HOW PRE-SERVICE ELEMENTARY TEACHERS EXPRESS EMOTIONS ABOUT CLIMATE CHANGE AND RELATED DISCIPLINARY IDEAS

A Dissertation in
Curriculum and Instruction

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

May, 2014
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ABSTRACT

As we face the challenges of serious environmental issues, science education has made a commitment to improving environmental literacy, in particular climate literacy (NRC, 2012; 2013). With an increased focus on climate change education in the United States, more research on the teaching and learning of this problem in science classrooms is occurring (e.g. Arslan, Cigdemoglu, & Moseley, 2012; Svhila & Linn, 2012). However, even though people experience a range of emotions about global problems like climate change (Hicks & Holden, 2007; Ojala, 2012; Rickinson, 2001), little attention is given to their emotions about the problem in science classrooms. Because emotions are evaluative (Boler, 1999; Keltner & Gross, 1999), they provided a lens for understanding how students engage personally with climate change. In this study, I drew from sociolinguistics, social psychology, and the sociology of emotions to examine a) the social interactions that allowed for emotional expressions to be constructed and b) the ways in which pre-service elementary teachers constructed emotional expressions about climate change in a science course. Three overall findings emerged: 1) emotions provided a means of understanding how students’ conceptualized climate to be relevant to their lives, 2) emotional expressions and the aboutness of these expressions indicated that the students conceptualized climate change as distanced, both temporally and spatially, and 3) although most emotional constructions were distanced, there were multiple instances of emotional expressions in which students took climate change personally. Following a discussion of the findings, implications, limitations, and directions for future research are also described.
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ACKNOWLEDGEMENTS

It only makes sense that a study about emotions is grounded in love, and as such I wish to thank some of the people who have shared their love in various forms these last few years.

To Peter and Hazel.
I cannot imagine sharing this journey with any other people. You help me be the person I want to be and for that I cannot thank you enough. I love you.

To my advisor, Greg.
Your thoughtfulness, wit, wisdom, and support have helped me grow as a scholar and educator. I am profoundly thankful for the time and energy you have put into my work.

To my committee members, Carla, Susan, and Stephanie.
I am incredibly grateful for your encouragement, generosity, and wisdom. I am inspired by each of you and your scholarly endeavors.

To the Hufnagel and Yezukevich families –
Mary Ellen, George, Kati, Jim, Margaux, James, Mary Anne, George, Mary, Viktor, Michael, Ellen, Al, Malcolm, David, Sheryl, and Julia –
and to my friends who are like family –
Catherine, Jenny, Jenn, Shannon, and Hon.
Your countless ways of supporting me in whatever dream I have, especially during the last four years, has been a constant source of strength for me. I love and thank you.

To the friends and mentors I have met while at Penn State, especially Alicia, Kortney, Madhu, and Vince
Your wisdom, generosity, and humor have been paramount to my journey.

To my former students in Boston and Brookline:
Working with you was the impetus and inspiration for this study. Thank you for being you.
Chapter 1: Introduction
We face a myriad of environmental issues that are both global and specific to communities. Although the research into pre-service teachers’ understandings of many of these dilemmas is varied in terms of methodologies and methods, students’ emotional responses to these crises is generally neglected. Work on the role of specific emotions like empathy in reasoning about socioscientific issues, in particular genetic engineering (Sadler & Zeidler, 2004, 2005), indicates the fruitfulness for research in all emotions in reasoning about environmental topics. Examining the role of emotions in environmental science learning is important because of the burdensome nature of the content. Underlying many environmental problems is the role humans play in causing such problems in many instances. To truly teach and learn environmental science means to engage in the ownership of our individual and collective actions. Over the last two decades voluminous research has illustrated people experience a range of emotions about climate change (e.g. Hicks, 1996; Swim et al., 2011). However, because of the perception of science as objective and value-free, there is an underlying tension within environmental science classrooms between teaching the facts and participating in ways of knowing, which includes emotions, in robust conceptualizations of objectivity. The dichotomy between valuing emotional sense-making and recognizing the importance of objective criteria for scientific knowledge is problematic in environmental science classrooms because if students understand the nature of environmental problems they will have emotions about them. Work in environmental psychology and environmental science has demonstrated that environmental decision-making requires emotionality (Mankad, 2012) because it not only promotes motivational and behavioral engagement, but also provides a means to encapsulate the complexity of these issues (Vining & Tyler, 1999). Emotions are evaluative, and hence decisions and learning in general can not be construed as rational because emotions “are an inescapable part of normal thought” (Lakoff,
2010, p. 72). In addition, emotions provide us with “information about what we care about and why” (Boler, 1999, p. xviii). Therefore emotions can indicate whether or not a student is moving beyond rote memorization and truly engaging with the understandings and practices of environmental science so that they may make well-informed decisions, a goal of not only environmental education (Colucci-Gray, Camino, Barbiero, & Gray, 2006) but also science education (National Research Council, 2012).

Examining emotions could not only improve student learning but could also provide a more realistic and holistic view of students’ understanding of and intentions to address the problem. However, how to investigate emotions in a classroom context so as to account for their nuanced connotations has been minimally studied in the field of education. With most research on emotion in science education focusing on the essentialized nature of emotions or “academic” emotions, there is more work to be done exploring the situatedness of students’ emotions, especially in response to environmental learning.

**Perceived Objectivity of Science**

While the role of emotions is imperative to making sense of our worlds, including the worlds of scientists, emotions themselves are markedly absent in science in classrooms, or school science. Classroom budgets, school-day schedules, teacher education, testing, and curriculum all contribute to the way science is conceptualized and taught (Committee on Science Learning, 2007) as a “final form” science (Duschl, 1990), whereby science consists of objective theories or the conclusions of science (Schwab, 1960). The research on students’ and teachers’ views of the nature of science provides some insights into the way in which science is operationalized in classrooms as well (e.g. Chen, 2006; Osborne, Simon, & Collins, 2003; van Aalderen-Smeets, Walma van der Molen, & Asma, 2012). One major finding within this body of
research is that many teachers and students do not understand science products based on rigorous and systematic evidence to be tentative and potentially biased, even with interventions (e.g. Carey, Evans, Honda, Jay, & Unger, 1989; Committee on Science Learning, 2007). This research is important because it provides a context for how science is taught in schools; again as static and impartial. At the same time, this body of research, while addressing some affective components of science, such as attitudes (e.g. Osborne et al., 2003), beliefs (e.g. Riegle-Crumb, Moore, & Ramos-Wada, 2011), and worldviews (Aikenhead, 1996), does not provide insight into what teachers and students know about emotions in science or scientists’ emotions. School science is represented and taught as objective and emotionless (Zembylas, 2002). Hence, typically what is presented in science classrooms are rational products of scientists, and even with the move to embed scientific practices within school science (NGSS Lead States, 2013), emotions of students, teachers, and scientists are overwhelmingly neglected. Currently, the focus of science classrooms is not on the practice of scientists but rather its products, or facts (Committee on Science Learning, 2007).

As we continue to face the challenges of serious and dire environmental problems, science education has made a commitment to improving environmental literacy, in particular climate literacy. In 2011, the National Research Council (NRC) concluded that anthropogenic climate change “poses significant risks for a broad range of human and natural systems” (p. 2). In addition, they also called for increased climate literacy (NRC, 2011), which, not surprisingly corresponds to the recent framework for K-12 education (NRC, 2012) and the Next Generation Science Standards (NGSS) (NGSS Lead States, 2013). In the NGSS, climate change is a
disciplinary core idea and human sustainability has its own performance expectations. Hence, learning about climate change is imperative to our global well-being, and is recognized as such by the science education community. However, despite the increased prioritization of climate change as an urgent issue in science education it continues to be researched in ways that marginalize emotions and reinforce the perceived objectivity of science. Even though there are connections between emotions and learning (Hascher, 2010; Imai, 2010; Immordino-Yang & Damasio, 2007), school performance (e.g. Gläser-Zikuda, Fuß, Laukenmann, Metz, & Randler, 2005; Glaser-Zikuda & Fuss, 2008; Meyer & Turner, 2006), and decision-making (e.g. Sadler & Zeidler, 2004, 2005), emotions are largely neglected in research on student learning about climate change.

**Brief History of Emotion Marginalization**

The history of emotion’s exclusion from science is long and embedded in Western traditions that continue to serve as structures of neglect today. Emotion has traditionally been excluded from science (Watts, 2005) and science education (Zembylas, 2005), because of the underlying assumption in Western thought that knowledge is rational and unbiased (e.g. Boler, 1999; Shields, 2002; Solomon, 2007; Zembylas & Barker, 2002). As Midgley argues, the dichotomy between “reason and emotion and the threat that emotion poses to emasculate reason are long-standing Western notions, even though dichotomizing these qualities is itself not logically based” (as cited in Shields, 2007, p. 93). Taking this idea even further, Boler (1999)

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1 **HS.ESS-CC Climate Change** is based in Earth and Space Sciences (ESS3.D Global Climate Change). **HS.ESS-HS Human Sustainability** is based in Earth and Space Sciences (ESS3.C – Human Impacts on Earth Systems).
maintains that emotion is purposefully excluded from both science and education based on the historical dichotomy between truth & reason and subjectivity & emotion. Science, as well as by extension, science education, has traditionally been replete with dualisms, including the emotion/reason dualism due to the Enlightenment epistemology of science (Brickhouse, 2001). The dualism that separates reason from emotion limits not only our ways of making sense of the world but also the ways in which we express ourselves. Yet, even the “most radical social theories tend to overlook this most silenced terrain of social control and resistance” (Boler, 1999, p. xx).

Why Research on Emotion in Science Classrooms is Important

Even though emotions are typically marginalized in school science settings, emotions are still part of learning. Research from various education fields illuminate the ways in which messages about emotions and emotions themselves contribute to learning environments. To begin with the most obvious, emotions, as inherently biological reactions, are always present, although they may not be articulated. Meghan Boler’s work on the role of emotions in education is especially important in this discussion. In her book, *Feeling Power: Emotions and Education*, she examines the ways in which discourses on science, education, and religion in the United States have changed in the last 100 years, yet still ignore emotion. She uses the term “inscribed habits of inattention” to “describe the selectivity of our attention” to emotions in both ourselves and others (Boler, 1999, p. 16), both in the past and present. Because these inscribed habits represent and are entrenched in educational discourse, whether acknowledged or not, emotions occur in every classroom, including the “most sterile and rational” (Boler, 1999, p. 15) ones. As a result, every classroom has both implied and overt messages about emotions and their value. But because there are so few instances in which explicit conversations about emotions occur, she
found that “…what defines the discourses of emotion most predominantly are silences” (Boler, 1999, p. 140).

**Emotions as a means to addressing social justice and morality.** As personal knowledge, emotions provide an inroad to addressing social justice and morality. While Boler (1999) draws upon the work of feminists in consciousness-raising to illustrate the value of emotions in dissatisfaction with the status-quo, including educational institutions, the recommendations she makes lend themselves to environmental science education, which is also replete with morality and can even be viewed as a form of social justice, especially since many community-based environmental problems disproportionately affect communities who are poor or are people of color. For example, people who express their anger about an environmental problem can catalyze “demands for justice and change” (Boler, 1999, p. 114). In order to understand emotion, we must examine justice, for not only do they overlap, but justice informs emotion as well (Jasso, 2007). Research on teachers’ emotions about their identity in relation to teaching multicultural education illuminates the tensions between their emotions and pedagogies (Keith, 2010). Keith (2010) highlights the need for teachers to not only be self-aware about their emotions about teaching for social justice, but to also learn how to emotionally engage with students about these powerful topics so that their pedagogies truly represent the curriculum. Emotions are essential in “challenging prevailing social norms about injustice and inequality both in schools and in society” that continue to function in part because of the suppression of emotions (Zembylas & Chubbuck, 2009, p. 344). If we want to work toward making our world a better place, we must investigate the ways in which emotions impact interactions within classroom communities (Boler, 1999). Since emotions “are a medium, a space in which differences and ethics are communicated, negotiated, and shaped” (Boler, 1999, p. 21), if we are
to consider how to better address the needs of all students, then we need to be attending to emotions within the classroom.

**Students’ disengagement with school science.** In addition to impacting learning and providing a springboard for equity work, emotions are particularly important in environmental science education for providing a greater understanding of students’ disinterest in science. As a sociologically compelling context for learning science, environmental science classrooms can also provide insight into students’ disengagement with school science. As interest in science remains low (National Academy of Sciences, 2007, 2010), science education continues to research reasons contributing to this lack of interest in pursuing science. In particular, work in the field demonstrates that students, especially from underrepresented groups, do not engage with traditional school science (e.g. Aikenhead, 1996; Mallya, Mensah, Contenko, Koch, & Calabrese Barton, 2012; Tan & Calabrese Barton, 2007). While there is work being done to understand and address this disengagement from various angles, like identity (Brickhouse & Potter, 2001; Carlone, 2004) educational psychology (e.g. Ainley & Ainley, 2011), socioscientific issues (Levine Rose & Calabrese Barton, 2012; Sadler, Barab, & Scott, 2007), and so forth, there are only a handful of studies researching the relationship between emotions and students’ engagement with and learning of science (e.g. Ritchie et al., 2013; Ritchie, Tobin, Hudson, Roth, & Mergard, 2011; Tobin, Ritchie, Oakley, Mergard, & Hudson, 2013). Some of the most current recommendations on engaging students especially from underrepresented groups include attending to their personal experiences and ways of knowing the world (Kane, 2012) as well as the identity work they need to perform in order to envision themselves as having a science identity (Archer et al., 2012). Despite the recognition of identities and the social structures in which they are produced, the field neglects the ways students’ emotions may (not) contribute to
their long-term engagement with science. Allowing students to express their emotions has the potential to provide insights into how students can feel more connected to science. Learning about environmental issues provides a sociologically significant and compelling context for learning science, which contributes to student engagement. Therefore, the understudied domain of emotion could provide important work in understanding the reasons behind students’ lack of interest in science.

**Nature and emotions.** Similar to the trend of students’ disengagement with science, recent work highlights youths’ detachment from nature (Louv, 2008). While nature can be limited in its conceptualization to merely refer to the natural world, I think of nature as more general and therefore less constrained. Nature encompasses the human world and its components as well as ecosystems we directly and indirectly impact. In other words, nature is not separate from where we live, work, and play; it is not only “out there.” Our relationship to nature, whether it is a section of woods or a city block, is inextricably tied with emotions (Reis & Roth, 2010) about that place. However, science often characterizes nature objectively thereby removing “emotional ties that bind us to each other and our world” (Broom, 2011, p. 124). Whether or not one subscribes to the biophilia hypothesis (that humans are genetically wired to affiliate with nature), “a connection between people and nature, beyond the need for food, is inherently necessary” (Noddings, 1993, p. 124). One of the goals of education, especially environmental science education, is to instill within students a sense of “care for the places in which they live and the earth itself” and as such to be engaged with the “issues and debates surrounding globalization and environmentalism” (Noddings, 1993, p. 125) that include acquiring knowledge about the underlying scientific principles. More so, the natural world provides a source of pleasure and curiosity for children. Hence it only makes sense to engage
students in the wonders of the natural world and so to build upon their connection with nature. In appreciating nature, we also come to realize that it is replete with all emotions, not just delight. Ecological principles and environmental problems entail suffering and even death and so provide interesting tensions by which to learn about life (Noddings, 1993).

The burdensome nature of environmental science. Most importantly, the very nature of environmental science content is problem-based, and hence onerous. Climate change continues to be one of the most pressing issues that we face. Teaching and learning about controversial and overwhelming environmental issues is challenging. The ultimate goals of changing learners’ behaviors compound the challenges of learning about environmental problems like climate change (NRC, 2011). Sadler and Zeidler (2004, 2005) have demonstrated that emotions influence students’ engagement and consideration with socioscientific issues. Examining emotions linked with environmental problems deepens our understanding of student learning. Studying emotion also provides a more realistic and holistic view of students’ understanding of and intentions to address the problems. Boler attributes our “cultural illiteracy with respect to translating emotion into knowledge and action” (Boler, 1999, p. 144) as a cause of numbness. This numbness, which borders on powerlessness and denial, drastically reduces our sense of agency to make change in the world. Therefore, understanding emotion in school science discourses, especially in environmental science, can provide insight into how students may act on an issue. In fact, emotions like frustration, anger, and worry impact learning as well as how one perceives him/herself as being capable of making change (Ojala, 2012b).

Goals of the Present Research

Allowing and encouraging emotion discourse in science classrooms levels the playing field for more students. By recognizing the value and range of expressed emotions in science
classrooms, more students have a voice in science, which is not typically the case. Emotional expressions provide ways for students to demonstrate their understandings and interests in the practices and content of science. What can become salient from expressed emotions is a better understanding of students, from insights into how the content knowledge does (not) conflict with their worldview to their general views of science to their epistemological orientation, all of which influence their understandings of science. Furthermore, promoting emotional discourse in environmental science education serves another valuable function. One of the goals of science education and especially environmental science education is to educate students about environmental and other socioscientific issues so that they may make well-informed decisions (NRC, 2012). However, a student can learn about a given issue, demonstrate proficiency on an assessment, and yet not care about the issue to address it by making well-informed decisions about her actions - not to mention advocating for others’ to change theirs. While a student’s emotional response will not indicate whether or not she will take action on the issue, the mere fact of having an emotional response to an environmental issue signifies that she is relating it to her life, and is therefore engaged about the implications on her and the world around her. Hence, studying students’ emotions helps us understand why and how students understand environmental issues in terms of their agency about causing and addressing them. To examine these issues, I developed the following four research questions:

1. How were opportunities for emotional discourse constructed in this science classroom?
2. How did students develop varying degrees of ownership in their constructions of emotional expressions when learning about climate change and related disciplinary ideas in a science classroom?
3. What were the objects of the emotions that students expressed when learning about climate change and related disciplinary ideas in a science classroom?

4. How do the ways in which students constructed emotional expressions about climate change provide insight into their conceptualizations of the problem?
Chapter 2: Review of Literature and Theoretical Framework
Introduction to Literature Review

The current research on the learning and practices of environmental science spans various topics using diverse methods and methodologies. However, little attention is given to students’ or pre-service teachers’ emotions regarding environmental learning. Work in undergraduate students’ decision-making about socioscientific issues (Sadler & Zeidler, 2004, 2005) and K-12 students’ engagement (Olitsky, 2007) and learning in science (Zembylas, 2004a) and science activities (Milne & Otieno, 2007) provides a foundation for examining emotions during environmental science learning. Since emotions both represent and are represented by social practices (Lutz & Abu-Lughod, 1990), researching emotion involves grounding it in discourse. Hence, analyzing emotions through a framework that brings together sociolinguistics and the sociology of emotions provides insights into studying emotion in environmental science classrooms.

The Need for Research on Emotions in Science Education

In the larger body of education literature, work on emotions in schools has centered on general academic emotions, relating to school success, with some significant exceptions in math education. There is a large body of work in educational psychology that focuses on the research on student achievement and motivation, seeking to examine connections between students’ successes in classrooms with emotional characteristics that influence motivation or engagement (e.g. Ainley & Ainley, 2011; Jarvenoja & Jarvela, 2005, 2009). Research in math education provides insights into how emotions impact learning. Meyer and Turner (2006) demonstrated the importance of students’ positive emotions when researching motivation and cognition in mathematics learning. Op ‘T Eynde, de Corte, & Verschaffel’s (2006) work with high school students also points to the significance of students’ emotions in mathematics class. In particular,
they identified the emotions students felt while solving math problems and make recommendations about the importance of situated emotions in mathematics learning. In addition, there is some recent work in the second language acquisition literature. Studying emotion in social and discursive processes, Imai’s (2010) work demonstrates that emotions facilitate learning. Furthermore, she found that emotions typically considered to be a hindrance to learning, such as frustration, could also contribute to learning depending on how the interactions of the group acknowledged these emotions (Imai, 2010). The findings from these studies illustrate that emotions are not only present during learning, but also influence the ways in which students learn. Despite these connections, there is a gap in science education literature about emotions during learning, in particular about climate change and related disciplinary ideas.

**Science teaching and emotions.** One of the interesting things about the research on emotion in the larger body of education research is that the preponderance of studies about in-service teachers’ emotions. There is work on the emotional geographies (Hargreaves, 2001) and emotional experiences of in-service teachers (Williams-Johnson, Aultman, & Schutz, 2008) in relation to the impacts of school reform (Kelchtermans, 2005; van Veen, Sleegers, & van de Ven, 2005). One of the most obvious themes that emerges from this body of work is that teachers’ emotions affect how they view themselves and in turn teach.

Within science education, there is a growing body of literature that investigates science teachers’ emotions. A theme that is apparent in the literature is that there are distinctions in the ways in which emotions are examined. Some studies utilize close-form methods to collect information about teachers’ emotions, whereas other studies use narrative and ethnographic data to examine emotions. Lombardi and Sinatra (2013) researched the role of specific emotions in pre-service teachers’ beliefs about the plausibility of climate change. They developed a closed-
form questionnaire to identify teachers’ emotions and intensity of emotions about teaching climate change in general. Analyzing pre-service elementary teachers’ emotions about different science disciplines, Brigido, Couso, Gutiérrez, & Mellado (2013) used a closed-form questionnaires as well.

Other work on teachers’ emotions goes beyond identifying them to grounding them in social interactions in the science classroom (Zembylas, 2002, 2004c). Over the course of three years, Zembylas (2004b) researched of the role of an elementary teacher’s emotions in teaching science. Informed by ethnography, Zembylas (2004b) examined the situatedness of a teacher’s emotions about teaching science through ethnographic field notes of the teacher’s class and conversations with the teacher as well as the teacher’s reflective writing. In Rivera Maulucci’s (2013) study of one pre-service teacher learning to practice social justice as a chemistry teacher, “Nicole,” the unit of analysis is emotion. Unlike most other emotion research in science education, this study did not prioritize positively valenced emotions, but instead focused on emotional ambivalence. In particular, Rivera Maulucci did not seek to label emotions, but rather examined the aboutness of the Nicole’s emotions (although not describing it as such) in her reflective writing and spoken discourse about her experiences enacting her philosophy of social justice in a chemistry class. One of the findings of this study was that emotions served as resources for Nicole to make sense of experiences as well as enact change (Rivera Maulucci, 2013). In their examination of teacher identities and power in relation to challenging current discourses about science, Melville and Bartley (2013) grounded their analysis of three in-service teachers’ narratives in a post-structural perspective. While emotional expressions were inherent in the framework guiding the study and the teachers’ narratives themselves, they were not explicated in terms of how they were conceptualized or how they actually informed the teachers’
identities. Rather, Melville and Bartley (2013) demonstrate that emotions in general inform the teachers’ sense of agency and identity.

**Emotion research in science education.** Outside of the research on science teaching, there is a group of studies in science education that to varying degrees incorporates emotions. Some of this work is particular to socioscientific issues, wherein studies about reasoning and morality illuminate the ways in which students make sense of such complex issues. In these studies, students’ emotions pertain to the issue at hand, whereas the other research in science education on emotion examines emotions across a wider range of stimuli, such as class activities, classroom community and general instruction, in addition to science content.

**Research on emotions and socioscientific issues.** Within the realm of scientific practices, research on decision-making and moral reasoning, especially in relation to socioscientific issues, have elements pertaining to the study of emotion. Because “talk about language…frequently has the effect of moral commentary” (White, 2000, p. 39) it makes sense to examine the literature on socioscientific issues to see how emotion is researched. These studies are insightful for two significant reasons. First, they all focus on emotions pertaining to the scientific issue (rather than classroom community or learning outcomes), or “topic” emotions (Broughton, Sinatra, & Nussbaum, 2013). Second, they highlight a tension within the field between theorizing about the role of emotion and actually researching emotion in morality and decision-making. For instance, some researchers conclude that emotion plays a role in decision-making yet do not address it. Using genetically modified (GM) food as a context, Böttcher & Meisert (2011) examined the impact of a decision-making intervention on German high school students’ evaluations of the issue. In framing decision-making as a dual process model, they acknowledged the role of emotions but separated what they described as the deliberate cognitive
from tacit emotional processes that influence decision-making (Böttcher & Meisert, 2011). While they identify emotion as important to decision making and the issue of GM food, they do not address emotion in their data or analysis. Another way in which emotion is referred to within research on decision-making is by the use of “intuition.” The dual-process model also frames Papadouris’ (2012) intervention study on the use of an optimization strategy for middle school students to make decisions by comparing trade-offs of potential solutions. In his explanation of the model, emotion is not mentioned, but only alluded to under the umbrella term of “intuition,” which is dichotomized from “analytical” reasoning (Papadouris, 2012, p. 602). Other researchers neglect to acknowledge the role of emotion despite the fact that it appears in their data and is an underlying factor in decision-making. Nielsen’s (2012a, 2012b) research on secondary biology students’ argumentation about gene therapy illustrates the complexity of understanding how students employ science in value-laden discussions. He found that students co-opted science claims to better match their values and beliefs (2012a, 2012b). Using discourse analysis to determine when and how students used scientific claims as opposed to personal justifications, he did not address considerations of emotion, even though they were apparent in the data and likely relevant to understanding the ways in which students value the issue. In addition, his approach to understanding scientific reasoning relies on the dichotomy between scientific argument and values & emotion when he proposes that science is invoked separately from values. In Levine Rose and Calabrese Barton’s (2012) research on the role of framing in decision-making in a local socioscientific issue, they make salient the tensions between personal experiences and scientific knowledge in middle school students. In doing so they recommend that in order to help students make sense of such complex issues, teachers should encourage them to carefully examine the intersection between scientific knowledge and personal stances in the context of dominant
framing of knowledge (2012). Although not investigated, the importance of emotion in such personal stances is obvious in both theory and the actual data collected by the researchers.

The research in socioscientific learning and decision-making in science settings is elusive about emotions despite their inclusion in either the theoretical framework or data. Even though research in decision-making about socioscientific issues provides a rich context for studying emotion because emotion influences both morality and decision-making (Sadler & Zeidler, 2005), research on emotion in reasoning about socioscientific issues is limited. Sadler and Zeidler’s (2004, 2005) studies are insightful because they have incorporated the role of emotions in decision-making and moral reasoning about socioscientific issues. In one study, the authors found that emotions were either the singular reason for or a component of undergraduate students’ overall decisions about genetic engineering scenarios (Sadler & Zeidler, 2004). In another study, Sadler and Zeidler (2005) determined three patterns to undergraduate students’ informal reasoning about genetic engineering: rationalistic, emotive, and intuitive. For Sadler and Zeidler, emotion plays a prominent role in morality and hence decision-making about socioscientific issues. These studies illuminate the ways in which emotion contributes to reasoning. First, according to them, morality takes into account three major models, one of which is care. Rather than embrace a singular approach such a mathematical formula or rubric to resolving moral dilemmas, care-based morality is context dependent. Therefore, it requires a “relational approach” and as such “emotions such as sympathy and empathy contribute significantly to decisions and actions” (Sadler & Zeidler, 2004, p. 7). Second, Sadler and Zeidler privilege emotion as a major factor in whether or not a person perceives of a situation as moral, which aligns with the work of White (2000) who demonstrates that the evaluative nature of emotion is moral work.
Even though this work elucidates the role of emotion in moral reasoning, Sadler and Zeidler limit their theorizing and analysis of emotions to empathy or care in either study, constraining the role of emotions in moral reasoning. According to White (2000) and Solomon (2007), it is emotions’ evaluative function that provides a moral judgment. Hence any emotion, but in particular those classified as negatively valenced (e.g. anger, fear, worry) are an indication of moral orientation. Although Sadler and Zeidler’s (2004, 2005) research highlights the common dependence of emotion in decision-making, the authors only focus on empathy and care as emotive responses, even though all emotions can depict moral orientations (Solomon, 2007). In addition, their definitions of three patterns of informal reasoning (rational, emotional, and intuitive) are significant in understanding their perception of emotions. For example, the way in which they describe intuitive reasoning seems to involve emotions. They write that it is “a ‘gut-level’ reaction or feeling that could not necessarily be explained in rational terms” (Sadler & Zeidler, 2005, p. 125). This delineation creates confusion in terms of what is and is not an emotion, which they do not explicate. Finally, even though they are studying the role of some emotions in reasoning, they are doing so along the reason/emotion dichotomy, acknowledging that each overlaps with the other while still separating emotions and intuitive feelings from rational thought.

**Research on emotions in science education outside socioscientific issues.** Outside of the work of Sadler & Zeidler (2004, 2005), there is some work in science education on emotions. The work is varied in terms of how emotion is implicitly conceptualized and therefore operationalized. Most studies do not describe the theoretical underpinnings of emotion. As such the implied and explicit conceptualizations of emotion are varied as well as the methods used to
collect and analyze them. In this section, I explore the research on emotions in science education in terms of science learning and teaching.

There is research on students’ emotions informed by the historical approach to emotion studies, which is guided by decontextualizing or essentializing emotions. Essentializing emotion reduces its meaning so as to be universal and has significant impacts about what can be learned about emotion (Lutz & Abu-Lughod, 1990). Lutz & Abu-Lughod (1990) identified interrelated consequences for the study of emotion based on essentializing it. One effect is that it separates emotional discourse from social life, buttressing the notion that emotions are universal in terms of their meaning regardless of culture or social context. Hence because of their universalism, they are more easily taken for granted (Lutz & Abu-Lughod, 1990). In their comparative study, Lin, Hong, & Huang (2012) explored the relationships between emotions and scientific literacy in 15-year olds and adults using a 108-item Likert-style questionnaire. They found that scientific literacy correlates with high levels of “emotional factors,” which they associated with interest. Although the authors do not explain their conceptualization of emotion, they studied emotion in a decontextualized manner through their use of survey questions that did not allow for explication of the situations in which emotions took shape. Other work on emotions in science learning involves instrument development and validation to measure three situational emotions: boredom, well-being, and interest (Randler, Hummel, Vollmer, Bogner, & Mayring, 2011). While it may be helpful to assess students’ emotions quickly during instruction, the authors neither explicate their conceptualization of emotion nor the reasons behind their decisions to only include these three affective factors. Plus, it is questionable whether or not these are even emotions. Castano’s (2008) design-based research on the impacts of group discussions and a role-playing scenario on the promotion of environmental interconnectedness in elementary-age
girls provides context for the study of empathy in environmental science education. In this study, one type of emotion is assessed, in this case empathy of other animals. Empathy was measured using a researcher-designed Likert scale to ascertain the relationship between students’ knowledge, connection to nature, and empathy toward animals. Similar to Lin et al. (2012) and Randler et al. (2011), Castano’s (2008) approach to emotion involved essentializing. This method decontextualizes the complex meanings of emotion in social situations and instead emphasizes a “referential significance” of emotion (White, 2000, p. 33).

Another theme in the science education research involving emotions is the prioritization of positively valenced emotions, like excitement and happiness. Broughton, Sinatra, & Nussbaum (2011) focused only on positively valenced emotions when they researched how students’ emotions related to their attitudes and conceptual changes about Pluto’s reclassification. In their study, they used questionnaires to elicit middle school students’ emotions about their initial emotional responses to Pluto’s reclassification (months prior) and a day following the reading of refutation texts (and in the experimental case group discussions about them). Underlying their work is the assumption that negatively valenced emotions hinder learning and positively valenced emotions enhance learning. While I do not agree with them on their polarization of emotions (because I think an emotional response is a sign of engagement with the practice and/or content), their distinction between “academic” emotions and “topic” emotions is relevant to my work. They consider academic emotions to be those like test anxiety that influence academic outcomes, whereas topic emotions are (positive) emotions relating to specific content (Broughton et al., 2011). Their conceptualizations of “topic” emotions are a helpful way to describe my work on emotions in the classroom. Topic emotions in environmental science have the potential to communicate a student’s connection and even type of understanding
about environmental problems. Tomas and Ritchie (2011) researched the roles of positively valenced emotions in science learning about the issue of biosecurity around hybridized writing activities. In particular, they focused on: attentive, strong, inspired, alert, active, excited, proud, enthusiastic, determined and interested. Hence, their study paints only a partial picture of how emotions relate to students’ understandings of biosecurity issues. In addition, while Tomas and Ritchie (2011) connected the importance of emotion to science learning, they neglected to conceptualize emotion. Hence, it is unclear why the authors chose to include attentiveness, strength, alert, active, and interested as emotions.

Work that moves beyond the essentializing of emotion takes into account the social construction of emotions and their meanings in context. Milne and Otieno (2007) analyzed high school student engagement during class demonstrations as a precursor to positive emotional energy using conversation analysis. Informed by Collins’ (2004) interactional ritual chains, they examined interlocutors’ pitch, rate of speed, and intensity as signs of engagement and positive emotional energy during chemistry demonstrations. While their collection and analysis on interactions-based data is fitting for studying emotion, they do not actually define emotion or what counts as emotion in talk. Instead they use an established framework that centers on behaviors such as “head nodding, humor, eye contact, body orientation, overlapping speech, and the completion of each other’s sentences” that are associated with group focus in order to provide the evidence and basis for positive emotional student engagement (Milne & Otieno, 2007, p. 528). Hence, emotional engagement, while examined in context is not directly analyzed. In addition, by using an established framework the analysis is confined to the way in which the behaviors do (not) demonstrate emotion rather than allowing emotion to take shape from interactions, which include but are not limited to behaviors. Using an ethnographic approach,
Olitsky (2007) also used Collins’ (2004) interactional rituals framework, but with the goal of finding evidence of student engagement based in communities of practice over the course of a school year. Hence, emotions, and more so, emotional energy, were present in the context of synchronous interactions rather than as a unit of analysis in itself. Zembylas (2004a) employed an ethnographic approach to studying elementary students’ emotional practices with science. His focus on the performative and relational nature of emotion provided the theoretical framework for examining how emotional utterances shaped classroom dialogue about science. Since classroom talk about doing science meshed with expressing emotions about science and its learning, he concluded that an understanding of students’ science learning is dependent upon understanding their emotional practices (Zembylas, 2004a). This work differs significantly from the other studies in that it both foregrounds emotion and examines emotion in context as it arises.

**Contributions of This Research to Studies on Emotion in Science Education.** There are a few trends that are salient in the research on emotion in science education. First, there is a lack of elucidating a theory of emotion, which causes the misuse of the word “emotion” to be used. Second, most of the work on emotions in science classrooms indirectly or only partially examines emotions. Third, studies from the literature often essentialize emotions. Fourth, there is a significant amount of research that approaches emotions as separate from scientific reasoning. As such, my research reconceptualizes the role of emotions in science learning by 1) grounding my work in psychological theories of emotions (Keltner & Gross, 1999) to focus directly on emotions, 2) using a situated methodology to study emotions, and 3) examining the ways in students engage emotionally regardless of valence about specific science topics during science learning.
Understandings of Climate Change

Currently, the most frequently examined environmental issue in science education literature is climate change (Hufnagel et al., 2013). Even though the literature on understandings and practices about climate change is varied, emotions are typically understudied, in studies both with pre-service elementary teachers and K-12 students.

Pre-service elementary teachers’ understandings about climate change. Most of the research on pre-service teachers’ understandings and practices related to climate change involves identifying and analyzing pre-service elementary teachers’ alternative conceptions about climate change and related disciplinary ideas (e.g. Arslan, Cigdemoglu, & Moseley, 2012; Demirkaya, 2008; Groves & Pugh, 1999; Papadimitriou, 2004; Ratinen, 2013). Work on pre-service elementary teachers’ moral reasoning about climate change (Lee, Chang, Choi, Kim, & Zeidler, 2012) include moral emotions within moral reasoning (Tuncay, Yılmaz-Tüzün, & Teksoz, 2012), but these conceptions of emotions are unclear (as they include respect and awareness) and limited to empathy and sympathy. Recently, Lombardi and Sinatra (2013) investigated both pre- and in-service teachers’ emotions about climate change in relation to plausibility perceptions. Using Likert-style surveys for quantifying intensity of emotions about climate change and teaching about climate change, the researchers determined that greater anger about climate change “results in lower plausibility, thereby suggesting the potential for less engagement with the topic” (Lombardi & Sinatra, 2013, p. 184). There is also research on other closely-related environmental areas of inquiry that inform pre-service teachers’ learning and teaching about climate change and related disciplinary ideas. For instance, the ways pre-service elementary teachers develop unit plans on environmental issues often relay contradictory messages about taking action (Gooch, Rigano, Hickey, & Fien, 2008). Another example is Almeida and
Vasconcelos’ (2013) work, which examined the philosophical underpinnings of pre-service elementary teachers’ conceptions of nature, which although not part of their study, are inherent in emotional reactions. O’Gorman and Davis (2013) found that pre-service primary teachers’ expressions of shock and embarrassment following ecological footprint quizzes were typical and part of their understandings about their individual impacts on the planet. In Hwang’s (2011) study, she suggested that, particularly in education on environmental topics, teachers should engage in continual, reflexive activities to explore what science is and how it is constructed. As a result of her study, she found that teachers were better able to address the complexity and tentativeness of scientific knowledge about environmental issues (Hwang, 2011). This type of reflectivity about science concepts, in terms of the power and implications of scientific knowledge, would seem to serve both pre- and in-service teachers in terms of their understandings about science and how to teach it. Hence, examining the ways in which prospective teachers engage emotionally about climate change and related disciplinary ideas provides insight into how they will teach about it.

**K-12 students’ understandings about climate change.** While this research study is on pre-service teachers’ emotions about climate change, due to the limited set of studies examining emotions about climate change, it is helpful to understand the ways in which science education is researching climate change. Hence, a brief overview of recent research on K-12 students’ understandings (cognitive and affective) of climate change provides a broader scope of how this work fits into the current literature. Similar to the research in K-12 settings, studies of pre-service teachers’ understanding of climate change use a variety of methodologies and methods yet largely exclude emotions. Within this set of studies there is a wide range of methodologies and methods to assess or describe students’ understandings, from the use of closed-form
questionnaires (Kilinc, Stanisstreet, & Boyes, 2008; Liarakou, Athanasiadis, & Gavrilakis, 2011; Punter, Ochando-Pardo, & Garcia, 2011) to drawing and writing (Shepardson, Niyogi, Choi, & Charusombat, 2009; Shepardson, Niyogi, Roychoudhury, & Hirsch, 2012). In order to develop learning progressions for students from upper elementary through high school on carbon cycling (Mohan, Chen, & Anderson, 2009) and climate change (Tsurusaki & Anderson, 2010), researchers analyzed written assessments (Tsurusaki & Anderson, 2010) in conjunction with interviews (Mohan et al., 2009). A significant portion of the work investigating students’ understanding of global climate change entails interventions, mainly in the form of curricular units (Lester, Ma, Lee, & Lambert, 2006; Taber & Taylor, 2009). In addition, there is also work on analyzing students’ discourse. Sternäng & Lundholm’s (2012) work analyzing interviews of middle school students illuminates the tensions between nature and economic development in terms of students’ conceptions of how to address the impacts of climate change. With the same group of students, they also analyzed individual student discourse to make salient the ways students assign the impacts of climate change to either themselves or others (Sternäng & Lundholm, 2011). Jakobsson, Makitalo, & Saljo (2009) examined the discourse within groups of high school students resolving contradictory statements in order to refine their understanding of anthropogenic climate change. Their work illustrates that student understanding of complex issues cannot be adequately gleaned from questionnaires. Instead, talk within groups made salient that students have a better understanding of the issue than is reported in literature (Jakobsson, et al., 2009).

What is so interesting about the range of methods that examine K-12 students’ and pre-service teachers’ understandings of climate change and other environmental problems is that the issues themselves can elicit emotional responses. People experience a range of emotions about
global problems like climate change, including fear, worry, anger, guilt, and hope (Hicks & Holden, 2007; Ojala, 2012; Rickinson, 2001). While there are a handful of studies that examine the role of emotions to varying degrees in understandings about climate change, an overall gap exists in the science education literature whereby research on students’ and pre-service teachers’ emotions about climate change is largely missing.

**Shared goals of ESE, EE, and STSE, but common neglect of emotions.** Many of the goals of environmental science education (ESE), environmental education (EE), and science technology society and environment (STSE) overlap in terms of citizenship practices. In addition, these strands of science education all research the teaching and learning of climate change. While there is no one widely accepted view of the goals of EE or ESE, there is general agreement that teaching environmental education should inspire students to develop concern and behaviors about environmental protection (Disinger, 1998), including climate change. According to the literature on STSE, one of the most important reasons for teaching socioscientific curricula is because the issues are situated and as such advance citizenship practices “through science education because the focal issues are relevant and can bridge school science and students’ lived experiences” (Sadler, Barab, & Scott, 2007, p. 373). Hence, an underlying assumption of both ESE and STSE is that students will engage in some behavioral change, whether it is in the form of well-informed decision-making, problem solving, or lifestyle changes. Also, STSE and EE by their very nature deal with issues that are controversial due to “contested knowledge” and conflicting values (Colucci-Gray, Camino, Barbiero, & Gray, 2006, p. 228). In addition, both strands of science education assume that students will connect to the content because it is sociologically significant and therefore a compelling context for science learning. However, questions surface about how researchers can determine whether or not these issues are indeed
relevant to students. Furthermore, students that are able to connect or relate to the context are vested, and that investment is replete with a range of emotions (Hicks & Holden, 2007; Ojala, 2007), which are understudied in the science education literature.

Despite this albeit clear connection between sociologically significant contexts for learning science and emotion, emotion is largely neglected within science education. Rather, the field focuses on students’ knowledge and attitudes, and to a lesser extent, decision-making and morality (Hufnagel et al., 2013), all of which are informed by emotion. Hence, this dissertation research explored the ways in which emotions are constructed in a science classroom and how those emotions provided a means to understanding which aspects of climate change and related disciplinary ideas were most relevant to the students.

**Theoretical Framework: What Are Emotions?**

According to Keltner and Gross (1999), emotions are “episodic, relatively short-term, biologically-based patterns of perception, experience, physiology, action, and communication that occur in response to specific physical and social challenges and opportunities” and “regulate the individual’s relation to the external environment” (p. 468). They differ from moods, dispositions, and attitudes in many ways, but in particular because emotions are short-lived and have aboutness. In other words, they are in response to something specific. This aboutness is important in this work because it provides an opportunity to more deeply understand which aspect(s) of environmental issues elicit emotions in science students.

Defining emotion falls on a continuum, with the major distinction between the “built,” or biologically based, and the “built-in,” or culturally constructed, form of emotion. While there is undoubtedly a biological basis to emotions, it is how emotions are shaped, used, and responded to in context, particularly in a science classroom, that is most relevant to my work. It is this
social aspect of emotion, or relational approach to emotion, that takes into account how both the individual and the context are inextricably linked (Campos, Walle, Dahl, & Main, 2011). Emotions are not discrete internalized entities, but rather “emergent phenomena that vary with the immediate context” (Barrett, 2006, p. 21). An emotion is performative in that it is “a practice not of corresponding to an inner state, but of signifying the world and constituting and constructing the world” (Zembylas, 2004b, p. 697). As such, when viewed through a sociocultural lens, emotional expressions are ways of making sense of the world based on the particular context and communicating that understanding.

**Sociology of emotions.** Emotions play an integral role in meaning-making and understanding our world because they arise “from social practices, and...convey meanings and effects to members” (Oatley, 1993, p. 341) of a group. As a result, emotion discourse “must be interpreted as in and about social life” rather than solely indicative of an inner feeling (Lutz & Abu-Lughod, 1990, p. 11). As such, the study of emotions as interpreted social phenomena requires understanding the discourse in which they emerge. There is interplay between one’s emotional response and the social context. Because emotions are embedded in a social context, they can be indicative of the cultural norms because there are emotion display rules in different social contexts (e.g. Besnier, 1990; Mesquita & Albert, 2007). In the words of Shields (2002), “display rules are the often tacit social rules directing when, how much, and which emotions should be expressed to others” (p. 56). Hence, in order to examine the ethical and social underpinnings of emotional expressions (White, 2000), contextual emotional display rules must be attended to.

The way in which language is used represents the socialization of emotional norms within a given context. In fact, the ways in which individuals understand and identify emotions
contribute to what Shields (2002) calls “bedrock beliefs” about emotion, or the set of fixed beliefs held by a dominant culture about the meanings and display rules of emotions (p. 10). While her work focuses on the intersectionality of emotion and gender, Shields’ ideas about the ways in which emotions are used to create and maintain cultural norms can be applied to the view of science in classrooms as well as the treatment of environmental problems in science classrooms. Ochs’ (1996) work on language socialization also provides insight into thinking about how socialization in science classrooms takes shape. One cannot be socialized without discourse and one cannot use language without navigating social and cultural structures. The processes of language use and socialization are interdependent and concurrent (Ochs, 1996).

Although emotions are considered a type of individual response, it is their function in a social setting that helps give them meaning. Also, it is how they are used that particular social setting that relays meanings about a given context and culture, such as a science classroom. However, socialization in and of itself does not fully explain the variability across time and contexts of how and when emotion is used (Shields, 2002). Therefore, an approach that examines the uniqueness of emotions, while taking into account larger institutional structures is needed.

**Researching emotions through discourse.** The role of emotion within discourse has not been researched with the same attention as other aspects of language, such as descriptive or social meanings, largely because of the Western construct that emotion is dichotomous to cognition (Besnier, 1990). Yet, emotion is coupled with language. As Shields writes, “everything about emotion changes when the cognitive capacity for symbolic representation, especially language, is introduced” (2002, p. 8).

To study language usage, specific discourse processes are examined in contexts of use (Gumperz, 1982; Kelly, in press), in this case, students in an environmental science classroom.
From a sociolinguistics perspective, individuals negotiate meaning based on both the intricacies of turns at talk and the “background assumptions that underlie” (Gumperz, 2001, p. 218) the particular conversation. Inferences about conveyed messages – both relayed and interpreted – make salient the “shared or unshared interpretations” of discourse (Gumperz, 2001, p. 218). As such, when researching discourse attending to both the discourse and “local circumstances in which they are produced” (Gumperz, 2001, p. 217) provides a means for making inferences salient. In addition, members of a community, such as a classroom, establish certain practices of talking and acting through social interaction that then create cultural practices, which serve as resources for further social interactions and even private internalization (Kelly & Green, 1998; Kelly, in press). When using a sociolinguistics approach to studying discourse and emotion, what becomes apparent is that the meaning of emotional expressions takes place through and in interactions, rather than solely in individuals (Gee & Green, 1998). Gumperz (2001) uses the phrase contextualization cues to describe the ways in which oral markers, such as prosody, speed, grammar, and so forth, in language serve as indicators to interlocutors about the meaning of messages. Contextualization cues are present in all talk and as such “provide direct evidence for the necessary role that indexicality plays in talk” (Gumperz, 2001, p. 222). Hence, analyzing emotion talk involves indirect cues because “even though emotion, even strong emotion, occurs frequently and we give priority to reading others and managing our own emotion, emotion language is a very small proportion of natural speech” (Shields, 2002, p. 176). Therefore, research on emotions in interactions must examine the ways and reasons that emotions are both manifested and not articulated.

Sociolinguistic work by Ochs and Schieffelin (1989), Goodwin (2007), and Goodwin and Goodwin (2000) have attended to emotion in situated activities. Goodwin (2007) described
affective stance as the emotions that an individual reveals to others through participating in an interaction. Hence, much like language, emotions only take on meaning within interactions. Goodwin & Goodwin (2000) analyzed children’s emotions in an activity system of hopscotch when no emotion words were uttered. Their analysis revealed that emotions “emerge within interaction and have strong social consequences” and are evident through “fully embodied practices, integrating syntactic choice, intonation, [and] timing” (Goodwin & Goodwin, 2000, p. 25) and as such there is no prescriptive way to analyze for emotion. Therefore, there are no sure-fire markers of emotions within language (i.e. pitch, emotion words, syntax). In explicating a wide range of linguistic resources for the communication of affect, Ochs and Schieffelin (1989) demonstrated the ways in which language were used to communicate various messages, including emotions, were not mutually exclusive. Emotions are embedded in language just as meanings about culture and understandings between interlocutors are.

Rather than separating social practices from emotion, Lutz & Abu-Lughod (1990) propose “a view of emotion as a discursive practice” (p. 10). Using this frame for emotions requires the study of social interactions to provide a more holistic view of the dynamic and disputed contextual meanings of emotions in language. Just as personal emotions are ways in which an individual understands her world, they are also a vital aspect of communication between people. As Warner and Shields (2009) maintain,

Others’ emotional responses can also directly influence one’s own emotional experience. Appraisals of others’ emotions affect not only the kinds of emotion an individual feels, but how intensely one feels, how long the emotion lasts, and the extent to which one believes she or he can cope with the situation. (p. 95)
Therefore, the relationship between emotions and discourse is mutual and interdependent and makes salient the ways in which each informs the other.

When emotions are explicated, they carry powerful messages. Emotion words are valenced, and therefore inherently evaluative. They serve to appraise events and in doing so indicate which state of affairs one wishes to uphold or change (White, 2000). According to White,

Whereas positive emotions express an acceptance or willingness to maintain a situation, negative emotions function as signs of discontent, signifying a desire to change the situation, the self, or both. The moral work done by emotion language is reflected in the preponderance of negative terms in emotion lexicons across cultures. (2000, p. 40)

Regardless of how emotions are conveyed, they evaluate situations, information, and events. Hence they provide a way to understand if a person finds a topic relevant to his/her life and why.
Chapter 3: Research Methodology
The purpose of this naturalistic study was to describe the ways in which prospective elementary teachers in a climate change science course spoke and wrote about emotions as they learned about climate change and related disciplinary ideas. As a participant observer (Spradley, 1980), I engaged in the classroom in a way to “fully learn the cultural rules for behavior” (Spradley, 1980, p. 60), which included taking on the role of the instructor at times to design and teach lessons as well as craft short assignments like exit slips and homework questions.

**Educational Setting**

Data was collected in an undergraduate science course about the impacts of climate change on ecological systems for elementary education majors. This course was co-developed and co-taught by faculty members in science education and earth and mineral sciences at a large university in the Northeast. In total there were three instructors the semester I collected data, one in earth and mineral sciences and two in science education (including myself). The course was geared toward prospective elementary education majors, who are required to take three science content courses during their program. It was offered as an alternative to large lecture-based science courses typically taught on university campuses. The majority of the class time was spent on science, however, the last four weeks involved a teaching project whereby students prepared for and then reflected on teaching a small group of elementary students at a local school. Thirty students (four males, 26 females) participated in the study.

**Research Methodology and Methods**

Ethnographic field notes, student artifacts, and transcripts of video provided the basis for answering my four research questions (see Figure 3.1). In addition, I also used video of research interviews to triangulate my findings. I initiated data collection on the first day of class (January 7, 2013) and continued through the last day of the semester, April 26, 2013.
Emotions play an integral role in meaning-making and understanding our world because they arise “from social practices, and...convey meanings and effects to members” (Oatley, 1993, p. 341) of a group. As such, the study of emotions as constructed and interpreted social phenomena requires understanding the discourse in which they are used, shaped, and shared. Framing my study in ethnography, sociolinguistics, and participant observation provided a means to understanding how others expressed emotions about climate change and related disciplinary ideas. In order to examine students’ emotional expressions, I also had to attend to the ways in which emotions were framed and constructed within the course. In this study, how emotions were framed was based in the moment-to-moment situational context of the norms and practices of the classroom as shaped by the instructors, curriculum, and overall classroom community. Students constructed emotions based on the ways in which emotions were framed in a given situation within the course. Students’ emotional constructions were interactionally achieved as a result of the norms and expectations of emotional discourse in the moment. The subset of students’ emotional interactions that were expressed were students’ emotional expressions. Hence, I examined the ways in which emotions were framed, constructed, and expressed on both a collective and individual level to make salient the factors that supported and promoted emotional discourse in the classroom as well as the ways individual students constructed emotional expressions.

Grounding my data collection and analysis in the Ethnographic Research Cycle (Spradley, 1980), I performed iterative analyses of the data sources to determine the ways in which opportunities for emotion discourse were created and framed as well as how students’ emotional constructions and expressions were embedded in the discourse within the science classroom. My ethnographic field notes and memos provided a foundation of the range of
activities and discourses throughout the course. These field notes and memos provided a means
to capturing what others as well as myself as the analyst understood to be significant experiences
(Emerson, Fretz, & Shaw, 1995) around emotions. Emerson, et al. (1995) use “immersion” to
describe ethnographic research whereby the researcher delves into the world of the participants
by both observing their interactions and experiencing them for herself. Using ethnographic field
notes, I initially identified key events that illustrated contextual conditions for promoting and
suppressing emotional expressions. These initial key events around emotional discourse served
as anchor points (Green, Skukauskaite, Dixon, & Córdova, 2007) from which to map both the
forward and backward constructions of emotions and discourse more generally within the class.

In order to better understand both the range of activities and the ways in which they were
constructed in the course, I analyzed the video recordings of classes based on the anchor points I
initially identified in my field notes to construct an event map (Kelly & Chen, 1999). Analyzing
the class video provided evidence for how different discourses, including emotional discourse,
were interactionally achieved throughout the course. I identified the phases of activity and key
events that the instructors and students constructed through spoken discourse and nonverbal
actions (Green, 1983). Informed by research using structuration maps (Kelly & Chen, 1999), I
mapped the interactions of how students and instructors oriented to both each other and the types
of discourse (Kelly & Chen, 1999) to determine discourse analysis units. Using my ethnographic
field notes and the video data, I first identified phases, which are interactions thematically tied to
content in both talk and actions of the group members. Within a phase, participants demonstrate
“a common focus” with “concerted and coordinated action” (Kelly, Brown, & Crawford, 2000,
p. 631). For example, a lecture on extinction or a class discussion about an assigned reading is a
phase. Once I identified phases, I then looked across phases to distinguish a broader set of events
based on shared content and purpose (Kelly & Chen, 1999) between members. An event, determined post hoc, was a set of activities with a common purpose usually tied to a specific content whereby constructed the event through verbal and nonverbal actions (Green, 1983; Green et al., 2007). These events and phases of activity were organized into an event map, whereby I could systematize my analyses of the different types of discourse students and instructors constructed throughout the semester.

After creating an initial event map, I began analyzing both the discourse activities and the written artifacts for emotional discourse (the details of which are in Chapter 4). Through this iterative and mutually-informing process, I modified the event map to include instances of emotional discourse as well as the other types of discourse constructed in the course. Because emotions are both represented by and representations of social practices (Lutz & Abu-Lughod, 1990), I used the event maps as well as the written artifacts to examine the ways in which emotions were constructed in the classroom discourse, as discussed in depth in Chapter 4. I explicate how I used each data source to develop analysis on a macro-, or collective, scale (to determine what counted as emotional discourse) and a micro-, or individual, scale (to analyze the nuanced ways in which students constructed emotional expressions).

**Ethnographic field notes.** Ethnographic field notes served two major functions. First, I captured descriptive observations of the social interactions based on a combination of folk (when salient) and analytic terms in the classroom language (Spradley, 1980). Second, in order to examine emotional expressions, I immersed myself in the discourse of the students to learn what counts as emotion for students.

While my original goal was to determine what counted as emotional expressions for the students, relying mainly on folk terms (Spradley, 1980), or the ways in which they defined
emotions, my goal changed due to two challenges. First, students had varying degrees of understanding of what emotions were. Second, and closely related, because emotional discourse was not consistently constructed within the classroom discourse activities, there were not enough opportunities to determine what students were counting as emotional expressions. This latter issue was compounded by the number of students, 30, who participated in emotional discourse to varying degrees. Hence, I ultimately analyzed emotional expressions from an etic perspective, determining what counted as emotional expressions.

After the first few weeks, I continued taking ethnographic field notes, but in a more focused and selective manner (Spradley, 1980) based on an early analysis of the first three weeks of field notes. I had analyzed early sets of field notes for understandings of culture within the given setting, which served to foreground my ensuing data collection decisions. I made use of open coding and coded my field notes for issues and attributes that emerged from the notes (Emerson, et al., 1995). While I approached my field notes with the lens of emotional discourse, I did not limit my initial coding of my early field notes to emotional discourse. As I continued to take field notes I concentrated my descriptions on activities and interactions in which emotional discourse was constructed by students and/or instructors based on patterns that emerged from my on-going analysis of field notes, class video, and student written artifacts. However, I also included field notes about events and interactions that were not directly related to emotional discourse but which I thought had potential to contribute understandings about the emotional discourse in the course. Because I was teaching lessons and was unable to take ethnographic field notes continuously, I also wrote memos following classes in which I taught in order to capture details of events in which students and/or I constructed emotional discourse. I used these
memos in conjunction with my field notes to identify potential instances of emotional
expressions within key events, which I then examined more closely using video.

**Video from select lessons.** In addition to recording ethnographic field notes and memos,
I video recorded every class to provide a more detailed record of the situatedness of the
discourse. I used my ethnographic field notes (Emerson et al., 1995; Spradley, 1980) as well as
the event map (Kelly & Chen, 1999) to determine the selections of video upon which to focus.
However, before I performed micro-analyses of the selections of video with potential emotional
discourse, I reviewed all the video to determine all events and phases of activity in the course.
The selections of the videos that I transcribed and analyzed were based on patterns about the
ways in which emotions were framed and constructed that attributed to students’ emotional
expressions (the topic of Chapter 4) and the emotional expressions themselves (the topic of
Chapter 5).

To study language usage, specific discourse processes are examined in contexts of use
(Kelly, in press) that are based on specific groups (Gumperz, 1982), in this case, students in a
particular classroom. Therefore, the content and features of discussions are influenced “by the
definitions people construct for what is occurring…and the rules of conversational participation
and discourse processes” (Green, 1983, p. 178). In order to understand how participants
constructed emotional expressions, as I analyzed video, I attended to the contextualization cues
that signaled emotional discourse among participants. Contextualization cues are both verbal and
nonverbal attributes of discourse that help relay meaning (Green, 1983; Gumperz, 1982), but are
not prescriptive. As cues, they are indicators and as such require inferencing on the part of
participants, including myself as the analyst (Green, 1983). Hence, expressing and interpreting
emotional discourse requires using various semiotic tools. We often talk around emotion and
emotion language is a very small proportion of natural speech” despite the prevalence of strong emotions (Shields, 2002, p. 176). Therefore, using contextualization cues offers insight into understanding how members construct emotional expressions in situ.

Through analyzing the emotional discourse what also became important were the ways in which emotions were framed both in discourse activities and written artifacts. Developed in interactions, frames provide members with reference points for expectations of behavior (Green, 1983). In addition, frames themselves change based on how other members respond to the frames and others’ ways of making meaning about the frames. What results is a dynamic frame of reference that is modified and refined as members continue to construct meaning together. Hence, in this study emotional discourse is framed differently by different instructors and across time (see Chapter 4).

In order to attend to both the verbal and nonverbal contextualization cues during discourse, I used both message units and action units to transcribe selections of video. As Ochs (1979) states, transcription is a “selective process reflecting theoretical goals and definitions” (p. 44). Hence, I aimed to transcribe video in a way that made emotion most salient to readers, taking into consideration page layout, placement of speakers, which behaviors were included, and how they were represented (Ochs, 1979). However, because “transcription is not solely a research methodology for understanding discourse but also, and just as importantly, a sociocultural practice of representing discourse” (Bucholtz, 2007, p. 785), the process itself was iterative and reflexive (Mondada, 2007). Because nonverbal contextualization cues are integral part of message units, I transcribed directly from the video recording. As the building block of linguistic meaning, message units are bounded “by utterances or social action” (Kelly & Chen, 1999, p. 894). Action units include one or more message units and as such illustrate “a semantic
relationship among message units and represent an observed intended act by a speaker” (Kelly & Chen, 1999, p. 894 – 895). Both message units and action units are identified post hoc. In this study, excerpts of transcripts have message units on separate lines so that the line number corresponds to a message unit. While I did identify action units when analyzing the video, I did not make them explicit in the featured excerpts of the transcripts. In addition, the transcription conventions I chose to include in the excerpts of my transcriptions (i.e. speed of speech, gesture, intonation, so forth) are based on the contextualization cues that were important to understanding the constructions of discourse in that interaction. The list of transcription conventions I used in my transcripts are in Appendix C. The details of how I determined what counted as emotional discourse as well as the ways in which students constructed and expressed emotions are explicated in Chapter 4 and Chapter 5, respectively.

Responses to writing prompts. Wherein spoken language provided understandings of the ways in which emotions were influenced by and reflective of social practices, written language also provided important insights. Since writing is an individual practice, it afforded me a pragmatic way of obtaining each person’s feelings, thoughts, and ideas in the moment. As a fundamental practice within science, writing involves the usage of various linguistic forms and functions, including emotional language (Levin & Wagner, 2006). A variety of writing prompts served as a means to collect data about students’ emotional expressions about climate change and related disciplinary ideas. I embedded questions that attempted to elicit emotions on students’ homework assignments and assessments. I also made use of exit slips, which are very short writing prompts used at the end of class, as a means for students to write reflectively about what they learned in class. These written responses served as situated sources of writing data because they were context based (i.e. referred to the events of that class). In addition, I also used pre- and
post-assessments to obtain initial and final data about how students associated emotions with science class and climate change and related disciplinary ideas. The complete set of writing prompts are in Appendix A.

Similar to the methods I used to record my observations and analyze the video, I made selection decisions about the written artifacts as well. Even though I initially analyzed all students’ written responses, to all questions in the course, I chose to focus my micro-analysis on those written artifacts with emotional expressions. The selection of these artifacts were based on my determination of what counted as emotional expressions, the process of which is explicated in the next sub-section.

Rivard (1994) regards writing as opportunities to generate and demonstrate personal connection to the content in addition to various cognitive practices around meaning-making. Writing also provides insights into students’ understandings, scientific voices, beliefs, and emotions about various scientific principles (Balgopal & Montplaisir, 2011; Fellows, 1994; Wallace, 2004). Student writing is a way for students to express affective stances, including emotions, that they may not otherwise express in class, i.e. verbally (McLeod, 1997). Although the practice and product of writing is often individualized, the writing still reflects, both implicitly and explicitly, the collective norms of emotional discourse within the context of a science classroom.

For the textual analysis, I used both content analysis and linguistic description (Bazerman, 2006) to make salient the ways in which students wrote emotively. Although my focus was on expressed emotions, the issue of emotion articulation was important. Barrett (2006) uses the term emotional granularity to describe the range of abilities of expressing an emotion precisely. For example, someone may express that she feels bad rather than using more specific
words like angry, frustrated, sad, and so forth. However, by using a research approach to emotion that embedded emotion within social interactions, there were two important outcomes. First, when speaking, even if an interlocutor did not precisely articulate her emotion, the emotion took shape within the interaction. Ultimately the interpretation of an emotional display is in the eye of the beholder (Shields, 2002), and grounding emotion work in social interactions accounted for the different ways in which I interpreted emotional expressions, both implied and explicit. Second, by examining the aboutness of the emotion, what became relevant was the object of the emotion. In other words, which aspects of the related disciplinary ideas elicited emotions became salient and were just as important as the emotions themselves because they were the cause of emotions.

**Determining what counted as emotional expressions and the features of those expressions.** Once I highlighted potential emotional expressions, I returned to those instances to determine what counted as emotional expressions (see Chapter 4). Once I identified what counted as emotion, I examined the emotional expressions for their objects (i.e. the aboutness), which provided opportunities to more deeply understand which aspect(s) of climate change and related disciplinary ideas provoked emotional expressions in the students (see Chapter 5). The process was iterative and complicated because what became salient was that students often wrote about more than one idea and it was not always possible to understand if they were expressing emotions about all the ideas or a single idea. To account for this complexity, I coded each response for topics (i.e. what they were writing about or the aboutness) and then grouped these topics into broader themes. What resulted from the analysis were a variety of emotions and categories of aboutness.
<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Sources</th>
<th>Data Analysis</th>
<th>Theoretical Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How were opportunities for emotional discourse constructed in this science classroom?</td>
<td>Ethnographic field notes</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Selective coding of field notes (Emerson et al., 1995) - Construction of event maps (Kelly &amp; Chen, 1999)</td>
<td>Participant observation Sociolinguistics</td>
</tr>
<tr>
<td></td>
<td>Transcripts of videos of key events and phases of activity</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Goodwin’s (1994) framework for analyzing discursive practices</td>
<td>Sociology of emotions</td>
</tr>
<tr>
<td></td>
<td>All written artifacts</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Contextual cues (Gumperz, 2001)</td>
<td>Sociolinguistics</td>
</tr>
<tr>
<td>2. How did students develop varying degrees of ownership in their constructions of emotional expressions when learning about climate and related disciplinary ideas in a science classroom?</td>
<td>Transcripts of videos of key events and phases of activity</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Content analysis and linguistic description (Bazerman, 2006)</td>
<td>Sociology of emotions Social construction of emotions</td>
</tr>
<tr>
<td></td>
<td>Written artifacts with emotional discourse</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Contextual cues (Gumperz, 2001)</td>
<td>Sociolinguistics</td>
</tr>
<tr>
<td>3. What were the objects of the emotions that students expressed when learning about climate change and related disciplinary ideas in a science classroom?</td>
<td>Transcripts with emotional discourse</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Contextual cues (Gumperz, 2001)</td>
<td>Sociology of emotions Social construction of emotions</td>
</tr>
<tr>
<td></td>
<td>Written artifacts with emotional discourse</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Content analysis and linguistic description (Bazerman, 2006)</td>
<td>Sociolinguistics</td>
</tr>
<tr>
<td>4. How do the ways in which students constructed emotional expressions about climate change provide insight into their conceptualizations of the problem?</td>
<td>Transcripts with emotional discourse</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Contextual cues (Gumperz, 2001)</td>
<td>Sociology of emotions Social construction of emotions</td>
</tr>
<tr>
<td></td>
<td>Written artifacts with emotional discourse</td>
<td>- Ethnographic Research Cycle (Spradley, 1980) - Content analysis and linguistic description (Bazerman, 2006)</td>
<td>Sociolinguistics</td>
</tr>
</tbody>
</table>

Table 3.1 Overview of research design. This figure illustrates the research questions and data sources, data analyses, and theoretical frameworks used to answer those questions.
Chapter 4: Course Context and How Emotions Were Constructed
Overview of the Study Setting

My work in the university SCIED297D course built off my findings and experience from the first run of the course the previous academic year. I was invited to be part of a team to design and implement a science education content course for undergraduate students in the elementary education option. In its second iteration, the course’s content storyline consisted of the ways in which populations responded to climate change and that climate change is happening faster than organisms can relocate or evolve. Since the course was focused on prospective elementary education majors, the Claims Evidence Reasoning (CER) framework (McNeill, Lizotte, Krajcik, & Marx, 2006; Zembal-Saul, 2009) was a mainstay of the course. This scaffold for explanations of science investigations and learning provides general and context-specific prompts for students to organize their scientific arguments (Zembal-Saul, McNeill, & Hershberger, 2013). In addition, it is a tool for students not only to develop evidence-based explanations for disciplinary ideas but also to teach their future students in science (Zembal-Saul, 2009). Developed by faculty members in both science education and Earth and Mineral Sciences, the course provided an alternative to large-sized science classes typically taught at large public universities. Since I had worked with the team since the course’s inception, I developed a strong working relationship with the collaborators, which not only helped to shape the direction and instructional methods of the course, but also provided me the opportunity to perform a pilot study about students’ emotions in the first iteration.

The Participants

The thirty students in the course were in various stages of their study (i.e. first-, second-, and third-year students in the program). In addition, based on the results from the pre-assessment, the students had a wide-range of understandings and concern regarding climate
change. Students who demonstrated knowledge about climate change on the pre-assessments included two of the students had taken Advanced Placement Environmental Science in high school, three students who had taken another science education content course about climate change (that focuses on the mechanisms of any climatic shift), and a couple of other students. The rest of the participants expressed either awareness to some degree of the problem or vague explanations of the problem. Students in this major program are required to take three science content courses, and hence chose to take this one. All thirty students in the course (26 women and four men) participated in the study. One of the students was a science major and two students were in the College of Education but not in the elementary education program. Since the course was developed for elementary education students, I included these students as participants in the study as they were members of the class community.

**The Course Instructors**

The original course design team consisted of four members: Tina, Mike, Ryan, and myself. Tina has extensive experience researching science teacher best practices. She has collaborated with various science faculty members at the university to create and teach multiple science content courses within the College of Education. In this iteration of the course, Tina took on more of a consultant role. Ryan, the other science education faculty member, also teaches numerous science education content courses for prospective elementary education majors. A paleoecologist, Mike studies mammalian fossil bones at various field sites in North America. His research contributes to the larger body evidence about how climate change impacts mammal populations. The course was the first time he had collaborated with science education faculty in teaching. This collaboration continued outside the classroom with the educational component of
the Neotoma database, an extensive database of plant and animal dispersal data in North America spanning the last five million years.

**The Course Structure**

The course was designed to model effective science teaching pedagogies and practices in terms of both science content knowledge and practices. This was the second time the course was offered, and the same design team of instructors were also involved with another science education faculty, Tina, in the planning and teaching of the first run of the course. The majority of class time was spent on scientific understandings and practices related to climate change and related disciplinary ideas. However, the last four weeks focused on a teaching project whereby students prepared for and then reflected on teaching a science lesson to a small group of elementary students at a local school. In total there were three instructors (one in earth and mineral sciences and two in science education), of which I was one.

There were two aspects of the course that guided the content storyline. First, integral to the course was the use of the Claims-Evidence-Reasoning (CER) framework. Students applied the framework to data from investigations as well as incorporated it into their teaching lesson. The framework requires that students make explicit their evidence and reasoning when making scientific claims. Second, the science faculty member’s paleoecological research not only guided the content, but also provided sources of data in investigations on the ecological impacts of climate change.

During the course’s first run, the content storyline focused on the speed with which anthropocentric climate change occurs in relation to the speed of evolution, with the conclusion that species will not evolve quickly enough, although all possible biotic responses were discussed. What the design team learned is that we underestimated students’ knowledge of
fundamental ecological principles. As a result, during the first run of the course we had to add mini units and lessons about ecological principles like interactions, habitats-ecosystems-biomes (their compositions and how precipitation and temperature impact them), population distribution, and plant reproduction. With the use of *Heatstroke: Nature in the Age of Global Warming* by Anthony Barnosky as our text for the second iteration of the course, it made sense to foreground ecology. When planning for the second run of the course, I proposed that we build these ecological principles into the course more directly and broaden the content storyline to include populations’ responses to any environmental disturbance, focusing on climate change as an environmental disturbance. Mike recommended that we build in the use of the Neotoma database, which was recently in operation. The database provided students access to distribution data of historic and modern ranges of a variety of animals across North America. Using this authentic data, students could expand their understandings of the connection between population distribution and climate (changes). In addition, the prospective teachers would have a resource for use in their future classrooms. Ryan proposed we build in a multi-media project to support the Neotoma database website. Students would design lessons, investigations, and tutorials for the database and they would become part of the website. The team agreed to all of these recommendations and we modified the syllabus to reflect the changes.

Each member of the team was present and active in most class meetings and had a particular set of roles in the teaching of the course. Because there were three instructors, each of us with our own teaching philosophies and styles, instruction and teaching practices were different for each of us. The instructor of record, Ryan, was the leader of the team in that he organized the course syllabus and schedule, graded assignments, and addressed the wide range of logistics for the course. Ryan was also the instructor who generally greeted the class at the
beginning of each class and provided the students with the plan for each day. Ryan taught class often, introducing and facilitating investigations and leading discussions of investigations, content, and teaching applications. Ryan’s high regard for the profession of teaching was evident throughout the course as he talked about teaching practices and the value of teaching. He also took time to chat with students about their lives outside of class. In fact, some of the students were in the course because Ryan was their instructor for another course. Mike also taught class often and was described as the science content “expert” by both himself and Ryan throughout the course. He taught as often as Ryan. Mike’s instruction centered mainly on lectures using PowerPoint slides to instruct students about climate change and related disciplinary ideas. Mike’s passion for his research and climate change more generally was evident in both his instruction and discussions with instructors. Both Ryan and Mike made themselves available throughout the course to the students to discuss concerns about the class. As the third instructor, I was not as prominent as Ryan and Mike; however, as I will explain in the next section, I taught various lessons, especially in the beginning of the course.

Negotiating My Role

My experience in conducting the pilot study the previous academic year provided me with valuable opportunities with not only understanding how students may or may not express emotions, but the ways in which emotions, and by extension myself, were framed and prioritized within the course. In the first iteration of the course, I found that my prompts or activities about emotions felt separate from other class activities and norms. During class discussions there were not many different voices or emotional discourse. In the pilot study when emotional discourse was constructed, it was almost exclusively in student writing. Therefore, in the second iteration of the course, I purposely used pedagogies and designed my lessons to promote student
discourse, especially reflective-type discourse in order to provide a space for not only student voice but also emotions to be constructed. For example, in the second week of classes I led lessons whereby students made initial concept maps of their ideas about ecology, which promoted student voice. During one activity, students worked in groups of four or five to draw a product map of the processes and material inputs required for the manufacture and delivery of a particular product assigned to them. Students were to not look up answers but to focus on collaborating with each other to explain as best they could what they already knew. In the third week of classes, I facilitated an investigation about energy transfer and trophic levels. After students used the CER framework to support their reasoning about the nature of energy transfer in ecosystems, I gave students an application question about how the rule of 10% relates to some vegetarians’ reasoning about why a plant-based diet is more sustainable. While students grappled with this question, they shared other questions they had related to vegetarianism and our food system. This conversation, while about scientific principles, was also a space for students to ask questions and share their opinions. This type of reflective-type discourse is described in the next section. Providing these spaces for students to ask their own questions became part of the norms in encouraging their voices in general when I taught a lesson. These types of discussions can be seen throughout the course when I led lessons.

Another aspect of promoting reflective-type discourse was not just designing lessons but also negotiating with the other instructors for time and space for me to have the floor during class. Because Ryan was the instructor of record and Mike the science “expert,” my role as an instructor was by default more ambiguous. However, at Ryan’s request I took on more of a role as an instructor early in the course, in part due to unplanned absences. As a result, I led more discussions and activities, especially in the first several weeks of the course, as can be seen in
Table 4.1. For instance, in class #4, I led the book discussion in Ryan’s absence. Had he been there, he likely would have led this event. The discussion continued into class #5, providing me the opportunity to have the instructional floor more consecutive class meetings, especially in the first few weeks of class when norms and expectations are initially constructed. These occasions to instruct lessons early in the course helped me establish rapport with the students as well as have them view me, and by extension my work, as integral to the course. Another such instance occurred in class #12 where Ryan typically would have led the natural selection investigation, but I did in his absence. As a result, I had a consistent presence throughout the course.
<table>
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<th>Key Instructional Event</th>
<th>Instructor</th>
<th>Class #</th>
<th>Key Instructional Event</th>
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<td>Ecological footprints discussion</td>
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<td><strong>Lead</strong></td>
<td>21</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>8</td>
<td>Video of ice melt and discussion</td>
<td>Beth</td>
<td>21</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>9</td>
<td>Introduction to field study site</td>
<td>Mike</td>
<td>22</td>
<td>Neotoma project</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>9</td>
<td>Exam</td>
<td>Ryan</td>
<td>22</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>10</td>
<td>Bone picking investigation</td>
<td>Mike</td>
<td>23</td>
<td>Video of elementary science teaching and learning</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>10</td>
<td>Bone picking reflections</td>
<td>Ryan</td>
<td>23</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>10</td>
<td>Discussion of class #6 exit slips</td>
<td>Beth</td>
<td>23</td>
<td>Update on field studies</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>11</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>24</td>
<td>Teaching project</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>11</td>
<td>Bone picking data discussion</td>
<td>Mike</td>
<td>24</td>
<td>Neotoma project</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>11</td>
<td>Paleoeocological data worksheets</td>
<td>Mike</td>
<td>24</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>11</td>
<td>Evolution lecture</td>
<td>Mike</td>
<td>24</td>
<td>Go over exams</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>12</td>
<td>Go over exams</td>
<td>Ryan</td>
<td>25</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>12</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>25</td>
<td>Exam</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>13</td>
<td>Bone picking investigation</td>
<td>Mike</td>
<td>25</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>13</td>
<td>Bone picking reflections</td>
<td>Ryan</td>
<td>26</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>13</td>
<td>Discussion of class #6 exit slips</td>
<td>Beth</td>
<td>26</td>
<td>Discussion of science teaching</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>14</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>26</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>14</td>
<td>Bone picking data discussion</td>
<td>Mike</td>
<td>27</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>14</td>
<td>Paleoecological data worksheets</td>
<td>Mike</td>
<td>27</td>
<td>Teaching project</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>14</td>
<td>Evolution lecture</td>
<td>Mike</td>
<td>27</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>14</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>27</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>15</td>
<td>Go over exams</td>
<td>Ryan</td>
<td>28</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>15</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>28</td>
<td>Teaching project</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>16</td>
<td>Bone picking reflections</td>
<td>Ryan</td>
<td>28</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>16</td>
<td>Natural selection investigation</td>
<td>Beth</td>
<td>29</td>
<td>Reflection of teaching</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>16</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>29</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>16</td>
<td>Natural selection data discussion</td>
<td>Ryan</td>
<td>29</td>
<td>Share out of Neotoma projects</td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>16</td>
<td>Evolution lecture</td>
<td>Mike</td>
<td>30</td>
<td><strong>Instructor</strong></td>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td>16</td>
<td><strong>Instructor</strong></td>
<td><strong>Lead</strong></td>
<td>30</td>
<td>Post-assessment</td>
<td><strong>Instructor</strong></td>
</tr>
</tbody>
</table>

Table 4.1. Summary of Key Instructional Events. This figure depicts the overview of the instructional events throughout the semester and which instructors led them. The instructional events highlighted in purple are those led by me. The thicker boxed instructional events represent
instructional events that I would not have led if Ryan was present.

While I was negotiating space to lead class I was also working to promote and maintain emotional discourse in the course. I was able to recognize the potential for points of divergence or frame clashes (Green, 1983) during both reflective and emotional discourse because I was already sensitive to the fact that science and science education typically marginalizes emotions (Boler, 1999; Watts, 2005; Zembylas, 2005). Hence, as a participant observer (Spradley, 1980), I paid close attention to how emotions and emotional discourse were framed and constructed by both the students and the other instructors. The ways in which the students expressed emotions is detailed in the next chapter. How I negotiated the role of emotions in the course is described in the next section.

**How Emotions Were Constructed**

Organizing the course events and phases into an event map allowed me to visualize how emotional discourse was shaped and used in the classroom. This part of the analysis paints a broad picture of the collective scale (Green et al., 2007) whereby members jointly constructed meanings of emotional discourse. Hence, while the individual students were an integral part of the meaning-making of emotional expressions, the patterned ways in which they constructed emotional discourse provided insight into what counted as emotional expressions. Within the event map (Kelly & Chen, 1999), I identified phases and events of activity that illustrated key contextual conditions for promoting and suppressing emotional expressions. In addition, I analyzed the phases and events to determine what counted as emotional expressions in the course. The former is explained in this section and the latter in the next chapter. In order to identify the contextual conditions for promoting and suppressing emotional expressions, I analyzed the key events and phases.
Types of discourse. In order to get a sense of how emotional discourse was constructed in the course, I developed an event map (Kelly & Chen, 1999) of events and phases for the entire course, including written assignments or artifacts. Once I created the comprehensive timeline, I developed codes for the types of discourse that were used by both instructors and students as seen in Table 4.2, a typical example of the timeline. These codes were not mutually exclusive as often more than one type of discourse was constructed within an event. Therefore, the timeline provided not only an account of the events and phases but also the types of discourse during each event.

<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
<th>Phases</th>
<th>Lead Instructor</th>
<th>Type of Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15/2013</td>
<td>Class Greeting</td>
<td>Class Greeting</td>
<td>Ryan</td>
<td>Emotional</td>
</tr>
<tr>
<td></td>
<td>Discussion of Claims Evidence Reasoning (CER)</td>
<td>CER framework reading discussion</td>
<td>Ryan</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Owl pellet data discussion</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1/15/2013</td>
<td>Introduction to Ecology</td>
<td>Ecological principles discussion</td>
<td>Beth</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students work on product maps in groups</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ecology walk outside</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students work on initial ecology models in groups</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4.2. Event map sample. Selection of comprehensive event map illustrating events, phases, and types of discourse during the events.
From this comprehensive timeline, I narrowed the timeline to events and phases in which either emotions or my teaching was involved, and then identified phases. I made the decision to include my instruction because of the ways in which my teaching promoted student discourse in general and was responsive to moments of emotional discourse. Using the comprehensive event map I determined how many events entailed reflective or emotional discourse, as seen in Table 4.3.

<table>
<thead>
<tr>
<th>Type of discourse</th>
<th>Science Content</th>
<th>Logistics</th>
<th>Miscellaneous</th>
<th>Science Teaching Content</th>
<th>Reflective</th>
<th>Emotional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discourse pertaining to...</td>
<td>climate change and related disciplinary ideas</td>
<td>assignments, expectations, scheduling, and instructions</td>
<td>interests and details about students, appreciation of students and their work</td>
<td>teaching practices about climate change and related disciplinary ideas</td>
<td>opinions, beliefs, and inquiries about climate change and related disciplinary ideas</td>
<td>emotions about climate change and related disciplinary ideas and teaching</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Science Content</th>
<th>Logistics</th>
<th>Miscellaneous</th>
<th>Science Teaching Content</th>
<th>Reflective</th>
<th>Emotional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Discourse Events</td>
<td>67</td>
<td>38</td>
<td>27</td>
<td>18</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Events with Beth Teaching</td>
<td>29</td>
<td>13</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Total Written Artifacts</td>
<td>15</td>
<td>n/a</td>
<td>n/a</td>
<td>4</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

*Table 4.3.* Overview of types of discourse. The different types of discourse used by instructors and students in the course and the number of events and written artifacts in which they occurred. Types of discourse were not mutually exclusive.

Reflective discourse involved opinions, beliefs, and inquiries about climate change and related disciplinary ideas by instructors and/or students. Emotional discourse pertained to the expression of emotions, whether personal or distanced, ambiguous or clearly articulated by instructors or students. As can be seen in Table 4.3, throughout the entire course science content discourse was constructed most often, whereas emotional discourse was constructed least. In addition, five out of the seven discourse activities containing emotional discourse were when I was instructing. All except one of the discourse activities with reflective discourse were when I was teaching class.
Furthermore, of the three instructors Mike and Ryan had less interest in emotion than me, as evidenced from the timeline. Mike lead class during two events that had emotional expressions about climate change or related disciplinary ideas. There were no events with emotional discourse relating to climate change during which Ryan led class. In terms of written artifacts, it is interesting to note that there were more expressions of emotion in written artifacts than in spoken discourse.

As I coded events for types of discourse, I broke events into phases in order to capture the means, spoken or written, by which emotions were constructed. As can be see in Table 4.4, emotional discourse was constructed in multiple types of discourse activities (spoken) and written artifacts. In addition, half of the discourse activities where emotional discourse was constructed also featured science content discourse. Also, all of the written artifacts that had emotional discourse also had science content discourse. Therefore, while emotional expressions were limited by instructor, opportunities for students to construct emotional expressions were integrated throughout the course and interwoven into science learning.
Table 4.4. Discourse activities and written artifacts with select discourses constructed. This figure depicts the types of discourse activities and written artifacts during which scientific, emotional, and reflective discourses were constructed. Discourse activities and written artifacts that had emotional discourse as well as another type of discourse are in bold.

**Reflective discourse.** I purposely included reflective discourse in these original discourse codes to account for the ways in which emotions were constructed in the course. There were times when reflective discourse had the potential to become emotional discourse but for various reasons it did not. One way in which reflective discourse did not transform into emotional discourse was when another instructor joined the discussion. Another feature of reflective discourse involved ambiguous framing of the discourse activity. In other words, the instructor was not forthcoming with the expectations for the discussion as being a place for emotions. For example, following the bone picking investigation on 2/7 when students worked with sediment
from Mike’s field sites to sort bones of mammals, I led a class discussion about the students’
reflections about working with the bones. I did this because as I walked around to help students,
I overheard students saying to each other things like “I think it’s kinda weird” and “I can’t believe
how old these [bones] are” in reference to working with bones that were thousands of years old. I
interpreted these utterances as inferences (Gumperz, 2001) of emotions as part of my interacting
as participant observer (Spradley, 1980). Hence, it seemed that providing students with
opportunities to reflect on their experiences could include constructions of emotion. However, as
students began to share their reflections, I invited Mike into the conversation to speak to one of
the student’s reflections. As can be seen in the transcript below (in which each line number
represents an action unit), the discussion turned away from students’ voices and thoughts and
was ultimately not an activity in which students expressed emotions about climate change and
related disciplinary ideas.

Excerpt 4.1

1. Beth: I heard some things as I walking around in terms of people like saying wow I can’t believe like
2. picking bones of animals that were once living or
3. that are really old or
4. that scientists sit here and do this eight hours a day
5. any other thoughts that came out while you were doing this?

6. Sammy: kinda part of the fun was ##
   (Mike pours sediment back into bags))
7. ### as the pellets
8. >I don’t know<
9. there was more variety in the pellets and that was surprising to me

11. as opposed to u:h

12. Sammy: ##

13. Beth: a::h. okay so any groups too have a question to think about
14. this is a good question to think about
15. this group did not find any jaw bones but just thin bones and vertebrae
16. okay
17. “it might be interesting to hear what other people found as well”
18. Bianca
19. Bianca: it was just kinda weird that like
20. they were from 2006
21. and like I guess that like the bags have just been sitting around not being analyzed

22. Beth: umhmm
23. that’s a good point too
24. I mean you probably have this image of scientists being like
25. oka^y as soon as we get back to the lab we are going to analyze it
((claps hands once in front of her))
26. but there is also the reality of the amount of data collected
27. and mike maybe you can speak more to this
28. I don’t know if you can say how many pounds or tons are collected each summer

29. Mike: yea
30. we can do that cuz we have the weight from each bag
31. and we probably collect about a ton (+) of sediment
32. each summer
33. and process it
34. so you've only seen a small fra^ction of what we bring back
35. o:h five to six bi^n boxes just pa:cked with these bags
36. and as your saying some of them=
37. I picked the one that had lots of bones so you would find things
38. a:nd the reason they have lots of bone is what we call the time averaging
39. think of the owl=
40. =if you just had one pellet than you wouldn't find many bones
41. but if you got an owl that is coming back there
42. and then the owl’s babies and the babies of the babies
43. and generations of owls coming back there
44. then you get tons of pelle^ts
45. and tons of bones
46. and that gets buried
47. but it means that the owl—that you got numerous years in there
48. its not just one years time
49. that’s what we call time averaging
50. so tha^t’s one reason
51. and the other thing=two things
52. this-this is what we call data collection
53. the excavation is the sample collection
54. >so that's what a scientist does and goes out has samples of something<
55. and then you collect data
56. and you can either do that in ya know in test tu:bes or with with electronic equipmen:t.
57. the data collection here is collecting the bo:^nes
58. and then part of that data collection is what I was doing that for you
59. is identification
60. and people who do this work have to be trained
61. so you know so >everybody goes< so how you know this
62. you know it because you work with mo^dern animals
63. and you learn what their skeletons are li^ke
64. and then you start compa^ring your fossils to mo^dern and you start learning,
65. just like anything e^lse,
66. and so you le^arn what the bones are like
67. and then you get better at doing the identifica^tions
In the excerpt above, the students began sharing their reactions to working with the fossil bones and sediment. When Bianca reflected upon the samples remaining unanalyzed for six years, I turned to Mike to see if he could explain the reality of the time lag. In his very lengthy response, Mike did not address the point about lag time between collecting and analyzing data. Rather, he talked about a wide range of scientific processes that did not relate to the reflections Samantha and Bianca had already shared. His three minute-long response altered the direction of the discussion, whereby students no longer shared their ideas after he finished. While I was leading
the discussion, Mike was pouring sediment back into bags (the sounds of which are heard on the video recording), and so it is likely he was not following the discussion. Even so, he did not check to see if he has addressed Bianca’s idea as he talked, thereby shifting the focus away from the students to himself as a scientist. However, when I took a turn of talk in line 94, I did not explicitly ask for students to express emotions but rather ask students for their “reflections.” Throughout the entire discussion I did not specifically ask students about their emotions, but rather asked them more broadly about their “thoughts” (line 5) and “reflections” (line 94) and “if anything else came out” (line 97). Therefore, although the discussion had potential to elicit emotions, likely due to my use of indefinites in asking students about their emotions, it did not and was therefore reflective discourse.

From analyzing the event map, I also found that students typically did not express their emotions in class discussions unless I specifically asked them specifically about their emotions. For instance, on 3/26 students talked about hope and other emotions when we discussed the last chapter of *Heatstroke*, entitled “Geography of Hope” in the first event of the class. I had begun the discussion by sharing with them some of the common ideas that were expressed in their reflective questions due that day. I then asked whether they felt the author relayed “a strong sense of hope” or whether they felt “hopeful after reading the chapter.” Students responded with various types of emotional expressions. After this discussion, students worked in groups to discuss an ecological footprint quiz they took. Following the group work, the class came back together to discuss the results from the quizzes and actions that they felt were feasible to take. I had expected that this would be a time that students may express emotions, since many of them had already expressed emotions about their lack of agency or others’ lack of action to address climate change earlier in the class. I had thought that the ecological footprints would provide
them an opportunity to understand their roles in causing climate change and provide ideas for addressing the problem. However, when we started talking about the ecological footprint quizzes, students’ questions and comments centered on recycling and reusing plastics, especially related to health. Even though we talked about potentially upsetting information about plastics and human health, students did not express emotion but rather continued to ask questions about plastics. Hence, this discussion following the ecological footprints was identified as an event with reflective discourse.

**Emotional discourse.** The focus of emotional discourse entails examining emotional expressions about climate change and related disciplinary ideas. Events in the timeline that entailed emotional discourse included not only a range of ways in which emotions were constructed and expressed but also the frequency in which they were expressed in a given event. Before discussing the ways in which emotions were expressed (the subject of the next chapter), it is first helpful to examine the frequency of emotional constructions in a given event. One way emotional discourse occurred involved an *isolated emotional expression* or a single utterance from one individual, either instructor or student. Another way emotional discourse occurred was an interactional construction of emotions by both students and instructor during a class activity or writing task whereby *multiple emotional expressions* were constructed. A third theme relating to the frequency of emotional discourse that emerged is *exiguous emotional expressions*, which only occurred in written artifacts. Figure 4.1 provides a timeline of when these different types of emotional discourses were constructed. As can be seen in this timeline, the number of emotional expressions do not necessarily follow a progression but rather ebb and flow. In addition, there are ways in which emotions are constructed that help explain the context of the course, but do not provide insight into students’ emotional expressions, the subject of Chapter 5.
Figure 4.1. Timeline of emotional discourse. This figure illustrates the frequency of emotional expressions in one discourse activity or written artifact.

**Isolated Emotional Expressions.** In this theme related to the frequency of emotional discourse, emotional expressions were minimal in both spoken and written discourses. In talk in class, there was only one emotional expression within an event, by either an instructor or student. There were three instances in which instructors expressed emotions, and in all of them no space was provided for students or others to share their emotions. Two of them occurred in the same class on 2/28. At the beginning of class, I shared with the class themes from the exit slips following the Four Corners Activity (the details of this activity are in Appendix B) the previous class. I talked about agency, specific emotions students wrote about, and why having these types
of conversations about feelings about climate change was important. I did not invite students to respond because they had little to say in the previous event about the “End of Pasta article” and I felt as though they had many spaces to share their feelings recently (i.e. in the preceding event, on the homework assignment due that day, and in the previous class). However, I felt sharing the feedback about the exit slips was important to maintaining emotional discourse throughout the course. The second isolated emotional expression occurred two events later when Mike alluded to the Four Corners Activity exit slips before he began his lecture, as seen in Excerpt 4.2 below.

Excerpt 4.2

1. Mike: okay uh
   ((hands clasped in front of him))
2. go ahead and get sta^rtered
3. before we start on the lecture though
4. I would just sorta like to put some of the stuff in perspecti^ve
5. is that
6. Beth shared a lot of your fee^lings
   ((unclasps hands and raises and lowers them in front of his chest))
7. about you know what's going on with climate change and that sort of thi^ng,
8. and uh just to sorta give you a perspective
9. I'm a little bit older than most of you in here
10. been around a little bit
11. and we've faced environmental crises before
12. maybe anything quite of this magnitude...

While Mike did mention students’ “feelings,” his broad use of the term without reference to the exit slip question that elicited them, does not provide a context for which there to be a discussion. In addition, Mike continued talking about how past environmental crises have been addressed, neither creating space for students to discuss their emotions nor constructing other emotions.

The third instance of emotional discourse occurred in the next class, 3/21, during his lecture on extinction that carried over from the previous class. Following a share-out of ideas from table groups about the factors that contribute to polar bears’ vulnerability to extinction, Mike spoke about the how the rapid destruction of the polar bears’ habitat compounds the issue
of their extinction and stated, “…so that’s the big issue that we are worrying about.” While the isolated use of emotional discourse in these three events contributed to the ways in which emotions were constructed in the course, they were not able to be taken up as discussion by the students. Another event that had limited emotional discourse involved one student, during a whole-class discussion about a reading from the night before, a magazine article entitled “The End of Pasta.” When I asked the class if they had any thoughts about the article, Wendy shared: “I would be sad if there was no more pasta.” While other students contributed to the discussion, no other students expressed emotions or referred to Wendy’s emotional expression.

In the written data, isolated emotional expressions pertained to those written assignments whereby only two or three students expressed emotions. As can be seen in Figure 4.1, there were two written assignments that had isolated emotional expressions: the exit slip on 1/29 and on the second set of reflection questions for *Heatstroke* due on 2/21.

*Multiple Emotional Expressions.* In contrast to isolated emotional expressions, multiple emotional expressions were events and artifacts that have numerous expressions of emotion. In spoken discourse, this type of emotional expression was interactional and prolific in terms of duration and number of students contributing their expressions of emotion. As seen in Figure 4.1, there were two events of spoken discourse in which this occurred: the Four Corners Activity on 2/26 and the discussion about the last chapter of *Heatstroke* on 3/26. Five different writing assignments elicited more than half the students to express emotions about climate change and related disciplinary ideas (see Figure 4.1).

*Exiguous Emotional Expressions.* Exiguous emotional expressions pertain to a frequency of emotional expressions between isolated emotional expressions and multiple emotional expressions. This median frequency only applied to written discourse. In these writing events
(see Figure 4.1) one-third of the students expressed emotions. The two assignments were reflective questions for an article, “The End of Pasta,” (due on 2/28) and the third and final set of questions for *Heatstroke* (due on 3/26).

**How Emotions Were Framed**

In order to better understand why emotional discourse, especially multiple emotional expressions, was inconsistent in discourse activities and written artifacts, I analyzed the ways in which emotions were framed. In addition to the curriculum, the norms and practices of each instructor in combination with the moment-to-moment interactions shaped the frames (Green, 1983), or reference points for expressions of emotions. What became apparent was that expectations for discourse activities and written artifacts that involved emotional discourse were explicated differently.

**Discourse activities.** Although emotions were constructed in various discourse activities, *multiple emotional expressions* only occurred during the Four Corners Activity and the class discussion about the last chapter of *Heatstroke*. In both events, as I explained what we would be doing, I framed both the activity and discussion as different than what we typically did in class. While I did not frame these discourse activities as emotional discourse activities to the students, I was up front with the students that “I was turning it [the discussion] over to [them]” (2/26) and I asked questions that I thought may elicit emotional expressions. In the Four Corners Activity, I also integrated prompts with emotional language, such as “I am angry more people don’t take steps to help climate change” and “I feel bad I don’t take more steps to help address climate change” (see Appendix A for the complete set of prompts). For the discussion about the last chapter of *Heatstroke*, I prefaced this first event of the class by signaling to the students that we
were deviating from the lecture and discourse norms from the preceding four classes, as seen in
Excerpt 4.3 from class on 3/26 below.

Excerpt 4.3

1. Beth: So,
2.  >I know its <=
3.    it can be a little strange
4.  >to kinda sit in a circle<
5.  >in a class<
6.  >when you haven't sat in a circle all semester
7.    so I do recognize that that might be potentially
8.  >I don't know<
9.    weird,
10.  >but maybe it isn't either<
11.  u:m (+)
12.  ^t I really felt like (+)
13.    uh the last chapter of this book
14.    ((picks up book from desk in front of her and raises eyebrows))
15.    worthy of this type of discussion

In the excerpt, I acknowledged to the students it may feel “strange” (line 3) or “weird” (line 9) that we were sitting in a circle after 12 weeks of not doing so. In addition, by stating that the last chapter of book was “worthy of this type of discussion” (line 14), I framed the ensuing conversation as important, student-based, and different from other class discussions. Hence, even though I did not explicitly frame the discussion as a place for emotional discourse, I relayed my expectations that it would be different from the typical norms of a science classroom. In both class discussions that resulted in emotional discourse, I asked similar questions when students were not taking a turn of talk unprompted. I asked a variant of “do other folks feel similarly or differently than the people who have spoken so far” (3/26) to try to maintain student voice.

These questions were more direct and explicit about students’ emotions compared to the ways in which I asked students about their “reflections” and “thoughts” during discourse activities without emotional discourse.
From examining the ways in which emotions were framed during discourse activities in which both isolated and multiple emotional expressions were constructed, what became salient is that particular cues signaled to students that constructing emotional expressions was expected. Both changes in the classroom layout and the instructor’s discursive moves signaled frames for emotional discourse during the Four Corners Activity and whole class discussion of the last chapter of *Heatstroke*. As can be seen in Table 4.5, both the physical layout of the classroom and the instructor’s discursive moves together cued to students different frames for emotional discourse.

<table>
<thead>
<tr>
<th>Discourse Activity</th>
<th>Physical Orientation of the Class Members</th>
<th>Instructor Discursive Moves</th>
<th>Discourse Activity</th>
<th>Physical Orientation of the Class Members</th>
<th>Instructor Discursive Moves</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;End of Pasta&quot; article discussion</td>
<td>Students sat at tables</td>
<td>Students asked about their “thoughts” or “reflections” about article</td>
<td>Four corners activity</td>
<td>Students not in chairs; moved around room</td>
<td>Integration of emotion words into prompts for students</td>
</tr>
<tr>
<td></td>
<td>Instructor stood at front of room</td>
<td></td>
<td></td>
<td></td>
<td>Activity explained as “student-based”</td>
</tr>
<tr>
<td>Lecture on extinction</td>
<td>Students sat at tables</td>
<td>Used emotional language as a statement within a longer turn of talk</td>
<td>Chapter 14 of <em>Heatstroke</em> discussion</td>
<td>Chairs rearranged into circle</td>
<td>Integration of emotion words into questions for students</td>
</tr>
<tr>
<td></td>
<td>Instructor stood at front of room</td>
<td></td>
<td></td>
<td>Instructors sat in circle with students</td>
<td>Prompted students to add their &quot;feelings&quot; to the discussion</td>
</tr>
</tbody>
</table>

Table 4.5 Ways in which emotional frames were constructed differently during discourse activities. Discourse activities in orange had an isolated emotional expression, and discourse activities in blue had multiple emotional expressions.

**Written artifacts.** Particular writing tasks provided students opportunities to construct emotions about climate change and related disciplinary core ideas, as seen in Table 4.4. Over the course of the semester, students were asked a variety of reflective-type questions about climate change and related disciplinary ideas through formative assessments (Furtak & Ruiz-Primo,
2008) and summative assessments (Black, 1995). Formative assessments included the pre-assessment, exit slips and homework questions, whereas the summative assessments were exam questions and the post-assessment. Questions were contextual and hence varied in terms of content, style, and topic; they also varied in directness about emotions. For example, on 3/12, Mike lectured about extinction and discussed with students why animals like polar bears are vulnerable to extinction. When I asked students about how they felt about animals going extinct because of climate change I specifically focused on polar bears. In addition, as I analyzed students’ writing and my ethnographic field notes, themes such as personal agency, lack of personal agency, and lack of knowledge about how to help address climate change emerged from students’ writing. Hence, I also crafted potentially emotion-eliciting writing prompts relating to these ideas. Finally, some questions that were not specifically constructed to elicit emotions, yet evoked emotional expressions.

While there were many different written artifacts where emotions were constructed, exit slips were the only writing tasks that I directly assigned. When I assigned the first exit slip, on 1/29, I framed the assignment as “reflective writing…not science writing.” I instructed the students to take “time to just process” about “what you are kindov [kind of] understanding and what you’re feeling” (1/29). For the following exit slips, I further explicated exit slips as opportunities to write reflectively about feelings. For instance, on 2/26, I said to students, “Take a moment to just check in with yourself. How are you feeling? What are you feeling? Why are you feeling it? If you have any feelings what are they and what are they about?” Hence, similar to the ways I introduced the Four Corners Activity and discussion of the last chapter of Heatstroke, I framed exit slips as deviations from class norms.
All of the other written assignments were built into the course schedule (even though the questions themselves were not created ahead of time) so Ryan typically reminded students when they were due and instructions for submitting them. The instructions for the questions for *Heatstroke* were general and consisted of an instructional note that read, “Some of the questions are more reflective in nature and should be treated as such,” but did not explicitly identify them as places for emotions. However, questions on each of these assignments directly and indirectly asked students about their emotions (see Appendix A for complete set of questions). Despite not explicitly framing these other sets of writing prompts as places for emotional discourse, students constructed emotions, at times to the same degree as on exit slips. For example, in Figure 4.1, one can see that out of the five written artifacts that had multiple emotional expressions, only two were exit slips. In addition, two of the written artifacts on which there were multiple constructions of emotions, the pre-assessment and *Heatstroke* #1, were assigned before any exit slips were. Hence, students constructed emotions even without explicit introductions of the assignments as potential places for emotional expressions.

**Discussion.** Two important trends emerged when analyzing how emotions were framed within discourse activities and written artifacts in conjunction with which discourse activities and written artifacts had multiple emotional expressions (Figure 4.1). First, multiple emotional expressions occurred on written artifacts even when they were not framed (outside of specific prompts in the assignments) as places for emotional discourse. Second, the only times that multiple emotional expressions were constructed within discourse activities were when they were framed as deviating from science talk. Hence, it can be concluded that students did not construct multiple emotional expressions during discourse activities unless given cues that it was “okay” to, and even then, fewer students expressed emotions than they did in written artifacts.
The need for students to be explicitly cued about emotional discourse during discourse activities makes sense. Typically, speakers construct their expressions based on who their audience is and the given situation (Green et al., 2007). An integral aspect of these contextual factors that contribute to how emotional expressions were constructed are emotion display rules (Shields, 2002). In addition, because of the limited audience in the written artifacts, it made sense that students would more frequently express emotions in writing than in spoken discourse.

**Conclusion**

By examining the ways in which the phases of activity and events were constructed in the course, I was able to identify the different types of discourse and the frequency by which they occurred (Table 4.3), and three patterns emerged. First, emotional discourse was rarely constructed during spoken discourse activities. By examining these instances closely, I discovered that five of the seven emotional discourse events transpired when I was teaching. In addition, only two of these discourse activities entailed multiple emotional expressions. In both instances I framed the discourse activities as departures from typical conversations using a variety of verbal and nonverbal cues. Therefore, the ways in which the three instructors framed emotional discourse resulted in three different types of emotional discourse: no emotional discourse, isolated emotional expressions, and multiple emotional expressions.

A second finding from this analysis is that students expressed emotions more frequently in written artifacts than in discourse activities (see Table 4.3). While the use of frames typically refers to discursive interactions, in this study, frames (Green, 1983) about emotional discourse, or expectations for the constructions of emotions, took shape across and within written artifacts as well as discourse activities. Because there were more emotional expressions within written artifacts – both in terms of the variety of students and the number of emotional expressions –
aspects of the emotional frame for written artifacts made it more acceptable. The emotional frame for discourse activities was more constrained and hence there were far fewer emotional expressions, both by student and number.
Chapter 5: Analysis of Emotional Expressions about Climate Change and Related Disciplinary Ideas
In the previous chapter (Chapter 4), I described how emotional discourse was varied in terms of the number of people who expressed emotions, whether in spoken discourse or written artifacts. Identifying the frequencies of emotional discourse served to provide an overall view of how emotions were constructed and by whom (i.e. students, instructors). What became apparent was that during the semester, there were key discourse activities and written assignments in which multiple students expressed emotions (see Table 4.4). In addition, students expressed emotions more often in writing than in verbal discourse. In this chapter, I discuss the findings from all instances of students’ expressed emotions to explain: (1) what counted as emotion for the students, (2) the ways in which students expressed emotions, (3) what students expressed emotions about (the aboutness), and (4) how the linguistic and content features of the majority of their emotional expressions relayed a sense of distance from climate change and related disciplinary ideas, with some key exceptions.

**What Counted as Emotion?**

While I was determining what counted as verbal emotional expressions, I simultaneously analyzed written emotional expressions. Hence, I took an etic standpoint to identify emotional expressions, with spoken and written discourse mutually informing the other. Performing this analysis side-by-side was helpful in understanding which emotions students expressed in either form of discourse and how these different forms of language provided potential resources for identifying emotional expressions in either type of discourse. There were many instances in both writing and speaking whereby students did not identify their emotions or the aboutness of the emotion. Hence, I referred to their writing when they were vague in a verbal expression to see if they had written about it more clearly. I also referred to their spoken discourse when their written
emotional discourse was ambiguous to gain a better understanding of the emotion and its aboutness.

**Instances of emotions in spoken discourse.** Informed by open coding, I reviewed my ethnographic field notes for depictions of emotional expressions by both instructors and students. I included instructors’ emotional expressions initially in order to understand how emotions were constructed in the course, as discussed in the previous chapter. However, before I could do that I had to identify what counted as emotional expressions. This process was iterative. I began by using selective coding (Emerson et al., 1995) of my ethnographic field notes. After developing initial open codes for my ethnographic field notes and memos from the first several weeks of the course, I focused on coding field notes and memos based on which events related to emotion. I then watched video recordings of those events and transcribed them. Once they were transcribed, I coded the transcriptions for instances of emotion and recorded these instances within the event map of the course.

My initial coding for expressed emotions in the spoken discourse included the use of emotions words and utterances in conjunction with gestures and facial expressions that relayed emotional expressions to others. Because interaction is “an ongoing process of negotiation” (Gumperz, 2001, p. 218), one’s utterances are based in the practice of interpretation rather than “denotational meaning” (Gumperz, 2001, p. 218). This practice of interpretation involves “monitor[ing] how one’s own contributions are received” (p. 218). Hence, I paid close attention to the ways in which interlocutors, including myself, talked about emotions not only directly (through emotion words) but also indirectly because of the prevalence of emotion display rules (Shields, 2002) that typically marginalize emotions in both science and education (Boler, 1999; Zembylas & Chubbuck, 2009). Therefore, it was no surprise that there were fewer instances of
emotional expressions during discourse activities than in the written artifacts (see Figure 4.1) due to the nature of spoken discourse in a classroom. A typical frame, or set of expectations for how to act and participate (Green, 1983) for science courses does not include constructing emotional expressions, especially to an entire class.

**Instances of emotions in written artifacts.** For the textual analysis, I used both content analysis and linguistic description (Bazerman, 2006) to make salient the ways in which students wrote emotively. In order to get a broad sense of the data, I first applied Goodwin’s (1994) framework for analyzing discursive practices by highlighting the contents of the students’ responses that focused on emotions to make them more noticeable. Included in this initial highlighting were:

- the use of emotion words like scared, worried, nervous, etc.,
- the use of broader affective words like bad, ridiculous, hurt, horrendous,
- sentences and phrases that were underlined or capitalized,
- sentences and phrases that had exclamation marks,
- sentences and phrases that had emoticons (e.g., 😞), and
- sentences and phrases that relayed a sense of urgency.

Hence, when highlighting emotions, I paid attention to not only explicit expressions of emotion (through the use of emotions words) but also ambiguous and implied expressions of emotion. Including ambiguous and implied emotions was important because there is a range of abilities in articulating emotions precisely (Barrett, 2006).

**How coding emotions in different discourses informed what counted as emotion.** As I coded emotional expression in each type of discourse, spoken and written, I referred to the initial potential markers of emotional expressions in each discourse to inform what may count as
emotional expressions in the other type of discourse. I looked for instances of spoken discourse that had applicable features from the writing data set. For example, in my initial analysis of what counted as expressions of emotions, I highlighted instances of affect-type words to account for emotion granularity (Barrett, 2006) as well as expressed urgency in student writing. I then returned to the transcripts of spoken discourse to highlight instances of affect-type words and expressed urgency as potential instances of emotional expressions. While these words and phrases are not definitive markers of spoken emotions, they were instances I examined more closely to understand whether students were expressing emotions through any combination of spoken language attributes and accompanying gestures and facial expressions. Once I determined what counted as emotional expressions in discourse activities and written artifacts, I returned to my events map and coded the corresponding events as emotional discourse.

**Different Ways Emotions Were Expressed**

I returned to the initial highlights of both spoken discourse and written responses and found there were different ways in which the students wrote their emotional expressions in terms of personal ownership. Hence, I used open coding to determine the diverse ways in which students wrote about emotions. Three themes emerged: “true” emotions, emotions at a distance, and a hybrid of the two. Examples of emotional expressions in each of these three themes can be seen in Table 5.1.
Table 5.1. Overview of types of emotional expressions. Examples of the three types of emotional expressions from both spoken discourse activities and written artifacts.

**True emotional expressions.** Instances of “true” emotional expressions exemplified the definition of emotions in that students seemed to be taking something about climate change and related disciplinary ideas personally. In both writing and in spoken discourse, instances of “true” emotional expressions were spoken and written in ways that indicated ownership of the emotion. Linguistic features of “true” emotional expressions were the inclusion of the first person, such as:

- “I am…”
- “I feel…”
- “It frustrates/angers me…”
- “This scares me…”

**Distanced emotional expressions.** Emotional expressions at a distance typically featured emotional language or words but without personal association to the emotion. There were instances in which students talked about emotions at a distance in a similar manner as the
linguistic features in the written data. However, contextualization cues (Gumperz, 1982) also revealed expressions of emotions at a distance in spoken discourse. For instance, during the Four Corners Activity, Renee moved to the “strongly agree” corner following the prompt, “My actions won’t make a difference in changing the climate change problem.” In response to my asking why she was in the “strongly agree” corner, her use of gestures in conjunction with her spoken discourse relayed distanced emotional expressions, as seen in Excerpt 5.1.

Excerpt 5.1

1. Renee: well I mean,
2. ((hands in pockets))
3. my=me as an individual?
   ((shrugs))
4. like I mean >I can only d^o so much<
5. as
   ((hands come out of pockets and her arms move outward as if embracing class))
6. >not like as a group as a whole<
   ((shrugs and lifts and drops her hands))
7. there’s so many other people,
   ((raises and drops hands in front of her))
8. that (+)
9. are affecting the environments that >so if I am the only one trying to do anything<
10. it’s really no^t going to make th^at big of a difference
    (2 s)
    ((frowns and shrugs and returns hands to pockets))

Throughout her entire turn of talk, Renee relayed her lack of individual agency about addressing climate change, and what emerged was a distanced emotional expression of helplessness. When Renee spoke of her lack of individual agency, contextualization cues reinforced and amplified her sense of not being able to address climate change by herself. Her two shrugs in lines 3 and 7 as she talked about her lack of agency signaled a level of helplessness. In addition, her gesture of lifting and dropping her hands while shrugging (line 7) further compounded her lack of individual agency. She reinforced her lack agency in line 7 by restating that her individual actions do not matter much. The third and final shrug is paired with her frowning in line 11. If
she was not taking this idea personally it would seem that she would not be shrugging so often. In addition to contextual cues as seen in the example of Renee above, linguistic features of this theme were the use of third person to write or talk about emotion, such as

- “climate change is scary/frustrating”
- “it makes others feel…”
- “if more people were angry…”

**Hybrid emotional expressions.** The hybrid emotional expressions were expressions that were in between the two other themes, whereby students expressed emotions but did not fully own them. The linguistic features most often used in this theme were “it makes me angry…” and “it makes me feel guilty.” However, there was also a subset of “true” emotional expressions that had the first person but used other linguistic features that dampened the emotional expression. These features included the uses of hedging language, adverbs to lessen the emotional expression (i.e. “kinda,” “somewhat,” “a little”), and other features. Examples from the same writing artifact, an exit slip on 2/26, are shown below to illustrate the different ways students used the first person differently in their emotional expressions about not doing more to address climate change. Here, Sarah expressed a dampened sense of guilt. The bold font represents how she composed the emotion and the underlined section represents the aboutness of the emotion. Red font is used to highlight features of the emotional expression.

I think overall the feeling I’m having is a bit of guilt that me and the people around me aren’t putting a lot of effort to help change the climate... (Sarah)

In using “a bit” to describe her guilt, Sarah lessened the emotional expression of guilt, thereby not fully owning her guilt despite using the first person. Denise’s emotional expression below indicates distance as well but with a different linguistic feature. In her response, she wrote that she is “starting to feel” emotions, which suggests she does not feel them fully yet.
I am starting to feel frustrated and guilty about my actions because I know I could take small steps to make a change… (Denise)

Sarah’s and Denise’s emotional expressions about their lack of actions to address climate change differ from Marilyn’s and Gillian’s expressions from the same exit slip. These latter emotional expressions are not dampened, as seen below.

Personally, I feel guilty that I haven’t taken more action…I really do feel guilty…I really do feel guilty…(Marilyn)

After the four corner activity we did in class today I realized I do not do as much as I could in helping address climate change. I really do feel guilty…I really do feel guilty…I really do feel guilty…I really do feel guilty…(Gillian)

Emotional expressions like Marilyn’s and Gillian’s are more personal and therefore serve as typical examples of “true” emotional expressions.

Ownership of Emotions by Individual Students

In order to get a sense of how the three types of emotional expressions were part of the overall emotional discourse in the course, I analyzed them by student (see Figure 5.1) and then by aboutness (see Figure 5.2, later in the chapter). I calculated both the average number of emotional expression by a student, which was 7.2, and the median of emotional expressions by student, which was 7. By grouping the varying degrees of emotional ownership by student, three trends emerged.

First, one can identify which students expressed emotions most often: Mallory and Denise. Moreover, even though both Mallory and Denise expressed emotions most frequently, the majority of their expressions were not “true” emotions, but rather were distanced. Twenty percent of Mallory’s emotional expressions were “true” and only 10% of Denise’s were.

A second trend that emerged from this data was that there were students who expressed emotions in a way to own them the majority of the time they expressed emotions. As seen in Figure 5.1, these students were Hope, Lorraine, Desiree, and Bridget. Hope, Lorraine, and
Desiree expressed true emotions 58%, 50%, and 70% of the times they expressed emotions respectively. These three participants also had a similar number of emotional expressions, between 10 and 12. Bridget had far fewer emotional expressions, just four, but three of those emotional expressions were “true.” Hope, Lorraine, Desiree, and Bridget constructed true emotional expressions most often during the course. The flip side of this pattern is that the other 26 students expressed distanced emotions the majority of the time they constructed emotional discourse, if they did at all.

A third theme apparent in Figure 5.1 relates to the students who expressed only a handful of emotions or none at all during the course. This figure provides insight into just how often students constructed emotions when given the opportunity. While it is impossible to quantify how many opportunities students had to construct emotions during discourse activities, it is somewhat easier to do so for written artifacts. Although every writing assignment had the potential to elicit emotions, students constructed emotions about climate change and its related disciplinary ideas in only nine such assignments. Hence, in aggregate, there were 260\(^2\) total written opportunities for emotional constructions by students. However, throughout the course, there were only 106 written expressions of emotion. This tally of 106 emotional expressions does not include multiple expressions by one student on one specific artifact. Hence, students expressed emotions in writing only 41% of the time, even though 67% of the 15 total writing tasks requested an emotional response. This percentage is actually lower since the students had more opportunities than the nine written artifacts included in the analysis. From Figure 5.1, it is

\[2 \text{ There were 260 total opportunities because there were 9 assignments but some students were absent or did not turn in all assignments. Hence, instead of 270 (9 assignments x 30 participants) opportunities, there were actually 260.}\]
clear that two students, Jayne and Edward, did not express emotions in either discourse activities or written artifacts. In addition, Briana and Laura expressed emotions only one time each.

Figure 5.1. Graph of emotional expressions by student. The figure illustrates the number of instances of emotional expressions by students in terms of number of true, hybrid, and distanced emotional expressions. This diagram illustrates that the students who expressed emotions most often (Mallory, Sandra, and Denise) did so in a distanced manner. From this diagram, it becomes apparent that Desiree, Hope, and Lorraine constructed true emotional expressions most often during the course.

The Categories of Aboutness of Students’ Emotional Expressions

After determining what counted as emotion and coding for the different ways in which students expressed emotions in terms of distance, I performed another round of open and iterative coding of all the emotional expressions by students for their objects (or the aboutness) related to climate change and related disciplinary ideas. By examining the aboutnesses of the emotions, the objects of the emotions became salient. In other words, the aspects of the related
disciplinary ideas that caused the students’ emotional expressions illustrate the triggers for their emotions. Six categories of aboutness emerged, as seen in Table 5.2: impacts of climate change, lack of action, causing climate change, severity of climate change, taking action, and that climate change has no solution.

<table>
<thead>
<tr>
<th>Category</th>
<th>Aboutness</th>
</tr>
</thead>
</table>
| Impacts of Climate Change         | • Who or what is being impacted  
• When the impacts will occur    |
| Lack of Action                    | • Who or what is not doing anything or enough to address the problem      |
| Causing Climate Change            | • Who or what is causing the problem                                      |
| Severity of Climate Change        | • The speed or severity of the problem                                   |
| Taking Action                     | • Who can or should take action to stop climate change                    |
| No Solution                       | • There is no way to fix climate change  
• There is no easy way to fix climate change |

Table 5.2. Categories of aboutness. The six categories of aboutness relating to climate change and related disciplinary ideas that students expressed throughout the semester in both discourse activities and written artifacts in order of frequency.

I then quantified all instances of aboutness (see Figure 5.2) in relation to the types of emotions within each emotional expression. Some important patterns emerged. Out of the 215 expressions of emotions, students most often expressed emotions (78 times) about the impacts of climate change, indicating that the impacts of climate change are what they found most relevant. However, only one-third of the emotional expressions about impacts were truly personal. The details of this aboutness category will be discussed later in this chapter. Another pattern that can be seen in Figure 5.2 is that students most rarely expressed emotions about climate change not having a solution. Finally, most of emotional expressions were dampened in some way, as seen by the number of distanced and hybrid emotions in relation to true emotions, which was a trend
visible in the individual student data (Figure 5.1). Each of these patterns, as well as other patterns specific to each aboutness category, will be discussed in the following sections.

![Bar chart](image)

**Figure 5.2.** Graph of aboutness categories. The number of instances of aboutness by category relating to climate change and related disciplinary ideas in terms of distanced, hybrid, and true emotional expressions.

**Aboutness: Impacts of climate change.** One third of the emotional expressions throughout the course were about the impacts of climate change. Furthermore, only six students did not express emotions about the impacts of climate change (two of which did not express any emotions). Hence, this is the aspect of climate change that students found most relevant in the course.

**Sub-categories of impacts of climate change aboutness.** Within this aboutness category, there are several sub-categories about who or what is being impacted by climate change and when, as seen in Table 5.3. One pattern that is obvious is that the impacts on other species elicited more emotional expressions than any other impact, including impacts on people or self. In addition, students expressed emotions about the impacts on people and nature equally. Hence,
what becomes salient here is that students either did not understand the impacts on people or are more deeply engaged with the impacts on other species. In addition, most of the emotional expressions about the impacts of climate change (65%) pertained to seemingly distanced bodies outside of the self, in effect “othering” the impacts of climate change.

**Prominent expressions of fear.** In addition to largely “othering” the impacts of climate change, the prominence of fear as an expressed emotion is also indicative of distancing. With 24 constructions out of 78 total emotional expressions, fear itself offers insight into how students conceptualized the impacts of climate change. At its fundamental level, fear is typically in response to anticipated events that are threatening (Harth, Leach, & Kessler, 2013). Hence, the students’ expressions of fear signaled that they viewed the impacts of climate change as future, rather than present-day, events, thereby creating temporal distance between themselves and climate change. Compounding this distance is that the majority of expressions of fear were distanced. Hence, what can be gleaned from the students’ expressed emotions about the impacts of climate change is that in terms of number (of emotional expressions) and aboutness, students viewed climate change overall as an anticipated event, rather than one that was currently happening (or whose impacts in many instances have already occurred).

**Prominent expressions of true emotions.** Students largely expressed true emotions about the impacts of climate change on other species. However, the true emotions that were most often expressed were “upset” and “bad” (see Figure 5.3), ambiguous emotions. These emotions are not clearly defined, which is not uncommon and representative of how we often talk around emotion (Shields, 2002) or do not have the ability to clearly articulate what we feel (Barrett, 2006). Yet, from examining the emotional expressions, these expressions of “upset” and “bad” indicate empathy for the species that will be negatively impacted by climate change. Empathy can be a
powerful for people to act so long as people do not experience extremes of it (either high or low) (Thoits, 1989) as well as have the willingness to act and action competence (Almers, 2013).

<table>
<thead>
<tr>
<th>Impacts of climate change on</th>
<th>Number of Instances</th>
<th>Prominent Expressed Emotions</th>
<th>Number of Instances of True Emotions</th>
<th>Prominent Expressions of True Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other species</td>
<td>28</td>
<td>Upset, bad, sad</td>
<td>12</td>
<td>Upset, bad</td>
</tr>
<tr>
<td>People</td>
<td>14</td>
<td>Worry, fear</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Nature</td>
<td>14</td>
<td>Fear</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Planet</td>
<td>7</td>
<td>Fear</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Self</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Weather</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>General impacts (not explicated)</td>
<td>10</td>
<td>Fear</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5.3. Emotional expressions about impacts of climate change. This table illustrates the sub-categories of the aboutness category of impacts of climate change as well as their frequencies, how often the emotions were expressed as true emotions, and any prominent emotions within that sub-category. Prominent expressed emotions represent those emotions that were expressed more than three times.

Emotional expressions about the impacts on other species. In addition to examining general patterns within this aboutness category, it is also helpful to examine how students expressed emotions about each sub-category of impacts. Students used a variety of linguistic features to relay a sense of ownership or distance in their emotional expressions about impacts on other species. For instance, Hope’s response to a post-assessment question below is an example of how students constructed true emotional expressions about this type of impact.

I feel sad when species that will be affected negatively by climate change are discussed, too, because whether or not we’ll be able to save those species is unknown, and that’s sad. (Hope, 4/25)

In her response, Hope relayed a sense of ownership of her expressed sadness by using the first person and being definitive about the fact that they will be impacted, and repeating the use of “sad.” Her response differed from Gabriella’s written response on the post-assessment:

I like animals and seeing them in nature, so thinking that the animals that I see everyday could soon move to different areas or be gone all together makes me sad. (Gabriella, 4/25)
Unlike Hope, Gabriella wrote about her sadness as something acting on her (“makes me sad”) rather than using “I feel” as Hope did. In addition, Gabriella included hedging language about the fate of other animals when she wrote that they “could soon move…or be gone all together” as compared to Hope’s description that they “will be affected.” What became salient is that even though both Hope and Gabriella were expressing emotions, even the same emotion, about the impacts of climate change on other species, they did so in different ways, indicating varying degrees of personal connection to these impacts. In addition, these emotional expressions provided insight into how these students conceptualized the impacts on other species. Even though they used different emotional discourse and ways of distancing themselves from the problem, both of them wrote about the impacts on other species as future events.

*Emotional expressions about the impacts on people.* Similar linguistic features were seen in the students’ emotive responses about the impacts of climate change on people. However, even though the students’ emotional expressions relayed varying degrees of ownership, their expressions illuminated a similar way of conceptualizing the impacts of climate change on people. Below are two different ways in which students expressed worry about the impacts of climate change on people.

I think climate change and global warming is very scary. It can have devastating consequences and I am often very worried of what will happen to us when it gets worse. (Daniella, 1/8)

*Climate change makes me worry for future generations.* If things continue the way they currently are, life may be different for this generation’s grandchildren and great grandchildren. (Fred, 4/25)

Daniella not only used the first person singular to express worry, but she amplified her worry with the use of both “often” and “very.” In addition, by using the first person plural of “us,” she included herself in the collective of people who will be impacted by climate change. She also did not use hedging language that humans will be impacted when she wrote, “when it gets worse.”
Although Fred also expressed worry about the impacts of climate change on people, he did so in a more distanced way. His use of “makes me worry” relayed distance, which was magnified with the aboutness of the emotion, the conditional impacts on “future generations.” In his second sentence, Fred elaborated that the “future generations” are 40 years at minimum in the future. Hence, the impacts of climate change are still generations away, and unlike, Daniella, impact people other than him. Fred further distanced himself from the worry he expressed by using two instances of hedging about climate change (“if things continue the way…”) and its impacts on people (“life may be different”). Similar to the examples from the sub-category of impacts on species, the emotional expressions for impacts on people had varying degrees of personal ownership. In addition, despite their very different ways of expressing emotions, both Daniella and Fred conveyed that they conceptualized climate change to not currently be impacting people.

*Emotional expressions about the impacts on self.* In the entire set of emotional expressions about impacts, both written and spoken, only three students expressed emotions about the impacts of climate change on themselves. They did so in varying ways as seen below.

...It personally affects me because I may never get to see the beautiful glaciers when I get older. 😢 (Persephone, 1/29)

...Talking about this scares me because I know this affects me, my family and everything on Earth but not everyone is knowledgeable about it. (Stacy, 2/26)

At first, the beginning of the course scared me because it made me realize just how serious climate change is and how much it is affecting not only the animals and environment around me, but how much it directly affects me too... (Marilyn, 4/25)

Persephone did not explicate an emotion with words but with the emoticon “😢,” signifying that she likely felt some degree of sadness. The impacts of climate change that she found relevant to herself were not seeing glaciers when she is older. However, she accompanied this impact with “may,” thereby evading the fact that glaciers are melting at a fast pace. Her conceptualization of the impacts of climate change was similar to those of Fred’s, Daniella’s, Gabriella’s, and Hope’s
in that the emotional construction is about a future event, implying that the impacts are not yet occurring. Persephone’s response differed from Stacy’s in that Stacy was more forthcoming about her emotion, in this case, fear by using the phrase “this scares me.” In addition, Stacy housed the impacts of climate change about her self within a larger and all-encompassing scope while still identifying both herself and her family. Marilyn expressed her fear in a similar manner to Stacy by using the phrase “[it] scared me.” In addition, the aboutness of Marilyn’s fear was similar to Stacy’s in that it distinctly includes herself but also the “animals and environment” around her. Unlike most of the other students, Stacy and Marilyn expressed emotions about the impacts of climate change on themselves presently, thereby indicating that they conceptualized climate change and its impacts to be occurring presently.

**Discussion about impacts of climate change.** Examining this one aboutness category offered multiple insights into how students engaged with climate change and in particular its impacts. Out of the 30 students in the course, only six did not express emotions about the impacts of climate change. In addition, students expressed emotions most often about the impacts of climate change. Therefore, it was apparent that this was the aspect of climate change students engaged with most personally (i.e. emotionally) throughout the entire course. Interestingly, it was not the ways in which impacts affect students, but the impacts on other species that provoked the most emotional expressions and the most true emotional expressions. Hence, students “othered” the impacts of climate change by not including themselves in their emotional expressions and created distance between them and the impacts. In addition, students also distanced the impacts of climate change temporally by expressing emotions about the impacts in the future. Throughout the entire duration of the course, there were only three emotional expressions about climate change impacting the self. Two of these expressions were
true emotional expressions indicating that the two students understood that they are impacted by climate change.

**Aboutness: Lack of action.** Twenty percent of the emotional expressions were about a lack of action in addressing climate change. This aboutness had three sub-categories, as seen in Table 5.4: lack of action by oneself, others, and the collective us. The majority of emotional expressions about a lack of action regarded one’s own lack of action (61%). Moreover, nearly half of these expressions were true emotional expressions. Hence, it is important to explore this sub-category more closely.

<table>
<thead>
<tr>
<th>Lack of action by</th>
<th>Number of Instances</th>
<th>Prominent Expressed Emotions</th>
<th>Number of Instances of True Emotions</th>
<th>Prominent Expressions of True Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self</td>
<td>27</td>
<td>Guilt, frustration</td>
<td>13</td>
<td>Guilt</td>
</tr>
<tr>
<td>Others</td>
<td>11</td>
<td>Sadness, frustration</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Us</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Table 5.4. Emotional expressions about lack of action. The sub-categories of the aboutness category of lack of action as well as their frequencies, how often the emotions were expressed as true emotions, and any prominent emotions within that sub-category. Prominent expressed emotions represent those emotions that were expressed more than three times.*

**Sub-category of lack of action: Self.** Within this sub-category students identified various emotions, many of which were similar and hence I grouped them, as shown below in Table 5.5. An interesting trend in this sub-category is both the number of instances of expressed guilt as well as the number of times students expressed guilt as a true emotional expression. Unlike fear, guilt focuses on the present or past rather than the future. It is directed toward the self in terms of personal actions and even implies self blame (Böhm, 2003). It is also more definitive in scope in that it results from one identifying specific actions or attributes of oneself that cause the guilt (Lewis, 1993). In addition, guilt elucidates the *desire* to address the specific actions that cause the guilt (Böhm, 2003; Lewis, 1993). As seen in Table 5.5, many students also expressed...
helplessness and frustration about their personal lack of action to address climate change, which were typically expressed in a distanced manner. These emotional expressions indicated a sense that climate change is too difficult to address personally.

<table>
<thead>
<tr>
<th>Student’s expressed emotions</th>
<th>Grouped Expressed Emotions</th>
<th>Number of Instances</th>
<th>Number of Instances of True Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guilt</td>
<td>Guilt</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Frustration</td>
<td>Frustration</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Bad</td>
<td>Not explicated</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Helpless</td>
<td>Helpless</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Overwhelmed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Devastated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discouraged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worried</td>
<td>Worried</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.5. Emotional expressions about role of self in lack of action. How student’s individual expressed emotions were grouped and the total number of instances of the grouped emotional expressions and true emotions about the lack of personal (self) action to address climate change.

*Emotional expressions of guilt about a lack of personal action.* In addition to examining general patterns within this aboutness theme, it is also helpful to examine how students expressed guilt about their lack of action. Students used a variety of linguistic features to relay a sense of ownership of their emotional expressions. Students expressed guilt during discourse activities, such as the Four Corners Activity. During this activity, Sandra explained why she stood in the “agree” corner about the prompt, “I feel bad I don’t take steps to help address climate change.” In Excerpt 5.2 of the transcript, she expressed guilt at the end of her turn of talk.

Excerpt 5.2

1. Sandra: um
   ((holding hands closed below her chin))
2. for m^e
3. for example like
4. when I’m in my dorm
5. and I drink a lot of water or >something like that<
6. instead of separating it I just put it one bag
When Sandra talked about her lack of action, she explained that she could easily recycle but does not, which caused her to express emotions of “bad” and “really guilty” (lines 11 and 12), implying self-blame. Contextualization cues helped to explain how she signaled her emotional expressions of guilt begin before line 11. In lines 6, 7, and 10, Sandra’s gestures amplified her verbal messages about how she could easily recycle but did not. Her chin lowering and nods amplified her recognition that she could easily recycle. Hence, when she used emotion words in lines 11 and 12, she took ownership of those emotional expressions in two ways. She uses the first person singular. She also repeated the emotional expression, clarifying it the second time. Using two different emotion words, “bad” and “guilty,” could be a product of her emotion granularity but was more likely a result of the norms of classroom emotion discourse. As seen in Figure 4.1 (in Chapter 4) emotional expressions were constructed much less frequently in spoken discourse in relation to written discourse. Hence, her naming the emotion during a spoken discourse activity further indicated her owning it. Finally, she amplified the emotion of “guilty” with the use of “really” in line 4. But her expression of “really guilty” was much quieter than the rest of her turn of talk, which again pointed to the hesitations students had about voicing their emotions during class discussions. Other expressions of guilt also signified ownership, as seen in the excerpts from written artifacts below.
I feel guilty that I don’t do more to address climate change…. (Lorraine, 2/26)

I definitely feel guiltier about my habits because there is stuff that I can easily fix to help the problem. But, I won’t stop taking the bus on cold days for example. (Denise, 4/25)

In the examples above, Lorraine and Denise were upfront about their guilt regarding their lack of actions in addressing climate change. Lorraine’s straightforward “I feel guilty” and Denise’s unequivocal phrase “I definitely feel guiltier” signaled ownership of their guilt about not doing more. Denise’s expression of guilt also explicated the actions that provoke her guilt, i.e. taking the bus on a cold day. These expressions contrasted with Sarah’s expression of guilt:

….I feel a tiny bit of guilt because I tell myself that I will make environmentally-friendly changes to my every day life, but I always seem to come up a bit short (do the minimum), when there is so much more I could be doing. (Sarah, 4/25)

Despite recognizing that she could be doing “so much more,” Sarah downplayed her expression of guilt despite using the first person singular. Her pairing of “a tiny bit” with “guilt” dampened the emotional expression.

Discussion of lack of action. Only one-fifth of the emotional expressions were about a lack of action to address climate change, illustrating that the majority of students in the course were not engaging deeply about how or why climate change is not being solved or mitigated. However, this category of aboutness was striking in that students expressed emotions about their individual roles in not taking action. In addition, most of these were true emotional expressions of guilt, signifying that students conceptualized climate change as a problem they could help address yet do not. Hence the emotional expressions in this category of aboutness provided insight into the specific actions that provoked guilt, and in essence students perceived as meaningful solutions to climate change. Unlike the impacts category, the role of self was prioritized within this category of aboutness, which is consistent with the prevalence of guilty expressions.
**Aboutness: Causes of climate change.** Only 17% of the emotional expressions were about who or what causes climate change. Despite this small percentage of total emotional expressions, there was still a range of objects of emotions (aboutness), or actors causing climate change, and emotional expressions that students explicated.

**Sub-categories of causes of climate change aboutness.** Within this aboutness, four types of actors causing climate change emerged: we, people, self, and society’s advancements. While “we” and “people” seem synonymous, linguistically there were differences between the two. The “we” category included Americans and the use of “we” or “us,” whereas the “people” category included the use of “humans,” “people,” and “someone,” arguably broader and vaguer terms for the actors causing climate change. The differences became clearer when examining the prominent emotions expressed (those expressed more than three times) for each set of actors. As can be seen in Table 5.6, there were three prominent emotions expressed when students constructed emotions about the collective “we” causing climate change: guilt, anger, and fear. Furthermore, the expressions of true emotions were largely about anger about the collective “we” causing climate change. The prominent emotion expressed about “people” causing climate change was frustration, however none of the emotional expressions about people causing climate change were truly personal.
Table 5.6. Emotional expressions about who is causing climate change. The sub-categories of the aboutness category of who causes climate change, as well as their frequencies, prominent emotions within that sub-category, and how often the emotions were expressed as true emotions. Prominent expressed emotions represent those emotions that were expressed more than three times.

Expressions of true emotions about the collective we causing climate change. Within the entire aboutness of who causes climate change, anger was the only true emotional expression. Anger is typically directed toward another person or entity (Böhm, 2003) and therefore ascribes blame and responsibility to someone or something other than self. Solomon (2007) describes anger as a “judgment that one has been wronged or offended” (p. 18). Hence, by its nature, anger implies a sense of moral superiority, whereby one is being wronged (rather than being wrong). Below are examples of the ways that two students expressed anger in a way to take ownership of it about the collective “we” causing climate change. However, they did so in different ways, making salient who or what they blame.

I’m upset and angry to learn that the place where it should be so serene is anything but, and because of the greenhouse gasses that we humans release into the planet. (Hope, 1/29)

...the whole idea of climate change angers me....Many of the species can’t fend for themselves and they are left with minimal to no options. This leads to anger. We are the reason for this issue. We are selfish for what we are doing to our home, the earth. No one will care to help until their lives are drastically affected and when it is too late. (Desiree, 4/25)

While writing differently about their anger, both Hope and Desiree were definitive in both their emotional expression of anger and the aboutness of the anger. Hope began her response expressing emotion in the first person. While it was not possible to discern what “upset” means
for her in this context, her use of it amplified her anger. Desiree was also unequivocal about her anger, both in her use of the phrase “angers me” and in her writing about the way “we are selfish.” Although her anger resonated throughout the rest of her response when she wrote that “no one will care to help…,” she shifted from ascribing anger to the third person plural (we) to the second person (no one), indicating that while she blamed the collective “we” for causing climate change, she did not view herself entirely to blame for causing climate change. A similar contradiction was also in Joseph’s response about anger. Unlike Hope and Desiree, he did not take ownership of anger when he wrote:

I guess that I feel angry or confused about climate change, mostly the global warming part of it. Climate change is nature, and the fact that humans possibly have a large negative effect on it makes me upset for us. (Joseph, 1/10)

Joseph dampened his expression of anger by using “I guess” to begin his sentence and pairing “or confused” with anger. He also used hedging about humans’ role in causing climate change with his use of “possibly.” These features of his response served to distance himself from both anger and his role as part of the collective of causing climate change. Although he expressed anger, which is indicative of blame outside of one self, he does not clearly indicate if he was angry at “us” or “humans.” This ambiguity relayed a sense of ambivalence about who or what he did blame.

When students expressed true emotions about the causes of climate change, they relayed anger, specifically about “us” causing climate change. However, most of the students who truly expressed emotions about who or what is causing climate change did so in a way to blame others despite using “we,” as seen in Desiree’s and Joseph’s written artifacts. Therefore, the constructions of anger were indicative of a distancing or othering of who causes climate change, even when it was about us causing climate change.
Discussion of cause of climate change. Despite only 17% of the total emotional expressions about climate change about who is causing climate change, this category of aboutness provided valuable insights into how students engaged with climate change. In particular, the prevalence of expressions of anger, especially in a way to take the anger personally, signified how students conceptualized who was responsible for climate change. While some of the students who expressed “true” anger did so in a way to implicate themselves as part of causing the problem, most of the students expressed “true” anger in ways that shifted the blame away from themselves or relayed an obscure sense of who is causing climate change.

Aboutness: Severity of climate change. When students expressed emotions about climate change, only 12% of the objects of the emotions were about the severity of climate change. This category of aboutness differs from most of the other preceding categories in that it could not be broken down into sub-categories. Students’ emotional expressions about the severity of climate change related to the nature of it being a problem: the complexity (including lag time), the extent of the impacts, and the speed at which it is occurring. These attributes of the problem were not mutually exclusive and therefore made categorizing them difficult. As can be viewed in Table 5.7, only six of the 26 emotional expressions (or 23%) about the severity of climate change were truly personal, a percentage similar to the number of true emotional expressions in both impacts of climate change and causing climate change.

<table>
<thead>
<tr>
<th>Severity of climate change</th>
<th>Number of Instances</th>
<th>Prominent Expressed Emotions</th>
<th>Number of Instances of True Emotions</th>
<th>Prominent Expressions of True Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26</td>
<td>Fear, despair</td>
<td>6</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5.7. Emotional expressions about the severity of climate change. This table depicts the number of instances of emotional constructions about the severity of climate change as well as the prominent expressions of emotions, the number of instances of true emotions, and if there were any prominent expressions of true emotions. Prominent expressed emotions represent those emotions that were expressed more than three times.
**Expressions of true emotions about the severity of climate change.** In this aboutness category, the emotions of fear and despair are most prominent. There were six instances of each of these emotional expressions for a combined percentage of 48% of the emotions expressed about the severity of climate change. However, students did not express one particular prominent true emotion. Instead there was a range of emotions that were truly personal. Lorraine expressed one during the Four Corners Activity, as evidenced in the transcript below. Stacy and Lorraine explained why they stood in the “strongly agree” corner in response to the prompt, “I feel bad I don’t take steps to help address climate change.” Although Stacy did not express an emotion in this turn of talk (she later did), her explanation as to why she strongly agreed with the prompt was taken up by Lorraine, who did express an ambiguous emotion of “feeling bad.”

Excerpt 5.3

1. Beth: let’s start with the strongly agree folk ((facing corner with Stacy and Lorraine))
2. can both of you speak to it?
3. Stacy: I just was never like taught about it before? ((hands crossed in front of her chest))
4. like stuff I do
5. like I d^o u:se plastic ba:gs and >stuff like that< ((shrugs with arms crossed))
6. but I can cut that stuff out:
7. Beth: okay. (2s)
   [can I can I ask]
8. Lorraine: [um: ####]
9. Beth: do you feel like you know wha^t to do.
10. Stacy: no ((shakes head))
9. Beth: Lorraine you want to add
10. Lorraine: yea it’s kinda like that ((holding arms crossed in front of chest))
   that I feel bad that I am just
11. learning about this no^:w
13. and then that I still don’t really know
   ((raises right arm in front of body))
14. "what to do"

Lorraine referred to Stacy’s utterance about “not taught about it before” in lines 11-12 when she stated that she felt bad that she was just learning about climate change now. Even though she did not articulate a specific emotion during this turn of talk, she is still up front about feeling “bad” about her previous ignorance about climate change. However, her exit slip from the end of that class provided more elaboration about her emotions, as she wrote,

   …I feel bad that I’m just learning the extent of the damage that will be done in the future. It’s frustrating that I am just learning the extremity of climate change to come. I am also embarrassed that I’ve scoffed at global warming before. (2/26)

Lorraine expressed true emotions about feeling “bad” and “frustrated” about only learning about the severity of climate change at that point in her life. She also expressed embarrassment about dismissing the severity of problem in the past. Lorraine’s multiple true emotional expressions about the severity of climate change provided insight into how she was aware of the problem in the past but did not consider it important, or possibly viable, let alone relevant. Another way students expressed true emotions about the severity of climate change was about others’ dismissal of the problem, as seen in one of Bridget’s responses on the post-assessment:

   …I also get very frustrated when people say they don’t think global warming is real or that climate change is happening because there is so much research to prove that it is. (Bridget, 4/25)

Bridget amplified her frustration with the use of “very” in addition to already expressing her frustration personally. Hence, what became clear is that although most instances of emotional expressions about the severity were distanced in some way, there were a very small number of students who were taking aspects related to the severity of climate change personally.

**Aboutness: Taking action/solving climate change.** Eight percent of the emotional expressions were about who or what is taking action to solve climate change. Similar to most of
the preceding categories of aboutness, this aboutness category is sub-divided into who or what plays or should play a role in addressing climate change. Table 5.8 provides a breakdown of the entities solving climate change that elicited students to express emotions. Like the aboutness categories of impacts and causing climate change, there were very few emotional expressions about the role of the self. Rather, nearly half of the emotional expressions were about the actions the collective “we” take or should take to solve climate change. In addition, the prominent emotion expressed about the actions “we” are taking is hope. However, there were no instances of students truly expressing hope, which brings to bear the question about just how hopeful the students feel about collective actions to address climate change. Students expressed hope in similar, distancing ways. For example, in response to a question about the last chapter of Heatstroke, Yelena wrote the following about hope:

I have hope after reading this chapter because the author outlines steps that can be taken to make a positive impact. Sure, the world will be doomed if nothing happens, but I think we have the resources to have hope when dealing with climate change today and for the future. (Yelena, 3/21)

Yelena’s expression of hope was linked to the author’s suggestions and plans about how to address climate change. She did not identify which actions she could or would take, but rather ascribed agency about addressing climate change to “we” without explaining who we are. Her expression of hope is further dampened by her casual and emotionally distant phrase, “sure, the world will be doomed if nothing happens.” Without a clear indication of how she will help to address climate change, her depiction of hope was not personal despite her use of the first person. In his essay about climate change, David Orr defines hope as more than a sentiment, but an active engagement in “defying the odds or changing the odds” (Orr, 2011, p. 324). Mallory’s expression of hope resonated more with the conception of an active hope when she wrote,

...there is hope but we must act quickly (Mallory, 4/25)
Even though Mallory connected the need for action to hope, she expressed hope in a distanced way (“there is hope”). In addition she did not explicate which actions should be taken “quickly,” thereby further distancing herself from hope.

There are many ways in which this aboutness category pertaining to who should or is solving climate change illuminated students’ conceptions of solving climate change. First, with so few emotional expressions about this category, it is clear students did not engage deeply with the notions about who should work to change the situation. Second, the few times students did engage emotionally about who should address climate change, they focused on the roles of the collective “we” or others, rather than themselves. Third, even when they expressed hope that climate change could be stopped or mitigated, they did so in ways that relayed their roles as passive. Hence, what became salient in this aboutness category was that students neither viewed themselves as significant players in solving climate change nor truly felt hopeful about a solution to climate change.

<table>
<thead>
<tr>
<th>Who is solving climate change</th>
<th>Number of Instances</th>
<th>Prominent Expressed Emotions</th>
<th>Number of Instances of True Emotions</th>
<th>Prominent Expressions of True Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>We</td>
<td>8</td>
<td>Hope</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Self</td>
<td>5</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5.8. Emotional expressions about who is or should be solving climate change. This table illustrates the sub-categories of the aboutness category of who is or should solve climate change, as well as their frequencies, prominent emotions within that sub-category, and how often the emotions were expressed as true emotions. Prominent expressed emotions represent those emotions that were expressed more than three times.

**Aboutness: Lack of solution.** Students expressed emotions about this aboutness category least frequently. Only five percent of the emotional expressions were about a lack of solution to climate change. Similar to the aboutness category of severity of climate change, this
aboutness category was not divided into sub-categories because there were no clear ones that emerged. The prominent emotion expressed was despair (see Table 5.7), however despair is a grouped emotion term, which in this aboutness category included emotional expressions of despair, discouragement, hopelessness, and overwhelmingness. Even though these emotions were expressed by different students, none of them were constructed as true emotional expressions.

<table>
<thead>
<tr>
<th>Lack of solution</th>
<th>Number of Instances</th>
<th>Prominent Expressed Emotions</th>
<th>Number of Instances of True Emotions</th>
<th>Prominent Expressions of True Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>Despair</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

*Table 5.9*. Emotional expressions about a lack of action. The number of instances of emotional constructions about the severity of climate change as well as the prominent expressions of emotions, the number of instances of true emotions, and if there were any prominent expressions of true emotions. Prominent expressed emotions represent those emotions that were expressed more than three times.

The ways students expressed emotions about the lack of solution to climate change took shape in different ways. Persephone, for instance, wrote about being discouraged in response to questions about the last chapter of *Heatstroke*.

...one thing this chapter said that **made me feel discouraged** instead of hopeful is that **global warming will happen no matter what**....I feel as though **people feel more hopeless** than helpful. (Persephone, 3/21)

Persephone’s emotional expressions were about the inevitability of global warming, for both herself and other people. She distanced herself somewhat from discouragement with her phrase “made me feel.” In addition, she ascribed hopelessness, a more intense emotion than discouragement, to others (“people”), thereby further distancing herself from the discouragement she expressed.

Marilyn also expressed emotion about the lack of clear-cut solution to climate change. During the whole class discussion about the last chapter of *Heatstroke*, she took a turn at talking
after other students had shared their thoughts and emotions about whether or not they felt hopeful after reading the book in conjunction with the course. She spoke about a sense of hopelessness in a distanced manner.

Even though Marilyn does not state an emotion word (“hope”) until the very end of her turn at talk, her emotional expression took shape within the interaction with the rest of the class and actually relayed a sense of hopelessness. Her quick speech (denoted by “>__<”) often occurred about the conditions needed to solve the problem, as seen in red font. In addition, she repeated the requirement of collective action while pairing it with “that would be really hard” in line 8.

Marilyn began talking about how she thought an idea of his “sounded good” and then he would “shoot it down” right afterward. What became clear in her talk was that the author’s discussion of the lack of easy solutions clashed with her desire to feel hopeful and even think there were solutions to climate change. This became evident as she talked about the condition of collective action needed for solving climate (lines 7 – 9) and the lack of solution. More so, over the course
of her turn of talk she shifted from talking about climate change to “all of our problems” (line 15), indicating a sense of being hopeless or overwhelmed by not just a lack of solution to climate change but “all of our problems.”

Students’ expressions about a lack of solution to climate change occurred most infrequently as compared to the aboutness categories. In addition, the emotional expressions were largely distanced. Despite being distanced, the emotional expressions of despair, the only prominent emotion expressed, provided insight into understanding how some students understood that there is no current, one-size fits all solution to climate change.

**Conclusion**

Using an iterative coding process, I determined that attributes of spoken discourse and written artifacts mutually informed what counted as emotional expressions about climate change and related disciplinary ideas. From examining all instances of students’ emotional expressions, three categories of emotional expressions emerged in terms of the ways in which students constructed their emotional expressions. These types of emotional expressions had linguistic and content features that relayed a sense of emotional ownership (“true” emotional expressions), emotional distance (emotional expressions at a distance), or a hybrid of the two. Within the class of 30 students, only four students expressed “true” emotions the majority of the time they expressed emotions. Two students did not express any emotions and another two students only expressed one emotion each. The other 22 students expressed distanced emotions the majority of the time they expressed emotions. Hence, not only did very few students express “true” emotions about climate change and related disciplinary ideas, but students largely did not express emotions about climate change throughout the course.
Due to the aboutness of emotions, emotional expressions provided opportunities to understand which aspects of climate change students took personally. When students did express emotions about climate change and related disciplinary ideas, they did so about six aspects of climate change (in descending order of frequency): impacts of climate change, lack of action, causing climate change, severity of climate change, taking action, and that climate change has no solution. Across many of the aboutness categories, emotional expressions were dampened in some way, signifying distance from climate change and related disciplinary ideas. However, even these emotional expressions offer insight into how students found climate change relevant to their lives. Twenty-four of the 30 students expressed emotions about the impacts of climate change, indicating that the impacts of climate change resonated most with the students in this study. Interestingly, it was not the ways in which impacts affect students, but the impacts on other species that provoked the most emotional expressions and the most “true” emotional expressions. Hence, students “othered” the impacts of climate change by not including themselves in their emotional expressions and created distance between them and the impacts.

Although most expressions of emotion were distanced, there were instances in which students expressed “true” emotions about their individual roles in climate change. These “true” emotional expressions offer insight into which aspects of climate change students engaged with deeply. Within the aboutness category of lack of action, students expressed true emotions of guilt, signifying that students conceptualized climate change as a problem they could help address yet did not. While some of the students who expressed “true” anger did so in a way to implicate themselves as part of causing the problem, most of the students constructed “true” anger in ways that shifted the blame away from themselves or relayed an obscure sense of who is causing climate change.
Chapter 6: Conclusions, Study Limitations, and Future Research
While there are multiple nuanced ways in which students expressed emotions about climate change and related disciplinary ideas, there are three overarching themes from the analysis of all of the students’ expressions of emotions. First, emotions provided a means of understanding how students’ conceptualized climate to be relevant to their lives. Second, the ways in which students constructed emotional expressions and the aboutness of these expressions indicated that they conceptualized climate change as distanced, both temporally and spatially. Third, although most emotional expressions were distanced, there were multiple instances of emotional expressions in which students took climate change personally.

**Emotions: Understanding Students’ Conceptualizations of Climate Change**

Students’ conceptualizations of scientific ideas included emotional components, and students’ emotional expressions were about their scientific conceptualizations. As seen in Table 4.4, students constructed emotional expressions alongside or in conjunction with scientific discourse in both discourse activities and in written artifacts. In addition, as the results from Chapter Five demonstrate, most of the students expressed emotions about climate change and related disciplinary ideas. While this finding may seem obvious, it serves to illustrate a fundamental issue within science education. Understandings of climate change and related disciplinary ideas extend beyond what is typically considered “rational,” and include emotions. Hence, these findings provide more evidence that the dichotomization of reason and emotion within science is false (Boler, 1999; Brickhouse, 2001; Zembylas & Barker, 2002). In addition, students’ emotional expressions about scientific concepts in this study also serve to challenge the ways in which emotions are often parceled out as one facet of reasoning or decision-making in the current science education literature (e.g. Böttcher & Meisert, 2011; Papadouris, 2012; Sadler & Zeidler, 2004, 2005). In this current study, students’ emotional expressions, while *about*
climate change and related disciplinary ideas, were not separate from the scientific content. Specifically, conceptualizations of the impacts of climate change were tied to students’ emotional expressions about the impacts. Also, students’ expressions of guilt about the role of self in not taking action to help address climate change illustrated the ways in which they conceptualized the role of an individual’s impact on the problem. Rivera Maulucci’s (2013) study about a pre-service teacher also demonstrates the ways in which emotions serve as resources for making sense of experiences. Hence, emotional expressions served as a way for students to make sense of various aspects of climate change while simultaneously expressing their meaning-making of the problem.

Since emotions are evaluative and provide us with “information about what we care about and why” (Boler, 1999, p. xviii), analyzing students’ emotional expressions made salient the aspects of climate change that students engaged with deeply. In Chapter Five I described how the students’ emotional discourse indicated which, if any, aspects of climate change the students took personally, thereby moving beyond rote memorization. While research on emotions in science education has prioritized positively valenced emotions (e.g. Broughton et al., 2013; Tomas & Ritchie, 2011), this present study illustrates how any emotional expression (positively or negatively valenced) provides deeper understandings of how students are engaging with a scientific issue like climate change. Therefore, emotions typically labelled “negative,” like anger, guilt, frustration, and fear, offered insights into how students made meaning about how climate change was relevant to their lives. Moreso, these types of emotional expressions are indicative of a moral orientation (Solomon, 2007; White, 2000). Although emotions are typically marginalized in science classrooms (Boler, 1999; Brickhouse, 2001; Zembylas, 2004) and even environmental decision-making (Buijs & Lawrence, 2013), given opportunities students expressed emotions
about climate change and related disciplinary ideas. Since one of the goals of science education is to inform decision-making (NRC, 2012), the findings here have implications for both understanding the relationships of emotions in learning and decision-making more deeply and the importance of creating a space for students to express emotions about burdensome issues like climate change in science class.

**Ways in Which Students Distanced Themselves from Climate Change**

The majority of emotional discourse made salient the ways students distanced themselves from climate change. There were three ways in which students put distance between themselves and climate change using emotional expressions: 1) by not expressing emotions, 2) by expressing distanced emotions, and 3) by the nature of the aboutness of their emotions.

**Not expressing emotions.** Throughout the entire course, two students did not express emotions about climate change or related disciplinary ideas. In addition, another 15 of the students, or half of the participants, expressed emotions seven or fewer times. In the most conservative manner of quantifying the opportunities students had to express emotions in writing, students only took up those opportunities at the most 41% of the time. Since students constructed emotions more often in writing than in spoken discourse, it is apparent that students did not consistently construct and express emotions about climate change. Even though students were provided with opportunities to express emotions in writing and spoken discourse, it makes sense that students did not construct emotional discourse often for several reasons. Due to the perception of science in schools as objective and value-free products (Committee on Science Learning, 2007), there is an underlying tension within environmental science classrooms between teaching the facts and participating in ways of knowing, which includes emotion in robust conceptualizations of objectivity. That dichotomy is pervasive and well-established.
Another potential constraint of emotional discourse in the course pertains to the ideology of men as passionate rather than emotional (Shields, 2007). While there were only four male participants, two of the three instructors were men and helped to set the discourse tone of the course. Hence, the cultural norms of how men should express emotions, in which ways, and when, or emotion display rules, (Shields, 2002) contributed to the ways in which emotional discourse was constructed throughout the course. These tacit emotion display rules also influenced how women expressed emotions and when. Even though I made spaces for students to construct emotions, their expressions were shaped by multiple and overlapping emotion display rules pertaining to science, science classrooms, and everyday interactions. In addition, because emotion display rules are context-dependent (Besnier, 1990; Mesquita & Albert, 2007), they changed depending on the instructor and activities in which students participated.

**Expressing distanced emotions.** There were two ways in which students distanced themselves from their expressions of emotions. One way in which students distanced themselves was in the composition of the clauses that had the emotional expressions. Students used various linguistic features to downplay ownership of their emotions or the emotions themselves. For instance, students often refrained from using the first person when writing or talking about their emotions. They also used adverb qualifiers like “kinda” or “a little” in conjunction with emotions to dampen the expression. These linguistic attributes were used throughout the majority of emotional expressions (see Figure 5.2). Interestingly, even students who expressed emotions most frequently did so in ways to distance themselves from or dampen the emotions. In addition, looking across the six aboutness categories, students expressed “true” emotions (expressions that exemplified the true nature of emotions as taking climate change personally) in a small proportion of each category, as seen in Table 6.1.
<table>
<thead>
<tr>
<th>Aboutness category</th>
<th>Percentage of “true” emotional expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of action</td>
<td>34</td>
</tr>
<tr>
<td>Impacts</td>
<td>27</td>
</tr>
<tr>
<td>Causing</td>
<td>24</td>
</tr>
<tr>
<td>Severity</td>
<td>23</td>
</tr>
<tr>
<td>Lack of solution</td>
<td>18</td>
</tr>
<tr>
<td>Taking action</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 6.1. The percentage of “true” emotional expressions in each aboutness category.

Aboutness as a means to distancing. Another mechanism by which students’ emotional expressions signified distancing from climate change pertains to the aboutness of their expressed emotions. Examining each of the aboutness categories closely made salient the ways in which students conceptualized who is causing, who should be addressing, and who is impacted by climate change. In addition, students’ composition of the aboutness categories illustrated three levels of personal involvement in climate change: the individual self, a collective “we,” and others. In particular, students’s emotional expressions illuminated a disconnect between their individual roles in the various aspects of climate change. When students expressed emotions about the lack of action being taken about climate change, they largely focused on their individual roles (see Table 6.2). However, students overwhelmingly did not focus on their individual selves in their emotional expressions about taking action about, causing, or being impacted by climate change (see Table 6.2).
### Table 6.2

<table>
<thead>
<tr>
<th>Aboutness category</th>
<th>Percentage of emotional expressions about the role of self</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of action</td>
<td>61</td>
</tr>
<tr>
<td>Taking action</td>
<td>28</td>
</tr>
<tr>
<td>Causing</td>
<td>13</td>
</tr>
<tr>
<td>Impacts</td>
<td>4</td>
</tr>
</tbody>
</table>

The role of self in students’ emotional constructions about climate change. This table depicts the percentage of emotional expressions about the role of self in four aboutness categories.

In the aboutness category pertaining to taking action to address climate change, which consisted of only 8% of the total emotional expressions, only 28% of the emotional expressions were about the role of self in taking action. Within the aboutness category about who or what causes climate change, only 13% of the emotional expressions were about the self causing climate change. Rather, 41% of the emotional expressions were about “people” causing climate change and another 41% were about the collective “we” causing climate change. Within the impacts category, which was the most frequent aboutness, a mere 4% of emotional expressions were about the impacts of climate change on self. Instead, students expressed emotions about the impacts on entities outside of themselves: other species, other species, and nature. Hence, by analyzing the aboutness categories it became apparent that while students expressed emotions about their personal lack of action in addressing climate change, they were not engaging emotionally about their individual roles in taking action, causing, or being impacted by it. What emerged is that students engaged emotionally with their personal lack of action in addressing climate change but did not engage as deeply with their individual roles in taking action, indicating a lack of motivation and/or awareness of what to do. In addition, students’ emotional expressions indicated that they as individuals are distanced from the problem in terms of both
causing it and impacting it, both of which have important implications for the teaching and learning about climate change.

**Ways in Which Students Took Climate Change Personally**

Despite students’ emotional expressions indicating an overall sense of distancing from climate change, expressed emotions made salient how students were taking climate change personally. Within each aboutness category, students expressed “true” emotions to varying degrees. As can be seen in Table 6.1, students most often expressed “true” emotions when they expressed emotions about a lack of action. In particular, half of these “true” emotional expressions were constructions of guilt. By definition guilt is focused on one’s own actions and self blame (Böhm, 2003). Hence, these emotional constructions of guilt provide insight into how students understood themselves as responsible for addressing climate change.

The “true” emotional expressions within the impacts aboutness also provide insight into which aspects of climate change students took most personally. More than half (54%) of the “true” emotional expressions were about the impacts of climate change on other species, most often animals. These expressions were not clearly articulated, but instead were described as “bad” or “upset.” Nonetheless, these “true” emotional expressions reinforce others findings about the role of empathy in decision-making about other scientific issues, like genetic engineering (Sadler & Zeidler, 2004; 2005). In addition, these constructions of empathetic-type emotions could have implications for engaging students in actions to address climate change, as empathy is known to spur actions to help those in need (Thoits, 1989).

Within the aboutness category of causing climate change the prominent “true” emotional construction was anger. Students expressed anger toward the collective “we” in causing climate change. However, while the object of the anger included self, the nature of anger implies one is
being wronged by someone else, rather than doing wrong (Böhm, 2003; Solomon, 2007). Hence, students took personally the idea that others are causing climate change, which highlights the tension between how they conceptualize themselves as inactive players in causing climate change and are angry that others cause it. This reassignment of blame in causing climate change from self to others is similar to the findings of Lee, Chang, Choi, Kim, & Zeidler (2012) who found that pre-service teachers attributed the causes of climate change to industrialized countries. However, Lee et al. (2012) did not examine emotions themselves but rather broader categories that included emotions about the pre-service teachers perceptions of climate change.

In the other three aboutness categories, no clear-cut themes about “true” emotions emerged. Within the aboutness category of severity, about a quarter of the emotional expressions about the severity of climate change were personalized. Students constructed a wide range of “true” emotional expressions, from frustration to guilt to embarrassment. In the other two aboutness categories, lack of solution and taking action, only two and one emotional expressions were expressed, respectively. Hence, it can be concluded that students did not engage as deeply about a lack of a solution to climate change or taking action to address climate change, as compared to the other aspects of climate change.

Limitations of the Study

Researching emotion, especially in educational contexts, presents challenges due in part to the dynamic nature of the classroom, the number of students within a classroom at once, and the episodic nature of emotions. In addition, methodological considerations about how to determine and analyze emotions contribute to the difficult task of conducting emotional research in a classroom. Decades of research on emotion have illuminated various facets of emotions, from neurobiological and physiological responses to sociological theories of emotion. While
studying emotion from a sociolinguistic perspective is beneficial in many ways, there are some important considerations. Even though some scholars argue that emotion is “created in, rather than shaped by, speech” (Lutz & Abu-Lughod, 1990, p. 12) the issue of emotion articulation is important. Barrett (2006) uses the term emotional granularity to describe the range of abilities of expressing an emotion precisely. For example, someone may verbalize that she feels bad rather than using more specific words like angry, ambivalent, sad, and so forth. By using a research approach to emotion that embedded emotion within social interactions, there was less concern that an interlocutor would not be able to precisely articulate his or her emotion because the emotion took shape within the interaction. However, ultimately the interpretation of an emotional display is in the eye of the beholder (Shields, 2002), which is why it was impossible to take a truly emic stance in this study. Hence, even though I grounded my interpretations of students’ emotional expressions within the social interactions in which they occurred and the overall norms of the course I observed and recorded as a participant observer (Spradley, 1980), I analyzed them from my point of view. Therefore, the accounts I provide of their sense-making are based on my understandings of what their emotions were.

Another potential issue that arises from the study of emotion is that emotions have inherent physiological and neurobiological aspects that are internal and hence not only difficult to ascertain in a lab context but near impossible to determine within classrooms. Coming from a perspective that appreciates the ways in which the wider societal and narrower interactive discourses combine to shape meaning between people, Gumperz (2001) defines interactions as continuous negotiations. Within interactions, there is a constant negotiation of relayed messages in order to construct shared interpretations (Gumperz, 2001). Inherent in these negotiations are the “background assumptions that underlie the negotiations of interpretations” (Gumperz, 2001,
Applying his insights to emotional discourse, the reasons for the study of emotion through a discursive lens become apparent. The ways in which emotional expressions take shape in an interaction are based on the context, which include the emotion display rules and other “background assumptions.” However, as was seen in this study, some aspects of emotion display rules were not static. By establishing emotional discourse practices through discursive processes, these cultural practices were constructed by students and instructors (Kelly, in press; Kelly & Green, 1998), albeit not all of them, through discourse activities and written artifacts. In addition, the ways in which emotional discourse was expressed and interpreted required using various semiotic tools. However, it is likely that students had emotions about climate change that they did not express, and these are not captured in this study. In addition, due to the size of the class, it was logistically impossible to capture every student’s utterances throughout the course to determine their emotional expressions. Hence, this study offers insight into only those emotions that were expressed to the entire class during class discussions (as compared to in small groups or to a friend) or on assignments. Even though my research questions are confined to verbal and written expressions, I still can only make claims about the students’ emotions that I observed.

Another related challenge of studying emotion in classrooms is the intricate nature of emotional expression. For example, prosody can reinforce or juxtapose spoken words. Gesture and facial expressions can perform similar contradictory functions as well. In addition, multiple emotional meanings may be conveyed concurrently (Shields, 2002). Compounding these issues are students’ varied understandings of what emotions are and the ways in which they have been socialized (by family, by school, by science) to express or not express emotions. Grounding my study in sociolinguistics, ethnography, and participant observation helped address these issues.
But there was still no definitive way to parse out specific criteria for emotional expressions and reasons why those emotional expressions were constructed linguistically.

**Study Implications and Future Research**

Understanding students’ expressed emotional responses to learning about climate change has implications for both instruction and research on student learning. In terms of instruction, this study illustrates that providing students with opportunities to express emotions when learning about an intense topic like climate change makes salient the ways in which students move beyond a limited focus on scientific facts. Allowing students to construct emotional expressions about science ideas provides time and space for them to reflect on what resonates with them most. Hence, students may find relevance through their emotional expressions. In addition, emotional expressions indicate that a student is taking an aspect of science personally, and therefore finds it relevant to his/her life. This has implications for not only climate change education, but also any science education topic, especially those that involve controversial, socioscientific, or human health related issues whereby teachers hope to foster more informed decision-making in their students. To reason carefully with substantive issues that have widespread consequences, students need to recognize their emotional responses. As resources for sense-making (Rivera Maulucci, 2013; Vining & Tyler, 1999), emotions are also potential sources of behavioral change (Ojala, 2012; Vining & Tyler, 1999) and decision-making (Sadler & Zeidler, 2004, 2005), and hence are inherent in reasoning with any issue. Moreover, this research also has implications beyond science education: history education, social justice, and teacher education and professional development, to name a few. Hence, one area of further research includes examining potential tools and techniques for emotional discourse in a science classroom. In this study, reflective writing prompts and the Four Corners Activity were effective...
in providing space for student emotional discourse. However, there are other potential resources for science teachers to use in their classrooms to support emotional discourse. One recommendation within the literature about engaging students’ emotions pertains to teachers providing students “a forum for the exploration of consequences, principles, emotions, and intuitions” (Sadler & Zeidler, 2004, p. 22) rather than prescribing the ways in which students ought to navigate ethical components of issues. In turn, students learn to make decisions about complex issues on their own. During Castano’s (2008) study of middle school students, she found that pedagogies that encouraged not only collaboration but also opportunities for students to openly talk about their personal connections with socioscientific issues helped students think more creatively about their relations to the living world. Tomas & Ritchie (2011) found a connection between students’ positive emotions and their engagement with the sustainability issue of biosecurity and writing hybridized scientific narratives. Hence, providing a not only a compelling context but also a means in which students can think and write about science creatively allows students to engage emotionally. In addition to providing a context, teachers can also approach science teaching in a manner that encourages science talk around students’ interests and informal science experiences (Crawford, Kelly, & Brown, 2000), which would likely include emotions. As Crawford et al. (2000) found, using such a range of resources enabled students to engage in science and scientific discourse. Incorporating emotions into this variety of sense-making mechanisms, teachers can incorporate emotion discourse into students’ scientific explanations without neglecting the importance of scientific argumentation and discourse.

Another implication for teaching relates to teacher education. Teacher education, especially science education programs, typically neglect emotional discourses (Rivera Maulucci,
Hence, researching tools and techniques for teachers to engage emotionally with not only their general practice but also the issues they teach would help teachers be more cognizant of their emotions and the ways they may influence their instructional decisions. Work in environmental psychology illustrates connections between specific emotions and coping strategies (e.g. Harth, Leach, & Kessler, 2013; Ojala, 2013). For example, in their study of group emotions and intentions about environmental problems, Harth et al. (2013) found when anger was the predominant emotion group members wished punishment upon the perceived wrong-doers. Guilt was associated with addressing the problem (Ferguson & Branscombe, 2010; Harth et al., 2013). Within science education, recent research on the connections between beliefs and environmental understandings and actions also provides insights into the complexity of teaching environmental issues like climate change. In-service teachers make sense of and enact environmental curriculum in relation to their beliefs about epistemological underpinnings of environmental knowledge (Hwang, 2011). Using reflexive practices, in-service teachers became aware of the ways in which they framed environmental problems because of their beliefs. In their investigation of in-service teachers’ emotions about the plausibility of climate change, Lombardi and Sinatra (2013) found that teachers’ emotions correlated with the degree to which they considered climate change plausible. Considering the ways in which emotions and reflexivity provide a means to understanding coping mechanisms, and by extension, teaching about onerous issues like climate change, it is important that science teacher educators help develop reflective practice about content knowledge with their pre-service teachers.

Science teaching portfolios offer continual opportunities for prospective teachers to reflect upon and provide support for “what it means to learn and teach science to children,” including “the implications of their tacitly held beliefs on classroom practice” (Zembal-Saul,
Haefner, & Avraamidou, 2002, p. 285). While work on portfolios does not explicitly address emotion, by providing an opportunity for teachers to contemplate both their beliefs and practices about teaching science, it would seem that emotions about not only teaching as a practice but teaching onerous content could be incorporated into such endeavors. More research is needed to determine if this type of reflective work could help teachers in responding to students’ emotions. Within the work in science education on teachers’ emotions, one major finding within this literature is that teachers have difficulty responding to students’ emotions. For instance, Bryce and Gray (2004) determined that teachers felt unsure about their level of involvement in class discourse about gene technology especially in regards to students’ emotions. In addition, teachers often dismiss students’ emotional expressions for fear of not completing a planned lesson, because they are not expecting them, or because they do not know how to respond to them (Rosiek & Beghetto, 2009). In failing to acknowledge students’ emotions, teachers forego learning opportunities to more deeply understand their students’ conceptualizations and in turn marginalize students (Rosiek & Beghetto, 2009). Just as important as developing teacher practices around responding to students’ emotions is helping educators understand how to ask students about their emotions. Because the practice is uncommon in science education, effective ways of prompting students to express their emotions about scientific concepts are relatively unknown. One of the findings from this study is that students did not construct emotions in discourse activities unless specifically prompted. Hence, only when the instructor asked students what they were feeling or which emotions they felt or used emotion words (e.g. hope, anger) did students talk about their emotions. When the instructor used vague language, like “reflections” and “thoughts,” students did not construct emotions. These findings are important to understanding how to effectively construct frames for emotional discourse about content in a
classroom. There are also implications about emotional discourse for in-service science teachers, due to the scope of this study I find it prudent to remain within the bounds of the empirical data collected from this research on pre-service teachers.

The findings from this study are also important for research in science learning. Since the goals of both science education and environmental education include fostering well-informed decisions (Colucci-Gray, Camino, Barbiero, & Gray, 2006; NRC, 2012), it is important to expand and deepen the research on the ways in which emotions impact decision-making and motivation to act. Work in environmental psychology and environmental science, respectively, has demonstrated that environmental decision-making requires emotionality (Mankad, 2012) because using emotions effectively not only promotes motivational and behavioural engagement, but also provides a means to encapsulate the complexity of these issues (Vining & Tyler, 1999). Hence, it would be useful to study how students’ emotional expressions, and the ways in which they are responded to, may or may not lead to changes in decision-making and motivation to act.

In addition, there are also important questions about the ways in which emotions inform science learning. In the science education literature there is an assumption that positively valenced emotions contribute to learning and negatively valenced emotions inhibit learning. However, the findings in this study challenge those presumptions. Hence, there are fundamental questions about the role of all types of emotions in science learning, an area that has not been examined closely due to the ideology of science as unemotional in order to be objective.

In a time when science education is concerned about an overall lack of interest in pursuing science in the United States low (National Academy of Sciences, 2007, 2010), providing ways for students to express emotions about scientific issues may help engage students who are typically uninterested or underrepresented in science. Some of the most current
recommendations on engaging students especially from underrepresented groups include attending to students’ needs by attending to their personal experiences and ways of knowing the world (Kane, 2012) as well as the identity work they need to perform in order to envision themselves as having a science identity (Archer et al., 2012). Hence, there are important questions about the ways in which students’ emotions during science learning contribute to their long-term engagement with science.
Works Cited


Appendix A: Questions from Written Assignments

List of all questions from written assignments that elicited emotional discourse

Pre-Assessment, Due 1/10

1. Suppose your friend asked you what an ecosystem is, how would you define it?

2. Suppose there was a major environmental disturbance, like a fire, in a forest.
   a. Identify different organisms that may live in the forest.
   b. What do you expect would happen to the various populations of organisms (that you identified in “a.”) in that forest immediately following the fire?
   c. What do you expect would happen to the same populations of organisms after ten years? Again, refer to the specific organisms you identified in part “a.”

3. Identify any one organism and identify one of its adaptations.
   a. Organism: ____________ Adaptation: ____________
   b. How did the adaptation you identified become an adaptation?
   c. What is the role of variation in adaptation?
   d. How do you define adaptation?

4. Although evolution is a powerful explanatory framework in biology, it can be controversial.
   a. People have a lot of thoughts about evolution. What are your thoughts about evolution?
   b. People also have a lot of feelings about evolution. What are your feelings or emotions about evolution?

5. What role do explanations play in science?

6. How are scientific explanations developed?

7. What roles do models play in science?

8. How are scientific models developed and used?

9. As best as you can, explain climate change.

10. How is human-caused climate change different than other climate change events in Earth’s history?

11. Why is human-caused climate change occurring?

12. What are some of the effects or consequences of human-caused climate change?

13. What can individuals like us do to help address the consequences of human-caused climate change?

14. What evidence helps explain that the climate changes?

15. What are the ways in which populations of organisms can respond to climate change?
16. Do you think there is a relationship between evolution and climate change? If so, what is it?

17. Similar to evolution, climate change can be viewed as controversial.
   a. People have a lot of thoughts about human-caused climate change. What are your thoughts about climate change?
   b. People have a lot of feelings or emotions about human-caused climate change. What are your feelings or emotions about climate change?

18. Describe a time when you felt strongly or experienced an emotion in science class or during a science lesson. (You can go back to any grade. Explain what emotion(s) you had and why you had it/them.)

19. Describe a time when you felt strongly or had an emotion about a specific topic in a science class. Again, you can go back to any grade. And again, explain what emotion(s) you had and why you had it/them.

20. Explain how feelings or emotions fit into your vision of scientists “doing” science or being scientists?

Heatstroke Reflective Questions Set #1, Due 1/29

Directions: Please answer each question completely by supporting your ideas. Some questions are more reflective in nature and should be treated as such (i.e. explain your thoughts thoroughly so that the reader may fully understand).

1. In chapter one, Barnosky provides some background on global warming.
   a. a. List examples of greenhouse gases (no need to explain).
   b. How do greenhouse gases function to increase global temperature?
   c. Be as specific as you can about sources of greenhouse gases (i.e. where do they come from?).
   d. What is significantly different about the current level of greenhouse gases as compared to in the past? What does it mean for the rate of climate change as compared to the past?

2. What is one specific way the changing climate is currently affecting humans? Again, be specific and descriptive.

3. Barnosky begins chapter two by drawing parallels between Gene Autry and Alfred Tansley to illustrate the importance of nature to us. In the second full paragraph, he writes how nature “means something to most people” (p. 18) and provides different ways in which feelings and emotion relate to nature.
   a. Reread this paragraph and reflect on what nature means to you in terms of your feelings and emotions.
   b. Explain what the word “nature” means to you.

4. Throughout the first four chapters, Barnosky provides multiple examples of how ecosystems and communities both on land and in water will be impacted by current climate change. He uses such words and phrases like “dire” (p. 56), “frightening” (p. 54), and “all hell break[ing] loose” (p. 10) to describe these changes. Do you agree or disagree with his use of these terms to portray the changes to the planet?
Exit Slip 1/29

Think about this idea of organisms not having some place to go because of climate change. With so much ice melting, what do you foresee happening to various organisms and how does that impact you personally?

Heatstroke Reflective Questions Set #2, Due 2/21

Directions: Please answer each question completely by supporting your ideas. Some questions are more reflective in nature and should be treated as such (i.e. explain your thoughts thoroughly so that the reader may fully understand).

1. Throughout the book so far, Barnosky provides numerous examples of the impacts of climate change on individual populations of species and entire communities in order to basically set the stage for one of his main ideas of the book: that right now there are more drastic ecological responses to climate change than we have seen in the past. He also provides evidence that "even if climate returns to pre-change conditions, there is no guarantee that all the habitats that were there before the climate change will return" (p. 101).
   a. Since we are all part of human-caused climate change, why do you think we all haven't made drastic changes to help the ecosystems of the earth?
   b. Barnosky focuses on ecosystems that are protected (i.e. in National Parks). How do you think his claims relate to the ecosystems humans live in and rely on?
   c. How do you see yourself teaching these concepts to elementary students?

2. Typically, antibiotics (like penicillin) kill bacteria. However, within a given population of bacteria, some individuals are resistant to penicillin. Use natural selection to explain how this population will evolve with respect to penicillin.

3. In reality, bacteria’s trait of antibiotic resistance exists on a continuum (like hair color amongst humans is not just black or white, but a wide variety of colors). In thinking about natural selection, why is it then important to take your entire course of antibiotics, even if you feel better after only a few days?

Exit Slip 2/26
(Following four corners activity)

Take a moment to just check in with yourself. How are you feeling? What are you feeling? Why are you feeling it? If you have any feelings what are they and what are they about?

“End of Pasta” Questions, Due 2/28

1. The article, The End of Pasta, published just a few months ago, provides a timely description of just one slice of the impacts pie of climate change. After reading the article (note: there are five pages) and thinking about the discussions from Tuesday’s class, why do you think climate change is
considered a social justice issue as much as an environmental issue?

2. Based on how the author explains the impacts of climate change on wheat production, how will climate change impact
   a. us in the next 30 years in terms of all of our food?
   b. people who are poor in the US?
   c. people who rely on subsistence farming throughout the world? (Subsistence farming is the type of farming in which people eat what they grow and usually do not sell it. Hence their food is what they personally grow.)

3. As roughly 4.5% of the population, the United States is responsible for about 22% of greenhouse gas emissions by nation. We are the second highest emitter of greenhouse gases. (China recently exceeded the US in emissions…they have almost 20% of the world’s population.) Yet the impacts are being felt throughout the world. But our government by and large is not taking steps to address climate change.
   a. Is this talk and thinking about addressing climate change appropriate to science class?
   b. How do you think your feelings and emotions about climate change are affecting your learning about it in this class?

Exit Slip 3/12

1. How would you address students who are upset (sad or angry) about polar bears dying because of climate change?
2. If you are also upset how do you deal with your feelings about polar bears dying because of climate change?

Heatstroke Reflective Questions Set #3, Due 3/26

1. Barnosky writes about the “best” and “worst” case global changes in temperature in this century. Regardless of whether the predictions are good or bad, he writes, we will still see temperature changes that will be faster and higher than we (people) have ever experienced. Hence, you and certainly your future students will experience climate shifts. How do you envision your lifestyle and community to be in 50 years as climates change?

2. The title of the last chapter is “Geography of Hope,” which is part of a quote from Wallace Stegner in the chapter.
   a. Explain how this last chapter does or does not provide you with hope for dealing with climate change.
   b. After reading about Barnosky’s vision for how to deal with climate change in this chapter how do you see yourself as part of his vision?

Post-Assessment, In-class 4/25

1. How is human-caused climate change different than other climate change events in Earth’s history?
2. Why is human-caused climate change occurring? Be as specific as you can.
3. What are some of the effects or consequences of human-caused climate change? Be as specific as you can.

4. What are the ways in which populations of organisms respond to climate change?

5. Based on your understanding of evolution, why will most species not evolve in response to climate change?

6. How are humans being affected by climate change?

7. What can individuals like us do to help address the consequences of human-caused climate change?

8. What evidence helps explain that the climate changes?

9. People have a lot of thoughts about human-caused climate change. How have your thoughts about climate change changed OR remained the same since the beginning of the semester?

10. People have a lot of feelings or emotions about human-caused climate change. How have your emotions about climate change changed OR remained the same since the beginning of the semester?

11. Did you find it helpful to share your and/or listen to others’ thoughts and emotions about climate change during class discussions and activities? Please explain.

12. Has learning about climate change changed the way you think about your life and/or the world? Why or why not?

13. Have you changed any aspects of your lifestyle after learning about climate change in the course?

14. Have you learned about climate change in any other classes?
   a. If yes, are there aspects of climate change you learned in other classes that should be included in this course?
   b. If yes, are there aspects of this course that you wish were part of a previous course related to climate change?

15. Do you consider human-caused climate change to be relevant to your life? Why or why not?

16. Do you think about climate change outside of this class? If yes, please explain.

17. Throughout the course, we discussed many aspects of climate change including: the scientific mechanisms of climate change, the effects on ecosystems (including humans), the role of Americans in causing climate change, and what can be done about climate change. As you learned about these different aspects of climate change we asked about not only your understanding but also your emotions.

18. Reflecting back on the course, are there aspects of climate change that evoke particular emotions for you now? If so, what are they and why do you have them?

19. Is there anything you wished you learned more about in the course?

20. What role do explanations play in science?
21. How are scientific explanations developed?

22. How are scientific models developed and used?
Appendix B

Description of Four Corners Activity

The Four Corners Activity was used to create space and time for students to express their thoughts, opinions, and emotions about various aspects of climate change. Each of the four corners of room had one of four signs: “agree,” “strongly disagree,” “disagree,” and “strongly disagree.” I put a prompt on the screen and students moved to the corner that best represented their views. Once everyone finished moving, I asked people in each corner to explain why they stood where they did. Students also had opportunities to respond to what others, regardless of where they physically stood. With each new prompt, students moved around the room and shared why they stood where they did.

List of prompts (in sequential order):

- The effects of climate change do not affect me personally.
- My actions won’t make a difference in changing the climate change problem.
- Laws should not be used to help stop or prepare for climate change.
- I am angry more people don’t take steps to help climate change.
- I feel bad I don’t take more steps to help address climate change.
Appendix C: Transcription Conventions

(+): short pause

(.5s), (1.5s): examples of timed pauses

^: primary accent

[ ]: overlapping talk

wor—: truncated word

wo:rd: stretched sound

###: unintelligible talk

=: latching (no pause between turns or words run together)

word: loud

"word": quiet

>word word<: quick speech

<word word>: slow speech

((gesture)): description of gesture
EDUCATION
The Pennsylvania State University, University Park, PA
Ph.D. Curriculum and Instruction, Science Education; August 2010 – May 2014
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PUBLICATIONS


SELECT PRESENTATIONS
• Hufnagel, E. (2014, March). Emotions and How They Emerge in a Climate Change Course for Prospective Elementary Education Students. Poster presentation accepted for annual meeting of the National Association for Research in Science Teaching, Pittsburgh, PA.

TEACHING EXPERIENCE
Penn State University, University Park, PA: January 2012 – present
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