, and socioscientific issue science instruction can be simultaneously developed. The accountability culture in education places the most significance on student performance, and the processes focused on dictated standards take precedence over the processes and goals of critical pedagogy. Based on this discrepancy and the small
number of curricula found through the extensive online search conducted for this study, a need exists for the development of more curricula that integrates critical pedagogy. The findings of this research suggest such curricula should be approached from the perspective of how they can teach the socioscientific issue through the development of scientific literacy and critical pedagogy. Such an approach would result in opportunities for students to fully develop their own understanding of the issue and its many implications.

Finally, this research has implications for the use of critical discourse analysis in elementary education. One need for this study was based on the framework of Rogers, Malancharuvil-Berkes, Mosley, Hui, and Joseph (2005), which indicated the need for critical discourse analysis to be used in the study of elementary education curricula and materials. Rogers, et al. argue that the discursive practices used in these materials can function to propagate hegemonic structures. The analysis conducted in this study found that the discourse was used to dismiss the significance of climate change and suppress the development of scientific literacy and critical pedagogy. For critical discourse analysis scholars, this study documents the discursive strategies being used to shape ideology. Additionally, it provides research that can be used for continued analysis of curricula resources and the processes they use. Additionally, this study documented the impact of the authoring organization’s ideology on the curricula. For educators selecting curricula or individuals who are interested in analyzing the discourse of curricula, these findings demonstrate the need to consider originating sources of curricula. Due to the suppressive nature of the NEED curricula, the findings also support the need for further analysis of curricula written with the backing of corporations. This is especially true for curricula
designed for intermediate elementary students for two reasons. As previously mentioned, worldviews are established at this critical age so it is important to challenge hegemonic curricula used at this grade level. Additionally, intermediate elementary teachers may not possess the subject matter content knowledge that allows them to confidently challenge such curriculum. Therefore, it is important that such curricula is identified and challenged.

Recommendations for Further Research

This study indicates the need for additional research in multiple areas. First, Gee (2011a) argues that the answers found in any analysis are only hypotheses in that further data collection functions to confirm or challenge them. Validity for these findings was established with coverage, the way in which the themes found in one area could be extended to other areas of the text or other curricula, and convergence, the way in which the data led to similar conclusions. Additionally, the themes found were validated by considering the contextual and grammatical linguistics of the curricula. However, Gee promotes the idea that validity is social. Therefore, further analysis of other socioscientific texts is needed in order to confirm these findings. Additional analysis would further confirm the correlation between fully discussing and addressing the socioscientific issue and developing scientific literacy.

The findings of this study suggest that science curricula that address socioscientific issues should, at a minimum, develop Vision II scientific literacy skills. As previously mentioned, doing so would result in the presentation of the socioscientific issue in a manner that allows students to form their own ideas about the issue and develop the skills needed to be scientifically literate members of society. Therefore, one
additional area of research involves the creation and application of additional curricula that integrate scientific literacy skills with the presentation of socioscientific issues.

Additionally, this study warrants more analysis of curricula written by corporations or corporate-sponsored organizations. Such research would confirm or challenge the findings that all such curricula dismiss socioscientific issues and suppress scientific literacy and critical pedagogy. Analysis of curricula written by non-profit organizations can also establish the patterns found and gather information to be used by those adopting curricula.

Finally, this study focused only on analyzing the intended effects of the discourse used in these curricula. It did not address the actual impact these curricula may have on students and teachers. Therefore, further research is needed to measure the impacts these curricula have on student understandings of climate change and their development of scientific literacy and critical pedagogy. Such research could be used to establish correlations between curricula intent and impact and further guide curricula writers and adopters.

Conclusion

This research is built on the argument that a scientifically literate citizenry capable of critically interacting with the numerous and complicated science-related policy issues is critical to the future of our world. However, the mere inclusion of socioscientific issues in the curricula does not guarantee the development of students’ full understanding of the various aspects of each issue. Based on the analysis of the curricula used in this study, the socioscientific issue of energy use and its impacts, specifically climate change, can be completely dismissed by any curriculum that suppresses the
scientific literacy and critical pedagogy skills of the student. However, the socioscientific issue can also be fully understood through the development of a student’s scientific literacy and critical pedagogy. Therefore, in order to prevent the presentation of socioscientific issues in a politicized, subjugating manner, science curricula at the intermediate elementary level must partner socioscientific issues with activities that advance students’ scientific literacy.

The purpose of this critical discourse analysis was to identify and analyze the discursive strategies used in intermediate science texts and curricula that address socioscientific topics and the extent to which the discourses are designed to promote or suppress the development of scientific literacy and a critical pedagogy. The analysis found that the curriculum that dismissed the socioscientific issue of climate change did so by using strategies that disconnect science from society and connect it with individual needs, and that disconnect science content from science skills and sociopolitical action. Similarly, the curricula that developed the students’ understandings of climate change did so by making connections between the issue and society at large and between science content and scientific literacy and critical pedagogy. The development of a citizenry prepared to confront the socioscientific issues our world faces depends on the creation of curricula that forge such connections and allow students to develop the vital skills included in scientific literacy and critical pedagogy.
REFERENCES


hooks, b. (1994). *Teaching to transgress: Education as the practice of freedom*. New York:


APPENDIX A

SEARCHING AND NARROWING PROCESS FOR IDENTIFYING CURRICULA

Search Phrases Entered into Google to Identify Curricula

Search 1: “intermediate elementary energy curriculum”
Search 2: “intermediate elementary energy lesson plans”
Search 3: “intermediate elementary climate change curriculum”
Search 4: “intermediate elementary climate change lesson plans”
Search 5: “intermediate elementary global warming curriculum”
Search 6: “intermediate elementary global warming lesson plans”
Search 7: “everyday science issues global warming elementary curriculum”
Search 8: “everyday science issues global warming elementary lesson plans”
Search 9: “everyday science issues climate change elementary curriculum”
Search 10: “everyday science issues climate change elementary lesson plans”
Search 11: “everyday science issues energy elementary curriculum”
Search 12: “everyday science issues energy elementary lesson plans”

Categories of the Types of Materials to which the Top 10 Searches Linked

(A) Journal or news article

(B) Blog

(C) Links directly to curriculum or lesson plans – Curricula sites eliminated from the search because their content or grade level fell outside the parameters of this study are also labeled with “wrong content or level.”
(I) Information and research as well as links to other sites

(L) Links to other sources or websites that include curriculum resources

(S) Standards listed and described

(T) Textbook

Top 10 Links and Source for Each Google Search Conducted in October 2016

Search 1: “intermediate elementary energy curriculum”

1. (C) Elementary Curriculum Resources – The NEED Project

2. (C) Intermediate Curriculum Resources – The Need Project (wrong content or level)

3. (C) Curriculum Resources: Efficiency & Management – The NEED Project

4. (C) Energy Curriculum – Energy Education- The NEED Project

5. (C) Curriculum Resources: Wind – The NEED Project (wrong content or level)

6. (C) Curriculum Resources: Solar – The NEED Project (wrong content or level)

7. (C) Energy Curriculum – PGE – The NEED Project (wrong content or level)

8. (C) Free Energy Curriculum and Lesson Plans- The NEED Project

9. (C) NREL: Workforce Development and Education Programs – National Renewable Energy Laboratory

10. (L) Solar Curriculum, Activities, Events and Resources – Florida Solar Energy Center

Search 2: “intermediate elementary energy lesson plans”

1. (C) SECO: Renewable Energy Lesson Plans – State Energy Conservation Office
2. (C) Download Lesson Plans and Activities – Energy4Me – Society of Petroleum Engineers

3. (C) Education: Lesson plans for educators on wind energy – American Wind Energy Association (materials not available)

4. (C) What is Energy? – Lesson – Teach Engineering Curriculum for K-12 Teachers


6. (C) Physical Science Lesson Plans: Intermediate Energy Infobook – Share My Lesson- American Federation of Teachers

7. (L) Science Lesson Plans for Teachers – Kids.gov

8. (C) EIA Energy Kids: Lesson Plans – US Energy Information Administration

9. (C) Energy from the Sun – Center for Science Education (wrong content or level)

10. (C) Lesson Plans Exploring NGSS – Wayne RESA (wrong content or level)

Search 3: “intermediate elementary climate change curriculum”

1. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools

2. (L) Climate Change Lesson Plans for Elementary School – Concordia University

3. (L) Climate Change Curriculum Connections – National Wildlife Federation

4. (C) Lesson Plans – Elementary- My NASA Data – NASA

5. (L) Youth Education: Cornell Climate Change – Cornell University

6. (C) Curriculum Resources: Climate Change – The NEED Project
Search 4: “intermediate elementary climate change lesson plans”

1. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools

2. (C) Lesson Plans for Educators: A Student’s Guide to Global Climate -United States Environmental Protection Agency (wrong content or level)

3. (C) Lesson Plans – Elementary: MY NASA DATA – NASA

4. (L) Climate Change Lesson Plans for Elementary School – Concordia University middle school

5. (C) Lesson Plan: Global Warming – NOW: Public Broadcasting System (wrong content or level)

6. (L) Environment and Climate Change Lesson Plans for Teachers- English Language Arts Flow.com

7. (L) Teachers Guide on Climate Change and Global Warming – Joy Hassol, environmental science writer

8. (C) Teaching English: Lesson Plans Climate Change (PDF) – British Council (wrong content or level)
10. (C) Earthwatch: Education Lesson Plans for Teachers- Earthwatch Institute

Search 5: “intermediate elementary global warming curriculum”

1. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools
2. (L) Climate Change Lesson Plans for Elementary School – Concordia University
3. (L) Teachers Guide on Climate Change and Global Warming – Joy Hassol, environmental science writer
4. (L) Climate Change Curriculum Connections – National Wildlife Federation
5. (C) Climate Change: Vital Signs of Planet: PBS/NASA Modules
6. (C) Lesson Plans – Elementary- My NASA Data – NASA
7. (L) Elementary School: Climate Change Education – Climate Change Education Organization
8. (L) Youth Education: Cornell Climate Change – Cornell University
9. (C) Intermediate Curriculum Resources – The Need Project (wrong content or level)
10. (B) Teaching Climate Science: It’s Elementary – National Center for Science Education

Search 6: “intermediate elementary global warming lesson plans”

1. (C) Lesson Plan: Global Warming – NOW: Public Broadcasting System (wrong content or level)
2. (C) Lesson Plans for Educators: A Student’s Guide to Global Climate - United States Environmental Protection Agency (wrong content or level)

3. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools

4. (C) Global Warming Lesson Plan – Public Broadcasting System (PBS) (wrong content or level)

5. (L) Teachers Guide on Climate Change and Global Warming – Joy Hassol, environmental science writer

6. (L) Climate Change Lesson Plans for Elementary School – Concordia University

7. (C) Teaching English: Lesson Plans Climate Change (PDF) – British Council (wrong content or level)

8. (C) Effects of Global Warming Lesson Plan (PDF) – Ventura County Air Pollution Control District (wrong content or level)

9. (C) Lesson Plans – Elementary- My NASA Data – NASA

10. (C) Lesson Plans – Middle School – My NASA Data – NASA (wrong content or level)

Search 7: “everyday science issues global warming elementary curriculum”

1. (A) Preparing Elementary and Secondary Pre-Service Teacher - PreSEES (PDF)

2. (C) Why everyday science? – PreSEES

3. (L) Lesson Plans, Teacher Guides and Online Resources for Educators – Environmental Protection Agency
4. (A and L) Climate Literacy in the Elementary Classroom - Ohio State University

5. (L) NSTA: Freebies for science teachers – NSTA

6. (A) The framework for teaching socio-scientific issues (DOC) - PreSEES

7. (S) Meteorology Standards – Georgia Standards – State of Georgia

8. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools

9. (A) Preparing Elementary Pre-Service Teachers to Teach Socio-Scientific – PreSEES

10. (A) New Science Standards Put Global Warming at Core of Curriculum – National Review

Search 8: “everyday science issues global warming elementary lesson plans”

1. (C) Global Warming Lesson Plan – Public Broadcasting System (PBS)
   (wrong content or level)

2. (L) Lesson Plans, Teacher Guides and Online Resources for Educators – Environmental Protection Agency

3. (C) An Inconvenient Truth – National Wildlife Federation (PDF) (wrong content or level)

4. (C) Earth Science Lessons, Printables, & Resources (K-12) Teacher Vision
   (wrong content or level)

5. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools

6. (L) Kindergarten Science Lesson Plans – Teacher.org
7. (L) NSTA: Freebies for science teachers – NSTA
8. (A and L) Earth Day: Lesson Plans, Reading Lists, and Classroom Ideas - Edutopia
10. (C) A Global Warning: The Earth is Getting Warmer – Royal Society of Chemistry

Search 9: “everyday science issues climate change elementary curriculum”
1. (L) Lesson Plans, Teacher Guides and Online Resources for Educators – Environmental Protection Agency
2. (A and L) Climate Literacy in the Elementary Classroom - Ohio State University
3. (L) Climate Change Curriculum Connections – National Wildlife Federation
4. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools
5. (L) NSTA: Freebies for science teachers – NSTA
6. (L) NSTA: Climate Science Resources – NSTA
7. (A) Preparing Elementary and Secondary Pre-Service Teacher - PreSEES (PDF)
8. (A) Preparing Elementary and Secondary Pre-Service Teacher - PreSEES (PDF)
9. (A) Curriculum offers teachers a new tool for teaching about climate - The Day
10. (A) Climate change included in US science teaching guidelines for the first time – The Guardian

Search 10: “everyday science issues climate change elementary lesson plans”

1. (L) Lesson Plans, Teacher Guides and Online Resources for Educators – Environmental Protection Agency
2. (L) Climate Change Live – Lesson Plans – Prince William County Public Schools
3. (A and L) Earth Day: Lesson Plans, Reading Lists, and Classroom Ideas - Edutopia
4. (L) NSTA: Freebies for science teachers – NSTA
5. (C) Global Warming Lesson Plan – Public Broadcasting System (PBS) (wrong content or level)
6. (C) An Inconvenient Truth – National Wildlife Federation (PDF) (wrong content or level)
7. (C) Hands-On Science and Literacy Lessons About Weather and Climate - Ohio State University
8. (T) Global Change: from research to the classroom - CarboSchools.org
10. (C) Education Resources for Secondary (7-12) Grades – United States Geological Survey (wrong content or level)

Search 11: “everyday science issues energy elementary curriculum”

1. (L) Science Lesson Plans for Teachers – Kids.gov
2. (A) Teaching about energy: From everyday to scientific understanding - Robin Millar
3. (A) University Energy Education Curriculum Project – Eastern Kentucky University
4. (L) NSTA: Freebies for science teachers – NSTA
5. (C) Citizen science: Real-world applications for science students – University of North Carolina School of Education (wrong content or level)
6. (L) Lesson Plans, Teacher Guides and Online Resources for Educators – Environmental Protection Agency
7. (C) Energy Unit – Teach Engineering.org (wrong content or level)
8. (S) Physics Curriculum The Georgia Performance Standards PDF – State of Georgia
9. (I) Teach Nuclear: Nuclear energy is already used every day in…- Canadian Nuclear Association
10. (C) The Energy Problem Lesson – Teach Engineering.org (wrong content or level)

Search 12: “everyday science issues energy elementary lesson plans”

1. (C) 6-8 Lessons – 3M Science of Everyday Life – Discovery Education (wrong content or level)
2. (L) Science Lesson Plans for Teachers – Kids.gov
3. (L) NSTA: Freebies for science teachers – NSTA
4. (L) Kindergarten Science Lesson Plans – Teacher.org
5. (C) Lesson Plan – The Energy Problem (PDF) – Clarkson University (wrong content or level)

6. (L) Lesson Plans, Teacher Guides and Online Resources for Educators – Environmental Protection Agency

7. (C) New Summer Activities – 3M Science of Everyday Life – Discovery Education (wrong content or level)

8. (C) Lesson Plan: Scientific Method – Flocabulary (wrong content or level)


10. (I) Brand New Science Passages – Readworks.org

Sites Resulting in Viable Curricula After Removal of Duplicates, Those Not Meeting Criteria, and Those Not Directly Linked to Curricula or Lesson Plans

1. (C) Elementary Curriculum Resources – The NEED Project

2. (C) Curriculum Resources: Efficiency & Management – The NEED Project

3. (C) Energy Curriculum – Energy Education- The NEED Project

4. (C) Free Energy Curriculum and Lesson Plans- The NEED Project

5. (C) NREL: Workforce Development and Education Programs – National Renewable Energy Laboratory

6. (C) SECO: Renewable Energy Lesson Plans – State Energy Conservation Office

7. (C) Download Lesson Plans and Activities – Energy4Me- Society of Petroleum Engineers

8. (C) What is Energy? – Lesson – Teach Engineering Curriculum for K-12 Teachers

10. (C) EIA Energy Kids: Lesson Plans – US Energy Information Administration


12. (C) Curriculum Resources: Climate Change – The NEED Project

13. (C) Climate Challenge for 7-11 years - Oxfam

14. (C) Earthwatch: Education Lesson Plans for Teachers- Earthwatch Institute

15. (C) Climate Change: Vital Signs of Planet: PBS/NASA Modules

16. (C) Why everyday science? – PreSEES

17. (C) A Global Warning: The Earth is Getting Warmer – Royal Society of Chemistry

18. (C) Hands-On Science and Literacy Lessons About Weather and Climate- Ohio State University

Curricula Categorized by Organization Type and Frequency in Google Searches

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