Boston College
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Teaching, Curriculum & Society

Program of
Curriculum and Instruction

FACTS, FALSEHOODS AND COMPETING AGENDAS: FRAMING CLIMATE CHANGE IN THE SCIENCE CURRICULUM IN THREE COUNTRIES

Dissertation

By

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Submitted in partial fulfillment

Of the requirements for the degree of

Doctor of Philosophy

June 2022

ABSTRACT

FACTS, FALSEHOODS AND COMPETING AGENDAS: FRAMING CLIMATE CHANGE IN THE SCIENCE CURRICULUM IN THREE COUNTRIES

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Changes in climate are being experienced by people globally, and increasingly pushing into school science. Educators struggle to make sense of the critical thinking and agency youth will need to face such changes. To this end climate change curriculum, teaching and learning in schools has garnered significant attention in educational research in the last decade. This is particularly important given that formal education is viewed as an important canvas for building the capacity of young people. However, curriculum materials are mostly understudied and taken for granted. In addition, there is also a paucity of scholarship from the global South with respect to climate change education. To address the need for climate change education as well as inclusion of international perspectives, this dissertation presents an analysis of climate change content in select textbooks and supplementary educational materials from Bangladesh, California & Ghana, and three widely different jurisdictions. Using a cultural politics framework, I explored the following questions related to climate change content in textbooks and supplementary materials: (1) How is climate change portrayed in select official/state approved textbooks (2) How is climate change portrayed in supplementary materials? (3) What are the similarities and differences the textbooks and supplementary materials?

Using a classical content analysis approach, I show that the content in all three textbooks acknowledged the contributions of human activity to climate change, for example discussing the primary role of human activity to the warming of the planet. However, there were some distinct differences when it came to discussions around the scientific consensus on climate change. While Bangladesh fully noted the scientific consensus, California presented mixed messaging and Ghana did not reference the scientific consensus at all. The textbooks from the three jurisdictions included local and global climate change impacts and policy solutions.

My analysis also showed that the two supplementary materials from the United States used different frames to challenge each other's messaging. And while Heartland Institute cast doubt on the scientific consensus, the Paleontological Research Institution embraced it. Lastly, the United Nations, as an exemplar of content intended for an international audience, was constructed similar to the textbooks in attempting to balance local and global perspectives on climate policy solutions.

Importantly, I argue that textbooks and supplementary materials need to provide robust content that attends to the context-specific complexity of climate change. I discuss cultural influences on climate change education. Finally, I conclude with recommendations for the inclusion of more localized ideas on climate change impact and policies.

DEDICATION

I dedicate this work to my incredible friend, David Jackson. I hope generations from now my children, grandchildren get to tell the story about our friendship, and that it becomes a family legend that when grandpa or daddy migrated to the United States from Ghana, he was showed kindness and generosity of spirit.

ACKNOWLEDGEMENT

I am forever indebted to God Almighty and his son Jesus Christ.

The PhD journey had taught me resilience and patience. But has also exposed some flaws and weaknesses that I have to work on. I am a work in progress. Many people have helped me along this journey. Primarily, I want to thank my Dissertation advisor, Dr. Cochran- Smith for taking me on and for agreeing to supervise this work. Thank you for the guidance and intellectual mentoring and push all these years. I am forever grateful.

Mike, thank you for your generosity of spirit and for making funds available to do this work. Thank you for teaching me about balancing family responsibilities and work. And to all the present and former members of the IUSE lab, thank you.

Audrey, thank you for agreeing to be on my committee and for providing critical feedback. Every time we interact, I learn that you can be a person of faith, a Catholic or Christian and still thrive in Academia. I feel at home each time we communicate. Thank you.

Jeremy, I will forever remain in awe for quickly agreeing to serve as a reader of this dissertation. Thank you.

The following people have supported me with paper work and administrative tasks: Rajeev Rupani, Brenda McCormick, Moira, Marsha. Thank you very much

For my cohort mates, Jasmine, Josie, Dave, Miriam, Kevin, Marisa, Reid every one of you. Thank you.

Melita Morales, no amount of words will capture the enormity of my gratitude. Gracias! God Richly bless you.

Patrick Proctor, Patrick Mcquillan, Dennis Shirley, Kate McNeill, thank you.

For my parents, Julius and Agnes. Thank you Mama and Papa for showing me that life is full of transitions, stops and starts. That I can always begin again. Thank you for nurturing a love of reading and delight in literature.

For my siblings, Richard, Clement, Alice, James and the ever loving, Rosemary. Thank you for being positive role models and for your patience with my idiosyncrasies, my flaws and sometimes the contradictory nature of my ideas.

To my friends, Ruben Addison, Herman Hesse, Matt Troy, Ekow Jones, Dennis Martey, Rockson Ashitey, the whole Shikpo republic. Oblitey Manya, Manya. Oblitey agbo.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

Research Gaps in Climate Change Education

In the last decade, leading stakeholders and experts across the globe have called for rethinking and reimagining teaching and learning in formal science education (Asabere-Ameyaw et al., 2013; Chowdhury & Siddique, 2017; Rudolph, 2020). In addition to a focus on scientific literacy, evidence, and facts, rethinking science education calls for adopting a cultural (Medin & Bang, 2010), sociological (Erduran, 2020), political (Shea & Sandoval, 2020) and moral (Rudolph, 2020) conceptualization of science instruction in the classroom. Arguments for reimagining classroom science education stem from the fact that many scientific concepts are rooted in the human experience (Sutherland et al., 2012), involve policy and politics at both state and national levels (Watson, 2005; Agre & Leshner, 2010), and generate much controversy and interest in the public domain. Examples of controversial concepts in the science curriculum are evident in state and professional policies and in school practices related to vaccines, pandemics, evolution, genetics (Race and IQ), biological sex, technology, and climate change. These issues are collectively referred to as socio-scientific issues (Zeidler & Nichols, 2009).

In addition to being relevant to the lived experiences of the public, these socio-scientific issues can have devastating consequences for the planet if not addressed. For instance, climate change, according to the United Nations (2020), remains one of the most pressing issues of the 21st century. Long and erratic changes in climate have devastating consequences for plant ecology, animal biodiversity, and human livelihoods across the globe (American Meteorological Society, 2019). From coastal communities in Alaska to arid lands in Kenya, climate change poses an enormous threat to a significant portion of the world's population. In recent times, scientists have attributed anthropogenic climate change to wild fires in Australia (Oldenborgh et

al., 2020) and California (Williams et al., 2019), flooding events in Bangladesh (Ferdous et al., 2020), and drought in rural Ethiopia (Yadeta et al., 2020). These natural events and disasters suggest that climate change is a complex problem spanning geographical latitudes, racial and ethnic groups, and socio-economic conditions, with the potential to exacerbate existing humanitarian challenges such as mass migration, refugee settlement, ethnic strife, and famine (Findlay, 2020; Kaczan & Orgill Meyer, 2020; Luetz, 2020).

Several strategies and policies have been recommended concerning adapting to and mitigating the effects of climate change and most importantly forestalling its acceleration. Climate change education, both formal and informal, has been recommended as a short and long-term strategy for dealing with the effects and the prevention of climate change (UNESCO, 2020). More importantly, climate change education for school age children is imperative for raising a generation that is critical of personal environmental behaviors, attentive to lifestyle choices, and deeply committed to sustaining their communities and the earth (Cordero & Todd, 2008; Henderson & Drewes, 2020; Monroe et al. 2019; Reid, 2019). Along these lines, there is evidence of school-age children and youth serving as agents of change with respect to wide-ranging sociological and scientific issues in their communities, such as healthy nutrition in families (Drummond, 2010), conservation of wildlife (Marchini & Macdonald, 2020), gun violence (Hardy, 2002), and sanitation and hygiene (Bresee et al., 2016). Researchers have reported that schoolchildren and youth have acted as change agents in various capacities in the Philippines (Haynes and Tanner, 2015), El Salvador (Tanner, 2010) and the United States (Trott, 2020).

Despite examples of action-oriented, school-age children and youth fighting against climate change, climate change education in formal school classrooms is generally inadequate

and constrained by multiple factors, such as political polarization and lack of relevant climate change information in approved school curricular and teaching materials (Deisenrieder et al., 2020; Henderson & Drewes, 2020). Informal learning environments are somewhat less inhibited by these challenges as they draw on a wide range of resources to provide robust instruction on climate change (Busch et al., 2019). However, enrichment-oriented, after-school programs are highly inaccessible to many students, especially in the poorer regions of the global South and in lower socio-economic communities in North America. For many of these students, formal schooling is the only opportunity to learn about climate change. This means, there is a great need to address the challenges involved in creating effective and successful climate change education in formal school environments across the globe. The great need for robust climate change education in formal schools underscores the fact that communities in the global South and low-income communities in the global North are more vulnerable to the effects of climate change such as rises in sea level, heat waves, diseases, and mass migration.

One of the key barriers to creating effective climate change education in formal learning environments is the lack of relevant and timely climate change curriculum. “Timely” and “relevant” mean that materials are linked to the lives of students and are up-to-date in terms of current research beyond the scientific consensus on climate change (Lovett et al., 2018; Pugh et al., 2019). There is a huge gap between the climate change curriculum that we urgently and increasingly need in the schools and the climate change curriculum that currently exists in most formal school contexts.

A systematic review of global climate change education by Monroe et al. (2019) revealed that effective climate change curricula in formal school environments tend to involve collaborative learning projects involving university researchers, teachers, and schools. These

effective climate change interventions in formal educational contexts involved innovative practices, resources, and as Monroe et al. (2019) observed, "Debates, small group discussions with worksheets, hands-on labs, and field trips" (p. 800). Once again, learning resources such as labs along with teaching methods and opportunities including field trips that enhance formal climate change education and science education in general are inadequate in poor communities in North America and countries in the global South. This means that in these resource-scarce environments, curricular materials such as textbooks are instrumental to the teaching and learning of science (Calabrese-Barton, 2001; Boakye, 2015). Sometimes, textbooks are essentially the only instructional materials available for teaching and learning of science, suggesting a great need for paying critical attention to how textbooks present scientific concepts and ideas such as climate change.

Several studies have examined how approved science textbooks present climate change content (Wynes & Nicholas, 2019; Diegnan et al., 2019; Morris, 2014; Radtka, 2013). For instance, a search in Web of Science (limited to articles only) using the search terms TS= (climate* AND textbooks) yielded 144 studies mostly from the United States (67), Germany (19), England (14), Canada (8), Australia (7) and countries from the global North. With the exception of China (5) and South Africa (3), there was a poor showing of articles from the global South. Figure 1 is a map portraying the results of the search for this research from the web of science. Deep green indicates countries with more research, while light green shows limited research.

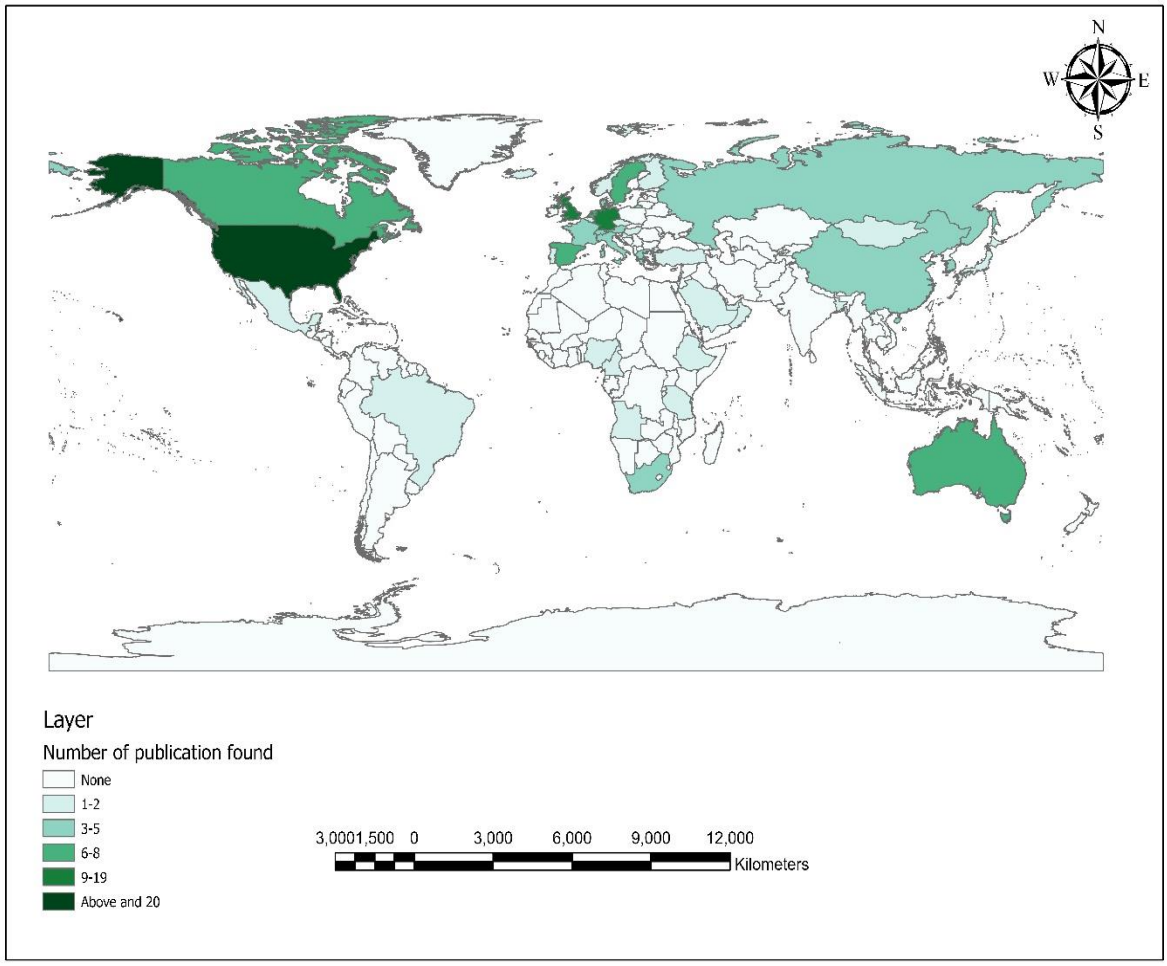

Fig 1: Map depicting textbook and climate change education research across the Globe

Figure 1 shows that North America, Europe, and Australia produce a significant body of knowledge regarding climate change materials while in the global South; there is a paucity of research. This dissertation sought to address this omission by conducting research from countries that are less represented in the peer review literature such as Bangladesh and Ghana. By bringing research on Bangladesh and Ghana into the conversation, this dissertation illuminates other ways of conceptualizing curriculum and textbook research beyond the western and industrialized

world paradigm. The dominance of western research means that other ways of being and existing in the world are relegated to the background. However, bringing into the academy bodies of work/literature from the global South expands and challenges our ideas about the purposes of schooling, educational policy and the human experience. The latter is particularly significant, since climate change is not isolated to one country. Rather it affects people in different contexts, situations and geographies.

While it remains true that more research about climate change curricular materials has been conducted in the United States compared to Bangladesh and Ghana, most of the United States studies (Roman & Busch, 2016; Meehan et al., 2018; Choi et al., 2010) analyzed textbooks that were published between 2007-2012. For instance, Roman and Busch (2016) looked at how science textbooks approved in the state of California presented evidence of climate change. Since the Roman and Busch (2016) study, however, California has adopted the Next Generation Science Standards, and new textbooks have been produced and required for instruction in schools across the state (Sawchuk, 2018). In late 2018, the state authorized new science textbooks for instruction (Sawchuk, 2018). The state's motivation for changing the curriculum was to make sure its students are instructed in scientific content and practices that prepare them for the 21st century. California seeks to ensure that its students develop climate literacy and help in the fight against climate change. In this dissertation, I show how official science textbooks, approved by the State of California for instruction, present the subject of climate change. It is important to acknowledge that, unlike Ghana and Bangladesh, both of which are countries with a centralized educational curriculum, the United States has a decentralized system. Many states do not have a statewide adoption system; rather, decisions are made at school- and district-levels.

I selected California as the unit of analysis for the United States for two reasons. First, California is a leader in climate change mitigation and adaptation efforts in the United States. It was the first in the United States to enact a statewide climate change policy. Second, as the largest, public school system in the country, California is one of the largest markets for textbook companies, and hence textbooks produced in California are sometimes used across the United States.

It is important to acknowledge that compared to some states such as Idaho, California takes the view that climate change is a closed subject. Likewise, Bangladesh and Ghana consider climate change as a closed subject. Here, as I discuss in further detail later, "closed" means that climate change is presented as a settled issue in that it is assumed there is a global scientific consensus about this topic, whereas "open" implies that climate change is a controversial issue within the global scientific community and is thus a curriculum controversy (Hess, 2009). In this dissertation, I investigated whether science textbooks presented the concept of climate change as open or closed in the contexts of Bangladesh, Ghana, and the United States (California) as well as the reasons, ramifications, and results of this designation. Along these lines, this dissertation examined whether science textbooks from Bangladesh, Ghana, and the United States (California) attribute climate change primarily to human activity or whether textbooks assign unknown natural causes to climate change.

As part of the curriculum, textbooks are often instrumental to teachers' pedagogical choices and to their students' learning (Sidaway & Hall, 2018; Gericke et al., 2013). Hence, there is the need for critical analysis of textbook contents in keeping with relevant climate change knowledge. This has implications for student activism and agency as well as enhanced students' capacity to be active change agents for addressing climate change in their respective

communities. As Leat and Thomas (2018) argued, "Localized curriculum making is fundamental to providing young people with participatory opportunities to develop competencies, work collaboratively, and make authentic contributions to society" (p. 18). Therefore, this dissertation also examined whether textbooks attended to local realities and contexts as well as whether they discussed localized implications, effects, and causes of climate change. For instance, the dissertation considered whether textbooks in California present a linkage between climate change and wildfires. In the case of Bangladesh, my analysis included whether textbooks discuss flooding and sea level rise as they relate to climate change. The assumption behind these questions is that universal and broad-based climate change education is inadequate for addressing the complexities of local and peculiar climate change effects. As Wilbanks and Kates (1999) rightly observed:

> Global changes in climate, environment, economies, populations, governments, institutions, and cultures converge in localities. Changes at a local scale, in turn, contribute to global changes as well as being affected by them. As a result, across a broad range of disciplines and problems, linking the local and the global scales – integrating assessments of population, economy, technology, and environmental change – potentially yields deeper understandings of global change in all its complexity. (p.1)

Students need to be equipped with local ways of knowing and thinking about climate change that are relevant and practical to their lived realities. For this to happen, climate change education would need to reflect a socially constructed understanding of particularities that varies from place to place while acknowledging the scientific consensus on climate change.

In addition to the state/government-endorsed climate change curricula, there are also non-governmental organizations actively participating in the overall discourse and the teaching

and learning of climate change. For example, in the United States, several conservative think tanks have developed materials for teachers on climate change. For instance, in the spring of 2017, Heartland Institute, a libertarian think tank mailed over 200,000 books to science teachers across the United States (Worth, 2017). The book titled, "Why Scientists Disagree about Climate Change" was explicitly intended to introduce teachers to climate denial and to provide support for this viewpoint.

To date, research on non-governmental organizations involved in climate change education, such as Heartland, have largely focused on the public discourse and frames used by these groups to propagate their positions on climate change education (Dunlap et al., 2012). Missing from these studies, however, is a systematic analysis of the climate change curricula and materials that these organizations have developed and enacted. This dissertation is intended to contribute to filling these gaps in knowledge by critically analyzing the contents of these non-governmental/non-state climate change curricula produced in various jurisdictions. Although these curricula are developed outside the authority of nations, states, and/or school districts, they are part of the milieu that organizes and influences climate change education. As Priestly and Philippou (2018) observe, curriculum enactment is not a predictable and linear process. Rather it

> occur[s] across multiple sites, in interaction and intersection with one another, in often unpredictable and context-specific ways, producing unique social practices, in constant and complex interplay, wherein power flows in non-linear ways, thus blurring boundaries between these multiple sites. (p.154)

Research Questions

Based on an extensive review of the literature and informed by the key ideas involved in relevant theoretical frameworks and concepts, which are elaborated upon in Chapter 2, this dissertation tackled the following questions:

1. How do the government/national/state approved school science curricula in Bangladesh, Ghana, and the United States (California) present the subject of climate change?
2. How do non-governmental/non-state curricula (e.g. supplementary materials) present the subject of climate change?
3. What are the similarities/differences among the national/state approved science curricula in Bangladesh, Ghana and the United States (California) and among official and supplemental materials?

These questions were posed to make sense of state/nation-approved and supplementary materials available that are part of the climate change curriculum. The first research question sought to investigate climate curricula that were officially approved for use in schools in Bangladesh, Ghana and the United States (California). Climate change has and will continue to have devastating consequences for the world. Hence, it is important to unpack and comment on the messages conveyed in the materials used in schools as sites of knowledge acquisition and transmission and to consider the roles they play a part in educating youth about climate change adaptation and mitigation and nurturing climate literacy in students. Climate literacy is key in terms of achieving policy goals, systemic changes and modifying environmental behaviors.

The second research question was intended to sort out and to make sense of non-state and non-government educational materials. Although not official, these documents have found their

way into schools and hence, there is the need to assess their content and as to whether content material is consistent with the scientific consensus on climate change.

Finally, with question #3, this dissertation compares and contrasts the contents, ideological leanings, scientific information of the state/national curriculum across the three countries, taking into consideration the particular and peculiar details of each country. The comparison across three different contexts illuminates and increases our understanding of the complexities of curriculum, climate change education and policy.

Context: Science Curriculum

Climate change as a topic is present in science, humanities, and environmental education curricula. However, this dissertation is limited to an analysis of science curricular materials for several reasons. First, historically, the field of science education and more generally, the larger scientific enterprise, is assumed to be governed by knowledge and scientific consensus that hinges on facts and evidence (Rauch, 2018). The epistemology of science and how it is conceptualized in public discourse hinge on accepted and universal notions of objective truth. Climate change as a scientific phenomenon is heavily contested by its doubters and by those who are skeptics about the "facts." Hence, the science curriculum presents an opportunity to make sense of facts and evidence of scientific consensus and their relationship to curriculum.

Another reason for focusing on the science curriculum is that science education, as compared to environmental education or to the humanities, has lagged behind in attending to sociological and cultural concerns (Lucas, 1980; Gough, 2002; Wals et al., 2014). Scientific advancement and enlightenment values have been instrumental in improving lives. However, there are still gaps in how scientists and other stakeholders have addressed social reality. For instance, in the climate change debate, doubters and skeptics have been effective at shaping and

controlling the direction of the debate. In contrast, those who are ardent about the consensual scientific perspective tend to operate in a reactionary mode. For example, having recognized the clashing objectives of science, ideology, and uncertainty, the National Science Teachers Association has released official statements, instructional materials, and resources as a counter strategy in response to years of aggressive campaigns from climate doubters across the country. The climate skeptics and deniers are keenly aware of the uncertainties of science, and as Roberts (2020) observed:

> Science is full of epistemic uncertainty. Circling the unknowns, inching toward truth through argument and experiment is how progress is made. But science is often expected to be a monolithic collection of all the right answers. As a result, some scientists — and the politicians, policymakers and journalists who depend on them — are reluctant to acknowledge the inherent uncertainties, worried that candor undermines credibility. (p.1)

Roberts' argument mirrors long-standing debates about scientific truths and evidence, about how they evolve or are used in policy, and about how the public comprehends scientific truths, evidence, and the role of debates. The notions of universal scientific truth and objectivity are heavily contested by postmodernists such as French philosopher, Bruno Latour (Shapin, 1992). On the other hand, there are serious, even harsh, criticisms of Latour by scientists such as Sokal (1996) who argues, "There is a real world; its properties are not merely social constructions: facts and evidence do matter. What sane person would contend otherwise? And yet, much contemporary academic theorizing consists precisely of attempts to blur these obvious truths" (p .4).

In contemporary times, we have seen a significant increase in scientific misinformation and disinformation. We know that political polarization together with the rise of populist

authoritarian regimes around the world have created significant distrust in expertise, bodies of knowledge, and scientific institutions (Szabados, 2019; Ricard and Medeiros, 2020). Science has always been a battleground for competing visions about the world, and climate change education as described above, is one of the major current battlegrounds. While the old debates about facts vs. climate denial, conservative vs. liberal positions on climate change remain, newer forms of contestations have arisen, and these defy simplistic explanations and political alignments (Starbird & Wilson, 2020). Along these lines, Starbird (2020) argued, "The notion of disinformation often brings to mind easy-to-spot propaganda peddled by totalitarian states, but the reality is much more complex. Though disinformation does serve an agenda, it is often camouflaged in facts and advanced by innocent and often well-meaning individuals" (p.1).

In addition to state-sponsored and voluntary disinformation, the format for dissemination of scientific misinformation has evolved from traditional media (local news, newspapers) to more viral transmissions on talk radio and in social media, including Facebook, Twitter, Tik-Tok, YouTube, and Instagram (Orben, 2020; Xu, 2020). Social media platforms have significantly changed and expanded the boundaries and frontiers of knowledge transmission and acquisition and hence, present a much more potent challenge to scientific integrity and truth, in part because of its dynamism and most importantly its acceptance and high rate of use among children and youth in North America as well as the global South. Social media access has expanded considerably in the global South fueling to some degree social and political conflict. Climate change education in the science curriculum presents an opportunity for science educators to engage in these debates about the nature of science particularly in an age where there is proliferation of conspiracy theories, assault on scientific expertise and an ever-changing world where scientific literacy is fundamental to human flourishing.

CHAPTER TWO

Theoretical Framework and Literature Review

This chapter will focus on the theoretical frameworks that underpin the dissertation as well as bodies of work, scholarship pertaining to climate change education. In the first section, I discuss the theoretical frameworks followed by a review of literature.

Theoretical Framework

In an article about the process and value of combining multiple theories, Cairney (2013) identifies three approaches, which he refers to as synthesis, complementary, and contradictory. He suggests that the complementary approach involves "synthesizing the most valuable aspects of each theory [and using] each theory independently to highlight different aspects of the policy process; or establish[ing] the extent to which these theories are contradictory" (p. 1). The complementary approach is advantageous in the sense that it allows for drawing on aspects of different theoretical frameworks and comparing and contrasting the inherent ideas in them. Following the complementary approach described by Cairney (2013), this dissertation took a complementary approach to establishing a theoretical framework. I drew on Apple's ideas about texts and cultural politics (1992) and upon Hess's ideas about curriculum controversies (2009) to make sense of the official and supplementary climate change curriculum in Bangladesh, Ghana, and the United States (California). In this section, I discuss Apple's (1992) frameworks under the heading, "power and politics." Subsequently, under the heading, "changing notions of curriculum controversies," I consider Hess's (2009) ideas about curriculum as they relate to controversies that are what she describes as "open, closed, or tipping."

Power and Politics in the Curriculum

In a significant body of work over many years, Michael Apple, widely known critical theorist and advocate of democratic education, has explored the role of power, ideology and politics in curriculum development and enactment. In his writing across several decades, he has argued that the curriculum should be perceived as a contested document and a reflection of the power imbalances that organize our societies. He suggests that power is possible and is attained through complex historical forces and in the case of democracies, through constitutionally mandated elections that give rise to different forms of state and decentralized power at the levels of cities, municipalities, and regions, which may have different visions about schools and schooling. This arrangement significantly influences the contents of the curriculum and the controversies that arise about curriculum (Apple 1990; Apple, 2001). In this dissertation, I drew on Apple's seminal work titled *Text and Cultural Politics* (1992) to make sense of the curricula under study in three countries and the politics that govern their use and distribution in schools. In the following pages, I discuss several of Apple's key ideas about texts, curriculum, and politics, and then I discuss how these ideas relate to science curricula and texts in the United States and the global South.

Apple (1992) theorizes the role of textbooks as pedagogical manuals, instrumental to the education students receive as well as cultural artifacts of inclusion and domination both locally and internationally. He examines the symbolism of textbooks and how power and politics mediate textbook content, distribution, and use in schools. Apple is keen to point out that we cannot make simple and singular assumptions about school texts. Rather, we should endeavor to read the texts' multiple meanings and from different perspectives. He argues also that students are not singular and simplistic in their views or identities but rather, "Students bring their own

classed, raced, and gendered biographies with them as well. They, too, accept, reinterpret, and reject what counts as legitimate knowledge selectively" (Apple, 1992, p. 10). Currently in the United States, there are highly politicized and polarized debates regarding the topic of race and whether/how this should be part of the teaching of history in the nation's schools. Although the history curriculum and curriculum materials pertaining to race and racism were not the focus of this dissertation, the curriculum controversies surrounding these issues stand as a stark reminder that there are drastically different competing visions of education in American society. This reminds us that very complex understandings of the relationships between curriculum materials, teaching, and student learning are necessary when it comes to analyzing curriculum controversies.

In terms of debates over the contents of the contemporary science curriculum, including issues such as evolution, climate change, creationism, and intelligent design, Apple's theories compel us to consider the deeper ideological sentiments behind the controversies. He argues that people who participate in these debates—on multiple sides-- view education as a pathway for the social reproduction and cultural transmission of value systems and politics. Apple emphasizes that there are widely varying objectives for various ideological groups when it comes to education. In other words, different groups have different visions of education, whether in democratic or authoritarian societies. Wide-ranging views about the goals of curriculum ignite debates as various interest groups and stakeholders seek to prioritize and entrench one view of education over the other. Apple (1992) identifies some strategies used in service of the agendas of various education stakeholders, including politicians, churches, industry leaders, activists, scientists, parents, teachers, and school leaders. Some of these strategies include public campaigns used to rally allies and recruit new members and policy choices related to public,

private, and home schooling; many of these are motivated by religious, democratic, or economic issues. Despite sharp debates about race and school choice, education is intended to be a public good in democratic societies. Textbooks are central to the attainment of any vision for society and are critical to the objectives of education for any group. Hence Apple argues that there is the need for scholars to pay attention to textbook content development and use in schools.

In addition to questions of power and competing visions about the contents of textbooks, Apple (DATE) argues that textbooks are cultural artifacts that transmit knowledge and information across geographies and cultures. Textbooks travel across state lines in the United States and across the globe into the broader world. Apple argues that the global travel of textbooks is a result of historical forces, such as colonialism, of the political power of governments, and of economic power, especially in relation to the commerce and trade of large publishing companies. However, it is important to note that while politics and commerce play a role in the reach of textbooks, it is also true that in the last century, knowledge production—at least what counts as legitimate knowledge particularly in the natural and physical sciences—has largely originated from western societies. This has created an unequal power balance with respect to knowledge production and dissemination between the global North and global South (Collyer, 2018). The global North produces a significant amount of scholarship that feeds textbooks and curricula used around the world (Lawhon & Roux, 2019). In light of this, some scholars in the global South have called for a blend of western knowledge and traditional local knowledge in education (Kolawole, 2012; Dei, 2002). The blend of multiple knowledge systems would introduce students in the global South to western and international ways of thought but also keep them grounded in local traditions and contexts that are relevant to their everyday lives. For instance, the government of Ghana recently created a course titled, “Our World and Our

People," and mandated that the course be taught in Ghanaian K-12 schools. The aim of this curriculum is to "provide space for learners to further explore their immediate world ─ homes ─ and other worlds – the people and their interconnectedness" (Government of Ghana, p. 1). Here, we see the national government of Ghana acting on its commitment to a blend of local and international knowledge, but made possible by the political power it wields. As Apple (1992) argues, "education and power are terms of an indissoluble couplet" (p.1). In other words, power and education go hand in hand and power underwrites curriculum.

In this dissertation, I drew on the ideas about power and politics as described by Apple (1992) to make sense of the climate change curriculum in Bangladesh, Ghana, and the United States (California). In the paragraphs below, I elaborate on how Apple's (1992) ideas are key to understanding the power, political. and public struggles over the climate change curriculum.

Power, Politics, and Climate Change Education

Since the advent of mass schooling in the United States and the opening up of education opportunities to poor and indentured whites (Vinovskis,1992) and freed blacks (Tyack & Lowe, 1986), there have been fractious debates about the contents of the curriculum (Kliebard, 2004). From the reading wars (Pearson, 2004; Carson, 1999) and Ebonics controversies (Wright, 1998) to debates about teaching evolution in schools (Zimmerman, 1991; Moore, 2005) and quite recently to controversies over critical race theory (Goldberg, 2021), the curriculum has been a site of disagreement about the purposes of schooling and the role of schools in a western democracy such as the United States. Of course, curriculum controversies and debates are not limited to the United States. In the global South, there are equally competing visions regarding curriculum issues such as bilingual education in South Africa (Heugh, 2000), sex education in Ghana (Awusabo-Asare et al., 2017), and the history curriculum in Pakistan (Zaidi, 2011).

Apple suggests that power is at the center of the struggle and the controversies over the curriculum. He argues that in the course of curriculum debates, what emerges as official curriculum is a result of power dynamics and competing interests, and as he noted:

> What counts as legitimate knowledge is the result of complex power relations and struggles among identifiable class, race, gender, and religious groups. Thus, education and power are terms of an indissoluble couplet. It is during times of social upheaval that this relationship between education and power becomes most visible. (p.3)

Although the current climate change educational discourse cannot be fully characterized as a form of social upheaval, it shares some of the features Apple describes with respect to how power has been used to legitimize and include or exclude certain perspectives on climate change in the curriculum. In the United States, state legislatures are among the most salient political and powerful forces that decide what type of climate change curriculum is approved for use in schools. For instance, in 2017, the legislative body of the State of Idaho authorized the removal of content about human-induced climate change from the state's science curriculum. This action led to three years of protests, public hearings, and fractious debates about which perspectives on climate change should be recognized as official knowledge in Idaho public schools (Worth & Hand, 2019). In contrast, in both Ghana and Bangladesh, central governments are the power brokers who make the decisions regarding climate change curriculum materials that are approved for use in schools.

It is worth noting that in the global South, and especially in the developing world, power is less distributed, and educational systems are more centralized than in the United States, which means there are few sites of engagement and therefore, fewer controversies over subject matter in schools. It may be the case that centralized power systems are in part responsible for the lack

of visible public dissent over climate change education in Ghana and Bangladesh. In the United States, however, the decentralized educational system means there are multiple power brokers at every level and multiple sites of engagement, and hence curriculum controversies abound.

In addition to the centralized or decentralized systems that organize schools, the political climate is a key factor in how curriculum debates are constructed in the global South in comparison to the global North. For instance, in many countries, such as Bangladesh, the lack of free speech and the ways in which political power is used to stifle freedom of expression has meant that public mobilization against curriculum mandates is unlikely to succeed. In contrast, there is much more freedom of speech by ordinary citizens in the United States and hence within that framework, protests and concerns over curriculum are much more likely. Climate change education is no exception.

As indicated earlier, power struggles over the curriculum have to do with which forms of knowledge are enshrined or prioritized. Apple (1992) argues that in the process of the curriculum wars and deliberation, the knowledge of historically marginalized populations and their points of view have traditionally been left out of the curriculum and out of the discourse on education.

In the United States and in the global South, rural and urban poor community voices are mostly silent in the debates about climate change education. These rural and urban communities are significantly affected by fossil fuel exploration, and yet curriculum and instruction in these areas de-emphasize the specific local concerns of these communities with respect to climate justice and rather center their concerns on industry interests (Eaton & Day, 2020). As Eaton and Day (2020) observed, "Teaching practices and resources work to center, legitimize, and entrench a set of beliefs relating to climate change, energy, and environmentalism that align with the interests and discourses of oil industry actors" (p. 2). Industry and oil actors have significant

financial power to fund politicians, lawmakers, and political campaigns that propagate and entrench their positions in the discourse and the curriculum. Money and politics, as Apple (NEED YEAR HERE) argued, result in the legitimizing of particular knowledge by "real people with real interests" (p. 4). In the case of Ghana and Bangladesh, "real interests and real people" can be interpreted as national interests and when it comes to climate change, state-sanctioned climate change education and policy.

In the last decade, Bangladesh and Ghana have both adopted climate change policy plans and have mandated climate change instruction in schools. Although these actions are laudable, the extent to which these policy plans and curricula attend to local conditions is tenuous at best. We know that the United Nations (UN), the International Monetary Fund (IMF), and other international organizations have significant influence on countries like Ghana and Bangladesh when it comes to issues of education and policy (Sayamov, 2013). In addition, international organizations such as the UN and IMF are funded largely by the United States and China (Whineray, 2020). These countries are also some of the leaders in greenhouse gas emissions contributing to climate change. Hence, there is a de-facto policy agenda, or in other words, through the United Nations and other international climate organizations, policy and curriculum in countries like Ghana and Bangladesh are heavily influenced by economic ideas and cultural visions from powerful countries in Europe, North America and Southeast Asia (Thakur & Weiss, 2009; Fernandes & Girard, 2011).

Despite the soft influences of international organizations on climate policy in the global South, Rajao and Duarte (2018) report that post-colonial societies are beginning to assert themselves in discourses on climate change. Rajao and Duarte (2018) observed that at the Paris Climate Negotiations, countries in the global South sought "to demand more commitments from

the North in tackling climate change and transferring financial resources to the South" (p. 13). In this dissertation, I was interested in the extent to which these conversations and negotiations about power are represented in the curriculum from the global South. In addition, I was also interested in whether the curriculum from the United States (California) attends to the unequal power dynamics at the local and international levels.

Changing Notions of Curriculum Controversies (Open, Closed and Tipping)

As I have shown in the preceding pages, Apple and many others have shown over years that politics and power are instrumental in curriculum controversies, changes, and reforms. Diana Hess (2009) provides a framework that is complementary to Apple's. Hess characterizes the shifting and changing nature of curriculum controversies powered by politics and power. She argues that at any given point in time, curriculum issues are either "open," "closed," or "tipping."

Closed or Settled. According to Hess (2009), "closed" means that aspects/specifics of a particular issue related to the curriculum is deemed as settled and not open to debate. The use of the words, "aspects" and "specifics" here is important because a topic can be considered closed to debate in one aspect and open to debate in other aspects. For instance, consider the issue of voting rights in a social studies or civics curriculum. Women's suffrage and voting rights for African Americans and other minoritized citizens are settled issues in the United States. That is, over the past century, there has been a significant consensus that women and African Americans are equal citizens under the law, and they are *by law* accorded the full rights and civil liberties formerly granted only to landed men. Thus, voting rights is a settled issue. However, this does not mean that there are no groups engaged in efforts to suppress voting access for African Americans and others in certain parts of the country, and in fact, in early 2021, there have been voter suppression laws proposed in a number of states by Republicans who believe greater voter

turnout disadvantages their party's power. These proposals are framed as "anti-voter fraud" bills, which is highly debatable, as opposed to "anti-voting rights" for women or minoritized communities, which is not a legally or politically open issue. These voting bills and proposals can be matters of debate and discussion in the classroom about a wide range of issues from States rights to the Supreme Court's decisions about the voting rights to voter ID cards. Here we see that even though voting rights have been granted to Black Americans, there are still a number of issues concerning voting that are controversial and can be debated or discussed in the classroom.

There are multiple important caveats to consider when discussing or referring to an issue as settled or closed. First, an issue can be considered settled in the broader culture and still be debated in certain quarters of society. For instance, in the United States, the majority of the public supports gay marriage, according to a recent Gallup public poll (McCarthy, 2020). However, in the Bible belt, gay marriage is very much open to debate. For instance, in evangelical and conservative Christian-affiliated universities, same sex marriage is not a settled or closed issue (Coley, 2020). In K-12 education contexts, sex and sexuality education is still open to debate in some states across the United States (Mazzeo, 2020). Along these lines, in recent times, the Arizona legislature passed a bill that would have allowed parents to opt their children out of sex education classes because they had concerns that these classes pushed LGBTQ identities and ideologies onto students (Associated Press, 2021). It is important to acknowledge that the Arizona Governor, Doug Ducey, vetoed the bill. However, a new bill, which still allows parents to opt out of sex education classes, is still up for debate in the Arizona Legislature (Associated Press, 2021). This year several states have passed bills that restrict instruction about sexual orientation and gender identity. For instance, Florida passed the "Parents

Right in Education Bill that restricts education about sex and gender orientation. And as argued above, the debates over these controversies reflect varying viewpoint in American society over values and politics. Applying Hess idea of settled we notice that even in the same jurisdiction/state, what is considered settled is constantly up for debate. I discuss the limitations of the settled framing in Chapter 6.

Another important caveat to consider when discussing whether a topic or issue can be called settled is the way in which it is framed. For instance, if marriage is framed as a union between a man and a woman, the issue may be considered settled among many religious groups and people who hold traditional views on marriage. In contrast, people with liberal views about marriage consider the traditional definition of marriage as completely open to debate and discussion. Here we notice that, when the topic is framed explicitly as gay marriage or same sex union, it is considered settled for some and open for discussion to other groups. However, when the topic of marriage is framed as traditional union between a man and a woman, ideological positions may change or shift. Framing is a key part of the way in which issues are perceived or problems are conceived in the public discourse (Stone, 2002), and as Scheufele and Iyengar (2014) observed "how we interpret information differs depending on how that information is contextualized or framed" (p. 3). Hence, to label any issue as settled or open to debate, it is essential to consider its framing.

Open. Hess (2009) suggests that when a topic is taught as an open issue, its basic premises and assumptions are presented as open for debate, discussion, and consideration from multiple perspectives on the topic. The assumption behind the open perspective is to expose students to diverse and conflicting viewpoints. For instance, in a debate on healthcare in the United States, the open perspective approach will entail different viewpoints on whether health

care should be privately or publicly funded. Debates are important to exposing students to wide ranging and different perspectives and it is deemed healthy for civic life (Zorwick & Wade, 2016).

Despite the above assumptions about open debates in the classroom, Hess (2009) makes it clear that an "open" perspective on a particular issue is not automatically good, and a closed perspective is not automatically bad. In fact, she cautions against presenting a particular topic as open to debate *if and when* there is significant consensus among experts on that topic. She suggests that in this case, it would be irresponsible to present that topic from an open perspective. Some may raise questions about who decides who the experts are or why selected groups of people get to make judgments on issues for the rest of the population. For instance, consider the issue of affirmative action. We can argue that within major universities and among many professors and academics, affirmative action has been for some time considered a settled issue. However, among a section of the public, this practice is still largely subject to debate as evidenced by recent lawsuit (Students for Fair Admissions Inc. v. President & Fellows of Harvard College) to be taken up by the United States Supreme Court regarding race-conscious admissions policies at Harvard (Liptak & Hartocollis, 2022). But there is an important caveat when considering a topic like affirmative action. Based on how it is framed, there may be greater public consensus in support or in opposition. When affirmative action is framed in racial terms, there is less support for it across all racial groups according to Pew Research (Graf, 2019). However, when affirmative action is framed broadly without a definition or explanation or without mentioning of race, there is greater support for it among a majority of Americans according to a Gallup poll (Newport, 2020). Here, we notice that, similar to the issue of marriage

(traditional/same sex marriage); framing is key as to whether a topic can be considered open or closed/settled.

Tipping. Finally, Hess (2009) characterizes some curricular issues as "tipping." She suggests that tipping occurs when an issue shifts from closed to open or vice versa. As indicated earlier, an issue may tip from closed to open because of changing public perception or new ways of looking at the topic based on fresh evidence. For instance, consider the topic of the Japanese Internment that occurred in the United States during World War II. Previously this was an open topic in the social studies and history curriculum with debates about whether this was necessary as a geopolitical strategy or whether it was an infringement on the civil liberties of Japanese Americans (Hess, 2009). Eventually, however, public perceptions shifted in favor of civil liberties over politics, and as Hess (2009) observes, this is no longer controversial or considered an open question in the history curriculum. Now the history books teach that internment was an egregious assault on the civil rights of Japanese Americans, who should have been afforded their civil liberties like any other Americans living within the United States. Again, because it is now a closed issue, this does not mean that the Japanese internment is not or should not be taught, discussed, and critiqued— in the United States history curriculum. But it does mean that this issue is now taught as a shameful event in American history.

Applying Hess's ideas to climate change education is very instructive. The scientific perspective is absolutely clear and resolved: human activity is the primary driver of climate change (Hulme, 2009), and for this reason, climate change should be taught as a settled issue with the curriculum focusing on how climate change is affected by human activity and what can be done in response. However, there are powerful groups, such as the Heartland Institute (2017), the Independent Institute (Dunlap & Jacques, 2013) and some Republican-led state legislatures,

such as Alabama and Texas, that deny the existence of climate change and argue that the idea that human activity is the cause of climate change should be open for debate. These groups want climate change to be taught as an open issue in the curriculum. In other words, they are advocating that the science curriculum should focus on debate about the evidence regarding human-induced climate change (Heartland Institute, 2017). Advocating for an open perspective is meant to cast doubt on the overwhelming scientific evidence regarding climate change and to invite students to believe that the issue is open. Here, "open" as it relates to the evidence or the causes of climate change should not be viewed as a positive democratic tool for helping to accomplish deliberative and democratic education in the classroom. Rather, the point here is that the science about climate change is backed by a scientific consensus that is settled, and thus climate change should be treated as a settled subject in the curriculum (Hess, 2009). However, the policy solutions to address climate change, their effectiveness, and issues related to climate change spending and local or international agreements are all climate change policies and practices that are open and should be debated in the classroom. For instance, debates about local climate policies or state led policies vs. a federal climate plan such as the proposed Green New Deal and other policy proposals are open to debate about their effectiveness and cost.

Most scientists, most educators, and many others argue that the phenomenon of climate change itself should not be open for debate or discussion in the science curriculum (American Meteorology Association, 2017; NASA, 2021). Rather, it should be presented as settled science, which means there is a scientific consensus that climate change is caused by human activity (Hulme, 2009). Again, I reiterate here that the proponents of the "settled" or "closed" view of climate change as a curricular issue are *not* against debate or deliberation. Rather they argue it is irresponsible to teach climate change in the curriculum as if there is *not* overwhelming

established scientific fact (Hess, 2009). In states such as Massachusetts, Connecticut, and California, the settled perspective on climate change is reflected in state science standards. In addition, the nationwide Next Generation Science Standards (NGSS) take a settled perspective on climate change. The NGSS standards were developed by nationally recognized scientific and teacher education bodies such as the National Research Council (NRC), a branch of the National Academy of Sciences, the National Science Teachers Association (NSTA), and the American Association for the Advancement of Science (AAAS). However, the perspective reflected in state or national science standards does not necessarily translate into the content of the commercial textbooks used in schools.

Changing Notions of Curriculum Controversies and the Wyoming Example

As mentioned earlier, the politics and power driving curriculum controversy are the result of competing interests. With respect to climate change, the movement to teach climate change as an open issue is driven by the interests of fossil fuel revenues. Interestingly, in some places over the last few years, decline in fossil fuel revenues as well as social activism in support of climate change have may influenced the portrayal of climate change in the curriculum. In some places, this has caused the climate change curriculum to shift from open to settled as in the state of Wyoming, which typifies the changing nature of the climate change education debate.

In 2014, Wyoming adopted what Hess (2009) would call an "open" perspective on climate change, in part by rejecting the NGSS. The state rejected these standards because they claimed that the standards presented climate change as settled science. The NGSS do indeed present climate change, as a settled science, as I pointed out above, and they have been consistent in presenting climate change as settled. Given that Wyoming is a leader in coal and fossil fuel exploration, there were fierce debates as to whether Wyoming's science standards

should emphasize human-induced climate change. Wyoming's climate change discourse reflected what Apple (1992) described as "the simultaneous results of political, economic, and cultural activities, battles, and compromises. They are conceived, designed, and authored by real people with real interests. They are published within the political and economic constraints of markets, resources, and power" (p. 1). Along these lines, one state legislator in Wyoming said that the curriculum was "very prejudiced, in my opinion, against fossil fuel development." (*Casper Tribune*, p. 1). The state legislator's argument exemplified the political and social dimensions described by Apple (1992) as "real people with real interests" and by Hess (2009) as "the curriculum as a proxy" for competing interests. The position of this Wyoming legislator reflects typical assumptions among the proponents of the open perspective on climate change, which is that teaching students about human-induced climate change socializes or orients them into a negative view about the use and development of fossil fuels. In this situation, it is clear that climate change education is understood as part of the way ideas about climate and fossil fuels are culturally reproduced in young people. In a state whose economic fortunes depend heavily on revenue from fossil fuel development, it is not surprising that there were strong sentiments against treating human-induced climate change as a closed issue.

Interestingly, however, the open perspective on climate change, reflected in the legislator's comments above, did not have a lasting effect in Wyoming. In fact, Wyoming has tipped since 2018 toward a more settled perspective in that its most recent science standards emphasize that human activity is the driver of climate change (Baker, 2020). The "tipping" of the climate change curriculum in Wyoming from open to settled can be conceptualized—at least in part—as the result of the decline in fossil fuel revenues. New visions have been compelled by coalmine closures and decline in fossil fuel revenues, not because there has been a change in

attitude. One could argue that proposing climate change, as a closed issue could be a way of defending mine closures and diminishing revenues rather than realizing the impact of fossil fuels on climate change. Furthermore, presenting the issue as closed could engender more interest, activity, and funding of renewable resources. Wyoming still produces extraordinary amounts of natural gas and is poised for producing solar, wind, and geothermal energy. Since 2016, Wyoming has seen record closures of coalmines and a reduction in coal jobs because of competition from renewable energy sources such as wind (Searcey, 2021). This gradual shift in economic activity has forced leaders in Wyoming to re-evaluate the state's dependence on coal. In this case, the decline in coal revenues has compelled new visions for the future and subsequently, a controversial topic like climate change could be perceived in a new light. But it is too early yet to establish clear causality for the shift to a closed perspective. As both Hess (2009) and Apple (1992) argue, the curriculum is always a site for changing and shifting interests.

Changing Notions of Curriculum Controversies and Subtle Public Campaigns

In the case of climate change education and the changing public perception of climate change and fossil fuels, fossil fuel companies have started subtle (and sometimes not so subtle) campaigns to get their message into the public sphere. For instance, the Ohio Oil and Gas Energy Education Program (OOGEEP) has developed and organized STEM and geology curricula that promote the use of fossil fuels. There is a myriad of these educational materials, including the pamphlets "Natural Gas: Your Invisible Friend," "Petro Pete," "Frack Twinkies," and a host of others. These pamphlets and other child-friendly materials are examples of efforts to influence public opinion, developed in response to changing public perceptions regarding climate change. Because of changing perceptions, new means of influencing public opinion are invented and new

messages are framed to present the open perspective in a different light. According to the Yale Climate Program, which surveys public opinion on climate change, the United States public is increasingly aware of the harmful contributions of fossil fuels to climate change (Leiserowitz et al., 2019).

Conclusion

In this dissertation, ideas drawn from Apple (1992) and Hess (2009) provided frameworks for generating insights into the motivations and assumptions that undergird curriculum development and enactment in schools. Together, both Apple (1992) and Hess (2009) illuminate the power, political and public struggles over the school curriculum. Applying their ideas to the climate change curriculum and to this dissertation, this dissertation considers whether and how the climate change curriculum in Bangladesh, Ghana and the United States (California) is shaped by the power and politics of climate change. We know that whether the curriculum adopts a settled or open perspective hinges on power and politics. In addition, politics is instrumental to policy solutions to address the impacts of climate change. Hence, in this dissertation, I also consider whether and how the curriculum attends to policy solutions that address the impacts of climate change in the three contexts: Bangladesh, Ghana and the United States (California).

Literature Review

There are four main bodies of work that are relevant to this dissertation study in various ways: research on science textbooks and climate change, curriculum materials and September 11 terrorist attacks, the Heartland Institute and climate change materials, and science textbooks and genetics. Two of these four topics do not explicitly touch on climate change, but their underlying arguments related to partisanship (Republican vs. Democrat), economic assumptions (capitalism,

free markets), cultural ideologies and geographies (urban and rural), and competing ideas about western civilization mirror many aspects of the climate change education debate. Thus, examining research on these topics in relation to the climate change debate provides a robust picture of curriculum and science education controversies. For instance, consider the debates about the civics curriculum and the September 11 terrorist attacks and subsequently the Iraq War. Here, the prevailing debates were split along ideological and somewhat partisan lines similar to climate change education in that left-leaning educators called for a critical analysis of the Iraq War with a push back from the political right, who called for teaching that America is a force for good around the world. Comparatively, in the case of climate change, the left is critical of fossil fuel exploration, while the right argues that fossil fuels are good for business and profits. Along somewhat similar lines, the genetics debate mirrors the climate change debate when it comes to religion, politics, and cultural identity as well as competing visions of the world in relation to race and sex. Here it is important to acknowledge that the genetics debate is mostly limited to the United States and spans controversies related to sex education, gender identity, race, and IQ, particularly questions about equality of outcomes versus equality of opportunities, including whether people of different races, genders, and cultures can achieve similar academic and economic outcomes. These four bodies of literature focus on the form and content of curriculum controversies and thus are in line with my goals and objectives for this dissertation. Even though two of them do not reference climate change directly, they are still worth examining as they provide important context and add to the groundwork for this dissertation.

Studies of Science Textbooks and Climate Change

In 1998, at the meeting of the Text and Academic Authors Association in St. Petersburg, Florida, John Wakefield, a Professor at the University of North Alabama, argued that textbooks

have remained useful in education because of their adaptability and capacity to embody different curricular and educational reforms. In some ways, science textbooks are no different from textbooks in general. From the post-World War II emphasis on advancement and progress to current paradigms of technology and culturally relevant science education, science textbooks have embodied changing visions of science education and have thus remained relevant to the teaching and learning of science. In addition, within countries in the developing world, such as in Ghana and Bangladesh, science textbooks are sometimes the only instructional materials available.

Despite their usefulness and longevity, textbooks in general are poorly researched and as Issitt (2004) sharply argued, "They [textbooks] are often scoffed at by academics who feel that they reflect no creative input and that the last thing leading-edge intellectuals engaged in research ought to be doing is formalizing yesterday's knowledge for passive consumption by students" (p. 1). Historically and certainly in science education, textbooks have not received the same priority as other research areas. For instance, in 1979, a survey of "priorities for research in science education" among science education researchers in the US revealed that textbook research had a lower priority than "instructional strategy, learning, and student and teacher attitudes" (Abraham et al., 1982, p. 1). Despite its neglect in science education, some researchers have dedicated time and resources to researching and theorizing about science textbooks in areas such as the nature of science and the visuals, language, and topics included in the area of climate change.

Literature for this review was located through two main approaches. First, I located literature using the search engine, Scopus, as it includes literature beyond the United States. The second source of literature is less systematic; here, I discovered literature related to the topic

through my personal readings as a doctoral student and through my doctoral coursework. With Scopus, I used the search term "science textbooks and climate change," which led to the location of 32 empirical studies in peer-reviewed journals, eight of which focused on K-12 textbooks and climate change education or were related to the topic under review. The remaining twenty-four studies focused on other aspects of climate change such as college/undergraduate education, forestry, engineering, etc. The eight studies that were related to K-12 climate change education were based on curriculum from United States (N=4), Canada (N=2), England (N=1), and Spain (N=1).

In addition to the eight studies from Scopus, I discovered three studies from personal readings. The three studies were based on curricula from Ghana (N=1) and Ethiopia (N=2). It is important to acknowledge that the Scopus search yielded studies from primarily North America and Europe, while studies discovered through personal readings were based on curriculum from the global South. In the paragraphs below, I review studies based of textbooks from California (North America), Europe, and Africa. In reviewing the studies, I describe research objectives, methodology, and findings, synthesize/summarize trends in the literature and pose reflection that relates to this dissertation.

Studies of California Textbooks

Within North America, there were four studies from the United States, with two focused on climate change in approved science textbooks from California. Textbooks produced in California have significant influence on nationwide science teaching and learning in the U.S., as Apple (1992) observed, "the texts made available to the entire nation, and the knowledge considered legitimate in them, are determined by what will sell in Texas, California, Florida, and other large textbook-adoption" (p .6). Following this assumption, Meehan et al., (2018)

completed a comprehensive study of California school-approved science textbooks. The authors selected nine California public high school textbooks in disciplines such as earth science, biology, and social studies as well as textbooks from large commercial publishers such as Pearson and McGraw Hill. In addition to the official textbooks, the authors selected eight supplementary curriculum materials from Non-Governmental Organizations (NGO's) across the United States for analysis and comparison. Meehan et al. (2018) sought to investigate how these textbooks and supplementary materials presented the causes, impacts, and solutions to climate change. The authors completed a conceptual content analysis by examining the concept of climate change in the texts using a deductive coding approach and relying on pre-existing ideas from organizations such as the Intergovernmental Panel on Climate Change and the National Aeronautics and Space Administration (NASA). Meehan et al. (2018) reported that textbooks presented mixed messages about climate change, with some texts acknowledging unequivocally human-induced climate change while others opened the topic up for debate or presented human-induced climate change with ambiguity. In addition, Meehan et al. (2018) concluded that the California school textbooks were inadequate in addressing either the local consequences of climate change or local solutions to California's climate challenges. The textbooks instead presented broad and vague solutions to climate change that elided local complexity and challenges in California. This can be attributed to the fact that, as Apple (1992) observed, textbooks are commercial entities and hence they are written for broader audiences beyond local jurisdictions.

With respect to the supplementary materials, the authors reported that some of the materials flatly denied climate change, others acknowledged climate change but downplayed its impacts, and others acknowledged human-induced climate change and its impacts. These

supplementary materials implied that if the goal of science education for young people is the ability to think and evaluate evidence critically, then presenting climate change as a closed issue might make this goal less attainable. Meehan et al., (2018) respond to this argument by suggesting that "if educators think that disciplinary norms require them to address the controversies around the causes, as social studies teachers might, they may find it valuable to help students explore the reasons that mass media and others in the public sphere portray the issue as more controversial than do scientific reports" (p.46). Meehan et al., (2018) suggest that teachers should provide context to help students understand why some members of the American public may consider climate change controversial. But the authors insist that the scientific perspective on human induced climate change must be presented. It is also important to note that despite the fact that Meehan et al. (2018) advocated for the scientific perspective, the authors did not comment on textbook alignment with the NGSS or whether Pearson/Savvas is oriented toward state-mandated testing, which would certainly skew content a certain way. In this dissertation, I discuss these two omissions in Chapter 4 & 6 making the argument that state textbook alignment with the NGSS is critical and that testing and market textbook production have significant influence on science content. I discuss the implications broadly beyond climate change to include teacher practice and science teacher preparation.

In another study, Roman and Busch (2016) also focused on school-approved textbooks in California. However, unlike the Meehan et al. (2018) study that focused on high school textbooks for different subjects in addition to science and included supplementary materials, Roman and Busch (2016) focused exclusively on middle school science textbooks and did not include supplementary materials. They sought to investigate how language was used to frame the uncertainty of science as it relates to climate change, and in addition, they were also interested in

how language in the textbook presented human induced climate change. Once again, unlike Meehan et al. (2018) who focused on the correctness of the ideas in the text, that is, whether they aligned with the scientific consensus, Roman and Busch (2016) used a systemic functional analysis to see how language was used to convey the scientific ideas. The authors explained, "Systemic Functional Analysis takes into account how content is instantiated, how the writer and readers negotiate roles, and how texts are structured to express abstract, technical, and evaluative meanings" (p. 9). Here, the authors were not only interested in "technical meanings," which was Meehan et al.'s (2018) primary focus but rather on sentence structure and the word choices that collectively framed climate change in the text. The authors found out that the language used to describe human-induced climate change obfuscated the compelling evidence that human activity is responsible for climate change. In addition, they found that the textbooks adopted language such as "could" and "might" to frame the science of climate change. It is important to acknowledge that although Meehan et al. (2018) and Roman and Busch (2016) used widely different approaches, both sets of researchers came to similar conclusions that science textbooks presented mixed messages and evidenced a lack of clear and coherent messaging about human induced climate change.

These two California studies focused primarily on how human-induced climate change is presented in textbooks. Both studies came to a similar conclusion despite the obvious methodological differences. The differences in methodology are important to note however, since in this dissertation, I used a broad deductive approach to mark and code the data according to causes, impacts, and solutions to climate change. In addition, and after the broad deductive coding, I inductively coded the thought units in the marked/unmarked parts of the text. This dual deductive and inductive coding approach was intended to account for the weaknesses in the

methodologies of both Meehan et al. (2018), Roman, and Busch (2016). By following a completely deductive approach, Meehan et al. (2018) might have missed some salient ideas in the text that their predetermined codes did not cover. While the systemic functional analysis by Roman and Busch (2016) is commendable in the ways that it focuses on language, it omits technical jargon and scientific references, which in themselves shed light on important climate messaging in the text. For instance, teasing out the differences between climate change at different scales and geographies involves paying serious attention to the concepts/technical jargon/vocabulary in the text. This dissertation accounted for these gaps in methods by adopting an in vivo approach that involves lifting ideas/concepts/codes from the texts itself and examining them on their own merit. It is important to mention that beyond their finding that science textbooks presented limited and sometimes inaccurate information about climate change, the textbooks analyzed in the studies by Meehan et al. (2018) and Roman and Busch (2016) are now almost a decade old. Since 2013 and the inclusion of climate change in the NGSS standards, California has adopted the NGSS standards. In fact, in 2018 the state approved a list of textbooks based on California Science Standards, which mandated the instruction of climate change. However, we know that inclusion of a topic in the science standards does not necessarily mean it is addressed coherently or accurately in the textbooks, which this dissertation does.

Other Studies from North America

In addition to the California studies, there were two other studies located in the United Studies and two studies from Canada that examine science textbooks and climate change, and these are reviewed in the paragraphs below. Tabor and Eichorst (2018) analyzed eleven earth science textbooks produced across the United States for their climate change-related messaging. The authors performed a content analysis by focusing on language used to portray climate

change. For instance, the authors looked at the number of occurrences of words such as “climate change,” “global warming,” and “temperature range.” The authors observed that while the terms “climate change” and “global warming” were present in the texts, other equally important vocabulary such as “fossil fuels” and “carbon cycle” were missing. The authors observed, “The carbon cycle’s omission was glaring, since it is a critical mechanism for climate and carbon impacts. (p. 12). The carbon cycle is the movement of carbon through the atmosphere and hence, it is a major omission since carbon dioxide is responsible for climate change.

In another study that focused similarly on earth and environmental science textbooks, Choi et al. (2010) explored the relationship between the contents of eight middle and high school textbooks and the literature on student misconceptions of climate change. Here, the authors first reviewed the literature on student misconceptions of climate change. Subsequently, the authors analyzed the contents of the textbook by performing a review of its contents in the language used to describe human-induced climate change. After analyzing both the literature on student misconceptions and textbook messages on climate change, the authors created a tabular framework and compared side-by-side whether student misconceptions about climate change were reflected in the textbooks. The overall aim was to see whether the contents of textbooks influence student misconceptions about climate change. The researchers found that textbooks indeed presented mixed messaging on climate change. They noted, “No textbook appears to clarify the relationships between pollution, greenhouse effect, and climate change in their treatment of these processes” (p. 7). Here, the authors indicated that the textbooks did not disentangle and delineate the causes of climate change, but rather mixed the ideas on climate change with other forms of pollution. This is a significant observation since presenting clear and coherent messages about the causes of climate change is in line with the scientific consensus.

As indicated earlier, there were two studies from Canada. One focused on how solutions to climate change are presented in textbooks and the other focused on how human-induced climate change is presented.

Wynes and Nicholas (2019) analyzed curriculum frameworks from all thirteen Canadian provinces, as well as ten textbooks approved for use in selected Canadian Provinces. The authors coded and categorized the contents of the curriculum frameworks based on already existing ideas from the Intergovernmental Panel on Climate Change (IPCC). With respect to the textbooks, the authors focused mostly on whether the texts presented clear and coherent messaging regarding the causes of climate change and the scientific consensus that climate change is human- induced. The authors reported that both the curriculum frameworks and textbooks opened up the scientific consensus on climate change to debate. They observed, "Textbooks and curriculum documents, however, often contained statements that might cause students to doubt the very robust existing consensus in the scientific community on the human causes of climate change and its negative impacts and risks" (p. 12).

Solutions to addressing climate involve both individual and societal actions. Wynes and Nicholas (2017) analyzed nine Canadian science textbooks to see which individual actions to address climate change are presented in the textbooks. The authors evaluated the focus of individual decisions to combat climate change in each text by estimating the frequency of occurrence of certain phrases and words related to individual decisions to combat climate change. The authors found that textbooks did indeed focus on individual actions; however, they also observed that the textbooks did not prioritize the most effective individual choices to combat climate change, such as a reduction in car and air travel.

The four studies reviewed above are vastly different from one another. Tabor and Eichorst (2018) focused on technical climate words in the text, while Choi et al. (2010) focused on the relationship between textbook content and student climate literacy. Wynes and Nicholas (2019) analyzed the contents of curriculum frameworks and science textbooks to see how human-induced climate change is presented, and in another study, the same authors (Wynes & Nicholas, 2017) analyzed how textbooks presented individual choices to combat climate change. It is important to note, while Tabor and Eichorst (2018) focused on language similar to Roman and Busch (2016), their methodological approach was different. Tabor and Eichorst (2018) evaluated language/concepts/ideas in the text mostly on their own terms, while Roman and Busch (2016) were interested in how language was structured and how it framed climate change in the text. These subtle differences in methodology are worth noting here. In this dissertation I analyzed wide-ranging curriculum materials from different cultures and jurisdictions, and the linguistic and content choices differed across the curricula. For instance, the use of the words global warming versus climate change has implications for how the public perceive the urgency of climate change. The term climate change is the broader umbrella term that includes both global warming and cold temperatures. The term global warming is an aspect of climate change. According to Whitmarsh (2009), global warming elicits more concern amongst the pubic than climate change. However, my argument is that the term "global warming" is easily refuted because people can point to cold temperatures to dismiss global warming. Whereas I will argue that climate change is a broader phrase that captures the full spectrum of long term and recorded changes in climate.

Wynes and Nicholas' (2017; 2019) studies focused on the curriculum question but the authors were also interested in the provincial/government vision for climate change education

and how that translates into the content of textbooks. Their results suggest a misalignment between the vision of stakeholders and the contents of textbooks.

Studies from Europe

There was one study about science textbooks and climate change from Spain and one study from England. It is important to acknowledge that in contrast to Canada and the United States, the curriculum is nationalized in European countries. Navarro-Diaz et al. (2020) analyzed national textbooks approved for teaching and learning in Spain's secondary schools. The authors reviewed the contents of 24 science and social studies textbooks for references to salient concepts on climate change education. They looked for both explicit and implied references to climate change such as greenhouse gases, carbon cycle, and transportation. They found that the approved school textbooks presented the scientific consensus on climate change in accurate terms. In contrast to the North American textbooks, Navarro-Diaz et al. (2020) observed that the messages in Spanish textbooks were clear, coherent, and in line with the scientific consensus about human-induced climate change. The differences in messaging between the North American studies and this one can be attributed to two factors. First, Navarro-Diaz et al. (2020) analyzed recent textbooks that were produced in 2016 and 2017 and were approved for use in schools. Around the world, at least since the Paris Climate Agreement in 2015, there have been increased concern and awareness about climate change particularly for Europe, which has emerged as a leader in the fight against climate change. Therefore, it is not surprising that Spain's most recent textbooks reflect the scientific consensus on climate change. Second, and as indicated earlier, a centralized education system in Spain with a national curriculum implies that the national vision is much more likely to be coherent with the contents of the curriculum.

In a much older study, Morris (2014) analyzed 10 secondary, school-approved textbooks in England to see how socio-scientific issues such as climate change were presented in the texts. Morris (2014) estimated the number of pages dedicated to climate change (N=5) and reviewed the contents of the text for messages related to climate change. The author also focused on high school science textbooks in single subject disciplines (biology, chemistry) and found that the textbooks in England presented the scientific perspective that climate change is human-induced. However, Morris also found that the solutions to addressing climate change in the textbooks emphasized individual behavioral actions over social and economic systems, even though it is now part of the scientific consensus that individual actions are inadequate to address climate change if not paired with changes in the economic systems of the world such as changes in practices and policies related to the fossil fuel industry, manufacturing, and luxurious transportation.

The two studies from Europe both focused on nationally approved school textbooks using conceptual content analysis methods to analyze data. Navarro-Diaz et al. (2020) focused on the representation of critical scientific references to climate change in the text, while Morris (2014) was primarily concerned with how solutions to climate change were portrayed. Navarro-Diaz et al. (2020) noted the absence of some critical information, such as carbon cycles, on climate change in the text, while Morris (2014) noted how textbooks prioritized individual actions as solutions to climate change over social systems. Both studies suggest that it is important to think critically about what ideas about climate change are emphasized in textbooks versus what ideas are omitted or absent in the text. In addition, Morris (2004)'s comment on the policy solutions, especially the failure to address systemic causes of climate change in the text is important. Her argument about the failure to address systemic changes is important in the sense that the UK and

other first world nations have economies that are responsible for a significant part of global carbon emissions. Hence, students and young people in these countries must be made aware to advocate for economic policies that prioritize clean energy sources and the environment.

Studies from the Global South

Ghana is one of the most vulnerable nations to climate change, and therefore, climate change education has become one of its strategies to adapt to the impacts of climate change. Boakye (2015) analyzed 13 primary and junior high (equivalent to Middle School in the United States) integrated science textbooks, integrated science curriculum frameworks, teacher guides, and examination questions to investigate the messages about climate change in these wide ranging educational materials. With respect to textbooks, teacher guides, and examination questions, the author focused primarily on their contents and on whether climate change was present or absent as well as how the impacts of climate change were presented in the text. There was very little methodological detail about what approach Boakye (2015) followed in her analysis. However, with respect to the curriculum frameworks/standards, Boakye (2015) estimated the percentages of textbook material dedicated to climate change. She observed that just about 2% of the curriculum standards were dedicated to climate change. With respect to textbooks and teacher guides, she reported an absence of climate change as a topic in the primary school textbooks and teacher guides. She also found that junior high school texts did mention climate change, but failed to consider the local environment, how Ghanaians live their lives, and how climate change would specifically affect them. She found that climate-related questions in the national examinations were sporadic, inconsistent, and in line with the broader pattern of very little focus on climate change in the curriculum.

In two related studies, Dalelo (2011; 2012) analyzed how climate change was treated in geography and biology curriculum materials approved for use in Ethiopian primary and secondary schools. He followed a content analysis approach by inductively coding the thought units in each text, and similar to the Meehan et al. (2018)'s study, Dalelo's thought units were based on the key ideas in climate change as they relate to causes, impacts, and solutions. He explained, "This study is based on the assumption that understanding the phenomenon of global climate change and participating in debates and discussions thereof require a thorough understanding about three dimensions of climate change. These are the scientific basis of climate change, impacts of climate change, and possible measures against climate change" (p. 7). Dalelo (2011 & 2012) found that in both cases the textbooks acknowledged human-induced climate change, however they did not present cogent and strong *biodiversity* examples to support the idea that humans are the primary driver of climate change.

Boakye's (2015) study revealed that climate change content is basically absent in primary science textbooks; however, it is important to note that she analyzed textbooks that are almost a decade old (2012). Since 2019, there have been educational reforms and new standards for textbooks that have been approved for use in schools. Informed by the issues related to studies with older textbooks, in this dissertation, I looked at new standards and textbooks that have been approved for use in schools. A significant gap in Boakye's (2015) study is that she did not examine coherence across all curricula she analyzed. Despite the fact that she analyzed curriculum frameworks, student textbooks, teacher guides, and examination questions, she did not focus on the alignment among these materials when it comes to climate change. Coherence in content across curriculums and wide-ranging materials is key to a robust science education and

as Schmidt and Prawat (2006) argued, “There is a direct relationship between students’ exposure to coherent content and their performance on achievement tests” (p. 1).

Dalelo (2011; 2012) noted that the “politics of global climate change” was absent from the curriculum. My literature review revealted that this is an area rarely investigated and discussed in climate change education. While there is a lot of emphasis on teaching about human-induced climate change, there is very little focus on the global agendas, power, and politics that support the fossil fuel industry. We know that China, India, the United States, and Europe are some of the world leaders in the release of greenhouse gases leading to climate change (Gillis & Popovich, 2017) with China and the United States responsible for a third of global carbon emissions—China 27% of emissions and the United States 11% (Newburger, 2021). This dissertation considers whether curricular materials from Ghana and Bangladesh attend to concerns about the asymmetry across large, wealthy countries and other countries in the release of greenhouse gases and whether/how-powerful nations should be made to account for this variation. For instance, we know that Africa is one of the smallest contributors to climate change, and yet we do not know whether and how the curriculum in Africa acknowledges this reality in their textbooks (Gillis & Popovich, 2017). This dissertation explores whether textbooks from Ghana and Bangladesh attend to the politics and power of global climate change.

Studies of Materials from the Heartland Institute

In this section, I review research on the content of climate change materials produced by “deniers” of climate change, including in particular materials produced and disseminated by the Heartland Institute, an organization that has attacked the teaching and learning of the scientific consensus on climate change. The Heartland Institute is a self-identifying libertarian think tank whose mission is clearly stated on its website:

> The Heartland Institute is one of the world's leading free-market think tanks. It is a national nonprofit research and education organization based in Arlington Heights, Illinois. Its mission since its founding in 1984 is to discover, develop, and promote free-market solutions to social and economic problems. (p.1)

Using the search terms "Heartland" and "Climate" in Scopus, I located seven studies in this area, three of which focused on analyzing climate materials from Heartland.

In a recent study that takes a comprehensive look at Heartland, Cann and Raymond (2018) analyzed multiple documents, including newsletters, press releases, and books produced by Heartland in order to identify messages and frames the organization employs to attack the scientific consensus on climate change. The researchers downloaded over 340 materials produced by the Heartland Institute and available on their website, including newsletters, articles, and documents. Cann and Raymond (2018) followed a qualitative content analysis approach that entailed developing a coding scheme based on select literature and applying the codebook to the text. The researchers were interested in the frames employed by Heartland in their quest to influence public opinion on climate change. They found that throughout the documents, Heartland consistently employed three frames, which they labelled, the "scientific frame," the "benefit frame," and the "policy design frame." According to Cann and Raymond (2018), the scientific frame was composed of messages in Heartland documents that cast doubt on the scientific consensus about climate change and human-induced climate change. The researchers also observed that the "policy frame" in the Heartland materials inadvertently cast doubt on policy measures to address climate change, while the "benefit frame" positioned climate change as a net benefit to humankind.

In a related study, Medimorec and Pennycook (2015) analyzed one specific document produced and disseminated by Heartland titled the NIPCC (Nongovernmental International Panel on Climate Change). The NIPCC is a name explicitly chosen by Heartland to mirror the IPCC (Intergovernmental Panel on Climate Change), which is the credible and international scientific body responsible for assessing the science of climate change. The researchers analyzed the document "on various levels of language and discourse" (p. 4). They found that the NIPCC document produced by Heartland contained aggressive language and employed a villain frame to attack the IPCC and the whole idea of human induced climate change, casting the IPCC as a hindrance to open scientific inquiry.

As indicated previously, public notions of credibility and expertise are the key to Heartland's operations. Heartland and similar organizations that deny the fact of climate change, understand the public's reverence and deference to scientific expertise. Hence, they use and co-opt language and resources that are similar to those scientists use. Along these lines, Janko et al. (2014) analyzed the bibliography of some of Heartland's materials and found that Heartland cited the same data and references used by the scientific community and that this was key in light of their campaigns to reach students and teachers. By citing the same references as other scientists, they positioned themselves as an alternative authority on climate change.

A common finding across the three studies of Heartland (Cann & Raymond, 2018; Medimorec and Pennycook, 2015; Janko et al., 2014) is that Heartland's explicit mission is to cast doubt on the scientific consensus regarding climate change through their website content, newsletters, books and pamphlets. But none of the studies reviewed above acknowledged the implications of Heartland's messaging on climate and general science education at the K-12 level. This dissertation fills that gap by analyzing Heartland's most recent book titled "Why Do

Scientists Disagree about Climate Change" and situating the analysis within a K-12 science education framework. It is important to reiterate the point, which I detail later, that in 2017, Heartland mailed the book, *Why Scientists Disagree about Climate C*hange to over 200, 000 science teachers and educators. At Boston College, science educators received a copy of the book indicating Heartland's wide reach and successful campaign and access. It is also important to acknowledge that none of the three studies reviewed above (Cann & Raymond, 2018; Medimorec & Pennycook, 2015; Janko et al., 2014) analyzed this recent widely distributed given that they focused on materials published by Heartland before the year 2017.

Studies of Science Textbooks and Genetics

As indicated earlier, genetics and climate change are very different science topics. However, they are both controversial, and the sentiments underlying the controversies sometimes mirror each other. For instance, consider the issue of biological sex and gender identity and sexuality. Among many traditional conservatives, there has been historic push back on teaching about these topics in schools, whereas more progressive educators have advocated for including these ideas in the curriculum. These opposing visions can be likened in a very general way to the split in viewpoints about climate change education, wherein mostly Republican states have attempted to limit instruction about human-induced climate change while Democratic-leaning states have endorsed these ideas (Worth, 2017). The subject of genetics includes discourses about race, sex, and diseases, among others. The issues here involve genetic influences and linkages in that particular genes code for skin color, hair type, biological sex (hormones) and in some racial populations, certain types of genetic diseases are much more prevalent (Cooper, 2003; Loannidis et al., 2004; Gissis, 2008). The concepts of race and biological sex have their foundations in genetics, and sometimes it is the science and evidence surrounding them that

court controversy. For instance, in the last few years the issue of transgender women in sports has generated much controversy as to whether the science is settled that hormone therapy can reduce male testosterone and biological advantage (Buzuvis, 2021). While the transgender debate might be new, historically, with respect to the subject of race and sex, many debates have centered around equality, which implies sameness, versus equity, which focuses on fairness. There are conversations and debates as to whether people of different races and sexes can achieve parity in STEM, engineering, politics, business, and sports or whether people of different races and sexes are built for different roles in society (Herrnstein & Murray, 1995). There are also debates as to whether equal opportunities exist for women and certain racial minorities, mostly Black and Hispanic (Harrison et al., 2020; Ladson- Billings, 2006).

Some researchers have taken an interest in how messages about race and sex are framed in school textbooks. Here my literature search followed the science textbooks search in Scopus as well as a less systematic approach that includes literature I had encountered throughout my time in the doctoral program. Using the search terms "science textbooks and genetics" and limiting the search to articles and journals, I located 81 articles, 10 of which touch on K-12 science education, with just three dealing with genetics as a controversy. Below I review these three studies along with two other studies discovered through personal readings. Out of the five articles, three deal with race and the remaining two with sex. As indicated earlier, the discourse on race is most prominent in the United States. Thus, four out of the five studies originated in the United States with a single study from Australia. Unlike the climate change review, this section is divided into race and sex and these are reviewed under separate headings.

Studies of race in science textbooks

As indicated earlier, race as an identity marker is more prominent in the United States than some other countries. For instance, in Ghana, poverty is assessed and discussed around ethnic and geographical lines. This is in contrast to the United States, which is a multi-racial democracy, where poverty is often discussed around racial lines, given that African-Americans are significantly poorer than other racial groups in the United States (United States Census Bureau, 2020). Liberals have broadly advocated for social programs to ameliorate poverty, while conservatives have often attributed the problems of poverty and crime to fatherless homes and other social pathologies (Moynihan, 1965; Sowell, 1976). Charles Murray's and Richard Herrnstein's (1995) book *The Bell Curve* framed the problems of poverty and crime in African American communities using the lens of differences in intelligence among different racial groups which they claimed were inherently genetic.

In the context of these discourses about race, Ann Morning, a Professor at NYU, who studies conceptualizations of race in American society, sought to examine how race was presented in high school biology textbooks. She sampled 80 high school science textbooks published in 1952 and in 2002, with the books 50 years apart to capture the changing notions of race in American society. She first identified explicit and implied references to race in the texts. Subsequently, she reviewed the passages that made explicit or implied arguments about race, noting the technical terms, scientific jargon and social language (e.g., "primitive people") used to describe race. Morning found that as new scientific evidence had emerged about race, the textbooks in 2002 had upgraded their contents to keep up with the new evidence of race and genetics. She also found that textbooks had moved away from phenotypic characterizations and toward a focus on genotypes and broader genetic concepts about race, which she attributed partly

to advances in the human genome project. But her broader argument was that genetics had provided a cover for essentialist views on race:

> Textbooks' genetic framing of race has preserved the authority of the essentialist notion of race by obscuring it, leaving it less accessible to potential critics. Applying a genetic model to race has meant translating the concept into a language that is still largely foreign to the layperson, making it unassailable by anyone outside elite scientific circles. Or, to use another metaphor, it buries the race concept under the skin so that it is no longer available to most for examination. Race goes from being a highly visible badge of surface phenotypical difference—one that even schoolchildren could grasp with simple charts—to being buried in our DNA and thus visible only to the expert in the laboratory. (p. 22)

Here, Morning observes that the genetic framing of race precludes the subject from public critique and careful examination; even though she admits it also bolsters biological notions of race. Morning (2008)'s main argument is that in their quest to provide sound scientific arguments for race, textbooks have inadvertently also propagated essentialist notions of race.

In a much more recent study, Willinsky (2020) analyzed how race was presented in textbooks published between 2014 and 2019. He selected 11 biology textbooks from various commercial publishers such as Glencoe and McGraw Hill. Willinsky (2020) followed Morning's (2008) approach by noting parts of the text where race was mentioned or treated as a subject. Following identification, Willinsky explained that he did a "close reading" of the text on race and reviewed the consistency of language and image in the text. Similar to Morning (2008), Willinsky also reviewed the scientific and social language used to explain the subject of race. He found that textbooks had moved away from race essentialism although the biological basis of genetic race still existed. His most poignant argument was that:

> The evolving and sometimes-contentious positions of researchers and research agencies on race may well be unsettling for the students, but this makes it all the more insightful about the intersection of scientific and cultural norms. As well, it could appear to play into the hands of those, such as climate-change deniers, who play on the uncertainty of scientific claims. For that reason, educators will need to highlight biology's demonstrable openness to new evidence. (p. 15)

Here Willinsky confronted the conflict between culture and science, alluding to climate change, pointing out that it is a truism that most scientific issues that straddle the line between science and society are in constant tension with each other. Willinsky's main conclusion was that educators should present a bold message on race that adheres to the science but also takes into the fraught nature of the debate in history and in society.

In the only study about race in science textbooks conducted outside the United States was McDonald's (2013) analysis of physical education textbooks produced between 1991 and 2011. McDonald (2013) adopted a similar approach to Morning's (2008) by identifying direct and indirect references to race in the text. Following this, the author reviewed those passages looking at the way in which physical characteristics such as "skin color," "facial features," "length of limb" were presented in relation to race. He observed that race essentialism as it related to athletic ability was prominent in the textbooks. This has been a point of contention particularly in debates about race and different abilities (Hodge et al., 2008), with public perceptions skewing toward the idea that people of African descent are more athletic than people of other races are.

The three studies reviewed above (Morning, 2008; McDonald, 2013; Willinsky, 2020), followed similar methodological approaches by first identifying the mention of race in the text

and subsequently reviewing how it was constructed scientifically and socially. Morning (2008) and McDonald (2013) were much more convinced of the presence of race essentialism in the books than Willinsky (2020). This is not unexpected since Willinsky (2020) analyzed the most recent textbooks (2014-2019). This research suggests that as is the case with most socio-scientific issues, the presentation of information about genetics is confounded by the problem that race is constructed in the public domain and sometimes-public perception can be in contrast to the science and vice versa. As Apple (1992) observed, the contents of textbooks are not immune from these perceptions particularly for a topic like race, which is at the core of people's identity and is a fraught topic with implications for public policy and the social fabric of societies.

The significance of the findings of the three studies (McDonald; 2013; Morning, 2008; Willinsky, 2020) to the climate change debate and to this dissertation is that both race and climate change are part of much bigger controversial discourses in society that are steeped in history and politics and in the case of climate change, economics and cultural identity. This dissertation considered how these larger social discourses undergird and perhaps influence the point of view (orientations) of the wide-ranging curriculum materials selected for analysis.

Another observation from the three studies reviewed above (McDonald, 2013; Morning, 2008; Willinsky, 2020) is that when it comes to race, the science or genetic basis itself is a central part of the point of contention. This is similar to the situation with climate change in that the scientific evidence is what climate deniers present in order to cast doubt on climate change. Climate denial sometimes contains some kernel of truth/facts and evidence and hence there is much complexity involved in disentangling false claims from true ones. In this dissertation, in my analysis of climate denier materials from Heartland, I was very cognizant of the blend of fact

and fiction and to the presence of misleading interpretations of climate change evidence in these materials.

Studies of gender and sex in science textbooks

Two studies I located focused on gender and sex in science textbooks. Bianchini (1993) analyzed high school science textbooks to investigate how the relationship between gender and purpose was portrayed. Similar to the race debate, there are larger controversial discourses on whether women and men are "built for" different purposes and whether parity in STEM and leadership can be attributed to differences in biology. Bianchini (1993) reviewed the contents of biology textbooks published in three different eras (1956, 1965 and 1989). She observed that the early textbooks (1956 & 1965) emphasized traditional gender roles through notions such as breadwinners, household chores, physical activities, when it came to the biological and social purposes of men and women. In addition, textbooks positioned men as the sole performers and arbiters of science. However, she also noted that the later editions of science texts published in 1989 had moved away from the binaries of the roles of men and women and also included material and images of women taking part in and performing activities related to STEM. She noted the changing discourse in the texts concerning women's participation in science and gender roles, which she argued, reflected the changing society and perceptions of the role of women in STEM.

Perhaps the study that is most relevant to the current discourse on biological sex is a study conducted by Nehm and Young in 2008. The researchers analyzed how sex hormones were portrayed in biology textbooks by first identifying references to hormones and biological sex in the texts. Following this approach, they reviewed the context in which ideas about sex hormones appeared. They read and reviewed whole passages in an attempt to delineate how sex hormones

were presented in the text in relation to other content. They found that science textbooks presented information about male and female hormones based on the prevailing scientific consensus, which is that testosterone is the male sex hormone responsible for muscle building, sperm production, and facial hair in men while estrogen is the female sex hormone responsible for breast development and ovulation among other female features such as the pelvic muscles and hair. Nehm and Young (2008) commented on the binary-based and exclusive portrayal of biological sex in the textbooks that did not take into account the complexities of sex and gender. In light of current transgender debates about what defines men and women, it is worth considering whether textbooks attend to these new ways of thinking about biological sex and gender.

Studies of the Curriculum and September 11

On September 11, 2001, the United States was hit with a horrific terrorist attack that claimed over 3,000 lives. In the aftermath, the attack spurred conversations around national security, radical Islamic terrorism, the compatibility of Islam and western civilization, and patriotism. Several educators called for civic education and social studies education to address these questions in the classroom. Since then, a number of official and supplementary curricular materials and texts have incorporated lessons regarding the September 11 attacks as well as lessons on Islam and what Islam means for a pluralistic democracy like the United States. As indicated earlier, this topic is obviously not a controversy in science education. However, September 11 has been a controversial curriculum issue, and some of the underlying issues are similar to those involved in climate change debates in that with each of these, there are underlying competing visions of America, which are cultural and political. In addition, this kind of research often follows a conceptual content analysis approach, where an idea or concept is

examined in both official and supplementary curriculum materials. The data sources and methodological approaches used in research of this kind parallel in certain ways this dissertation's analysis/examination of official and supplementary curricula. I located three studies related to the September 11 attacks in the curriculum and their implications for education.

Hess and Stoddard (2007) assembled a wide array of curriculum materials ranging from school-approved textbooks to supplementary curricula, and from commercial textbook publishers to materials produced by the State Department as well as non-profit organizations. The researchers then analyzed the contents of these materials for frames and messages regarding September 11 and more broadly terrorism. They found that the supplementary curriculum materials produced by non-governmental organizations, such as *Bill of Rights Institute* and *Facing History and Ourselves*, anticipated and attended seriously to the furor and controversies that would emerge after the terrorist attacks. The materials produced by these organizations provided alternative perspectives on terrorism beyond the mainstream nationalist narrative. With approved textbooks, on the other hand, they concluded that:

> While the textbooks give numerous examples of terrorism, they provide no opportunity for students to analyze whether a particular incident was actually an act of terrorism. Even more striking is that many examples of terrorism given in the texts do not match how the book defines the concept. (p. 4).

Hess and Stoddard's (2007) observation is in line with the mixed messaging in textbooks regarding climate change (Meehan et al., 2018; Roman and Busch, 2016) and race (Morning, 2008; Willinsky, 2020). Even more pertinent to climate change is Hess and Stoddard (2007)'s conclusion that textbooks continued to present outdated information even as evidence about the failure of the United States' involvement in Iraq was emerging.

In a related study four years later, Hess and Stoddard (2010) returned to the subject again and analyzed both old and new official textbooks and supplementary materials published between the years 2002 and 2010. The researchers wanted to investigate whether textbooks presented a fuller picture of September 11 and the evolving complexities of terrorism than the conclusion based on their previous analysis that textbooks lacked clear and coherent messaging on the subject. They stated

> Relying on textbooks to provide the level of detail that is needed is most likely not going to be sufficient, given that few textbooks we analyzed provided enough specific information. The supplemental curricula generally did a better job by providing a rich narrative of what happened, but in some cases this was not the case. (p. 4)

In excerpt above, Hess and Stoddard (2011) pointed out that not all supplementary materials provide detailed and robust messaging on September 11. Perhaps more importantly, they found that terrorism was presented as a closed topic, not open to debate in some of these materials. Here, it is important to reiterate the point I made above that context influences whether a particular topic is presented as open or closed. In the aftermath of the September 11 attacks, there was a consensus about terrorism, and according to congressional records, about 99% of the United States House of Representatives and Senate voted to authorize the Iraq war (https://www.congress.gov/bill/107th-congress/house-joint-resolution/114). However, currently and particularly in light of the United States' withdrawal from Iraq and Afghanistan, there has been a shift in how terrorism and the United States' general involvement in the world is viewed. It is important to provide a caveat here about the wars in Afghanistan and Iraq: it is a fact that a major act of terrorism occurred on 9/11/2001. There is no contradictory evidence about the

nature of the event. Thus, this part of issue is closed. How it was handled subsequently, however, is certainly up for debate.

Hess and Stoddard (2011) noted a subtle shift in language in how congressional support of the war was presented in a textbook first published in 2005 and then in 2010 respectively. The authors noted that in the 2005 version, there was clear and coherent messaging (active voice) about how Congress agreed with then President Bush about the Iraq War and the idea that there were weapons of mass destruction held in Iraq. In the latter version of the same textbook published in 2010, the authors noted that there was an omission of the word "weapon." The authors argue that the omission of the word "weapon" signified changing notions about the motivation for United States involvement in Iraq among the public and textbook companies. The change in language from inclusion of the word "weapon" to its removal is not surprising given that and as Apple (1992) argued, textbooks are commercial products and hence, in some aspects and at any given time, they may reflect the public perception on contemporary issues. In addition, the deeply ideological and partisan nature of the discourse on the Iraq war meant that several versions of the same textbook investigated by Hess and Stoddard analyzed were printed and distributed for different regions of the United States where there might be conflict due to the partisan leanings of state legislatures and school boards. We know that across the United States, local control of education and curriculum is treasured and upheld deeply. Thus, it is not surprising that these textbooks leave out content that editors and publishers believe might stir controversy.

The two studies reviewed above (Hess & Stoddard, 2007; 2011) concluded that supplementary materials rather than primary textbooks were more inclined to present a complex and in-depth narrative about policy and political discourses regarding September 11 and

subsequently the Iraq War. They found that primary textbooks did not present complex and in-depth content regarding the September 11 attacks and subsequently the role of the United States in Iraq. In addition, the authors noted that even when textbooks presented the topic of the Iraq war, they used conservative language to present the subject. And which means they avoided direct confrontation/critique of US policy in Iraq. Applying this argument to climate change education and in this dissertation, I looked at how the Paleontological Research Institution and the Heartland Institute framed the causes of climate change. As noted above, both Heartland and the Paleontological Research Institution are opposed to each other. Hence, I was interested in which of the institutions offered direct attacks on its opponents. The findings from my analysis of the language used to describe the opposition are discussed in Chapter 5.

CHAPTER THREE

Research Design

This dissertation investigated how official textbooks from Bangladesh, California and Ghana portrayed the subject of climate change. The dissertation also focused on how supplementary materials from Heartland, the Paleontological Research Institution, and the United Nations portrayed climate change. Using a complimentary cultural politics framework, I show that messages about climate change in these texts cannot be viewed in isolation; rather, they should be conceived as part of a broader discourse on how societies are organized in the United States and the global South. In light of this, sections that follow consider content analysis as a research design, researcher positionality, the research contexts of the three countries from which textual materials were analyzed, and data sources and data analysis. A content analysis approach is best in this dissertation as it allowed for critical examination of curricula from three

very different regions of the world, with uniquely different political, geographic, cultural, social, and economic characteristics.

Content Analysis as a Research Design

Content Analysis as a research method has roots in the field of communication studies (Krippendorff, 2018) where it has been used to analyze political rhetoric, newspaper editorials, and other journalistic texts (Gerbner, 1958). Content analysis has since been adopted by researchers in fields such as public health (Datta & Petticrew, 2013), education (Wininger & Redifer, 2018; Tan et al., 2018), and a wide variety of other fields. Content analysis may follow either a quantitative or a qualitative paradigm (Berelson, 1952; Weber, 1990). This dissertation study followed qualitative content analysis approaches.

Hsieh and Shannon (2005) define qualitative content analysis as a "research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (p.2). This definition makes it clear that content analysis is based on subjective interpretation and making sense of data by developing categorical coding schemes that explain the data. Subjective interpretation means that various researchers who differed from one another in multiple ways (e.g., disciplinary background, personal life experiences, positionality, skill level, familiarity with the content) might arrive at similar or slightly different interpretations of the same texts. Subjective interpretation, however, does not mean that the process of analysis is not systematized. It still requires rigor on the part of the researcher such as carefully reading the text, stepwise coding, drawing on published literature etc.

In addition to subjective interpretation, the context in which a document/text is produced or introduced is important to consider during content analysis. In the paragraphs below, I discuss

some of the key assumptions underlying qualitative content analysis, including the role of context and subjective interpretation. In addition, I provide a summary of the content analysis methods and coding approaches that I used in analyzing the data.

Context and Content Analysis

One of the advantages of content analysis is that it can be deployed to examine decades-old data as well as current text. However, to make sense of any document/text, it is important to understand the context in which the text was produced. As King (1986) rightly observed, "any approach to curriculum practice or research which overlooks or denies the importance of curricular contexts inevitably distorts and misrepresents the reality of curricular events" (p. 4). For instance, to analyze the contents of an elementary science textbook, it is important for the researcher to note the prevailing political agendas that led to the development and production of the text and the local or larger policy reforms that governed the production of the textbooks. This is because, as noted above, policies and politics influence the selection and content knowledge included in school textbooks (Apple, 1992). In addition, as King (1986) observed, "No phenomenon exists without a context. The curriculum is part of a number of overlapping and integrated contexts which give meaning to the curricular experiences for participants" (p. 3). For instance, to analyze either the *New York Times* "1619 Project" or President Trump's rival "1776 Project," it would be essential to understand the 400-year history behind the former and the contentious political context behind the latter. It would also be important to understand the motivations that undergirded both the curricular texts for these two projects and the discourses surrounding them. Understanding policy and political contexts helps the researchers interpret their findings and situate them in the larger discourse or as part of the existing ideas in that field of research.

Contexts also provides a historical perspective. What curriculum already existed and what historical events shaped or led to the current curriculum? These questions provide a reference point for content analysis research, given that, as King (1986) noted, "At the level of the curriculum field, models of curriculum development proposed in the past create the historical context for current efforts" (p. 4). For instance, Asadullah et al. (2018) considered the history of gender representation in English language textbooks in Bangladesh. They observed that although there was growing Islamization in Bangladesh, stereotypical representations of girls and woman existed prior to the current Islamist demands. Hence, in their analysis, these researchers looked at what was driving current Islamist groups' demands, the politics that surrounded them and future events that might exacerbate their demands. The context about Islam and women's rights/liberation in Bangladesh is important not simply as an example, but also because this dissertation focused on curricula from three distinct regions with varied socio-political characteristics, one of which was Bangladesh.

Context also helps researcher determine which aspects of a topic in the curriculum are worth focusing on or, in other words, what ideas are worth analyzing in the text. For instance, in the case of climate change, there are some existing assumptions or arguments in the field that are worth noting. We know that questions about the causes of climate change drive the debate on climate change education. In fact, this is the most contested part of the climate change curriculum (Hess, 2009). Thus, the category of cause is an essential aspect of content analysis regarding climate change materials.

Subjective Interpretation

One of the key assumptions of qualitative content analysis is that researchers must understand their own positionality or, as Janson and Lacity (1994) observed, researchers "must

understand their own cultural filters and biases. The interpretations that researchers ascribe to a particular text reflect their own culture, faith, and experiences" (p. 13). Here, we see that researchers' biases and positioning influence their interpretations of text data and subsequently shape the results of their studies. In light of these assumed biases, some scholars have questioned whether results from non-standardized qualitative content analysis methods can be generalized or whether they can be trusted or seen as reliable and objective (Lombard & Snyder- Duch, 2004; Krippendorff, 2004). To address these issues and to account for bias and make results from content analysis reliable, several approaches have been recommended. One of the approaches includes using statistical tools to measure the reliability of codes. Measures of coding reliability use statistical measures such as the use of percentages, probabilities, analysis of variance, and coefficients (Krippendorff, 2004; Gisev et al., 2013). Despite the importance of validity and reliability, there are scholars who disagree with the statistical approach. For instance, Yardley (2008) has argued that the aim of qualitative research is to interpret human experiences and that its epistemology by definition is shaped to a certain extent by researcher positionality, views, and experiences. Along these lines, Daft (1983) observed:

> Ultimate proof of an idea or theory is its acceptability to common sense. An important test of validity is liking an idea, feeling right about it, being able to use it to throw light on a previously hidden aspect of organization. Objective proof seldom will exist somewhere outside one's self that will demonstrate correctness or validity. No statistical test will do this for us; no amount of replication will make acceptable an idea that does not square with experience. (p. 543)

In other words, researchers' views, backgrounds and cultures—that is, the sum of a person's experience—should not be cast aside during qualitative research. To take into consideration

researchers' experience and at the same time to test the validity and reliability of results from content analysis methods, some scholars propose that there should be at least two coders and a comparison of codes to achieve consistency. (O'Connor and Joffe (2020). But it is not often possible in a one-person dissertation study to have two coders code an entire corpus of data or even segments of data when the data involves some level of familiarity with the subject matter and with limited time and funding.

Types of Content Analysis

In addition to attending to context and coder (inter-rater) reliability, it is important to acknowledge the different types of content analysis methods that are widely used. There are two main types of qualitative content analysis: relational content analysis and conceptual content analysis (Columbia School of Public Health, 2021).

The relational content analysis approach involves examining the relationship between two concepts (Palmquist et al., 1997). For instance, this approach would be appropriate to examine how the treatment of climate change in the curriculum relates to the treatment of evolution or genetics or to compare the way curriculum controversies about evolution were framed in the public discourse in the 1990s to how the current climate change education controversy is framed currently. This type of analysis is also useful when comparing two big ideas and examining relationship between them. For example, Bromley and Skinner (2019) used relational content analysis to compare how human rights and social movements were presented in 556 secondary school textbooks from 80 countries between 1950 and 2011. This type of comparison makes sense in that social movements are important and are often a precursor to the attainment of rights as demonstrated in the civil rights movement, independence movements in colonial Africa, and the feminist movements of early 20th century. For instance, Clayton (2018)

used a relational content analysis approach to analyze how civil rights movement leaders framed their public arguments in comparison to the current framing by leaders of the Black Lives Matter movement. Clayton (2018) reported on the relationship between the Civil Rights movement and the Black Lives Matter movement, highlighting the similarities and differences in terms of messaging and inclusivity.

In contrast to relational content analysis, conceptual analysis involves the identification and interpretation of a particular concept or concepts in a text (Hoffman et al., 2011; Krippendorff, 2004). In this type of analysis, the researcher pays attention to a specific concept or concepts and tries to make sense of those concepts in the text. Some researchers count the number of times the concept appears. Others categorize and code concepts and subject them to interpretation based on the contexts in which they are used. Rusek and Vojir (2019) observed that a significant number of textbook studies employ a conceptual qualitative content analysis approach. For instance, using conceptual analysis methods, Tshuma and Sanders (2015) analyzed the concept of evolution in official approved science textbooks by the government of South Africa. The researchers identified parts of biology textbooks that referenced evolution and then using both deductive and inductive analyses, they examined the evolution content based on its scientific accuracy.

Overview of Content Analysis Methods for this Dissertation

Because the point of this dissertation is to examine a specific concept—climate change in official school textbooks and supplementary educational materials, it draws on conceptual qualitative content analysis methods, particularly as described by Elo and Kyngas (2008) and Kyngas (2020). According to these authors, content analysis involves the coding and categorization of thought units in a given text. The coding and categorization can be either

deductive or inductive. The deductive approach involves drawing on existing theories and literature to inform the analysis whereas with the inductive approach, the researcher "moves from the data to theoretical understanding" (Graneheim et al., 2017, p. 2). This dissertation adopted both a deductive and an inductive coding approach. The deductive approach entailed drawing on key ideas about climate change and the discourse of climate change from the literature to broadly sort/classify and segment parts of the text. The inductive approach involved coding and categorization of the thought units in the text data.

Codes are initial phrases used to represent ideas in a text whereas categories are an aggregation of codes (summation) based on similar ideas and patterns (Saldana, 2009). Categories exist at a higher level in the hierarchy of ideas than codes. In this dissertation, each thought unit in a designated text was inductively coded and categorized, and the qualitative analysis software known as Nvivo was used for the management of codes and categories. Nvivo allows for clustering the codes and categories in large textual data sets such that it becomes easy to organize and interpret the codes (Zapata-Sepúlveda et al., 2012). Nvivo was first released in 1997, developed by QSR international. It has node, tabulation, visualization functions that allow the researcher to group codes under a single heading, estimate the number of codes that capture ideas in the text, and sort concepts and categories based on common themes and patterns. In this dissertation, I employed these functions of Nvivo to organize the codes and categories that I have designated and applied to the text data. The use of Nvivo is mainly to manage and organize the coded text.

In the paragraphs below, I describe the methodological approaches that were followed in analyzing the data selected for this dissertation, which is also represented in chart form (Figure 2). Detailed and in-depth coding examples are described in the data analysis section.

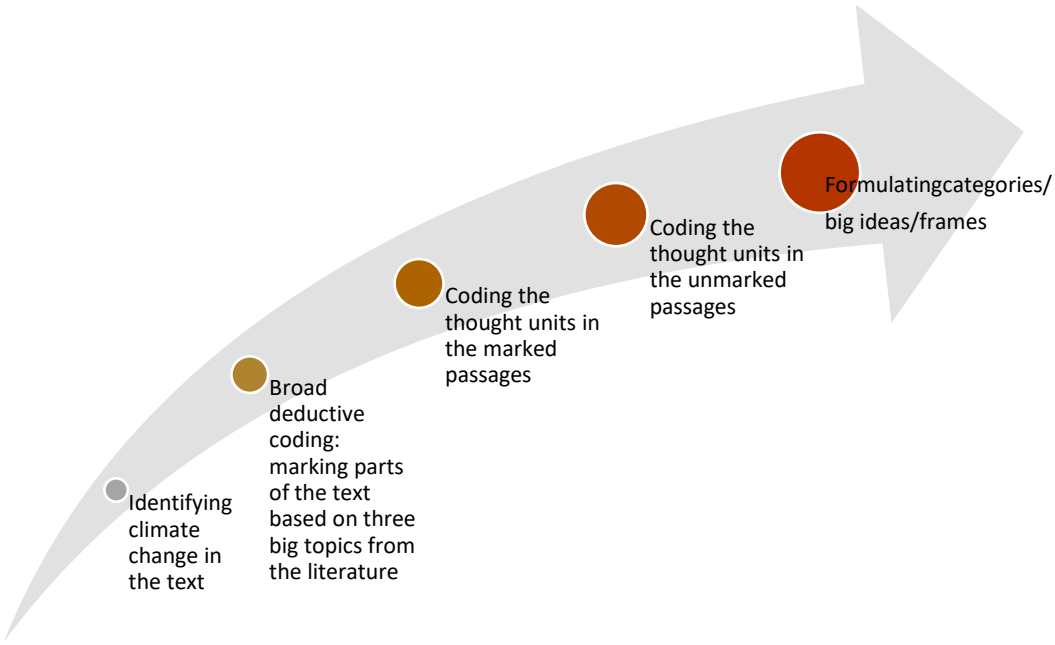

Fig 2: The five-step approach to data analysis

The first step in analyzing the textual materials was thoroughly reading the texts and identifying explicit/implicit reference/mentions of climate change. This first step applies mainly to textbooks because they contain topics apart from climate change. This first step does not apply with respect to the supplementary materials because these materials focused only on climate change content.

The second step in data analysis is to conduct broad deductive coding, which focused on marking/highlighting all parts of the text that correspond to the notions of climate causes, impacts, and solutions. These three ideas are considered by educators and scientists to be the most salient aspects of climate change education (Meehan et al., 2018; Hess, 2009; NASA, 2021;

NOAA, 2021). This step involved labelling entire passages in terms of their reference to causes, impacts, and/or solutions to climate change.

The third step involved inductively coding thought units within the highlighted/marked passages/parts of the texts. Here, initial open codes were assigned to each thought unit in the texts. Based on an iterative process, these open codes were refined into final codes. Some of these codes were short phrases used to represent the ideas in the text while others were *in vivo* codes lifted directly from the language of the texts (Saldana, 2009). In vivo codes were often used because climate change contains many technical and scientific terms and references those themselves embody whole ideas and concepts.

The fourth step involved inductively coding the thought units within the remaining unmarked/un-highlighted parts of the text. This is an important step because there are other important ideas in the climate change discourse beyond the causes, impacts, and solutions to climate. Further we know that official school-approved textbooks are narrow in their focus on climate change education (Boakye, 2015; Wynes & Nichols, 2017; Meehan et al., 2018). However, when it comes to the supplementary materials, there are also public messaging, campaign strategies, and particular strategies to rally allies, which are important to look at as part of the bigger picture on how climate denial/acceptance become mainstream.

The fifth and final step involved the grouping of codes into categories and larger level ideas and themes. This process is about fully realizing and teasing out the big ideas/messages/frames in the texts. This involved identifying the sum of the ideas in the texts as well as the larger meanings whether political, socio-economic, power, scientific uncertainty, stories of decline and how major oppositional arguments are framed in the text.

This five-step approach to data analysis is represented in Figure 2, which features an upward arrow with concentric colored circles. Each colored circle represents one of the five steps described above.

Researcher Positionality

As a researcher, I conducted this study from the perspective that the scientific consensus on climate change is accurate. Hence, that perspective should be adequately presented in curriculum materials. This stance on climate change education was shaped and influenced by my own education and my life experiences. My undergraduate degree was in Zoology, and I conducted research on insect pollinators in landscapes where urbanization was threatening bees and butterflies. My master's thesis focused on the migratory and foraging ecology of waterfowl in a river ecosystem using chemical isotopic signatures. These experiences have undoubtedly influenced how I perceive the subject of climate and factors that threaten ecosystems. In addition, my social world and life experiences both at home in Ghana in the Global South, where I grew up, and abroad in Canada and the United States, where I worked as a scientist and researcher, have made me aware of the extent of the vulnerabilities of various regions and countries to climate and of the parallels of the impacts of climate change across broad geographies. These travel-related and lived experiences position me to be aware of different ways of thinking and how various cultures approach issues and problem solving. In this dissertation, these educational and lived experiences and subjectivities undoubtedly came to bear as I analyzed curriculum materials from various geographies and jurisdictions and with different orientations and epistemologies. However, my intention throughout the analysis in this dissertation was to be as even-handed as possible as I identified the frames, themes, and ideas related to climate change that were explicit and implicit in the texts I examined.

Research Contexts

As I have argued above, context is key in terms of understanding how the three countries that are the focus of this dissertation are organized in terms of politics and other social factors. Given this, this section describes the research context of each the three countries I studied—Bangladesh, Ghana, and the USA (California) — in terms of climate change and socio-political conflicts and tensions. These help to illuminate how these societies are organized in terms of salient characteristics such as religion, social class, ethnicity and religious composition and political orientation. For instance, we know that religious identity is a major influence on electoral politics and political power (Burge & Djupe, 2014). We also know that political power has significant influence on curriculum development and enactment (Apple, 1992; Hess, 2009).

Bangladesh

Bangladesh is one of the most vulnerable nations to climate change based on its low-lying geographical landscape and as the United Nations Children Fund (UNICEF 2019) observed "Devastating floods, cyclones and other environmental disasters linked to climate change are threatening the lives and futures of more than 19 million children in Bangladesh" (p. 1). One of the most prominent impacts of climate change in Bangladesh is the mass movement of people from flooded areas into safety areas, which further fuels social and religious conflict in an ethnically and religiously fraught nation (Sovacool, 2018).

Bangladesh's complex founding has meant that the state has been able to straddle the lines among a secular representative democracy, a Muslim majority, and small ethnic and religious minorities (Chaney & Sahoo, 2020; Ahmed, 2009). This means that secularism and other religious identities apart from Muslim have had a place in the construction of a Bangladeshi national identity. However, during the last decade, there has beena growing

Islamization and an assertion of a Muslim identity, which has brought tensions around civic life, free speech, and education in several ways (Asadullah & Chaudhury, 2010).

In recent times, questions in Bangladesh about matters such as female student's participation in physical education or the content of English textbooks have come under intense criticism by Islamic groups. To placate Islamic groups and because of their immense voting power and political mobilization, the government of Bangladesh has altered textbooks to remove content that was deemed offensive to religious sensibilities. For instance, in 2017, the government removed stories and poems from English textbooks that Islamic clerics called "atheistic" (Barry& Ali-Manik, 2017).

The extent to which increasing Islamization in Bangladesh influences the climate change curriculum is still unknown. Currently, there is no documented protest or public opposition regarding the teaching of climate change in schools by Islamic groups, political parties, or any other religious or ethnic groups or segments of Bangladeshi society. However, as Hess (2009) has noted, topics shift from being controversial to "settled" as societies change and reorganize themselves around different sets of values and ideas. Hence, it is worth investigating Bangladesh's current climate change curriculum.

Ghana

Ghana is a country in Sub-Saharan Africa with a tropical climate and varied social conditions in different parts of the country. The southern part of Ghana is significantly wealthier and urban than the poorer and rural north. The geography of southern Ghana is dominated by forests while the north is predominantly grassland. Ghana continues to experience long term changes in climate, as Asante and Amuakwa-Mensah (2015) observed:

> Considering historical data, rainfall was mostly high in the 1960s but this decreased to low levels in the latter part of 1970s and early 1980s. This decline in rainfall patterns still prevails in recent times, as using 20 years' data observed that; temperatures in all zones in Ghana are rising, and rainfall has been reducing and becoming increasingly erratic. (p. 3)

The long-term climatic changes described above have altered the landscape and are projected to impact agriculture, fisheries, and animal husbandry sectors of the economy (Asante & Amuakwa-Mensah, 2015). The changes in the country's topology mean traditional land use activities such as cattle grazing are significantly affected (Kleemann et al., 2017). Already, ethnic tensions have emerged over land use in certain parts of Ghana. Nomadic cattle herdsmen mostly from the north have clashed with crop farmers in the south over access to land and water (Olaniyan et al., 2015). The conflicts stem from cattle grazing interfering with crop production. The conflicts have become part of a polarized national discourse and have ignited debates over cultural values, national and regional identity, and citizenship. For instance, during the debate over farmland, there were polarized discourses as to whether northern and nomadic herdsmen embodied Ghanaian identity and values in a country largely dominated by southern culture and politics (Alhassan, 2020).

In addition to conflicts over land use, the lack of fertile land for farming fuels the mass migration of people from rural to urban centers with its problems such as sprawling and dilapidated settlements, increased poverty, and strains on urban environments and landscapes. Continuous changes in climate have the capacity to exacerbate the social tensions described above. This suggests that it is important to examine whether and how the Ghanaian school curriculum attends to the various ways climate change and its associated impacts fuel social

conflict. In analyzing Ghana's curriculum materials, I was particularly interested in whether and how the curriculum attended to second order effects of climate change such as urban poverty, ethnic and cultural tensions.

California

Unlike Bangladesh and Ghana, California and the United States at large have the technical and financial capacity to ameliorate the effects of climate change (California Environmental Protection Agency: https://calepa.ca.gov/climate/). However, efforts to address climate change in the United States have faced an uphill battle because of climate denial (Fischer, 2019), competing economic interests (Johnsson et al., 2019), and a lack of commitment to policy goals (Krause, 2011). The latter is important because there are no coherent policy agendas from the political class when it comes to climate policy. Neither of the major political parties have coherent climate change agendas. And even when climate policies are legislated, implementation falls short because of industry interests and local politics.

As indicated in Chapter 1, I selected California as a study site for two reasons. First, California is the premier state leading the fight against climate change by adopting a statewide climate policy. In addition, California is a large textbook market, and books produced in that state often finds their way across the United States and into other markets.

In the state of California, there are significant threats from climate change that are worth noting. According to the Environmental Protection Agency (2016), wildfires and altered landscapes, sea level rise, and drought are some of the immediate and projected impacts of climate change. Despite the varied nature of California's climate change impacts, the recent spate of wildfires in particular has attracted significant national attention. Scientists have argued that climate change has exacerbated already existing environmental conditions and bad forest

management practices that fuel the wild fires, although they are careful to raise questions about how much of the fires can be attributed to climate change vs poor forest management (William et al., 2019). These complexities undergird the impacts of climate change, which is why understanding the particular details of the environment and local contexts is important as well as the policy prescriptions to address local climate change impacts. In addition, policy solutions involve many compromises, multiple parties, clashing interests of scientists, politicians and businesses in a capitalist democratic system (Wollenberg, Edmund & Andersen, 2001).

In the case of California's wildfires, policy solutions involve state and federal forest management, politicians, communities that live near fire-prone areas, scientists, and industry leaders, among other actors. In analyzing California's climate change curriculum, I was interested in how and to what extent the curriculum mentioned/acknowledged these various actors and institutions and their roles in mitigating and adapting to climate change. The ability of students to parse out roles and contributions, strength and weakness, and the interdependence of various institutions is an asset for complex problem solving in the future. It is also an opportunity to deepen student understanding of the bilateral roles of civic institutions such as state government vs. federal government. It is also critical for students to systematically collect and analyze data about climate change.

Data Sources

As indicated earlier, this dissertation used a qualitative content analysis approach. There were two major data sources for the content analysis: school-approved curriculum materials from the three sites and supplementary school curricular materials. The category, official school-approved curricular materials, refers specifically to science textbooks while the category, supplementary materials, includes those produced by non-governmental/non-state organizations

and advocacy groups, such as the Heartland Institute and the Paleontological Research Institute in the USA and the United Nations more globally.

Textbook Selection

Textbooks are key instructional materials that support teaching and learning in various contexts. They provide content material for teachers (Bryce, 2011), and they influence teachers' pedagogical choices in the classroom (Hedrick & Harmon, 2004). Sometimes, science textbooks are the only instructional material available for instruction, particularly in the Global South where science labs are under-resourced or absent, and pedagogical support for teachers is nonexistent. In these situations, teachers often default to textbooks as the sole source of material. Along these lines, Smart et al., (2020) observed:

> Whether published by government or following government-approved criteria, the textbook in such contexts not only specifies what is to be taught and learned and affects how it is to be taught, it is also a policy document that represents an instrument of accountability to check on teachers and students' progress. The result is that classrooms in such settings may be neither learner-centered nor teacher-centered, but textbook-centered. (p. 7)

Smart et al.'s (2020) observation about the textbook as a policy document is evident in the ways in which the governments of the global South have prioritized textbook distribution to students in public schools. For instance, at the beginning of every academic year, the government of Bangladesh distributes textbooks to all students enrolled in public schools across the country (*Dhaka Tribune*, 2021), and the content of school textbooks represent the government/state's vision of education.

For this dissertation, textbooks were acquired from the three contexts (California/United States, Bangladesh, and Ghana) based on the following criteria: (1) the textbooks are approved for use in schools; (2) the textbooks are "popular" in the sense that they are widely used by students and teachers; and (3) the textbooks focus on integrated science, which means that their content captures equal amounts of the basic sciences—biology, physics, chemistry, and earth science. Science textbooks are either integrated science or single discipline science. With single discipline science textbooks, the content is focused on one discipline, such as physics or biology. For this study, I focused primarily on integrated science textbooks over single discipline texts because climate change is an interdisciplinary subject, and it was important to investigate how climate change is framed across the subject disciplines in the same textbook.

It is also important to acknowledge that despite the criteria above, there are some salient and major differences among the three contexts under study and hence, textbook selection in one context may vary from another. Unlike California and Ghana, which utilize science textbooks beginning in Grade 1, Bangladesh begins science education in Grade 3 and hence, there are no science textbooks or official science curriculum materials produced for Grades 1 and 2. Bangladeshi science education and science textbook production end in Grade 10, after which, the remaining levels of education (college and university) are optional. This means that Bangladesh has eight streams (Grade 3 through Grade 10) of compulsory K-12 integrated science education, and there are integrated science textbooks produced for these grade levels.

In contrast, California and Ghana have 12 streams (K-12), each of which has a science textbook. However, when it comes to integrated science, which was one of the criteria for selection, California has integrated science textbooks for Grade 1 through Grade 8 only, while Ghana has integrated science textbooks for Grade 1 through Grade 12, and Bangladesh has

integrated science textbooks from Grade 3 to Grade 10. Therefore, Grade 3 through Grade 8 is where the three countries overlap in integrated science content, and given this, this dissertation focused mainly on the grades that overlapped with some additions that I describe below. In addition to the textbook grade levels that overlapped, I also looked at the textbooks for Grades K-2 from California and Ghana. As indicated above, there is a paucity of research on elementary science curriculum and including these two grades presents a more complete picture of climate change and elementary education in those two important contexts: California/United States and Ghana. The table below shows where the countries differ and converge in terms of integrated science and at which grade levels: the blue colored boxes show where the countries and states overlap (Grades 3-8), and the red boxes show where they differ across the K-12 stream. It is important to state that this dissertation focused on elementary and middle school science textbooks only, which from grade 1-8.

Integrated Science	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Bangladesh												
Ghana												
California												

Table 1: Science textbook availability in Bangladesh, Ghana, and California, USA

Bangladesh. In Bangladesh, a designated governmental body known as the National Curriculum and Textbook Board (NCTB) is responsible for the development, production, and

distribution of textbooks to students. The NCTB produces textbooks for students through primary, middle, and secondary school. At the beginning of every academic year, the NCTB distributes its textbooks to students across the country (Hossain-Opu, 2020). This dissertation focused on textbooks produced specifically by the NCTB in the year 2020. The textbooks released by the NCTB in 2020 represent the latest version of texts approved for instruction in schools. The NCTB produces textbooks known as *Elementary Science* for primary and middle school, and *Science* for secondary school. These textbooks come in traditional print format although there are PDF versions available. The textbooks are produced in both local and English languages, and I acquired the English versions of the 2020 NCTB science textbooks for analysis.

Ghana. In Ghana, a singular governmental body known as The National Council for Curriculum and Assessment (NaCCA) is solely responsible for approving textbooks for use in Ghanaian schools. Unlike Bangladesh where the government-mandated NCTB develops and produces all the textbooks, in Ghana, the government-mandated NaCCA approves some selected privately published textbooks for use in Ghanaian schools. The NaCCA grants approval to privately owned publishers to print textbooks for the market, although the private publishers must follow national standards developed by NaCCA to produce the textbooks. The standards lay out the learning goals, content material and rubrics for examining and testing student knowledge. For this dissertation study, I ordered elementary and middle school textbooks from two different publishers because NaCCA gives multiple publishers different rights to publication. The middle school science textbooks were ordered from a private publisher known as Aki-Ola Publications for analysis. Now, the Aki-Ola Publishing Company, a private publisher approved by the government, produces middle school textbooks that are commercially successful and the most widely used in Ghanaian schools (Essah, 2020). With respect to elementary school, there is

no available/existing data on sales and usage in schools. However, through informal conversations with teachers, many of them indicated that they used textbooks published by Ruben Gbedemah.

California. In 2018, the California State Board of Education approved a number of textbooks for use in schools. Similar to Ghana, California approves textbooks from selected private publishing companies, including *Accelerate Learning, Amplify Education, Savvas, McGraw Hill, Activate Learning* and *Houghton Mifflin Harcourt Publishing Company*. Here, each publisher was required to follow state science standards, which lay out the content material, learning goals and assessments that is required by the state.

Among the textbook publishers listed above, Savvas (K1-12) integrated science textbooks were selected for analysis in this dissertation because Savvas is one of the largest textbook publishers in the United States and has a wide global reach: https://booksrun.com/blog/the-biggest-educational-publishers/. It is important to note that Savvas is the new name for the giant conglomerate formerly known as Pearson K-12 Publishing. Savvas Textbooks produced in California have a nationwide reach in the United States in that they are also used in schools outside of the state of California. As Apple (1992) observed almost 30 years ago: "The texts made available to the entire nation, and the knowledge considered legitimate in them, are determined by what will sell in Texas, California, Florida, and other large textbook-adoption states" (p. 4). This is still true today (Lucy et al., 2020). This means that my analysis of Savvas textbooks reveals to some extent the status and content of climate change education in the United States more broadly. In addition, California has the largest population of school-age children of any US state with about 6 million children in its public schools, and this means that Savvas textbooks reach a significant number of students in the United States. There is

no specific data on how many students use Savvas textbooks in California or across the United States. However, the existing statistics show that the parent company, Pearson Inc., makes 6 billion annual revenue in the United States indicating huge sales (Book Scouter, 2020) and the wide reach of the books.

It is important to note that, unlike Bangladesh and Ghana where textbooks exist in print or PDF versions, in the state of California, Savvas textbooks come in an interactive format. This means that the textbooks are digital, electronic, or cloud-based. These textbooks have touch functions; write in functions, and several multimedia functions (video and audio) that allow for editing and personalized learning. Textbooks produced in Bangladesh and Ghana do not have editable functions, multimedia, or personalized learning components. Rather, they are paperback textbooks. In Table 2 below, I provide a list of all the books used for thia analysis and their respective title and publishers.

Table 2: List of Textbooks selected for analysis in this dissertation

Country	**Title of Book**	**Grade**	**Publisher**
Bangladesh	*Elementary Science*	3-6	National Curriculum and Textbook Board (NCTB)
Bangladesh	*Science*	7-8	National curriculum and Textbook Board (NCTB)
Ghana	*Science*	1-6	Ruben Gbedemah
Ghana	*Integrated Science*	7-9	Aki-Ola Publications

California	*California elevateScience™*	1-5	Savvas (Formerly Pearson K-12)
California	*California elevateScience™ Preferred Integrated*	6-8	Savvas (Formerly Pearson K-12)

Unofficial Curriculum: Supplementary Materials produced by Non-Government Organizations

In addition to examining school-approved texts, this dissertation examined supplementary educational materials produced and distributed by the non-government sector. Although supplementary materials are produced outside of the jurisdiction of states, nations, and school districts, they are still often part of the discourse on climate change and other controversial curriculum issues and their approaches and viewpoints regarding content material often differs from textbook companies. For instance, in a study about the September 11 attacks on the United States and terrorism discourse, Hess and Stoddard (2007) observed that supplementary curricular materials presented alternate views and sometimes contributed to deeper understanding of the subject than major textbook publishers contribute. For this dissertation study, I examined supplementary educational materials from three organizations whose materials about climate change are widely distributed: Heartland Institute, Paleontological Research Institute (PRI), and the United Nations.

The Heartland Institute self identifies as a "free market think tank" with a commitment "to discover, develop, and promote free-market solutions to social and economic problems" (p.

1). As one of the leading climate-denying organizations in the United States, Heartland has organized several climate conferences across the United States. In 2018, they mailed out more than 200,000 copies of educational curricular material to science teachers across the United States. Their key text, *Why Scientists Disagree about Climate Change*, is part of the supplementary material that was analyzed in this dissertation. The text is available on the Heartland website, as indicated in Table 3, which contains the list of materials used for analysis in this dissertation.

Based at Cornell University, the Paleontological Research Institute (PRI) is committed to supporting teachers in their efforts to teach the scientific consensus on climate change in the United States. As a counter narrative to Heartland Institute, PRI has developed a climate change curriculum for teachers titled, *The Teacher-Friendly Guide to Climate Change.* The text is available on the PRI website.

The United Nations (UN) deems climate change an existential threat to the planet. The UN considers education pivotal in mitigating the effects of climate change. Hence, it has developed multiple curricular materials on this topic, including material for school-aged children. A curriculum titled *Children and Climate Change* was approved by the global body for instruction. The text is available on the UN website. As indicated earlier, the United Nations has a significant influence on educational policy in the global South and hence it is appropriate to include the UN climate curriculum designed for teaching and learning. For instance, the UN together with Ghana's Ministry of Education has organized several professional development programs on climate change for primary school teachers in Ghana. Table 3 provides information about the supplementary materials selected for analysis.

Table 3: Supplementary materials selected for analysis

Country/Region	Document Title	Publisher
United States	*Why Scientists Disagree about Climate Change*	Heartland Institute: http://climatechangereconsidered.org/why-scientists-disagree-about-global-warming/
United States	*Teacher Friendly Guide to Climate Change*	Paleontological Institute: https://www.priweb.org/science-education-programs-and-resources/teacher-friendly-guide-to-climate-change
Global South	*Children and Climate Change*	United Nations: https://unccelearn.org/course/view.php?id=23&page=overview

Data Analysis

As noted, I used a five-step approach to data analysis for this dissertation study. Below I provide more detail about each of the five steps and offer an example of each. As noted earlier, the five steps involved first identifying passages that are related to climate change in the text either explicitly or implicitly, followed by broad deductive coding and labelling/marking/highlighting of the passages according to "causes," "impacts," and "solutions" to climate change based on the literature. Subsequently, the thoughts units in each of the marked passages were coded. The remaining unmarked parts of the text were also then coded, and finally codes was connected to each other and to larger categories and themes, a process also known as axial coding.

Step 1: Identifying climate change in the text

This first step mainly applied to textbooks because they contained topics other than climate change, unlike the supplementary materials that focus only on climate related content. Hence, with respect to textbooks, I first read the entire texts and marked passages that explicitly reference or imply a connection to climate change. For instance, consider the text below from a 7th grade Bangladesh integrated science textbook: "Climate is changing due to global warming. The main cause of global warming is the increase of carbon dioxide in the atmosphere. So the best way to prevent climatic change is to minimize the emission of climatic change" (p. 177). The statement above is contained within a chapter titled "Change in climate" and the chapter begins by addressing and defining terms like weather and temperature and the differences, laying the groundwork before getting to climate change and addressing the causes. Here, the entire chapter was highlighted/marked in this first step, since it is as an explicit reference to climate change and embodies ideas about the causes of climate change (carbon dioxide) as demonstrated in the quote above. The quote above gives the reader a brief sense of what the chapter entails or is mainly concerned with.

Step 2: Broad deductive coding

In this step, large parts of the text were broadly and deductively coded based on whether they referred to the causes, impacts, or solutions to climate change. In keeping with the premise of deductive coding, these three topics were derived from the literature and from the science community as the most salient parts of climate change education (Meehan et al., 2018; Hess, 2009; NASA, 2021). "Broad and deductively coded" here means entire paragraphs and passages were marked and labelled because they dealt with ideas related to causes, impacts, and solutions to climate change. For instance, consider the statement below from *Teacher Friendly Guide to Climate Change* published by the Paleontological Research Institution (PRI):

> Earth's average temperature has been rising in a way that cannot be accounted for by natural variation alone. Climate models that incorporate increasing CO2 explain this warming trend better than any models based on natural variation alone. The pattern of the observed warming fits the pattern that we would expect from warming caused by the buildup of greenhouse gases, that is, almost all areas of the planet are warming; the Earth's surface and lower atmosphere are warming; and the temperature changes are greatest in the Arctic during winter. (p. 11)

This excerpt from PRI was highlighted/marked as "cause" because it has to do with the driving forces or causes of climate change as human activity. First, we notice that in the statement, carbon dioxide and greenhouse gases are deemed as contributing to "warming." Second, the statement implies that the warming of the planet cannot be explained by natural causes alone. Collectively, these statements suggest that text is referring to the causes of climate change.

Step 3: Coding the thought units within a marked text

This step involved two stages. The first stage involved identifying and parsing out the thought units in the marked/highlighted passages. The second was coding the thought units in the given text.

Stage 1. This stage identifies the thought units in a highlighted or marked text. Here and using the previously highlighted text from *Step 2,* I demonstrate below the identification and parsing of thought units in the text.

Earth's average temperature has been rising in a way that cannot be accounted for by natural variation alone//

Climate models that incorporate increasing CO2 explain this warming trend better than any models based on natural variation alone//

The pattern of the observed warming fits the pattern that we would expect from warming caused by the buildup of greenhouse gases//

, that is, almost all areas of the planet are warming//

the Earth's surface and lower atmosphere are warming//

and the temperature changes are greatest in the Arctic during winter (p.111)

In the textbox above, the thought units are separated by two slashes. As shown, six thought units in the passage were previously labelled as "causes" of climate change. The next stage after identifying the thought units was to assign codes.

Stage 2. The next step was to code the thought units in the textbox. Although this entire passage above broadly describes the causes of climate change, coding the thought units teases out the specific ideas and frames that are explicit or implied in the text. In addition, inductively coding the thought units after a broad deductive coding allows for singling out specific ideas in the previously labelled text. For instance, although the text above describes broadly the causes of climate change, we know that there are human causes and natural causes, which are supported by scientific evidence. How these concepts are framed in the text is important.

In assigning codes to the thought units, the first thought unit in the box was coded as "rising average temperature" while the second thought unit was coded as "increasing CO_2." The third, fourth and fifth thought units were coded, respectively, as buildup of greenhouse gases,

warming planet, and warming lower atmosphere. The last thought unit was coded as changes in the arctic. At first these codes were tentative, but they were finalized based on a full reading of the documents.

Step 4: Coding the unmarked parts of the text

After coding the thought units according to causes, impacts, and solutions of climate change, the remaining unmarked/un-highlighted parts of the text were also coded. While it remains true that the causes, impacts, and solutions to climate change are the dominant climate change themes in education, there are other big ideas in textbooks – particularly in the supplementary materials – and these are worth examining. For instance, the materials from the Paleontological Research Institute (PRI) includes references to how public messaging is critical to climate change beliefs and acceptance in the public domain. Consider the statement below from PRI that comments on the public campaigns of climate change advocates such as Bill Nye and the politician Al Gore:

> Al Gore and Bill Nye are examples of many who point out the urgency and apocalyptic outcomes of rapid climate change. While they've both done great work and deepened the understandings of millions of Americans, they've simultaneously unintentionally deepened the convictions of millions who reject the scientific consensus on climate change. The reasons for these mixed outcomes are complex, but at least one may be the apocalyptic storylines associated with their messages. (p. 223)

Similar to *Step 3*, this step also involved two stages: first identifying and parsing out the thought units in the text then coding the thought units in the text.

This stage identifies the thought units in the text as shown below. Individual thought units are separated by two slash signs.

> Al Gore and Bill Nye are examples of many who point out the urgency//
>
> and apocalyptic outcomes of rapid climate change. //
>
> While they've both done great work and deepened the understandings of millions of Americans, //
>
> they've simultaneously unintentionally deepened the convictions of millions who reject the scientific consensus on climate change. //
>
> The reasons for these mixed outcomes are complex//
>
> , but at least one may be the apocalyptic storylines associated with their messages (p.223)

In the text above, there are six thought units in the passage and these were coded respectively as follows "Positive advocates" "Apocalyptic outcomes," "Positive advocates," "Advocates and Negative outcomes," "Mixed outcomes," and "Apocalyptic storylines." These codes were tentative at first but were finalized based on the entire data corpus.

Step 5: Grouping of codes into categories

This step involved axial coding, or grouping of codes into categories that are related to one another and which begin to get at the higher-level ideas or frames in the text. Here, I demonstrate categorization using the two coding examples above and an additional example from PRI that looks at the impacts of climate change.

In the first coding example of the marked text, six codes were assigned to the thought units. These included rising average temperature, increasing CO_2, buildup of greenhouse gasses, warming planet, warming lower atmosphere and changes in the arctic. Here, we see that all six codes carry similar ideas pertaining to human-induced climate change. Hence, the six codes were collectively categorized as: Climate Change-Human Induced.

In a coding example from text that was not coded for the three big themes of causes, impacts, and solutions, I identified six thought units that were coded respectively as "Positive advocates," "Apocalyptic outcomes," "Positive advocates," "Advocates and Negative outcomes," "Mixed outcomes," and "Apocalyptic storylines." Here, we see that unlike the previous example about causes of climate change, there are distinct and similar ideas among some of the codes. For instance, the codes "Advocates and Negative outcomes" and "Mixed outcomes" could collectively be categorized as "Climate Denial- Celebrity Advocates." Here, the two codes (advocates and negative outcomes, mixed outcomes) collectively speak to the idea that certain types of advocacy might actually contribute to climate denial.

It is also important to state here that the coding scheme and approaches described above were applied to both textbooks and supplementary materials. Both types of documents followed a similar approach, although this does not mean that all of the codes were used for every text. Rather this means that the master coding system was applied to all materials and was laid out in a big grid/table pulling together the salient ideas/themes and frames into a coherent framework as shown in the Appendix Section (p. 226-229).

CHAPTER FOUR

Official Textbooks and Climate Change Education

This chapter argues that the portrayals of climate change in official science textbooks from Bangladesh, California, and Ghana are complex and are influenced by political polarization, globalization, economic interests, and the challenges of the modern nation state in the West and the global South. To build this argument, this chapter offers an analysis of how official textbooks from Bangladesh, California, and Ghana portray the causes, impacts, and possible solutions to climate change. In addition, this chapter also discusses why certain messages regarding climate change are present textbooks while other messages are omitted, based on each nation's history, progress, economic status, and governance. Lastly, this chapter lays out some of the similarities and differences across the textbooks and the three contexts out of which they emerged. By doing all of the above, this chapter tackles this dissertation's first and fourth questions: How is climate change portrayed in science textbooks from Bangladesh, California, and Ghana? (Dissertation question 1) and How is the climate change content of the textbooks from these countries similar or different across contexts? (Dissertation question 2).

Using Apple (1992) and Hess (2009) as the main theoretical lenses, this chapter makes three arguments about the portrayal of causes, impacts, and solutions to climate change in the official textbooks. These are based upon an analysis of the texts following the analytic approaches described in Chapter 3 coupled with information about the countries' economic, historic, and demographic characteristics. First, this chapter shows that messages about the causes of climate change in official science textbooks from Bangladesh and Ghana – and to a lesser extent from California – work from what Hess (2009) calls a "settled" perspective. This does not mean there are no debates about what to do about climate change. Rather, following

Hess, this means that the textbooks convey the point that science shows that climate change is caused by human activity, a point that is backed by an overwhelming consensus among those in the scientific community.

The second argument that organizes this chapter is that textbooks in Bangladesh and California to a certain extent, acknowledge specific local impacts of climate change while in contrast, textbooks from Ghana present broad and vague climate impacts in some respects, but attend to local concerns in other aspects. In other words, the Ghanaian textbooks, by the very nature of their development and production, communicate mixed messages about the impacts of climate change. This point about textbook production is discussed in detail in later sections of this chapter. Finally, this chapter argues that the textbooks from all three contexts focus on local solutions, personal solutions, and lifestyle changes to address climate change but do not focus on solutions related to fossil fuel reductions in their respective countries. In other words, the three sets of textbooks do not acknowledge the harm of carbon dioxide emissions from their own fossil fuel activities, and they do not propose solutions related to fossil fuel reduction in that regard.

In order to make the above arguments, this chapter is organized into five sections. The first section provides an overview of the amount and occurrence of climate change-related content in all three sets of textbooks. The second, third, and fourth sections present analyses of the causes, impacts, and solutions to climate change as portrayed in the textbooks from Bangladesh, California, and Ghana, respectively. Lastly, the fifth section presents a comparative analysis of the portrayal of causes, impacts, and solutions to climate change across the textbooks from Bangladesh, California, and Ghana. It is important to state that sections two, three, and four also contain discussion of possible explanations as to why certain messages about climate change are present or absent from the textbooks produced in Bangladesh, California, and Ghana.

Description of Textbooks

In the paragraphs below, I briefly describe the materials analyzed and reported on in this chapter. I highlight key content areas in the textbooks to give the reader an insight into how climate change is positioned and organized in the official science textbooks from the three contexts that are under study- Bangladesh, California, Ghana.

Bangladesh

In the Bangladeshi official textbooks selected for analysis, climate change content was addressed in the Grade 5 and Grade 7 textbooks. The remaining textbooks (Grades 3, 4, 6) did not contain climate change content, even though some of the books tackled wide-ranging environmental issues such as pollution. The Grade 5 and Grade 7 textbooks had chapters titled "Climate Change" and "Change of Climate" respectively.

The Grade 5 textbook dedicated about eight pages to climate change and this included content areas, definitions, lists, activities, and assessments. The climate change content in the textbook for Grade 5 began with a definition of climate change and later included a graph that depicted rise in global temperatures from the late 19th century to the 20th century. Subsequently, localized perspectives on climate change were presented and once again, a graph showing rising temperatures in the Bangladeshi capital city of Dhaka was presented alongside the texts on climate change. The term "climate change" was positioned as the overarching framework in the Bangladeshi textbooks, and global warming was framed as a sub-topic of climate change. The following sub-headings were used in the text to address the causes, impacts, and solutions to climate change respectively: "Greenhouse Effect and Greenhouse Gases," "Human activities and the Global Warming," and "Observational Facts of Global Warming." The section titled "Greenhouse Effect and Greenhouse Gases" was dedicated to explaining how gases in the

atmosphere trap heat leading to the warming of the Earth. The section titled "Human activities and the Global Warming" was dedicated to describing the burning of fossil fuels and coal and the increase of carbon dioxide in the atmosphere. The section titled "Observational Facts of Global Warming" described sea level rise and the melting of glaciers over the Himalayas. Additional sub-topics addressed under the chapter were "Climate Change Mitigation," which focused on reducing carbon dioxide in the atmosphere, and "Climate Adaptation," that dealt with solutions to live and cope with the impacts of climate change. The chapter also mentioned the impacts of climate change on Bangladeshi society, where it referenced natural disasters and weather-related events such as tropical cyclones, floods, drought, and tornadoes. The chapter concluded with assessments and exercises based on the topics/content discussed in its pages.

In the Grade 7 textbook, the chapter "Change of Climate" began with elaborate definitions and discussions of topics such as "Atmosphere of the Earth," "Water Cycle in the Environment," and "Weather and Climate." The entire length of the chapter was about 16 pages, however, with six of these pages dedicated to exploring climate change, and as I show below, the remaining pages provided context for the subject of climate change. Similar to the climate change content in the Grade 5 textbook, the Grade 7 textbook presented a graph that depicted the global rise in temperatures over several decades and referenced the contribution of burning fossil fuels. There was also a greenhouse activity in the chapter for which teachers were expected to engage students in an experiment that demonstrated the greenhouse effect. The chapter also presented content on how to reduce carbon dioxide in the atmosphere, and it listed solutions such as reduction in fossil fuels, planting more trees, and suggested the use of renewable energies such as solar and wind. The chapter concluded with exercises and assessments based on the topics/content discussed in its pages.

California

All the California textbooks– integrated science (Grades 1-5), middle school integrated science (Grades 6-8), contained both explicit and subtle references to climate change. Before describing the climate change content in these textbooks, it is important to state that California state science standards require climate change instruction in middle school (Grades 6-8) and in high school (Grades 9-12). Hence, while climate change is touched on in the other textbooks, the sixth grade textbooks treated climate change in much more detail and more explicitly than the other textbooks.

The Grades 1-5 textbooks did not treat climate change as a topic. Rather, these textbooks made subtle references to the topic in various ways. For instance, the Grade 3 textbook made an implicit reference to climate change when it discussed fossils and how fossils helped scientists uncover long-term changes in climate, but the text did not explicitly mention the words "climate change" or "global warming." Likewise, the Grade 4 textbook implicitly referenced climate change when it presented topics such as energy and fossils. However, when making a comparison between using electric cars versus cars that use gasoline, the text argued that gasoline cars pollute the environment and this leads to the warming of the atmosphere. Thus, the Grade 4 textbook – without explicitly mentioning climate change – highlighted one of the solutions to reduce greenhouse gases that are responsible for climate change.

As indicated earlier, due to California's state science standards and requirements, the Grade 6 textbooks and high school environmental textbooks is where more robust and detailed climate change information was offered. In the paragraphs below, I describe the Grade 6 textbook in detail and highlight a few content areas from the high school environmental science textbook.

In the Grade 6 textbook, there were two lessons dedicated to climate change and these were titled "Climate Change" and "Effects of a Changing Climate." The content of the "Climate Change" lesson was dedicated mainly to exploring and understanding human contribution to climate change. Here, and also in the Ghanaian and Bangladeshi textbooks, the text delved into the concepts of the greenhouse effect, greenhouse gases, carbon dioxide, and the linkages to climate change. The text highlighted the increase in carbon dioxide with a graph showing carbon dioxide increase "over the past 800, 000 years." (p.6). In addition to the concept of greenhouse gases, the interactive content also presented material on the role of fossil fuels and their contribution to climate change. Here, the text presented the various contributions of different types of fossil fuels such as coal, petroleum, and natural gas.

The second lesson, titled "Effects of a Changing Climate," was dedicated to discussing the impacts of climate change and efforts to reduce emissions. The text mentioned climate change impacts such as the thermal expansion of water, sea level rise, and specifically mentioned threats to coastal cities such as San Francisco. Some of the strategies recommended for reducing emissions in the text included changing the sources of energy; that is moving away from fossil fuels to alternative and cleaner sources of energy such as bio fuels, biodiesels, and wind energy.

Ghana

Climate change content was mentioned in all of the Ghanaian textbooks selected for analysis: Primary Integrated Science (Grades 1-6), Junior High Integrated Science, and Senior High Human Geography. Across the above textbooks, the climate change content was organized differently. For instance, the Primary School textbooks presented climate change under a broader topic "Humans and the Environment" and within this framework, climate change was discussed as a sub-strand. The Grades 1, 2, and 3 textbooks followed a similar organization in that climate

change was mentioned in all three textbooks, but it was not conceptually defined. Rather, the textbooks referenced climate, burning, pollution, and general human activities on the environment. These topics were used to set the stage for a much bigger discussion about the linkages between human activity and climate change.

In the upper primary textbooks (Grades 4-6), climate change was defined and linked to human activities (burning, cutting of trees, exhaust from cars), which were referenced earlier in the lower primary grades textbook (Grades 1-3). For instance, the Grade 4 textbook had a subtitle called "What Causes Climate Change?" and under this subtopic, the burning of fossil fuels, bushes, and waste materials were discussed. The Grade 5 textbook also focused on human activity; however, instead of focusing on fossil fuels, the goal of the text) was that, "At the end of this sub strand, the learners will identify the impacts of deforestation on climate change." Here, the Grade 5 textbook devoted almost six pages to talking about the effects of deforestation on climate and the importance of planting trees. The Grade 6 textbook presented much more comprehensive material on climate change than other primary school textbooks. For instance, it provided a definition of climate change and discussed the causes of climate change by referencing human activities. The text also delved into the effects of climate change on human beings, and presented a section titled, "Ways of Controlling Climate Change," wherein it listed policies such as tree planting and lifestyle changes as some of the ways to deal with climate change.

In the middle school science textbook, climate change (in this case termed, "global warming") was discussed under the broader topic, "Carbon Cycle." Here, the text depicted how carbon moves through nature before it delved into the topics of greenhouse gases and global warming. Global warming was portrayed under three sub headings, which included "Causes of

Global Warming," "Damaging Effects of Global Warming," and "Reduction of Global Warming." The title "Causes of Global Warming" explored the role of fossil fuels and other pollutants in contributing to climate change. The text specifically mentioned that the "burning of coal and oil results in the production of more carbon dioxide into the atmosphere." The title "Damaging Effects of Global Warming" referenced impacts of global warming such as melting of icebergs, increase in atmospheric temperatures, and rising in sea levels among others. The section dedicated to addressing climate change listed activities that reduce carbon dioxide such as planting more trees, similar to the Grade 6 textbook.

The textbook descriptions in all three contexts suggest that at least climate change is included in official textbooks used in schools in Bangladesh, California and Ghana. As referenced above, there is a commonality of focus in terms of the topics discussed in all three contexts. Principal topics that overlap include causes of climate change, climate mitigation, climate adaptation etc. In addition, textbooks from all three contexts suggested assessments and activities to text student learning and understanding.

Bangladesh Textbook Analysis

In this section, I present an analysis of the causes, impacts, and solutions to climate change as portrayed in the official textbooks selected from Bangladesh. This section builds upon Section 1 and presents an analysis of the textbook content that is described in that section.

Causes of Climate Change

My analysis revealed that textbooks from Bangladesh framed the causes of climate change as a matter of "settled" science. Here, two main assertions were used to communicate the settled perspective on climate change in the textbooks. First, it was made clear that there is a scientific consensus about climate change. Second, the texts also made it clear that climate

change is caused by human activity. Together, these two assertions, referred to as the "scientific consensus" frame and the "human activity" frame– convey the idea that climate change is a settled science (Hess, 2009). The "scientific consensus" frame in the Bangladeshi textbook encapsulates scientists' conclusions, predictions, and observations about the phenomenon of climate change, while the "human activity" frame signals that climate change can be attributed to the activities, endeavors, and enterprises of human beings. The distinction between the "scientific consensus" and "human activity" frames is important in that the textbooks can acknowledge the human activity perspective while dismissing the point that scientists have reached a consensus on climate change (Meehan et al., 2018; Roman & Busch, 2016; Medimorec & Pennycook, 2015). For instance, consider the statements in the two boxes below, which are taken from Grade 5 textbooks in Bangladesh and California respectively:

Bangladesh:	California**:**
"Climate of any areas does not change suddenly. The scientists observed after calculating that the average temperature of the earth is increasing" (NCTB, 2020, p.81).	"Earth's temperatures have been getting warmer. Scientists are still investigating what is causing the climate to change" (Savvas, 2020, p. 16).

In the statements above, we observe that the Bangladeshi textbooks embrace a "scientific consensus" framing, while the Californian textbooks frame the "scientific consensus" in ambiguous "inconclusive" language. The Bangladeshi text uses the language "scientists observed," while the California texts say, "Scientists are still investigating." The former treats the diagnosis of climate change in terms of a known conclusion that is settled among scientists,

while the latter acknowledges that the earth is warming but opens up the possibility that scientists are still finding out the causes of climate change.

One could argue that the Californian textbook allows for discussion about possible causes of climate change, and of course we know that democratic discussion of controversial topics in classrooms promote civic consciousness among students (Fitzgerald et al., 2021; Flanagan, 2019; Dover, 2009). However, Hess (2009) has cautioned that for a topic like climate change where there is overwhelming scientific consensus, it is irresponsible to presents the "causes" as open to debate/discussion. As a corollary to Hess (2009)'s arguments, it is also important to reiterate the point that scientists have been vocal and emphatic that they have reached a consensus on human induced climate change (IPCC, 2016; NASA, 2016; AMS, 2017). A brief comparison with the United States is helpful here in emphasizing the importance of the consensus frame in the Bangladeshi texts. We know that among a certain section of the public, and in some jurisdictions in the United States, the topic of climate change remains controversial (Marlon et al., 2020; Weatherholtz, 2018; Anderson, 2014). The climate change controversy in the United States and what Apple (1992) called "the commercialization of textbooks" help explain the "open" language used in the Californian textbooks. Here and as Apple (1992) has argued, textbooks produced in California are sold widely across the United States. This means that the Californian textbooks are used in jurisdictions/states in the United States where climate change is not a settled science. This wider reach of textbooks beyond the jurisdictions in which they were produced and as Apple (1992) argued, influences how various subject matter/knowledge is positioned in the textbooks. The Bangladeshi textbooks, on the other hand, present a more coherent and consistent message about the scientific consensus in part because Bangladesh uses a centralized textbook production system. Here, there is a centralized body, the National

Curriculum and Textbook board, which is responsible for textbook development and production. We know that coherence and uniformity of curriculum and educational policy is attainable in centralized educational systems like Bangladesh (Weiler, 1989; Bray, 1991). For instance, scientific predictions and claims about the evidence of climate change are included at least four times in both the Grade 5 and Grade 7 Bangladeshi textbooks.

Based on consistent messages acknowledging the scientific consensus, it is evident that the government of Bangladesh, which produces and distributes the textbooks, recognizes the important role that scientists have played in increasing our understanding of the science of climate change. Thus, the government seeks to pass on this relevant climate knowledge to its citizenry using formal education. As Apple (1992) and Hess (2009) have both noted, the curriculum represents – or is a proxy for – the visions and interests of those in power. Thus, it can also be said that with the explicit acknowledgement of the "scientific consensus" regarding climate change, in addition to the "human activity" framing in the textbooks, Bangladesh appears to embrace a much more complex vision of climate change education than Ghana and California; neither of which fully acknowledges the scientific consensus even though they do show in their textbooks that human-induced climate change is real. But these differences in climate messaging among the three contexts is expected and as Hess (2009) argues, different jurisdictions have different visions of curriculum and this translates into varied perspectives on the same subject matter.

As indicated above, in addition to the "scientific consensus" frame, messages that focused on "human activity" as the cause of climate change were consistently deployed in the Bangladeshi textbooks with details highlighting many of the various activities and enterprises

that increase carbon dioxide in the atmosphere. For instance, consider the statement below from the Grade 5 Bangladeshi textbook:

> Grade 5:
>
> "Fossil fuel such as coal, oil, natural gas, etc. is burnt in energy plants, factories and vehicles. A lot of carbon dioxide emits into the air due to the burn of fossil fuel. At the same time, due to deforestation, the absorption of carbon dioxide by tree is decreasing. As a result, the carbon dioxide in the air is increasing. The increased carbon dioxide traps much heat. In a consequence the earth's temperature is increasing day by day. Average earths increase of temperature is called global warming" (NCTB, 2020, p. 84).

In the text above, the connections and linkages among burning fossil fuels, increases in carbon dioxide, and the earth's rise in temperature are highlighted. In addition, another human activity—deforestation—is also mentioned, and the impact of deforestation on carbon dioxide removal in the atmosphere is established. Collectively, these ideas suggest that the factors responsible for the increase in carbon dioxide in the atmosphere are human-driven. Both Apple (1992) and Hess (2009) have argued that governments and people in power prioritize certain forms of knowledge as part of a selective tradition in upholding certain values and beliefs. In the case of the Bangladeshi textbooks, we can argue that the state seeks to legitimize the idea that climate change is a human-driven endeavor. In addition to the textbooks, several Bangladeshi national

policy documents have linked human activity to climate change. For instance, in the Nationally Determined Contributions (NDC) document put forth by the Government of Bangladesh at the Paris Climate Change Accord, the text specifically acknowledges human contributions to emissions (NDC, 2015 & 2020). Thus, it is not surprising that the textbooks contain same messages and framing about the causes of climate change.

Bangladesh's scientific consensus and human-induced framing of climate change cannot be decontextualized from the country's broader vision of "liberatory" and "developmentally" focused education (Rahman et al., 2010; Chowdhury & Kabir, 2014; Unterhalter et al., 2003). However, the "liberatory" and "developmental" educational aspirations have been hampered by structural challenges such as funding and technical expertise (Rumnaz- Imam, 2005). Therefore, Bangladesh has had to rely partly on global organizations such as the United Nations (UN) for developmental assistance. These dependencies have led to influences and cultural exchanges from the United Nations (Sarkar & Salam, 2011) and climate change education is no exception. For instance, earlier this year, the United Nations Children's Fund commissioned an extensive report on schoolchildren and climate change (UNICEF, 2021). We know that these reports and policy documents from organizations such as UNICEF influence educational policy in Bangladesh (Sarkar & Salam, 2011). In the case of climate change, organizations such as the UN can be quite useful in setting agendas and influencing perspectives on climate change education (Mrema & Sagadi, 2021). One may argue that these influences from the UN and other international organizations are possible because of the unequal power dynamics between a developmental nation state, such as Bangladesh, and global bodies, such as the UN and UNICEF, backed by money from Western countries (Mingst et al., 2018; Prashad, 2013; Andersen, 2019). While this may be true, the UN influences on climate change education in Bangladesh cannot be

viewed solely through the lens of power and cultural domination and as Apple (1992) rightly argued "We cannot assume that because so much of education has been linked to processes of class, gender, and race stratification that all of the knowledge chosen to be included in texts simply represents relations of, say, cultural domination or only includes the knowledge of dominant groups" (p. 10). While cultural influences by organizations such as the UN do exist through funding schemes, policies, and trade (Farrall et al., 2020), the government of Bangladesh should also be credited with agency in seeking to educate its citizenry about climate change through the use of formal education, of which textbooks play an important role.

Impacts of Climate Change

My analysis revealed that largely and with a few exceptions, the textbooks in Bangladesh framed the impacts of climate change in terms of local threats and issues. Here, the textbooks consistently deployed language that linked the impacts of climate change to the Bangladeshi context. For instance, consider the two statements below in the boxes from the Grade 5 and Grade 7 Bangladeshi textbooks:

Grade 5:	Grade 7:
"Bangladeshi is one of the most disaster prone countries in the world. We are exposed to a variety of natural disasters including tropical cyclones with associated storm surges, floods, drought, tornadoes and rover erosions and so on. We should know about climate and be	"Sea water is increasing due to the increase of temperature. As a result, sea level is rising. If temperature increases like this, the water level of the sea will go on rising. As its consequence, low lying areas of the world including Bangladesh will be inundated" (NCTB, 2020, p. 176).

prepared to face the natural disaster risks" (NCTB, 2020, p. 86).	

In the statements above, the impacts of climate change – whether natural disasters (cyclones, storm surges) or physical events (sea level rise) – are framed as Bangladeshi problems, or in other words, the textbooks acknowledge that these climate change impacts have deleterious consequences for Bangladesh. For instance, the impacts of sea levels rising, which causes flooding is acknowledged in the text, and this is consistent with expert assessment on the vulnerabilities of low lying countries like Bangladesh to rising sea levels and subsequently flooding (Ahmed & Meenar, 2018; Davis et al., 2018; Khan et al., 2011).

The localized framing of the impacts of climate change in the case of Bangladesh is consistent with the state's vision of education, which has been to foster in its young people an appreciation for local Bangladeshi culture, systems, and language (Chowdhury, 2010; Hamid & Jahan, 2015; Erling, 2017). However, despite Bangladesh's localized framing of the impacts of climate change, there are a few important ideas that are missing from their textbooks. For instance, while the textbooks acknowledge the natural disasters and weather-related impacts of climate change, they leave out one major impact—the potential for climate change to exacerbate the existing Myanmar refugee crisis and the broader social conflict related to this. In many studies (Meehan et al., 2018; Roman & Busch, 2016; Busch, 2021; Reid, 2019; Slimani et al., 2021) about climate change, the research focuses mostly on the messages and frames in the textbooks. However, in this dissertation, I am also interested in messages that are omitted from

the text as that is an important contribution to the literature on climate education. In the paragraphs below, I discuss the omitted messages about the impacts of climate change.

As indicated above, the Bangladeshi textbooks leave out the impacts of climate change on social conflict. It is important to highlight here that while the government omits the impacts of climate change on social conflict from textbooks, it acknowledges it in other documents and speeches. For instance, the Bangladeshi Education Sector Plan – a policy document that outlines the government's vision of education – acknowledges the relationship between education, climate change, and forced migration of people (Government of Bangladesh, 2020). Likewise, in a recent speech at the climate change conference in Glasgow (COP26), the Prime Minister of Bangladesh remarked that "the issue of loss and damage must be addressed, including global sharing of responsibility for climate migrants displaced by sea-level rise, salinity increase, river erosion, floods, and draughts" (Dhaka Tribune, 2021). Here, we notice that the government of Bangladesh recognizes the linkages between climate change and the displacement of people at various levels, whether in public speech or government documents. However, and as indicated above, these linkages among climate change, mass migrations, and displacement of people (particularly refugees) are missing from the Grade 5 and Grade 7 textbooks. I would suggest that the government acknowledges social conflict in these documents but leaves them out of textbooks because textbooks – unlike other policy documents – have a bigger appeal, reach the masses, and have the potential to influence the next generation. Thus, it is not surprising that messages about climate impacts and social conflict that are present in other public documents are missing from the textbooks.

As Apple (1992) has argued, "The curriculum is never simply a neutral assemblage of knowledge, somehow appearing in the texts and classrooms of a nation. It is always part of a

selective tradition, someone's selection, and some group's vision of legitimate knowledge. It is produced out of the cultural, political, and economic conflicts, tensions, and compromises that organize and disorganize a-people" (p.1). One may argue that perhaps topics related to refugees, demography, and conflict were left out of the Grade 5 and Grade 7 textbooks because of age appropriateness. One may also argue that perhaps these topics do not belong in a science curriculum. However, we know that regardless of the above arguments, the linkages among climate change, vulnerability, and the Myanmar refugees in Bangladesh are well- documented (Ahmad et al., 2021). In addition, we know that in some government-approved curricula in Bangladesh, conflict is acknowledged when it projects a national identity and historical narrative. For instance, Bickmore et al., (2017) analyzed Bangladeshi global studies curricula and concluded that "The Bangladesh and Global Studies curriculum document normalizes war and violence through narratives that represent violent retaliation as the only feasible response to conflicts with (ostensible) enemies or oppressors" (p. 12). The above observations by Bickmore et al., (2017) and the reluctance of the government to include the potential impacts of climate change to exacerbate social crisis in the curriculum cannot be decontextualized from Bangladesh's brutal colonial history that has shaped the country's vision of education (Chowdhury& Kabir, 2014; Qazi & Shah, 2019). As Apple (1990, 1991, and 1992) has argued in several instances, the curriculum is borne out of complex historical and powerful forces, and these forces shape the contents of the curriculum and impinges on the "relationship between school knowledge and the larger society" (p. 2). In the case of Bangladesh, the country was colonized by Imperial Britain and it had to liberate itself from Pakistan in 1971 (Baxter, 2018). These colonial and violent histories, together with existing structural challenges have led to the government acknowledging the impacts of climate change (Paprocki, 2019). However, at the

same time, the social tensions borne out of Bangladeshi history and contemporary challenges have shaped what kinds of narrative the government wants it citizens to imbibe; whether omitting the relationship between climate impacts and social conflict and marginalization from the textbooks or as Bickmore et al., (2017) observed, the inclusion of conflict in curriculum materials when it serves a nationalist purpose.

Solutions to Climate Change

My analysis revealed that textbooks in Bangladesh framed climate solutions from both a local perspective and a more generic and overtly technical perspective employing language similar to international scientific organizations such as the National Aeronautics and Space Administration and the Intergovernmental Panel on Climate Change. Here, two main points were used to communicate solutions to climate change. First, the texts highlighted solutions to reduce carbon dioxide in the atmosphere, which was referred to as *climate mitigation* in the textbooks. This point relied on generic framing and technical language to communicate climate mitigation strategies. Second, the text presented ideas on how to cope and live with the impacts of climate change, which was characterized as *climate change adaptation* in the text and this point, mostly, attended to local perspectives.

As indicated above, climate change mitigation was used in the texts to characterize measures to reduce carbon dioxide. For instance, consider the text below taken from the Grade 5 Bangladeshi textbook and which discusses climate mitigation measures:

> “The main cause of climate change is the increased carbon dioxide in the atmosphere. So we can reduce the risks by reducing the carbon dioxide emission by decreasing the use of fossil fuel such as coal, oil and natural gas. Increasing the use of renewable resources such as solar energy and wind can reduce the carbon dioxide emission. Also, we can reduce carbon dioxide in the atmosphere by planting trees. We can reduce energy consumption in our daily life to reduce carbon dioxide emission. These actions will limit the magnitude and rate of long term climate change” (NCTB, 2020, p. 86).

In the statement above, three strategies are recommended to reduce carbon dioxide in the atmosphere. The strategies include reduction in dependence on fossil fuel, tree planting, and lifestyle changes. These three strategies are consistent with measures recommended by international scientific organizations such as the National Aeronautics and Space Administration and the Intergovernmental Panel on Climate Change. Nevertheless, when it comes to fossil fuels, the Bangladeshi text does not acknowledge the country’s local contributions to emissions. We know that fossil fuels are primarily responsible for the increase in carbon dioxide in the atmosphere and so it is appropriate that the Bangladesh text would include ideas about moving forward from the use of fossil fuels. However, the framing of fossil fuels in the textbooks elides the fact that Bangladesh still dabbles in commercial exploration of fossil fuels. For instance, in

2021, the *Dhaka Tribune* (a major newspaper in Bangladesh) reported that the state has given permits for gas exploration in the Bay of Bengal (Tribune Desk, 2021). One may argue that countries like Bangladesh are hardly responsible for greenhouse emissions compared to China and the United States and therefore, Bangladesh should be allowed to generate revenue from fossil fuel activities. However, as Mott et al., (2021) rightly observed, "Every country must act because CO_2 emissions anywhere threaten development everywhere." Here, even though Bangladesh and other developing countries contribute a small amount of emissions to climate change (Boden et al., 2017), their emissions are still substantive, and as Mott et al., (2021) argued, these low emissions still exacerbate climate change.

Policy solutions to tackle climate change remain debatable among scientists and educational stakeholders compared to the causes of climate change. The latter is a much more settled issue among a majority of scientists and educational stakeholders such as the National Science Teacher Association (NSTA), American Meteorological Society (AMS) and scientific organizations in the global South such as the Bangladesh Meteorological Department.

My argument here is that policy solutions to climate change cannot be treated as settled or closed because of questions of scale, politics (Brenton, 2013), trade (Harrison, 2015), and logistics (Poulsen & Lema, 2017). With regards to this kind of situation, Hess (2009) has acknowledged – using an example from social studies – that "one can imagine a social studies class that includes discussion of policies concerning what should be done about global warming" (p. 123). Here and as argued previously, the content in the textbooks and the ways of teaching climate change can be widely different as teaching allows for more possibilities and explorations. Textbooks on the other hand are limited in the amount of information they can provide but in the case of Bangladesh, and because in this context, textbooks are the primary materials for

instruction, much more robust content about climate policy is needed. Here, an "educative curriculum" approach might be appropriate. Educative curricula are instructional materials that are designed not just for student learning but also include content that support teacher instruction (Ball & Cohen, 1996). The Bangladeshi textbooks do not contain suggestions, templates, or pedagogical content knowledge and instructional practices as to how teachers can navigate teaching and presenting complex climate policy solutions in their classrooms.

As indicated earlier, there were two points used to communicate information and ideas about climate solutions in the Bangladeshi textbook. The one discussed above was concerned with *climate mitigation,* which has to do primarily with the reduction of carbon dioxide in the atmosphere. The second solution, *climate adaptation*, has to do with how to cope and live with the impacts of climate change. For instance, consider how the Grade 5 textbook lists various adaptation activities:

> "The following are examples of adaptation activities:
>
> Developing the infrastructure such as houses, schools and factories
>
> Constructing of flood and cyclone shelters
>
> Creating Coastal afforestation
>
> Changing our lifestyle
>
> Disseminating Knowledge of climate change" (NCTB, 2020, p. 86).

The text lists five adaptation strategies for coping and living with climate change and these include infrastructure, afforestation, shelters, lifestyle changes, and climate education. Usually, climate adaptation strategies have focused on infrastructure and other physical projects, but by

including “climate education” as one of its adaptation activities, the Bangladeshi textbook once again demonstrates the government’s commitment to and vision for creating a climate literate population. However, despite the inclusion of climate education as one of its adaptation goals in the textbooks, the text provides little information as to how climate knowledge would help people cope and live with the impacts of climate change. As indicated previously, since textbooks are the primary instructional materials used in classrooms in Bangladesh, it would seem that these texts should include robust and elaborate information about climate adaptation strategies and how they can be instrumental in helping particularly marginalized communities in Bangladesh to live and cope with climate impacts. However, we know that now, Bangladesh’s adaptation measures do not attend seriously to the disparate and disproportionate impacts of climate change on its poor and disenfranchised citizens. As Sovacool (2018) observed “community coping strategies for climate change have entrenched class and ethnic hierarchies ultimately trapping the poor, powerless, and displaced into a predatory patronage system that can aggravate human insecurity and intensify violent conflict” (p.1). Sovacool (2018) rightly argues that climate adaptation strategies implemented by the government of Bangladesh marginalize certain segments of Bangladeshi society. This would suggest that there is a need for an education that empowers students to become change agents in their communities. However, there is a power imbalance here in the sense that the government decides on textbook content at the same time that the government is the implementer of climate adaptation strategies. Thus, the curriculum is less likely to be skeptical of the government’s climate adaptation strategies. We know that governments are often selective in the ideas that are allowed in the curriculum (Apple, 1992), and so, it is not surprising or unexpected that Bangladeshi textbooks omit the fact that the

government's climate adaptation strategies marginalize and/or negatively affect some segments of Bangladeshi society (Sovacool, 2018).

It is also important to reiterate the point that climate mitigation and climate adaptation cannot be treated as settled strategies, as Hess (2009) defines these. In other words, unlike the causes of climate change, which can be framed in "settled" terms given widespread consensus in the scientific community, policy solutions that address and help people live with the impacts of climate change requires an "open" framework for the curriculum. There are still ongoing debates and unsettled questions about what to do about climate change and while scientists have agreed on the causes of climate change, the policy solutions and the scale of climate impacts are subject to debate and considerations whether at state, local, regional, or on a global scale (Ostrom, 2010; Landauer et al., 2019).

California Textbook Analysis

In this section, I present an analysis of the Californian textbooks chosen for this dissertation. Like my analysis of Bangladeshi and Ghanaian textbooks, this analysis focuses on how the causes, impacts, and solutions to climate change are framed in the textbooks.

Causes of Climate Change

My analysis revealed that the California textbooks framed the causes of climate change from a "settled" perspective. That is, the texts explicitly acknowledged the accepted role of human activity in climate change. Interestingly, however, there was mixed messaging with respect to the scientific consensus about climate change. For instance, consider how the scientific consensus on climate change is framed in the Grade 5 and Grade 6 textbooks that are represented in the boxes below:

Grade 5	Grade 6
“Earth’s temperatures have been getting warmer. Scientists are still investigating what is causing the climate to change” (Savvas, 2020, p. 16).	“Evidence of earths past suggest that most climate change takes place over long periods of Time-Thousands or even ten thousands of years. However, over the past century, scientists studying the climate have observed a clear and alarming trend in the data” (Savvas, 2020, p.1).

The excerpts above show that the Grade 5 textbook employed inconclusive language (e.g., “still investigating”) when discussing scientists’ claims about climate change. This was in contrast to the language used by the Grade 6 textbook, where “observed” was used to denote scientists’ conclusions about the “alarming trends in data.” The inconsistency in how the scientific consensus was framed across these two textbooks is in line with the findings of previous research on climate change in Californian textbooks published between the years 2007- 2012 (Roman & Busch, 2016; Meehan et al., 2016). The researchers noted that the role of human activity in climate change was acknowledged in certain parts of the texts and framed vaguely or as uncertain in others. On a broader note, inconsistencies and differences in messaging about scientific issues and historical events are rife in commercial textbooks as a whole (Hess, 2009; Morning, 2008). Apple (1992) has argued that the differences and gaps in messaging are proxies for wider debates and viewpoints about legitimate knowledge. He suggested:

> It is important to realize, then, that controversies over "official knowledge" that usually center around what is included and excluded in textbooks really signify more profound political, economic, and cultural relations and histories. Conflicts over texts are often proxies for wider questions of power relations. They involve what people hold most dear. (p. 4)

Apple (1992)'s argument mirrors the current debate over climate change, and his point about "what people hold dear" is particularly relevant when it comes to climate change, economics, and cultural identity. In the United States, climate change education debates are prominent in places where fossil fuels are an important source of revenue. For instance, Colston and Ivey (2015) have documented the tensions over climate change education standards in oil-rich Oklahoma. The researchers observed that "stakeholder's perceptions about the process of standards revisions illustrates how the ambiguity of the process allows multiple actors across different trajectories to exercise domination, submission, and even resistance to climate change education." (p. 20). Colston and Ivey's observations about the role of multiple actors in curriculum development is central to understanding why climate change education remains controversial in the United States, as compared to Bangladesh or Ghana. When multiple actors are involved in curricular debates, this tends to democratize education in a certain sense, giving multiple stakeholders a say in how curriculum is organized, and at the same time, encouraging and fostering controversy and various kinds of power negotiations.

Discourses and contests over power are not always negative. As shown above, California's textbooks – despite inconsistent framing – generally advance the human-induced perspective on climate change. As Apple (1992) observed, "Power is, of course, complemented by a more positive vision. Here, power is seen as connected to a people acting democratically

and collectively, in the open, for the best ideals" (p.7). With regard to Apple's point about a positive vision, California and other states, including Wyoming, have embraced the reality of human-induced climate change and have updated their curricula to reflect the contribution of human activity to climate change. In the past year, California legislators have introduced a bill to include climate change in the curriculum, but this has been met with criticism from some climate-denier organizations such as the Heartland Institute, which is discussed at length in the next chapter. California's liberal majority means that human-induced climate change education will likely remain in the curriculum in the near future. However, as long as textbooks are produced by commercial entities with varied editorial standards, mixed or inconsistent messaging is likely to happen, as shown by the previous statements in the boxes above (Grade 5 & Grade 6 textbooks). Here, Apple (1992) has argued:

> Text publishing often is highly competitive. In the United States, where text production is a commercial enterprise situated within the vicissitudes of a capitalist market, decisions about the "bottom line" determine what books are published and for how long. Yet, this situation is not just controlled by the "invisible hand" of the market. It is also largely determined by the highly visible "political" hand of state textbook adoption policies." (p. 6)

These points about commercialization and state adoption policies are important with regard to the inconsistencies in messaging in the California and Ghanaian textbooks when compared to Bangladesh. As indicated previously, the textbook production and adoption process in Bangladesh is centralized and operated by the government, which is in contrast to California and Ghana where textbooks are developed and published by private actors. Along these lines, in both California and Ghana, as argued previously, there are multiple actors (governments and private

publishers) and as Colston and Ivey (2015) observed, "Textbooks are mediators in relationships between other teachers, administrators, textbook publishers, and state evaluators" (p.4). What this suggests is that to unpack and make sense of climate change curriculum in California and Ghana is to attend to the role and vision, power struggles, negotiations between the multiple actors referenced by Colston and Ivey (2015), Apple (1992) and Hess (2009). Here, it is important to add that the state and private level actors are not the only factors to consider in the conceptualization of the climate change curriculum. As I noted previously in this section and extensively in Chapter 2, climate change education is influenced and organized by larger systemic and seismic shifts in science, economics, culture and politics at local, regional and global scales.

Impacts of Climate Change

My analysis revealed that the Californian textbooks took seriously the local impacts of climate change as evidenced by the fact that the texts discussed the mainstream impacts of climate change, such as sea level rise, flooding, wildfires, but connected them to local contexts in California. For instance, consider how the impacts of sea level rise is discussed in the middle school textbook:

> "Humans are vulnerable to the changes that are occurring and will continue to occur as a result of global warming. Millions of people across the United States live in coastal communities, such as San Francisco" (Savvas, 2020, p.69).

In the statement above, there is explicit and tacit acknowledgement of the fact that rising sea levels have serious consequences for cities like San Francisco. It is important to highlight that on the page from which this quote was extracted, the text showed an image of high-rise buildings in San Francisco, a bridge, and rising water levels. Previous research by Meehan et al., (2018) about Savvas textbooks (formerly Pearson, Inc.), which were produced in California, concluded that there was broad and generic messaging about climate change consequences. However, my analysis reveals the opposite, showing that California textbooks have upgraded their content to center on more local perspectives. For instance, consider another example, from the Grade 4 textbook and its subtle terms and references to California's wildfires:

> "But during a drought, grasslands and forests dry out. One lightning strike can cause a wildfire, a fire that burnt out of control. Wildfires can burn huge areas of forests and grasslands. In 2017, wildfires in California burned 1.2 million acres of land" (Savvas, 2020, p.27).

In the statement above, the text mentions the linkages among drought, ecosystems, and wildfires in California. However, it is important to acknowledge that the science on linking climate change to wildfires is still not fully established (Keeley et al., 2007; Wong-Parodi, 2020; Goss et al., 2020). Here, unlike discussion of the causes of climate change wherein scientists have overwhelmingly determined that human activity is a cause, the impacts of climate change are still open to discussion amidst changing evidence. Here, applying Hess (2009)'s "settled" and

"open" framework to make sense of climate change impacts in textbooks is inadequate or falls short of capturing the complexity or impacts or solutions to climate change. Hess (2009) acknowledges the limitations of the open and closed framework, and as she argues:

> Empirical questions are those that can be answered through systematic inquiry requiring observation or experimentation — such as whether climate change is occurring. Policy issues are what we should do as a matter of policy — they are broader than empirical questions. For example, what we should do to stem the problems caused by climate change is a policy issue. (p.1)

In the statement above, Hess (2009) acknowledges that questions about climate change impacts and ideas about the appropriate solutions to climate change are still open to debate and discussion. This is related to Apple (1992)'s point about "controversies over 'official knowledge' that usually center on what is included and excluded in textbooks really signify more profound political, economic, and cultural relations and histories" (p.4). Along these lines, I found that there was a tension in the textbooks between addressing the causes of climate change and addressing its impacts. In other words, there were questions about observed or perceived impacts of climate-related events and the driving forces behind them. The California textbooks, as I will argue, have sought to address these complexities by using specific language to describe the causes of climate change. For instance, consider the text below from the Grade 6 textbook:

> "There are more dairy cows in California than any other state in the country. But raising livestock, producing feed for them and waste produced from agriculture contribute to greenhouse gas emissions such as nitrous oxide and methane. It is estimated nearly 9 percent of all greenhouse gas emissions in the United States come from agricultural activities" (Savvas, 2020, p.1).

In the text above, raising cows is directly linked to greenhouse gas emissions, and these specific connections can be employed when discussing human activities and climate impacts. This textbook uses specific examples from California and highlights their contributions to climate change, which provides a useful context when discussing climate impacts that are contested, such as the wildfires.

As mentioned previously, this dissertation is also concerned with missing messages about climate change in the text. My analysis revealed that the impacts of climate change on racial and ethnic minorities was not acknowledged in the California texts even though we know that climate impacts have dire consequences for racial and ethnic minorities in the sense that the resources (Wealth, Housing, Health Care) available to these groups are inadequate to cope/live with the impacts of climate change (Liévanos, 2018; Winter et al., 2019; Curtis & Schneider, 2011). However, when the impacts of climate change were discussed in the textbooks, these ideas were left out. For instance, consider how climate impacts are framed in the Grade 6 California textbooks:

> "Polar Regions Under Threat- In addition to causing a rise in global sea levels, melting conditions in polar regions appear to have set off a chain reaction of other negative climate effects. Higher temperatures allow the atmosphere above the ice caps to hold more water vapor, which acts as a greenhouse gas. The loss of reflective ice covering polar seas also allows solar energy to be absorbed by ocean waters, increasing temperatures even more" (Savvas, 2020, p.71).

In the statement above, the text acknowledges that melting ice and rising temperatures have consequences for polar environments. However, the text does not acknowledge human impacts – and more specifically climate change impacts – on communities that are located in polar regions. We know that native, American Indian, and other indigenous communities reside in polar environments and that climate change has severe consequences for their livelihoods (Herman-Mercer et al., 2016; Zentner et al., 2019; Vincent, 2020). As a corollary, it is important to mention that in the current debates over the teaching of race in American schools, the role of textbooks in highlighting climate impacts on racial and ethnic minorities needs to examined. To date, very little research has looked at how race and social class are positioned in textbooks when climate change is discussed. In that regard, it is important to emphasize here that threats to Black, Hispanic, and other ethnic minorities are not mentioned when climate change impacts are discussed in the Californian textbooks.

Solutions to Climate Change

My analysis revealed that textbooks from California presented both generic and localized perspectives when it came to policy solutions to address climate change. The texts focused mostly on measures to reduce carbon dioxide in the atmosphere through climate mitigation, while there was very little in terms of policy solutions to live and cope with the impacts of climate change through climate adaptation. For instance, consider how the Grade 6 California textbook framed measures to cut down on carbon emissions:

> "California is a leader in developing and mandating the use of energy-efficient technologies. In 2015, a state law was passed that mandates a minimum of 50% renewable energy usage by state-regulated utility companies by the year 2030. Even more aggressive laws have been proposed" (Savvas, 2020, p1).

The excerpt contains three important ideas: developing efficient technologies, legislation to encourage renewable energies, and the role of California's utility companies. Here, we observe that all three propositions are local-based and reflect California's state climate policy. In that regard, one could argue that the text – in this particular instance – attends to local perspectives and is in alignment with California's climate policy.

It is worth noting that the inclusion of "legislation" as a solution to climate change in the Californian textbook differs remarkably from the textbooks from Bangladesh and Ghana. Neither of these countries includes government legislation or mandates as part of its climate mitigation approaches. California is unique in this regard among the materials from the three countries considered here. However, it is also worth noting that Bangladesh and Ghana are

really not exceptions in a more general sense, given that the inclusion of legislation or policy in science textbooks is rare. Historically, science education textbooks have focused on providing empirical knowledge or established facts over contentious policy debates (Rudolf, 2020; Reid et al., 2021; Sadler, 2004, & 2009).

Here, it is important to mention again that Hess's framework, which considers how issues are treated—either as "open," "closed," or "tipping"—falls short in addressing the policy questions and solutions to climate change. The limitations of Hess's framework to address climate policy result from the fact that policy questions in science textbooks as well as teaching students about policy questions can be particularly challenging with a subject like climate change where there are many competing interests and agendas at multiple levels of scale (Turnbull, 2020; Sovacool, 2013; Zhang et al., 2011). Some of those with clashing interests with regard to climate change include politicians, industry leaders (automobiles and oil companies) and, in the case of California, agriculture and technology industries as well. Hence, unlike the causes of climate change, which can be theorized as settled or unsettled according to Hess (2009), policy questions about how to address climate change are neither settled nor unsettled but depend on wide ranging factors at local, regional and global scales. In addition, and as argued previously, scientists have been emphatic that the science underpinning the cause of climate change is settled.

As a corollary to the nuances of climate policy, the challenge for teachers who are teaching about policy questions or proposed legislation is to help students disentangle and delineate the causes and effects of climate change and also help them understand the scale at which climate change impacts a population and what practical steps can be taken to address climate change. This major challenge makes it difficult for curriculum and policy to be aligned

since policy prescriptions involve many compromises and multiple parties in a democratic system. For instance, there are on-going debates as to whether the wildfires in California can be attributed to climate change or to poor federal and state forest management, and there are debates about what to do about the wildfires. Hence, policy solutions concerning events such as wildfires and other climate events need to be approached in complex ways. However, we know that textbooks often fall behind in terms of including new evidence, caveats, and complex evidence (Roman & Busch, 2016; Busch, 2021). Across urban schools in North America as well as in schools in the global South, older versions of textbooks often continue to be used in teaching and learning. However, this exacerbates equity issues regarding robust climate change education, particularly for students from minoritized or low socioeconomic communities across the globe must receive. California is no exception and in fact, with the shift towards digital and interactive texts, there will be further gaps in access to textbook resources for Black and Hispanic students, which will further entrench unequal access to climate change education.

Finally, robust climate change education – at least in the case of California – is vital for one main reason. We know that working class and minoritized communities in both rural and urban areas of California are particularly vulnerable to the impacts of climate change. A robust climate change education that tackles complex policy questions and considers the economic and political dilemmas of climate policy is necessary to nurture climate consciousness among marginalized youth. As mentioned previously, the recent debates over teaching about racial injustices has once again spotlighted the need for an expansive climate policy education that considers the nuances of economics, race, and geography. In the light of larger debates about race and equity—and in the case of California, the tensions surrounding the state's ethnic studies curriculum—it is important to question whether textbooks and climate change curriculum will

address racial/ethnic/class disparities and also to consider whether science textbooks are the appropriate place to discuss contentious policy issues.

Ghana Textbook Analysis

In this section, I present an analysis of the Ghanaian textbooks whose content I described briefly in the first section of this chapter. I discuss the contents of the textbooks and provide contextual explanation as to why certain kinds of messages about climate change are present or absent from them.

Causes of Climate Change

My analysis revealed that Ghanaian textbooks presented a settled perspective on climate change. Here, the cause of climate change was attributed to human activity or in other words, a "human activity" frame was used to communicate the settled perspective on climate change. For instance, consider the framing in the Grade 6 and Middle School science textbooks represented in the boxes below:

Grade 6	Middle School
"There are certain human activities that causes climate change. Examples of these activities: Burning (Fossil fuel, Bush burning, Burning of rubbish), Smoke from car exhaust, deforestation" (Ruben, 2021, p.147).	"Burning wood for the purposes of fuel. Burning of wood results in the production of high amounts of carbon dioxide and Methane into the atmosphere. Moreover, burning of coal and oil results in the production of more carbon dioxide in the atmosphere" (Aki-Ola, 2018, p.298).

In the two statements above, when employing language such as "burning" and "fossil fuels," the Ghanaian textbooks acknowledge the contribution of fossil fuels and other human activities to climate change. The language and framing used in this text is consistent with how international organizations have discussed and written about climate change (NASA, 2016). Ghanaian education has historically been influenced by western ideas (Adjei, 2007; Quist, 2001), thus, it is not surprising that the Ghanaian textbooks adopt some western framings and language. One can argue that western influences can be problematic when they impose foreign constructs and ideas that do not apply to local contexts in countries like Ghana (Adjei, 2007; Quist, 2001). However, in this instance, they have influenced the consensus perspective on climate change and have contributed immensely to climate education in Ghana. As Apple (1992) observed, cultural influences cannot be viewed entirely through the lens of power and domination. In that regard, I would argue that western influences on the "settled" perspective on climate change could be considered a good thing rather than an act of domination. For instance, the United Nations and the Government of Ghana have teamed up to launch a "National Climate Change and Green Economy Learning Strategy," which aims to foster climate literacy among the Ghanaian populace (United Nations, 2016). Among other things, the learning partnership has led to professional development workshops for primary school teachers on how to teach relevant climate content in Ghanaian schools (United Nations, 2020).

As a corollary to the United Nations influences on Ghana, it is important to reiterate the ideas about the globalization of education mentioned earlier wherein western norms about curriculum are imported to former colonies in the Global South. Apple suggests, as noted above, that this is not entirely a process of domination. The "settled" framing of the causes of climate change in Bangladeshi and Ghanaian textbooks is consistent with the vulnerabilities of these

countries to climate change, as well as existing forces of globalization and mobility that have shaped educational policy and curriculum in these countries in significant ways.

Globalization and mobility have led to ideas from the West influencing societies in the Global South through generous funding schemes (Smith, 2005; Fichtner, 2010), as well as a burgeoning of Global South intellectuals trained in Western higher education institutions (Nwauwa, 2020). For instance, Ghana's current minister of Education was trained at the University of Southern California and in less than three years since his tenure, Ghana has witnessed sweeping reforms to education such as the introduction of climate change education in primary schools, the institution of teacher certification examinations, the development of common core standards, and a radical shift towards educational policies aimed at global competitiveness (Ministry of Education, 2020). This is not to say that Western and global influences are solely responsible for these shifts in education in Ghana. Rather, I make this point to call attention to the fact that messages about climate change in the texts cannot be decoupled from the larger social forces and ideas that are changing and governing education in developing countries like Bangladesh and Ghana.

Impacts of Climate Change

I found that Ghanaian textbooks presented mixed messaging about the impacts of climate change. Here, the primary school textbooks attended to local contexts, while the middle school and high school textbooks presented generic and overly broad impacts without attending to local contexts. All the textbooks highlighted similar climate impacts such as floods, drought, and change in seasons. For instance, consider how the Grade 6 textbook and Middle School textbooks discuss climate impacts as it relates to changes in weather patterns in the boxes below:

Grade 6:	Middle School**:**
Have you noticed that it could rain anytime of the month lately? This is a result of change in climate, which has caused changes in the rainfall pattern. This affects human lives in so many ways. Farmers are unable to keep proper track of when to grow and when not to grow some crops (Ruben, 2020, p. 149).	An increase in global temperatures may in turn cause other changes, including sea level rise and changes in the amount of precipitation resulting in floods and drought (Aki-Ola, 2018, p. 298).

As indicated above, in countries like Ghana, textbooks are the primary instructional material available for science instruction and therefore, there is a need for local and culturally relevant climate instruction. In the two statements above, the Grade 6 textbook connected changes in precipitation patterns to agriculture, which seems appropriate given that Ghana depends heavily on agriculture (Lanz et al., 2018).But the textbook from the middle school science textbook listed technical terms such as "precipitation" without discussing what that means for the way Ghanaians live their lives. Here, in the text above we see that the elementary science textbook connects rainfall to agriculture an important economic activity in Ghana. However, the middle school textbooks do not link the impacts of rainfall to any Ghanaian context. It is important to state that the differences in how climate impacts are portrayed in both textbooks can be explained by the decentralized process of textbook development and production in Ghana.

In Ghana, Grade 6 and Middle School textbooks are authored and produced by different private publishing houses. The Ghanaian government develops science standards and authorizes

private companies, such as Ruben and Aki-Ola, to produce textbooks based on these standards. As we know, different publishers in the U.S. produce private and commercial textbooks with different emphases and foci (Morning, 2008; Meehan et al. 2018). However, in Ghana, how different private publishers frame particular subject matter is an understudied issue. As indicated previously, both Ruben and Aki-Ola are publishers that have been granted authorization by the government of Ghana to produce textbooks. My analysis revealed that the Ruben series of textbooks and the Aki-Ola series of textbooks had different messaging about climate change impacts. The primary school textbooks from Ruben attended seriously to local contexts when compared to the more general and generic middle school textbooks from Aki-Ola.

It is interesting to note that the textbook development and production process in Ghana differs significantly from the process Bangladesh. While the government prints textbooks in Bangladesh, in Ghana the government authorizes private publishers to produce them. This explains the coherent messaging on climate impacts in the Bangladeshi textbooks when compared to the Ghanaian textbooks. In this regard, Ghana is more similar to the United States in that private publishers are authorized by the state to produce textbooks. The major difference between Ghana and the United States in this context is that Ghana functions with a centralized government education system, while in the United States; each state approves textbooks based on the state's science standards. As Apple (1992) and Hess (2009) have rightly argued, different jurisdictions have different visions of education, which are borne out of political, economic, and social systems. The three contexts under study in this dissertation have varied socio-political systems and are organized differently at various levels; both of these differences influence textbook production and subsequent messaging about climate change. The United States is a powerful capitalist economy with a decentralized educational system at multiple levels, whether

in the adoption of science standards or in the textbook production process itself. Ghana, on the other hand, is a former British Colony with a mixed economy and a centralized adoption and development process of curriculum, wherein textbook production is in the hands of private publishers. Here, Ghana and the United States differ in terms of the adoption of science standards. Whilst the United States has a decentralized process, Ghana has a centralized ministry of education that is in charge of developing science textbooks.

The centralized vs decentralized textbook production process and the power and politics of curriculum are largely understudied in curriculum studies. Apple (1990 &1992) in many instances has argued that textbooks represent the cultural politics of the state at various levels, whether it is the state's decisions and choices about curriculum or the power entrusted into the hands of private commercial publishers. In the case of Ghana, and when it comes to climate change, the authority of the state being relinquished to private commercial publishers has had a significant influence of how the subject matter is portrayed in the textbooks.

Solutions to Climate Change

The Ghanaian textbooks presented local, generic, and broad measures to reduce climate change. Overall, the elementary school textbooks linked solutions to reduce climate change to the lived experiences of Ghanaians. On the other hand, the middle school textbooks presented broad solutions to climate change. For instance, consider how the Grade 6 and Middle grade textbook frame solutions to climate change as represented in the boxes below:

Grade 6:	Middle School:
"One major way to control climate change is by conserving electricity and learning to	"Global warming can be reduced by; encouraging the use of natural gas and

recycle our waste materials. This will help reduce the amount of smoke released into the atmosphere through the burning of fossil fuels" (Ruben, 2020, p. 149).	liquefied petroleum gas" (Aki-Ola, 2018, p.298).

In the statements above, and similar to the manner in which the impacts of climate change were portrayed, we see in the example that the Grade 6 textbook frames climate change using local examples such as recycling, which has become ubiquitous in Ghana in the last decade. The language of the Grade 6 textbook is also simple, accessible, and avoids technical jargon. The text uses the pronoun "our" to indicate collective responsibility. In the Grade 6 textbook, there are sketches/drawings of young people holding placards in English and carrying signs such as "Save Trees," "Save the Forest," and "Save Lives, plant more trees." The images are captioned "Campaign on Climate Change." "Here, one can argue that the text uses the image to position young people as activists and agents in the fight against climate change. The Ghanaian middle school textbook, on the other hand, shows no images to represent local responses to climate change and as shown in the box above, the text employs technical jargon that is removed from the Ghanaian context and does not attend to the way Ghanaians live their lives.

It is important to state that regardless of the framing—whether focusing on contextual solutions or generic ones—neither text acknowledges or references Ghana's burgeoning commercial oil and gas industry. The decision to include that perspective remains a contested one because of the cultural politics in Ghana, which involve the "very nature of the connections between cultural visions and differential power" (Apple, 1992, p. 7). In regards to this, it is also important to highlight the fact that at the top level of government, Ghana accepts the idea of

human-induced climate change but also pursues oil exploration ventures. In fact, at the recent climate conference in Glasgow (United Nations, 2021), the President of Ghana argued that Ghana was going to increase its oil exploration despite the concerns of climate change, and called instead on developed countries to cut down on their emissions and contribute towards efforts to fight climate change (United Nations, 2021). The tensions between economics and climate change remain ongoing whether in Bangladesh, California or Ghana, which confirms Apple's argument that "conflicts over texts are often proxies for wider questions of power relations" (p.4).

While Apple's (1992) ideas apply to Ghana to a great extent, Ghana (and other countries in the global South) have shown that support for the conclusion that climate change is human-induced can coexist with support for fossil fuel explorations. This is because countries like Ghana do not perceive themselves as mainly responsible for climate change and hence are not ready to shift or move away from fossil fuel explorations and even though they recognize the threats of climate change to their respective countries. For instance, during a speech at the recent climate change conference in Glasgow, the president of Ghana, Nana Akuffo- Addo argued that:

> The development and industrialization of today's wealthy nations were also hinged on the exploitation of their natural resources. This development came at the expense of pollution and the emission of greenhouse gases. Even today, the western world is responsible for 76% of carbon emissions. Ghana acknowledges the importance and effects of Climate Change and the urgent need to combat it, and we acknowledge equally the importance of protecting our development. However, we believe that a balance must be struck and maintained between our social, economic and environmental imperatives (Akuffo- Addo, 2021, p.1).

In the statement above, the president of Ghana highlighted two key issues. First, he laid the blame for global emissions on developed nations. Secondly, he argued that the economic opportunities and revenues that natural resources provide were key to the development of Ghana. The point about economics is similar to points that describe the situation in countries like the United States, where climate change is also underpinned by economic arguments. However, the two countries are organized differently in terms of its politics. The United States is a multiracial democracy with 50 states and multiple levers of power and decentralization. Hence, multiple sites of engagement allow local politics to play a major role in curriculum decisions. Ghana, on the other hand, operates a government where the levers of power are mostly centralized. Therefore, there are very few local avenues and proxies for curriculum controversies. The political structures and organizations described above are crucial to understanding the politics of curriculum, selection of content by publishers, and subsequently what ends up in the curriculum as legitimate climate change knowledge.

Comparisons across Bangladesh, California and Ghana

Considerations of textbooks and other curricular materials cannot be decoupled from the powers and contexts that give rise to them. Along these lines, Apple (CITE) has argued that the curriculum is a kaleidoscope of how different societies are organized differently. My analysis revealed some differences in how climate change is positioned in textbooks from Bangladesh, California, and Ghana. In the next few paragraphs, I highlight some of the similarities and differences in climate change content in these three contexts.

As argued in previous paragraphs, the textbooks in all three contexts acknowledged and included human-induced climate change. In other words, the textbooks in all three contexts noted that human activity was the primary driver of climate change. Despite these similarities,

however, there were some striking differences in how the scientific consensus that underpins the human activity argument was framed across the texts. Texts in Bangladesh acknowledged both the human activity argument and the scientific consensus framing. Across the textbooks that were analyzed, there was consistent messaging whether the text was discussing the role of human activity or the scientific consensus on human induced climate change. As noted in previous sections, the consistent messaging found in the Bangladeshi textbooks can be attributed, at least in part, to the fact that a single entity (the Bangladeshi Government) is responsible for the development and distribution of textbooks. We know that consistent messaging is a feature of a centralized educational and curriculum development system, like the one in Bangladesh.

Similar to Bangladesh, Ghana also uses a centralized educational system. However, unlike Bangladesh, Ghana leverages the private sector in the development and production of textbooks, which gives rise to the inconsistency in messaging across the Ghanaian textbooks that were analyzed. With respect to the framing of climate change issues as human-induced and based on scientific consensus, Ghanaian textbooks did not include the notion of scientific consensus regarding climate change in the textbooks. Ghana's Ministry of Education-approved syllabus does not mention the scientific consensus regarding climate change. At this point, however, there is no evidence in the news or in politics that Ghana deliberately excluded the notion of a scientific consensus regarding climate change, and we also know that Ghana has consistently acknowledged the need for climate change education, whether in curriculum or in policy documents. It may be that the acknowledgement of human induced climate change in Ghanaian textbooks is purely an editorial decision rather than suggesting that Ghana denies scientific consensus on climate change. As mentioned previously, textbooks are a product of

many author, editor and publishing decisions and the Ghanaian textbooks are no exception to these editorial decisions. But climate change is a settled issue in Ghana.

As indicated earlier, the Californian textbooks acknowledged the role of human activity but in terms of scientific consensus and compared to Bangladesh, it presented mixed and inconsistent messaging. This is historically in line with how climate change has been positioned in California's textbooks, and, as we know, the content of textbooks produced in the United States cannot be decoupled from commercialization and the textbook market. We know that textbooks produced in states such as California find their way across the United States and into jurisdictions where climate change is considered controversial. It may well be that because California based textbooks are used elsewhere in the United States, including in places where climate change is considered controversial, textbook producers make the editorial decision to present a "both-sided" narrative with regards to the scientific consensus. Here, presenting a mixed message or narrative about climate change allows textbooks produced in California to cross over into other states textbook markets. Or in other words, the mixed messaging allows textbooks to avoid criticisms of liberal bias and activism.

A striking similarity across the textbooks I examined in all three contexts, was that examination of the extent and nature of climate change impact on poor and marginalized communities was omitted from the text. For instance, it is well known that in Bangladesh, climate change significantly affects refugees living within its borders. In the case of Ghana, climate change disproportionately affects rural and agrarian communities. Similarly, in California, the state's rural and urban poor are especially susceptible to the impacts of climate change. However, the textbooks in all three countries did not acknowledge or reference these and other related impacts. As argued previously, nation states are often reluctant to include

contentious material in their textbooks except when the content extols or highlights a nationalist identity. Topics such as race in California and ethnicity in Bangladesh and Ghana elicit strong debates and controversies over equality, equity, and national identity, which may explain the omission in textbooks. However, despite these omissions of issues related to race and equity, taken together, the similarities and differences across the three contexts revealed that when it comes to the subject of climate change, Bangladesh, California and Ghana seek to empower their students with knowledge about human induced climate change. However, I argue that there are cultural (Bangladesh), editorial (Ghana) and commercial (California) factors that moderate how the scientific consensus on climate change is presented. In as much as these countries succeed in including human induced climate change in the curriculum, there are nuances and variations when it comes to the solutions and impacts of climate change. And as discussed above, textbooks in each context attend to both local and generic impacts and solutions to climate change in diverse ways, some more than others.

CHAPTER FIVE

The Framing of the Causes of Climate Change and Policy Solutions in Supplementary Educational Materials

This chapter focuses on climate change materials disseminated by the Heartland Institute and the Paleontological Research Institution, both organizations in the United States, and by the United Nations (UN), an international organization; each set of materials is described in detail below. The chapter presents a portrayal of the causes of climate change in materials from the Heartland Institute and the Paleontological Research Institution. The chapter also focuses on solutions to climate change with respect to an educational document from the United Nations. I argue in this chapter that the portrayal of the causes of climate change in select material from the

Heartland Institute and the Paleontological Research Institution must be understood in terms of political polarization and economic developments in the context of the United States. The chapter also argues that the framing of solutions to climate change in the material prepared by the United Nations has also been influenced by geopolitics as well as by structural and systemic challenges pertaining to countries in the Global South.

To build the arguments above, this chapter analyzes how the causes of climate change were portrayed in materials from Heartland Institute and the Paleontological Research Institution. Because the causes of climate are inextricably linked to the solutions to address them, the chapter also discusses solutions to climate change that arise from certain portrayals of the causes of climate change in the materials from Heartland and the Paleontological Research Institution. Similarly, the chapter analyzes how climate solutions are presented in the text from the United Nations. Lastly, the chapter compares the portrayal of climate change in the texts from Heartland and the Paleontological Research Institution and connects them to my previous analysis of the causes of climate change in California textbooks. As a corollary to the above and to the broader context of using official textbooks and supplementary materials in teaching and learning, the chapter connects my analysis of the UN text to the textbooks from Bangladesh and Ghana.

Using previously described frameworks from Hess (2009) and Apple (1992) as theoretical lenses, this chapter makes arguments about the causes of climate change in materials from Heartland and the Paleontological Research Institution and solutions to climate change from the United Nations document. These are based upon an analysis of the texts following the analytic approaches described in Chapter 3, coupled with information about each organization's ideological position and the context in which it operates. For instance, in analyzing and

discussing the contents of materials from Heartland Institute and the Paleontological Research Institution, it is important to note that both organizations operate within the United States and are in subtle (and sometimes not so subtle) opposition to each other in terms of ideology. I also consider the fact that the United Nations is a global organization whose materials are used mainly in the Global South and thus are influenced heavily by geopolitics and cultures/needs of the global South.

I begin by comparing the Heartland Materials with the Paleontological Research Institution materials, showing that messages about the causes of climate change are oppositional to each other. The Heartland materials reject the "settled" perspective (Hess, 2009) that climate change is caused by human activity and that scientists have reached a consensus on the matter. In direct contrast to the framing from Heartland, the Paleontological Research Institution portrays the causes of climate change from the settled perspective, emphasizing the point that science shows that climate change is caused by human activity, a point backed by an overwhelming consensus among those in the scientific community.

Following the comparison of Heartland and the Paleontological Research Institution, I turn to the document from the United Nations. My analysis shows that first; the United Nations proffers solutions to reduce the emissions of greenhouse gases, also known as climate mitigation. Second, the United Nations document discusses solutions that pertain to how to live and cope with climate change, which is characterized as climate adaptation. In both instances, climate mitigation and climate adaptation are portrayed with examples broadly drawn from the contexts and cultures of the global South.

This chapter is organized into three sections. The first section provides a brief description of the content of the materials from Heartland, the Paleontological Research Institution and the

United Nations. The second section contains the comparison of frames between Heartland and the Paleontological Research Institution. This section also connects the frames of Heartland and the Paleontological Research Institution to the California textbooks. Lastly, the third section depicts the portrayal of the solutions to climate change in the United Nations document. This last section connects the portrayal of the solutions to climate change in the UN document to the frames /messages from the Ghana and Bangladeshi textbooks.

Description of Supplementary Materials

In this section, I briefly discuss key content areas from Heartland, the Paleontological Research Institution, and United Nations Text. In the descriptions below, I highlight content that characterizes the ideological position of the Heartland, the Paleontological Research Institution and United Nations document.

Heartland Institute

Heartland Institute is one of the leading climate-denier organizations in the United States. In 2017, Heartland mailed a climate denier curriculum to more than 200,000 science teachers. The document, titled *Why Scientists Disagree about Climate Change,* is the subject of analysis in this chapter.

Why Scientists Disagree about Climate Chang, is organized into seven chapters. The first chapter, "No Consensus," attempts to cast doubt on the fact that an overwhelming majority of scientists have agreed that human induced climate change is real. The "No Consensus" chapter selectively cites studies that purport to debunk the scientific consensus on climate change. At first glance, the references seem to follow standardized scientific citations. However, a careful look at the citations reveal that peer-reviewed publications are rare. Instead, white papers from think tanks and opinion articles are positioned as counter evidence to the scientific consensus on

climate change. In situations where peer reviewed papers are cited, referenced, or discussed, one notices that Heartland relies on papers that comment on procedural claims about the scientific consensus rather empirical results that challenge current scientific understandings of climate change. For example, Heartland cites a paper by Dennis Bray (2010) titled, "The scientific consensus of climate change revisited." However, a closer look reveals that Bray's article is mostly concerned with survey data on whether scientists have agreed on climate change rather than with new empirical revelations about human induced climate change, which the article does not contain. As Dunlap (2012) observed, the aim of climate denial is to highlight oppositional arguments among scientists, even when the disagreements are not mostly about evidence.

Chapters 2 and 3 titled, "Why Scientists Disagree" and "Scientific Method Vs Political Science," argue that the scientific consensus frame is driven by politics and ideology rather than by science. It casts the scientific community as part of an elite liberal organization. For instance, in Chapter 2, the climate activism of former Vice President Al Gore is cited as proof of the politically biased nature of the scientific consensus on climate change. The logic here is that Gore is a politician, not a scientist, thus his lectures and presentations are biased and politically motivated.

Chapter 4, 5, and 6 represent Heartland's attempt to provide substantive empirical evidence and data to counter the evidence regarding human-induced climate change. The chapters are titled, "False Postulates," "Flawed Projections," and "Unreliable Circumstantial Evidence" respectively. These chapters are similar in many regards. All three chapters contain graphical representations and models that purport to challenge the data of the Intergovernmental Panel on Climate Change (IPCC). In many instances, the graphs are based on selected data from some peer-reviewed papers and think tanks. In some instances, Heartland provides commentary

on the graphics highlighting the supposed flaws in the IPCC model. Chapter's 4, 5, and 6 deviate from the three earlier chapters in that these chapters cite a lot of peer reviewed literature instead of policy documents from think tanks and news opinion pieces. But the literature reviews that Heartland cites in chapters 4, 5 & 6 do not tackle climate change models or long term climatic data. For instance, Heartland cites a paper written by Roderick et al. (2009) as evidence that there is no relationship between global warming and drought. However, the authors of this paper do not deny climate change. Rather as many scientists do, Roderick et al. (2009) challenge existing global estimations about drought and recommend more robust methods. This is a typical feature of climate science in that scientists continuously improve on the methods and evidence. But the nuances and caveats do not mean that the baseline evidence on climate change and drought is not established, as is implied in the Heartland material.

The final chapter, chapter seven, focuses exclusively on policy. Here, Heartland discusses its own policy agenda as it relates to the so-called evidence it has presented about climate change. In this chapter Heartland makes three key arguments. First, they argue that policy makers should seek out other sources of evidence beyond national and global scientific organizations such as the IPCC. The second argument is the idea that individual countries should set up their own climate agenda. Finally, Heartland concludes by admonishing the world not to spare scarce resources on what they describe as "politicized and unreliable science. I elaborate these points in the analysis section where I look at the economic, cultural and political incentives that explain Heartland's position on climate change. I also discuss the cultural war impetus that underpins Heartland's framing of the "no consensus" frame in its attempt to undermine the idea that climate change is human induced.

Paleontological Research Institution

The Paleontological Research Institution is an organization committed to climate change advocacy, teaching and learning and is affiliated with Cornell University. As indicated previously, the Paleontological Research Institution endorses the conclusion that climate change is human induced and focuses on the scientific consensus that backs this conclusion. The Paleontological Research Institution text analyzed in this dissertation is titled *The Teacher-Friendly Guide to Teaching Climate Change*, which is organized into 12 chapters with a common theme highlighting human induced climate change and the evidence that underpins it. The first chapter in the Paleontological Research Institution document is an exposition on climate change education. This chapter also discusses broadly the tensions between science and politics and the implications for climate change education. The second chapter in the Paleontological Research Institution document tackles the scientific consensus on climate change. Here, the text references both education scholars and climate change scientists endorsing human induced climate change. The text mentions scientists from organizations such as NASA as well as education managers from climate literacy networks and TERC (Technical Education Research Center). The central argument in the second chapter is that there is an overwhelming scientific consensus on human induced climate change. The third and fourth chapters are organized similarly, and both focus on the science of climate. These two chapters contain definitions, technical terms, scientific evidence, and graphic images that collectively lay the groundwork and provide the background for the evidence underpinning climate change.

The fifth chapter, "Evidence For and Causes of Recent Climate Change," focuses on proving that climate change is real and offers recent evidence of human activity inducing climate change. This chapter discusses global changing temperatures and the increase in carbon dioxide because of human activity. The chapter also concerns itself with concepts such as "Effects of

Climate Change," "Rising Sea Levels," "Greenhouse Gases," and "Shrinking Ice Sheets and Glaciers." Chapter 6 discusses regional climatic conditions across different geographies in the United States.

Chapters 7, 8, and 9 focus on climate change mitigation and adaptation. The connective tissue among the final three chapters is how to reduce carbon dioxide in the atmosphere and how to cope and live with the impacts of climate change. The content here is fairly generic, and it is similar to how climate change mitigation and adaptation are portrayed by scientific organizations such as NASA. Some of the mitigation measures include recommendations to shift away from the use of fossil fuels and toward technological innovation such as carbon dioxide removal and renewable energies. The adaptation measures highlight technological innovation and robust public policy toward building infrastructure and ecosystem restoration, among others. It is important to state that the climate mitigation and adaptation measures discussed in the Paleontological Research Institution material are similar to the ideas that occur in the California textbooks. Chapter 10 and 11 return to the ideas discussed in Chapter 1. Here the text rehashes and reiterates the need for climate change education. It tackles the controversy over teaching climate change and calls for a robust dialogue and empathy on the subject matter. In these chapters, subtitles such as "Resistance to Change is not Equivalent to Lack of Education," "Use of Language and Perspective in Teaching Climate Change," and "Science Teaching Toward a Sustainable World," are used to communicate the larger point that there is a need for complex understandings and teaching of climate change.

The final chapter is a question and answer section that attempts to debunk misconceptions about climate change. This section includes questions such as "How do we know the increase in CO_2 since the 1800s is from human activities?" "Is there consensus among

climate scientists that global warming is occurring and that humans are the cause?" "How can we be sure that changes going on now are not just part of natural climate variation?" The chapter aims to correct some of the misinformation around climate change.

United Nations

The United Nations document, titled *Children and Climate Change,* is divided into five sections. The document proposes this overall goal for its users who are expected to:

> Learn how children are and can be impacted by climate change, how children's resilience could be strengthened, and how measures to reduce greenhouse gas (GHG) emissions could lead to a wide range of benefits. You will also be reflecting on solutions, focusing on the empowerment of children as actors of change and on the key role of governments in children's protection. Several examples, interactive exercises and links to external resources are made available to support the content. (p.1)

The first section of the UN document tackles the impact of climate change on children. The text discusses key impacts such as "drought and water stress," "floods and severe storm," "heat stress," and "air pollution," and how they negatively affect the health, wellbeing, and development of children.

The second and third sections of the United Nations document focus on climate adaptation and mitigation measures that can support children's resiliency to the impacts of climate change. Here, the text discusses measures such as cutting greenhouse emissions, education, nutrition and enabling an environment that fosters child wellbeing. The text uses examples from countries such as Bangladesh, Zimbabwe, and Central African Republic. The fourth section of the UN document focuses on climate change education policy. Here, the UN

advocates for three types of climate change education, which are formal education, non-formal education, and informal education. These communicate the idea that we need multiple avenues to teach children about climate change. The chapter recommends that when stakeholders "educate [children] about climate change, it is important to incorporate the subject in all aspects of the formal education system. Common strategies include reviewing the curricula with information relevant for local adaptation; [and] preparing teachers with appropriate content" (p. 78).

The last and final section of the UN document focuses on policy agendas that address the needs of children during the climate crisis. Here, the text reiterates some of the previous content from the early sections. Topics such as climate mitigation and climate adaptation are framed as part of the policy agenda for children. This section argues for robust government efforts and policy towards protecting and building the resiliency and knowledge of children in the fight against climate change.

The descriptions of the pages above from Heartland, the Paleontological Research Institution, and the United Nations show that each document is different. However, in each of these documents, climate change content and perspectives are in line with the ideological positions and missions of each organization.

Comparative Analysis of Heartland and the Paleontological Research Institution

This section presents an analysis of the materials from Heartland and the Paleontological Research Institution, comparing and contrasting how the causes of climate change are portrayed in both sets of materials. In the paragraphs below, I present the frames that are used to characterize/denote the causes of climate change in the materials from Heartland and the Paleontological Research Institution respectively. Before delving into the frames actualized from my analysis, I discuss briefly the use of framing in this dissertation and in particular this section.

Frames accentuate the social, political, cognitive, and discursive elements of human experience. They are deployed in discourses on public policy to mobilize allies, recruit new members, or reject other frames (Fisher, 1997; Burgers et al., 2016). In education, frames about climate change, evolution, school choice, critical race theory, secular humanism, and sex education reflect larger fractious debates and competing visions in a pluralistic democracy. For instance, Price et al. (2005) observed the deployment of a frame about the destruction of the traditional family unit as a tactic for critique of gay civil unions, Cochran-Smith and Fries (2001) reported the use of "evidence," "outcomes," and "politics" as frames for policy advocacy in competing discourses around teacher education reform, and Stone (2002) noted the construction of a "villain" frame in many debates about policy prescriptions and problem definitions. Climate change education controversies mirror long-standing ideological debates about the mechanisms of education in American society. Frames in education "bear some meaning, direction, intent, and they orient or focus attention, perception and action" (Berryman and Sauvé, 2013, p. 134). Thus, I argue that by examining the ways in which Heartland and the Paleontological Research Institution build their positions, it is important to identify the frames and framing they use. As Benford and Snow (1992) observed:

> Frames are constructed in part as movement adherents negotiate a shared understanding of some problematic condition or situation they define as in need of change, make attributions regarding who or what is to blame, articulate an alternative set of arrangements, and urge others to act in concert to affect change. (p.5)

In the statement above, Benford and Snow (1992) argue that frames are mental building blocks used to construct reality for a large group of people. In the climate change education debate, Heartland and the Paleontological Research Institution construct frames to communicate their

viewpoint on the causes of climate change. As argued earlier, these two institutions are in subtle (and sometimes not so subtle) opposition to each other and are ideological opponents in terms of the causes of climate change. For instance, in 2017, Heartland mailed more than 200, 000 copies of their curriculum "Why Scientists Disagree about Climate Change." In response to Heartland, Alexandra Moore, a Senior Education Associate at the Paleontological Research Institution indicated, "We were just about to send this book to the printer in the spring of 2017 when we read that climate change deniers at the Heartland Institute were mailing out 200,000 copies of a climate denial booklet to teachers nationwide. We knew we had to respond" (p.1). In the statement above, the Paleontological Research Institution admitted that Heartland's campaign influenced their own outreach programs. Both organizations have done significant outreach to schools and educational communities to get their materials into the hands of the public. And as mentioned previously, both curricula (*Why Scientists Disagree about Climate Change* and *Teacher Friendly Guide to Climate Change*) are the subject of my analysis in this chapter.

My analysis revealed that the Paleontological Research Institution framed the causes of climate change using two main points/arguments. These arguments include two major frames, which I call the "scientific consensus" and the "human activity" frames, respectively. In short, the scientific consensus frame is based on the argument that an overwhelming majority of scientists around the world have reached a consensus on climate change. The human activity frame reflects the conclusion that human activity is the primary driver of climate change.

Heartland disagrees with both of the frames for climate change used by the Paleontological Research Institution and rejects the arguments put forth by the Paleontological Research Institution. In contrast, Heartland makes it arguments using two different frames, which I refer to as the "no consensus" frame and the "doubt" frame. The no consensus frame

reflects rejection of the idea that scientists have agreed on human induced climate change, while the doubt frame is an attempt to bring uncertainty to the conclusion that human activity is primarily responsible for climate change. In the next paragraphs, I focus on the two opposing frames "Scientific Consensus" and "No Consensus" from the Paleontological Research Institution and Heartland. In the following excerpts, consider how the "Scientific Consensus" and "No Consensus" frames are depicted in the text from the Paleontological Research Institution (left) and Heartland (right) respectively:

The Paleontological Research Institute	Heartland Institute
"Multiple studies published in peer-reviewed scientific journals show that 97 percent or more of actively publishing climate scientists agree: climate warming trends over the past century are extremely likely due to human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position" (Paleontological Research Institution, 2017, p.242).	"Extensive survey data show deep disagreement among scientists on scientific issues that must be resolved before the man-made global warming hypothesis can be validated. Many prominent experts and probably most working scientists disagree with the claims made by the United Nations' Intergovernmental Panel on Climate Change" (Heartland Institute, 2017, p.21).

Before delving into the two statements from Heartland and the Paleontological Research Institution, it is important to mention that the term "consensus" appears 122 times in the

Heartland document and 22 times in the Paleontological text. This goes to show that both institutions are very much aware of the controversy surrounding the scientific consensus.

In the text above, Heartland uses language such as “deep disagreement among scientists,” and “issues that must be resolved,” to argue that there is significant evidence showing scientists have not reached the consensus that climate change is human induced. Heartland also asserts that “prominent experts” disagree with the findings of the “United Nations Intergovernmental Climate Change Panel.” While Heartland contends that there are disagreements among scientists, the Paleontological Research Institution leans into the idea that scientists have indeed reached a very strong consensus on human induced climate change. Citing a “97%” agreement among scientists, the Paleontological Research Institution argues that established scientists around the world have concluded that there is clear scientific evidence for human induced climate change. The oppositional arguments by both Heartland and the Paleontological Research Institution must be understood in the context of larger debates in American culture about whether there is scientific consensus on climate change. In other words, the missions of Heartland and the Paleontological Research Institution represent competing arguments about the nature of climate change and the climate change curriculum in the United States. As Apple (1993) rightly observed:

> Education is deeply implicated in the politics of culture. The curriculum is never simply a neutral assemblage of knowledge, somehow appearing in the texts and classrooms of a nation. It is always part of a selective tradition, someone’s selection, and some group’s vision of legitimate knowledge. It is produced out of the cultural, political, and economic conflicts, tensions, and compromises that organize and disorganize people. (p.1)

Apple illuminates the intricacies that produce curricula in American schools. He argues that curricula are developed, organized, and enacted based on salient political ideologies. These ideologies are undergirded by economics, religion, and cultural values. Different views about the curriculum co-exist because different communities have different visions of how curricula should be organized. Climate change education is no exception. Different communities in America have different visions of climate change, and the Paleontological Research Institution and Heartland represent vastly opposing ideological commitments and communities. Here, the framing of the Paleontological Research Institution about climate change in terms of "scientific consensus" framing is embraced by groups such as National Science Teachers Association, National Research Council, American Meteorological Society, and progressive leaning legislatures in states such as Vermont, Connecticut, and Massachusetts.

In contrast to the above organizations and legislatures, Heartland's "no consensus" frame is embraced by conservative leaning organizations and legislatures such as the Cato Institute, Pacific Research Institute, Discovery Institute, and conservative leaning states such as Texas, Florida, and Alabama. Politically conservative states endorse the instruction of the *no consensus* perspective. For instance, in 2017, the legislative body of the State of Idaho authorized the removal of the idea of human induced climate change from the state's science curriculum. This action led to three years of protests, public hearings, and fractious debates on which perspective on climate change should be recognized as official knowledge in Idaho public schools (Worth and Hand, 2019). As a corollary to the above, Heartland's "No Consensus" framing should be viewed as part of larger culture wars as reflected in education. For instance, in a recent newsletter on climate change education, Heartland argued that, "Critical race theory is invading our schools and spreading woke propaganda throughout our education system." Heartland has

also commented on and weighed in on major educational controversies such as public education vs school choice. As Cochran-Smith and Fries (2001) observed, ideological "viewpoints are embedded including their differing notions of evidence, fairness, results, progress, public benefit, the American way" (p.1). The larger culture wars and public controversies regarding climate change serve Heartland's purpose in recruiting new adherents and mobilizing allies for their ideas and the "No Consensus" frame is deployed to that effect. We know that national controversies influence pedagogy and instruction in the classroom (Rymes, 2008). Research suggests that the climate change education controversy influences teacher pedagogical choices and student conceptualization of climate change knowledge (Plutzer and Lee, 2018). The culture of controversy around climate change education has made some teachers reluctant to teach the subject for fear of parental complaints (Kamenetz, 2019). I will argue that the reluctance of teachers to broach the subject of climate change in their classroom is a testament to the success of campaigns by Heartland and other climate denying groups to spread misinformation and most importantly, create controversy surrounding climate change education.

Heartland's success stems from the fact that they are entirely aware that even the "facts" underpinning climate science are considered political among a section of the populace. This means that Heartland recognizes that the scientific process and climate scientists are not believed to be neutral among some communities in the United States. This of course represents a major challenge for groups like the Paleontological Research Institution and their framing of the scientific consensus: mistrust of climate scientists and of the scientific process in the public domain tend to undermine messages based on science. The point that the scientific process/inquiry that underpins climate change is perceived as political and biased by a significant sector of the American populace is not addressed by the Paleontological Research Institution. For

instance, consider the statement below from the Paleontological Research Institution, which misses the point that climate change is both politically and scientifically controversial in the public domain:

> And we must communicate to our students that climate change is politically but not scientifically controversial. More than 97% of climate scientists agree that climate change is caused by human activity. Many in the public believe scientists are divided, and that science teaching ought to address this (perceived) divide. There is uncertainty and disagreement about many of the finer details of climate change, but the overarching question of whether human induced climate change is occurring is not questioned by a large percentage of climate scientists. (p.13)

In the statement above, the Paleontological Research Institution argues that schools should teach the conclusion that there is scientific consensus about the causes of climate change. The institute also admonishes teachers to make a distinction between what is politically controversial and what is scientifically controversial when it comes to the idea of human induced climate change. However, the point I am making here is that in the case of climate change, there is not a clear distinction between scientific and political controversies among certain sectors of the public. Interestingly, this point seems to be very well understood by Heartland and by other climate denying institutions, which push the message that climate scientists are part of a liberal elite and/or that they belong to groups holding a particular political ideology. In these ways and others, Heartland uses the "No Consensus" frame to make the argument that the science of climate change is biased and political. For instance, consider the statement below from Heartland concerning the IPCC, the global scientific body responsible for climate predictions:

> The United Nations' Intergovernmental International Panel on Climate Change (IPCC), created to find and disseminate research finding a human impact on global climate, is not a credible source. It is agenda-driven, a political rather than scientific body, and some allege it is corrupt. Climate scientists, like all humans, can be biased. Origins of bias include careerism, grant-seeking, political views, and confirmation bias. (p.55)

In the statement above, Heartland uses language such as "political," "biased," and "careerism" to suggest that the IPPC and its findings cannot be trusted. Heartland's direct attack on IPCC reflects its recognition of a polarized culture around scientific evidence, scientific institutions, scientific processes, and scientists themselves.

But Heartland does not simply reflect the polarization in the USA about climate change; rather, through its framing and messaging, Heartland has also contributed significantly to the polarization around climate science. Gauchat (2012) has observed that the polarization around scientific research and institutions has gotten worse over the years with severe implications for the public discourse and as he argued:

> The relationship between public trust in science and political orientations also poses larger questions about the unevenness of the cultural authority of science and the potential for deep sociocultural divisions in the public sphere. (p1)

In light of the climate change debate, Gauchat's (2012) point on cultural authority is relevant to the fact that both the Paleontological Research Institution and Heartland as well as organizations such as the American Meteorological Society and the Cato Institute can be regarded as cultural gatekeepers/authority on climate change. The point about cultural authority and legitimacy is significant with respect to the frames (*Scientific Consensus* Vs *No Consensus*) uncovered

through my analysis in the sense that these frames represent arguments about who is the legitimate voice on climate change and whose perspective on climate change the public should trust and consider legitimate. As argued previously, a cultural politics framework (Apple 1992) is the lens through which climate change education is conceived in this dissertation. And the cultural politics framework attends to arguments about legitimacy and cultural authority of institutions over wide ranging issues and in this case, climate change. In the paragraphs below, I discuss some of the framing from the American Meteorological Society and Cato Institute to give a sense of the cultural milieu that embodies the climate change discourse.

The American Meteorological Society (AMS) is a professional organization of weather and climate scientists, which endorses the teaching of the scientific consensus on climate change. As an organization, the AMS would be viewed as a national and cultural authority on climate change education and curriculum. Consider the following statement from AMS on teaching climate change:

> the AMS seeks to confirm the solid scientific foundation on which climate change science rests, and to emphasize that teaching approaches different from other sciences are not warranted. Uncertainty is a natural component of all scientific endeavor. The existence of uncertainty does not undermine the scientific validity of climate change science; to the contrary, it provides a sound example for broader instruction of the scientific method. (AMS, 2017, p.1)

In the excerpt above, the AMS references "uncertainty in science," framing their position based on accepted characteristics/qualities of empiricism and broader constructs of the continuous nature of scientific inquiry. Second, references to terms such as "solid scientific foundation" and "validity" appeal to and establish scientific authority on the part of the scientific community

grounded in a long and trusted history of empiricism and scientific innovation. Finally, the AMS appears to address the possibility that teachers, confounded by the transitional nature of scientific evidence particularly with respect to climate change, might fail to make the distinction between inquiry teaching and established facts instruction. Inquiry teaching in this regard is opening up the evidence of climate change for a debate. Here, the AMS is arguing that climate change should be instructed as an established fact similar to other science topics such as photosynthesis. In other words, if the evidence of photosynthesis is not debatable in the classroom, neither should climate change be presented as a topic of debate.

The cautionary framing "teaching approaches different from other sciences are not warranted" of the AMS is consistent with the relentless campaign of the scientific community, asserting that the global scientific consensus on climate change is the only factual perspective, grounded in deep traditions of empiricism, that should be instructed in schools. But the legitimacy of the scientific consensus and as argued previously, is opposed by Heartland and its ideological allies such as Cato. For instance, consider the statement below from Cato Institute. Here, it is important to acknowledge that although Cato is not the focus of this dissertation, it is another organization that could be considered a cultural authority on climate change curriculum. In the case of climate change, this means Cato is part of the larger discourse on the cultural politics of climate change. Cato attacks the scientific consensus on climate change:

> Lots of people get called "climate experts" and contribute to the appearance of consensus, without necessarily being knowledgeable about core issues. A consensus among the misinformed is not worth much. Second, the "97%" mantra is untrue. It is nothing but a phony claim of unanimity meant to squelch debate and intimidate people into silence. (p.1)

The Cato statement above, which is typical of climate denial organizations similar to Heartland, rejects the idea that scientists have reached a consensus on human induced climate change. Cato rejects the claim that 97% of scientists have reached a consensus on the causes of climate change. As noted, Cato and Heartland have significant influence on the public discourse and on the perceptions of climate change (Hoffman, 2012; Cann & Raymond, 2018).

The public's perception and beliefs about climate change subsequently influence state politics and elected legislatures (Busch & Judick, 2021). We also know that the conservative leanings of state legislatures have had significant influence on climate messaging in school textbooks (Worth, 2021). However, even in states that have liberal/progressive legislatures, there are inconsistences in messaging about climate change. My analysis of California's state approved textbooks (Chapter 4) showed that there was inconsistent messaging about the scientific consensus on climate change.

Comparing California's framing to the messaging by the Paleontological Research Institution, I observed that the Paleontological Research Institution was consistent with its messaging about the scientific consensus on climate change. This bodes well for climate change education given that the Paleontological Research Institution is influential in climate change education discourses in the United States. But this also raises questions as to why a supposedly liberal state such as California approves textbooks that carry mixed messaging about the scientific consensus. As argued previously, editorial decisions might have influenced California's textbook messaging. This means that editors and authors responsible for putting together the various grade levels may have different views on what kind of messaging about should be included in the text. We know that the textbook production process involves major editorial overrides that influences the messages in the textbooks (DiGiuseppe, 2014; Apple,

2006& 2009). However, it is also important to consider the profit motive that underpins textbook production. California's textbooks are used in jurisdictions where climate change is deemed controversial. Thus, it is not surprising that text presents a mixed messaging on climate change. Despite the above, California textbooks still differ significantly in messaging from Heartland. While California presents mixed messaging on climate change, Heartland's framing is an *outright*/*absolute* denial of the consensus among scientists. Acknowledging the differences in messaging between the Paleontological Research Institution, the California textbooks, and Heartland is important for climate change education, advocacy and communication. This is because there is a broad spectrum of beliefs among the public about climate change, which includes students and teachers. In order for educators to navigate the controversy surrounding climate change education, it is important for them to understand the framing from multiple perspectives, institutional logics and the clashing objectives of climate science and cultural politics. But instructional practices and curricula that support climate change education must also attend to the power and politics of curriculum development and enactment. In addition to attending to the power and the politics of curriculum, the Paleontological Research Institution and allied organizations could be more proactive in addressing teacher knowledge deficits as well as providing resources to support teacher pedagogical choices. A proactive approach would also include intense public campaigns focused on explaining the evidence of climate change and the scientific method that produces the evidence. These public campaigns must be fact based, devoid of emotional triggers as demonstrated with the deceptive image of starving polar bears. Rather, the campaigns should be framed in accessible language, steeped in scientific integrity and take into account the political ideologies of the American public.

As indicated above, in addition to the "scientific consensus" and "no consensus" frames, other frames are also deployed by both the Paleontological Research Institution and Heartland curriculum materials. The second frame from the Paleontological Research Institution is the idea that climate change is caused by human activity, which, as noted above, I refer to as the "human activity" frame. In contrast, Heartland's materials challenge the idea that human activity is responsible for climate change, using what I call the "doubt" frame. For instance, consider the two statements below from the Paleontological Research Institution and Heartland, which exemplify the two contrasting frames that emerged from my analysis:

The Paleontological Research Institute (human activity frame):	Heartland Institute (doubt frame):
"Carbon emissions from human activity and concentrations of CO2 and other greenhouse gases in the atmosphere have risen dramatically since the industrial revolution began in the early 1800s. Earth's average temperature has been rising in a way that cannot be accounted for by natural variation alone" (PRI, 2018, p.111)	"IPCC's reliability was crippled at birth, mandated by the UN Framework Convention on Climate Change (UNFCCC) to define climate change as human-caused climate change and to disregard naturally caused climate change. Since natural climate change is at the very center of the debate over whether human activity is influencing the climate and by how much, this essentially predetermined IPCC's conclusions" (Heartland Institute, 2017, p. 64)

In the statement above, the Paleontological Research Institute suggests there has been a rise in temperature that is not entirely natural or cannot be attributed to natural variations in climate. Rather, the text contends that the rise in temperature has been caused by an increase in carbon emissions from human activity. The point about carbon emissions and human activity is important to note because Heartland argues the direct opposite.

As seen in the text above, Heartland disputes the notion that human activity is responsible for the current rise in the earth's temperature. Rather, Heartland calls for consideration of natural factors that are responsible for warming temperatures. The Heartland materials reject the idea that human activity is primarily responsible for climate change. For instance, in the text above, Heartland challenges the idea that IPCC's estimation of human induced climate change is valid. Heartland's argument can be understood in relation to the idea that acknowledging human activity as responsible for climate change would mean that there should be a reduction in fossil fuel exploration and subsequently, a loss in fossil fuel revenue (Dunlap & McCright, 2012; Boykoff & Farrell, 2020). Here and when it comes to climate change education, Heartland assumes that there would be deleterious consequences if students were taught about human induced climate change. For instance, consider the statement below from H. Burnett, Ph.D., a leading researcher affiliated with Heartland:

> It seems New Mexico's schoolchildren will be the latest casualties in the battle to ensure science education in the state's schools is based on facts and the best available evidence, not driven by political activists pushing an anti-fossil fuel, anti-capitalism agenda. (p.1)

Here, Burnett employs the metaphor of "anti-capitalism," which is intended to strike at the heart of one of the fundamental ideals on which America was founded. By labeling specific schools, teachers, and scientific organizations as "anti-capitalists," Burnett is telling his audience that this

specific group of actors and their allies are against fundamental American ideals. From this perspective, it would follow that by teaching that climate change is human-induced, students are being taught to question and challenge capitalism. By framing schools as anti-capitalist, Burnett is shifting the focus away from the original argument about the science of climate change and toward capitalism, a framing that has resonance with an audience who care about jobs and the economy. In other words, Burnett implies that schools and teachers who teach about the scientific consensus on climate change are against the fossil fuel industry and thus against economic freedom for Americans. Heartland's perspective anticipates that teaching students about the contribution of greenhouse gases to climate change would produce a generation of young people who were antagonistic towards the exploration of fossil fuels. Here, fossil fuels serve as a proxy for the reality of the economic machine that seeks to fill coffers of the unsustainable energy industry.

The economic argument of Heartland resonates in states that depend heavily on revenue generated from fossil fuel exploration. The economic underpinnings of climate denial have contributed significantly to the pushback against climate change education and environmental activism. For instance, Harmon (2017) reported that in a coal-mining town in Ohio, students rejected their teachers' claims about human induced climate change. Citing the loss of coal jobs, students argued that climate activists were a threat to the livelihoods of their parents. As a corollary to the broader point about pushback on environmental and climate activism from fossil fuel interests, Lewin (2019) observed, "coal companies' subtle, yet continuous, acts of obstruction, non-cooperation, and dissimulation prompted activists to withdraw from protest." (p.1). It is also important to state that despite the climate denial campaigns of fossil fuel interests and think tanks such as Heartland, the economic and cultural concerns of local people in coal and

fossil fuel producing areas are legitimate. For example, across the United States, white working class communities have been devastated by economic losses in coal mining. Hence, teaching human induced climate change requires a sensitive and complex approach that honors the correct and accurate scientific evidence and at the same time, provides opportunities for discussion and debates about communities economically affected by losses in fossil fuel revenues. Henderson et al., (2022) have recommended that the curriculum should:

> Discuss and reinforce productive interactions related to that tension, defining the various role identities people embody (e.g., community and family member, scientist, citizen) and studying them alongside each other in culturally contextualized environmental systems" (p. 12).

In the statement above, Henderson et al., (2022) suggests that the curriculum should attend to local contexts, culture, and lived experiences. The authors suggest that there should be discussions around the various relational actors (community, family, scientist, citizen) and their roles in discourses on climate change. But it also important that the authors acknowledge the "contextualized environmental system or local/place based environmental practices and processes. This implies that the curriculum should honor local and placed-based ecosystems and environmental practices. For instance, a climate change curriculum in West Virginia should address mountain top removal and how it affects the respiratory health of surrounding communities. Likewise, a curriculum in Alaska should include lessons on how climate change affects the production of fisheries and biological resources from the ocean. In the case of California and as argued previously, the curriculum should address the impacts of climate change on rural ecologies and urban ecosystems.

Analysis of the United Nations Document

My analysis of the United Nations document, *Children and Climate Change,* revealed that it framed climate policies using two main ideas: climate change mitigation and climate change adaptation. It is important to acknowledge that the framing of policy solutions by the UN is consistent with how established scientific bodies, such as IPCC and NASA, have discussed climate change policy. The UN framing was also consistent with how Bangladesh and Ghana framed climate change mitigation and adaptation measures. This is discussed further in later paragraphs.

The mitigation idea in the UN text is concerned primarily with policy measures to reduce greenhouse gas emissions and the implications of these measures for the wellbeing of children. For instance, consider how one measure on climate mitigation is framed in the UN text:

> "Energy is often generated from unsustainable sources and applied with inefficient technologies. This leads to waste and pollution, and aggravates climate change issues. Therefore, it is important to embrace low-carbon development pathways that also benefit and address the sustainable energy needs of the poor, including disadvantaged children" (United Nations, 2020, p.52)

In this excerpt, the United Nations document argues that current energy generation approaches aggravate climate change, and hence the text calls for a shift to "low-carbon technologies and which is an established and recommended approach by major scientific organizations such as NASA, IPCC. The United Nations document's attempt to incorporate established knowledge about climate change mitigation from western organizations such as NASA and IPCC reflects Apple's point about the politics of curriculum and knowledge exchange from the global North to

the global South. We know that the United Nations is generously funded by Western countries (Macarthur & Rasmussen, 2018). Hence, while the UN document focuses on low- carbon energy sources and the importance of children's wellbeing in its curricula, it is still necessary to view the curriculum as part of a larger discourse on global power and politics. This means that the UN curriculum and its emphasis on low carbon technologies cannot be decontextualize from the Western and most recently Chinese influences that organizes the UN as a global organization. And while Western countries and Chinese influence are worth considering, there is also the question of whether countries in the global South have the capacity to implement technological approaches to climate mitigation such as the one recommended in the UN document. But in recent times, the UN has adopted climate mitigation policies that attend to social and local contexts as well as technologies that are easily adaptable to countries in the global South. The above approach has been included in the UN curriculum. For instance, the United Nations curriculum acknowledges specific examples from the global South, including actionable climate mitigation strategies in Zimbabwe in Southern Africa that involve among other things low cost technologies such as clean stoves:

> In 2015 and 2016, UNICEF Zimbabwe conducted an improved cook stove program. Women learn to construct the stoves and then go on to train other women. The stoves are cleaner, more efficient, portable, emit less smoke and use less wood. The resources to make the stoves are free and locally available, and their impact is reducing deforestation and respiratory problems. The projects encourage members of the community to conserve their forests, reduce air pollution and support climate change mitigation. (United Nation, 2020, p. 65)

In the text above, the United Nations document provides an important context for climate change mitigation that connects actionable policy to a specific country, Zimbabwe, which is a poor country in Southern Africa. The text mentions alternative energy sources like clean stoves as well as engaging communities to protect their forest reserves. The text also names a gendered approach by including women in the policy discourse. We know that in African societies and most countries in the global South, women are key figures with respect to cooking and hence, their inclusion in climate policy is necessary (Gonda, 2016; Karanja & Gasparatos, 2019; Chikulo, 2014). Climate change education in countries like Bangladesh and Ghana need to include perspectives that consider culture-specific gender roles. In contrast to the UN materials, however, the textbooks from Bangladesh and Ghana, however, do not attend to gender when discussing climate mitigation and adaptation.

It is also important to mention that the absence of an inclusive gender perspective in the Ghana and Bangladesh textbooks corroborates Apple (1992)'s argument that curriculum is organized according to societal norms and characteristics. We know that in Bangladesh and Ghana, there are still significant gaps with respect to gender and equity in major sectors of society (Dowuona-Hammond, 2020; Bawa, 2019; Awumbila, 2006; Blunch & Das, 2015; Islam et al., 2017). Thus, it is not surprising that de-facto government documents, such as textbooks, omit the crucial role of women and girls to climate change mitigation and adaptation. Along these lines, Ayeb-Karlsson (2021) has documented the gendered impacts of climate change and shown how women are mostly disenfranchised in Bangladeshi society. This suggests that climate mitigation policies and subsequently climate change education efforts in Bangladesh and other countries in the global South must attend to gender and social norms and the role of women and girls in these societies. For instance, in Bangladesh, about a third of girls do not have access to

secondary education (grades 6-12) where climate change education is more detailed and sophisticated (World Bank, 2017).

What I want to suggest here is that even though education is an empowerment framework for women and girls in Bangladesh, it is still inadequate in addressing entrenched systemic barriers. Educational shifts need to be accompanied by changes in cultural and social norms about the place of women in society. Bangladesh is not an exception. As argued previously, this dissertation follows a cultural politics framework. Thus, the point about gender and climate is worth exploring as part of a broader patriarchal culture in the global South, in which girls and women face systemic barriers to education (Mudau & Obadire, 2017). In the case of the climate change curriculum, this means that textbooks from Bangladesh and Ghana need to include content about the role of women and girls in climate mitigation efforts. For instance, policies such as be the provision of clean cooking stoves and other resources to aid women in climate change mitigation efforts account for their roles in society as primary care givers and that includes cooking for the family. The above ideas about women and girls and their specific roles in climate mitigation efforts need to be formally adopted and incorporated into official textbooks in the case of Bangladesh and Ghana. But an important question here is about how climate policy should be conceived in science curriculums in the global South, particularly how they might take into consideration the role of tradition, religion, and gender and more generally, how societies in the global South are organized. Hess (2009) has argued that there are multiple ways arguments about policy can be constructed. Unlike an inquiry into the causes of climate change –which might now be considered settled questions–policy arguments involve multiple viewpoints and still unresolved questions. The United Nations document recognizes that policy decisions related to climate mitigation involve competing agendas and multiple points of view. For instance,

consider the two statements below from the UN document on education, government and climate change mitigation policy:

"Through education, projects and action, children can contribute to every aspect of climate change policymaking, mitigation and adaptation. Furthermore, today's children are tomorrow's business leaders, decision makers and consumers" (United Nations, 2021, p. 63)	"Young people are best placed to identify their own risks, needs and capacities. Involving them in the fight against climate change is very important. But children can't do it alone. They need adults to fulfill their commitments to children's rights. Governments are key to this effort and to ensuring the concrete implementation of international commitments" (United Nations, 2020, p. 81)

Through the statements above, the UN document frames climate mitigation policy as both an educational and a governmental effort. The role of government is worth considering in light of the fact that in the global South centralized governments are primarily responsible for setting education agendas. At least in the case of Bangladesh and Ghana, centralized governments are responsible for setting climate change education agendas.

The role of government in education cannot be decoupled from politics, whether cultural, national, or partisan. Hess (2009 & 2011) has argued that there is a distinction between a partisan and political discussion, and the United Nations document reflects Hess's distinction in that it acknowledges climate change mitigation as a corollary to education and government specific climate change policies. For instance, and as mentioned previously, Ghana, which has been a

leader globally in climate change education, has made very little commitment towards climate mitigation policies that demand a shift away from fossil fuels. In 2017, Ghana launched a ten-year strategy to teach climate change (United Nations, 2017). However, there is no existing national strategy to move away from a dependence on fossil fuels. Here, I would suggest that the concurrent/simultaneous climate change education strategy, on one hand, and dependence on fossil fuels by countries in the global South, on the other hand, represents a major contradiction that is not addressed by the United Nations curriculum. While the United Nations curriculum mentions, references, and connects mitigation strategies to specific countries in the global South, it fails to acknowledge that at the same time, many of these countries are relentlessly pursing fossil fuel interests. My argument is that the UN document does not address the dependency of fossil fuels in the global South. But much of the fossil fuel exploration in the global South is also driven by global demand for fossil fuels and energy resources from the global North. The UN curriculum omits the economic contexts that surround the extraction and production of resources to meet global demand. The text does not account for the ongoing struggle against the legacy of colonialism and bad governance in the global South, which is linked to fossil fuel exploration (Dagett, 2021; Gonzalez, 2021; Bhambra, 2020). For instance, Aczel (2020) has argued that in Algeria (North Africa), a legacy of colonial business practices with France coupled with the capitalist interests of the Algerian government has led to tension, protests and pubic opposition to the shale gas industry in Algeria. In Nigeria (West Africa), there have been decades of documented tensions and feuds between corporations such as Shell, corrupt Nigerian officials, and local people who live near oil resources (Babatunde, 2020; Adunbi, 2020; Obi, 1997 &2000, Livesey, 2001). The above examples suggest that climate mitigation education must contend

with the complexities and tensions between capital and global needs, on one hand, and local people, on the other. But the UN document falls short in that regard.

As indicated above, in addition to the theme of climate change mitigation, the United Nations documents contain another perspective focused on how to live with the impacts of climate change. This idea here is referred to as climate change adaptation. The UN document focuses on two types of adaptation when it comes to children. The first type of adaptation titled by the UN as "Adaptation for Children" focuses on developing programs and policies "where the capacity of caregivers to focus on children's needs and capacities is enhanced" (p.33). The second type of adaptation titled "Adaptation with Children" focus on policies and programs "where children are centrally involved in the decision-making, planning and implementation of adaptation at all levels" (p.33). In the paragraphs below, I discuss the two forms of adaptation in detail and what it means for robust climate change education in the global South.

Adaptation for Children involves policies and programs that build the capacity of the caregivers of children to provide for them. Consider how the United Nations frames policy recommendations as an example of Adaptation for Children:

> As climate change is projected to have significant impacts on the agricultural sector and on water access, as well as cause loss of livelihoods, access to adequate nutrition is set to worsen as impacts intensify and the incidence of extreme events increases. Children are particularly vulnerable to climate-related food insecurity, with millions of children around the world struggling to get sufficient nutrition in their daily diet. Child centered adaptation interventions intend to reduce malnutrition of children and their caregivers as well as enhance families' livelihoods. This will help realize children's rights to adequate nutrition (United Nations, 2020, p.52)

In the statement above, the UN document references the impact of climate change on food and water, resources that are essential to the wellbeing of children. But most importantly, the text connects the provision of these resources to the livelihoods of caregivers and families. This kind of adaptation aims at strengthening and supporting families to provide for their children. Here I would suggest that while the statement above is poignant in terms of its considerations for caregivers and children, it does not take into account the changing nature of work (technology, hospitality, corporate and skills based jobs) as a result of globalization and how that would affect children's needs and wellbeing. It is documented that skills based jobs fuels the migration of caregivers and adults from rural to urban centers leaving children behind and with consequences for their wellbeing in Africa and Asia (Appianing, 2013; Xu & Xie, 2015; Cadsby et al., 2020). Likewise, growing urbanization has implications for children's health and wellbeing (Shobande, 2020; Ameye & Weerdt, 2020; Zerbo et al., 2020).

It is important to mention that globalization does not appear in the UN text. I argue that it is a significant omission not to address these ideas in the context of a curriculum that seeks to educate the world about children and climate change. The omission of discussions of globalization on climate change adaptation and education for children is fairly significant in light of the fact that the United Nations is a symbolic organization or, in a certain sense, a metaphor for the globalization that has come to define the world after the second World War, as well as the independence movements in Africa and Asia. Globalization, in practice, has opened up vast channels of communication, knowledge exchange, cultural engagement and influences and financial capital across borders and geographies in Africa and Asia. And while aspects of these intercultural exchanges have supported development in the global South, they also come with structural inequities, particularly for children. For instance, household goods and agricultural imports to Europe and North America exacerbate child labor in Africa and Asia (Berlan, 2016; Robins, 2012; LeBaron & Gore, 2020). Further, there is documented evidence that extractive industries such as cobalt mining in DR Congo also exacerbate child labor, hamper children's education, and enforce patriarchal norms against women working in the mines (Sovacool, 2021). This point about extractive industries, markets and children is important to consider in light of globalization and the movement of goods and services across borders. There is a tension and interaction between local conditions and child wellbeing in the global South as well as between market forces across the West and the globe. Hence, a climate change curriculum that prioritizes and links globalization and market forces to climate change and children is one that offers student a comprehensive and robust view of the complexities that underpin climate change policy. As argued previously, these ideas are omitted from the UN curriculum. But globalization is not the only concept/topic that is not tackled by the curriculum. Colonialism and which has

organized the modern world and nation states across the global South is also missing from the text. And as mentioned previously, one of the significant contributions of this dissertation is the critique/discussion of missing elements/ideas in the curriculum that I argue; provides a layer of complexity to climate change education.

A significant number of countries in the global South have a history of colonization and displacement of indigenous and natives people. It is necessary to include these histories and their implications in climate change education, particularly with respect to the distribution and use of physical resources such as land, water and minerals. A robust knowledge of the colonial enterprise is necessary for unraveling local and place-based environmental histories and remedies. Several scholars have noted the importance of place-based climate change education that contextualizes the challenges at local scales (Littrell et al., 2020; Rousell & Mckenzie-Knowles, 2020; Hu & Chen, 2016; Bang, 2020). It is important to mention that the recognition and inclusion of a robust history and colonial past can be an empowering framework for children's education and as and as Apple (1992) argued "people help create their own texts, ones that signify their emerging power in the control of their own destinies. (p. 7). We have seen several countries in the global South create new curriculums and texts that honor their colonial history (Bentrovato, 2017; Adu-Gyamfi & Anderson, 2021). For instance, since 2018, Ghana has re-introduced a compulsory history curriculum to primary school students. More than three decades ago, history education was mainly available to select high school students or was taught as part of social studies. But the designation of a history curriculum at the primary school level in Ghana, as Oppong (2022) noted, is an attempt at emphasizing a national heritage and pride in a complex and colonial past. There are still gaps in the literature on how disciplinary subjects such

as history and topics/ideas such as colonialism and globalization can complicate or increase students understanding of climate change mitigation and adaptation policies.

As indicated above, there are two types of adaptation represented in the United Nations text. In previous paragraphs, I discussed "Adaptation for Children," and particularly how the text omits discussion of colonialism and globalization, which needs to be considered in the framing of climate change adaptation. It is also important to consider the framing of "Adaptation with Children." According to the UN, adaptation with children focuses on policies and programs that build children's capacity and resilience to live with climate change impacts. Consider the statement below, an excerpt that typifies the UN's recommendation about building the capacity of children to live with the impacts of climate change:

> Children are a key part in the identification of risks and resilience building options for development programs (United Nations, 2020, p. 35)
>
> Children's specific needs and capacities are included in the vulnerability assessments and planning processes for climate smart development (United Nations, 2020, p. 35)
>
> Children are included in the processes of monitoring and evaluation of programs and initiatives that affect them (United Nations, 2020, p. 35)

The three statements above collectively speak to recognizing the agency of children and involving them in climate change development programs and implementation. The UN recommends that the input of children be regarded in identifying climate risks and impacts, as well as the policy measures designed to solve the risks and challenges. As a curriculum, this means helping students to think through and identify climate challenges in their local

communities. We know that children have the capacity to engage with the complexities of knowledge and ideas when educators recognize and support student ideas and identities. This means that children are not passive recipients of information, but rather they interact and engage with that knowledge. As Apple (1992) observed "Students bring their own classed, raced, religious, and gendered biographies with them as well. They, too, accept, reinterpret, and reject what counts as legitimate knowledge selectively" (p.5). Apple's point that students bring their own identities and epistemologies to school with them is important in light of the fact that countries such as Bangladesh and Ghana are multiethnic and multi-religious states and geographies. But the UN document does not acknowledge how identities shape curriculum and student learning. The UN uses the word "local" in many parts of the curriculum to denote particular community-based projects. And while "local" can be an important description of particular communities, it is important that the complex identities that underpin how countries in the global South are organized is acknowledged when it comes to climate change adaptation as such understandings come with implications for children. Currently, there is documented evidence that government climate adaptation policies in countries in the global South such as Cameroon (Azong & Kelso, 2021), Bangladesh (Sovacool, 2018), and Nepal (Sujhaku et al., 2019) favor majority groups and ignores or marginalizes certain geographical and ethnic groups. This reinforces the conclusion that we need robust climate change education that attends to questions/concerns related to local and global scales, the vulnerabilities of women and girls, and the marginalization and displacement of some ethnic and religious minorities in the global South.

This chapter continues my analysis of curriculum materials from a cultural politics framework. Using that lens, I analyzed curriculum materials from Heartland Institute, the Paleontological Research Institution and the United Nations. My analysis reveals that Heartland

Institute and the Paleontological Research Institution used different frames. And these frames are oppositional and in contrast to one another. While the Paleontological Research Institution argues that human activity is primary responsible for climate change, the Heartland Institute rejects that claim. In addition, while the Paleontological Research Institution asserts the scientific consensus on climate change, the Heartland Institute rejects it. Rather, Heartland claims that scientists have not reached a consensus. Instead, the organization argues that the scientific consensus is politicized. In my assessment, the climate change curriculum controversy symbolizes one of the most visible examples of controversies regarding the cultural reproduction of knowledge, which has long been an element of education. Heartland and the Paleontological Research Institution recognize the importance of education as a canvas for transmitting worldviews, value systems and culture. As Feinberg (1983) argued:

> To speak of education as social reproduction ... is to recognize its primary role in maintaining intergenerational continuity and in maintaining the identity of a society across generations ... Education in this sense has two functions. First there is the reproduction of skills that meet socially defined needs ... Second, there is the reproduction of consciousness or of the shared understanding that provides the basis for social life. (p.2)

Both Heartland and the Paleontological Research Institution recognize the importance of education as an avenue to entrench ideals, sustain viewpoints, and generate causes of action over an entire generation. Although the information they present and the frames they use to describe climate change are dramatically different from one another, the curriculum materials disseminated by both Heartland and the Paleontological Research Institution reflect the assumption that the content and perspectives of curriculum material are profoundly important in

that they help to reproduce (or, in some cases, challenge) fundamental understandings about how the world works.

The UN text takes the climate change curriculum in two different directions altogether. My analysis shows that the UN as an organization is committed to both localized and global perspectives on climate change adaptation and mitigation. But, as I have shown, the UN curriculum materials do not interrogate the colonial histories and aspects of ethnic and religious marginalization that characterize societies in the global South. This means that the in the future, the United Nations might have to adopt a more complex definition of the word local, which pays attention to ethnic, religious, and class marginalization. This also means that researchers need to adopt a comprehensive lens for framing, theorizing, and using/deploying terms such as globalization, local, indigenous, and gender they apply to climate change education.

CHAPTER SIX

Overarching Findings and Implications: Teaching, Learning and Research

To make sense of climate change education in Bangladesh, California and Ghana, this dissertation examined official textbooks and supplementary materials (from Heartland Institute, the Paleontological Research Institution, and the United Nations) produced and used in the three jurisdictions named above. To this end, the dissertation tackled three major research questions related to the portrayal of climate change in official textbooks and supplementary materials. In addition, I looked at the similarities and differences in climate change portrayals across the textbooks and supplementary materials from the three widely different sources.

My analysis revealed that Bangladeshi textbooks framed the causes of climate change as settled, which means the texts acknowledged human induced climate change as backed by an

overwhelming scientific consensus. With respect to the impacts and policy solutions to address climate change, Bangladesh largely acknowledged local impacts and measures to live with and mitigate against climate change. The text discussed impacts associated with climate and weather events such as storms and cyclones. Bangladesh is significantly prone to weather related catastrophes and hence it made sense for the curriculum to reference/mention this reality. The text recommended infrastructure and coastal afforestation as some of the measures to adapt and mitigate against climate change. The point about coastal afforestation is locally relevant considering Bangladesh's watery and coastal landscape.

My analysis of the Ghanaian textbooks revealed that while Ghana acknowledged the role of human activity to climate change, the text omit the fact that scientists have reached a consensus on the subject. With respect to the impacts of climate change, agriculture and disease burdens of climate change were discussed in the text, and these were connected to the local Ghanaian context. However, the text largely framed the impacts of climate change in generic terms. When it came to policy solutions and similar to the generic framing of the impacts, the Ghanaian textbooks rarely connected/linked policy measures to the local Ghanaian context.

Finally, my analysis revealed that while California noted the role of human activity in climate change, the text presented mixed messaging on the scientific consensus. California's textbooks discussed climate change impacts mostly in relation to livelihoods. The text connected these ideas to some local contexts. For instance, it discussed the effects of sea level rise on cities such as San Francisco. Unlike Bangladesh and Ghana, California's climate solutions policies in the text focused mainly on advanced and technological shifts away from fossil fuels. The texts recommended alternative energy sources such as biofuel. My observations about the framing of the causes, impacts and policy solutions to climate change are fairly in line with previous work

by Meehan et al., (2018), Roman & Busch, (2016) among others. The major distinctions come from the recent shift to include more local perspective and technological advances.

Beyond the actual content of the textbooks, I drew two broad conclusions from the study. First and in a broader sense, climate change content in textbooks follows closely the cultural politics and policies of education in each of the three countries. Second and in a much larger sense, the content of the supplementary curriculum materials aligns ideologically with the mission of the organizations that produced the documents. For instance, the Paleontological Research Institution embraced the scientific consensus on climate change. However, using an oppositional frame, Heartland rejected the argument that scientists have reached a consensus on climate change. Rather, Heartland suggested that the IPCC and other established scientific bodies are liberally biased.

As a corollary to the above observations, it is important to state that this dissertation specifically examined the portrayal of the causes, impacts and policy solutions to climate change as presented in national/state approved textbooks from Bangladesh, California and Ghana. With respect to the supplementary educational materials from Heartland and the Paleontological Research Institution, I examined the portrayal of the causes of climate change in both texts. Finally and with respect to the UN document, I looked at the portrayal of policy solutions in the text.

To examine the portrayal of climate change in the curricula and documents mentioned above, the dissertation employed two complimentary theoretical frameworks. I used Michael Apple (1992)'s seminal text "Textbooks and Cultural politics," as the overarching theoretical lens to make sense and contextualize frames/messages about climate change in the select textbooks and supplementary materials. I also employed Diana Hess (2009)'s ideas on the

changing notions of curriculum as either "settled," "open," or "tipping," to make sense of the portrayal of the causes of climate change in the textbooks and supplementary materials.

Apple (1992) and Hess (2009) argue that the curriculum is a reflection of the power dynamics that organize societies. In addition, both authors stress the absence of marginalized voices from the curriculum. The point about the role of power in shaping the curriculum is a central thesis of Apple's ideas on textbooks and cultural politics. He argues that the curriculum is an imposition on marginalized voices, which includes former colonies in the global South. Largely and with few exceptions, he posits that there is a sharp distinction between the knowledge and the cultures of the powerful and powerless, the West and the global South. While Apple's assumptions about power imbalance between colonizers and (former) colonies exist, I argue that knowledge exchange between the West and its former colonies is not always a question of power and domination. Cultures in the global South and despite being subjects of colonialism and domination, also embrace, borrow and re-contextualize knowledge and culture from the West and its former colonial powers because they see certain values in these ideas for the betterment of their own societies (Van de Kuilen et al., 2020; Yamada, 2008; Steiner-Khamsi & Quist, 2000 & 2004). The broader point here is that cultures in the global South at least in the case of Ghana retain some originality or distinctiveness. However, at the same time, they are constantly changing and borrowing; these shifts in norms cannot be attributed solely to Western domination (Gyekye, 2002; Gyekye & Wiredu, 1992). Applying the above arguments to the climate change curriculum from Bangladesh and Ghana, it is not the case that the West merely influences these countries when it comes to climate change knowledge. Rather, as I have shown, both countries despite their structural challenges, have exercised *agency* in recognizing that climate science is useful information/knowledge for their students and future generations.

As argued in previous chapters, Hess argues that climate change is a "settled" science and hence, the curriculum should treat and present it as such. However, *who decides what is settled*? Reputable scientific bodies have stated that climate change is caused by human activity. However the solutions to addressing the role of human activity have economic consequences such as loss in oil revenues. This means that it is very difficult to separate the causes of climate change from the policy solutions that undergird them. While Hess admits that climate and policy solutions require nuance and complexity, her thesis fails to account for the fact that the "settled" perspective reinforces the narrative that we need to reduce fossil fuel exploration. This point about reduction in fossil fuel exploration and the economic losses that inevitably accompany that is what feeds the climate change controversy. My point here, which I have argued throughout this dissertation, is that when people and climate denier groups such as Heartland are litigating the causes of climate change, it is mostly because of economics and politics.

Another limitation of the so-called settled perspective is that it does not fully account for the nuances of place, geography, and jurisdiction when it comes to climate change. The settled perspective as postulated by Hess assumes a coherence across different actors in a particular time and place. For instance, consider the case of the State of New York and New York City. Climate change education is a settled science in the state of New York, and the state has endorsed the teaching of human-induced climate change. However, at a recent climate protest organized by New York City students, the city's department of education banned teachers from joining the protest. Moreover, while some may argue that teachers are not required to be part of protests, the reason provided for teachers to abstain from the protest is the most important point here. The New York City Department of Education argued that by participating in the protest in support of the recognition of human induced climate change, the teachers were taking a "political position"

on climate change. Some may ask why teachers are required to teach the settled perspective on climate change as a fact/truism yet told to abstain from openly supporting the settled position because it is politically biased. In other words, why should teachers abstain from advocating for something that they are required to teach in their classrooms? My argument is that the New York City department of education recognized that even in New York, which has endorsed the settled perspective on climate change; the topic remains largely unsettled among a segment of the population. The above nuances and distinction of place and the role of different actors are missing from Hess's tripartite classification of the changing notions of curriculum regarding controversial topics. As this New York example shows, the state's vision of a settled perspective and the public discourse along with its sub-divisions raises questions as to who has the final say on whether a topic is settled, open, or tipping. Despite my critiques of Apple's and Hess's ideas about curriculum, their theories serve as a powerful lens for making sense of climate change messaging in the textbooks and supplementary materials as shown in Chapters 4 and 5.

First, applying Hess's framework of "settled," "open," and "tipping," revealed that Bangladesh, California and Ghana framed the causes of climate change as settled. Nevertheless, there were some distinctive differences within the settled portrayal in the textbooks from the three jurisdictions as discussed in Chapter 4. For instance, while all three jurisdictions embraced the role of human activity in contributing to climate change, Bangladesh acknowledged the scientific consensus while California presented mixed messaging on the subject. In the case of Ghana, the text did not mention the scientific consensus at all even though the text *repeatedly* stressed the role of human activity in causing climate change. Informed by both Hess's and Apple's ideas about textbooks, publishing and cultural politics, I argued that aspects of context explained the differences in the framing of the scientific consensus across the three contexts—

Polarization in the case of California, editorial decisions in the case of Ghana, and national policy as in the case of Bangladesh. With respect to the portrayal of the impacts and policy solutions of climate change in the textbooks from Bangladesh, Ghana and California, I used both Apple's and Hess's ideas of curriculum as a representation of national and state interests to explain why certain messages of climate change are present or absent in the text. For instance, using Apple's idea that curriculums are proxies for national identity, I showed that Bangladesh frames the impacts and policies of climate change using an "emancipatory" language that borrows heavily from its national identity after independence.

Second, applying Hess's ideas of settled and open topics in the curriculum revealed that the Paleontological Research Institution framed the causes of climate change as settled while Heartland Institute framed the causes of climate change as open to debate. Here, I discussed and provided context to show that the contrasting framing (settled/open) by Heartland and the Paleontological Research Institution mirrored the climate change debate in the public discourse in the United States. As argued earlier, both Hess and Apple have argued that the curriculum is a representation, proxy, or metaphor for the debates and controversies that organizes societies. Climate change education at the K-12 level in the United States is fraught with debate and controversy as evidenced through state legislation, protests, advocacy and efforts to recruit new members, mobilize allies and antagonize the opposition.

Finally, focusing on the complexity of policy in education, I revealed that the United Nations document succeeds and sometimes fail to balance local and global climate change policies and interests. Here, using notions about competing interests, I pointed to the UN's omission of fossil fuel exploration by countries in the global South. I argued that the UN

document should account for the competing interest between climate mitigation and aggressive national fossil fuel activities and explorations.

Collectively, my findings suggest that climate change education in Bangladesh, California, and Ghana is underwritten by many assumptions and issues, including those about national identity, private textbook publishing, globalization, economics and political polarization. This suggests that robust climate change education that prepares students to tackle the challenges of climate change in the next century must account for these ideas and assumptions. In the next heading, I discuss what my findings mean for climate change teaching, learning and research.

Implications for Teaching, Learning & Research

In this section, I discuss the implications of my findings and their relevance to the teaching and learning of climate change in formal education systems broadly in the global South (Bangladesh, Ghana & United Nations) and in the United States (California, Heartland and the Paleontological Research Institution).

Global South (Bangladesh, Ghana & the United Nations)

As argued in Chapter 1, textbooks and curriculum materials are the primary resources for teaching and learning in the global South, which includes both Bangladesh and Ghana. Hence, the content of the textbooks is critical to student climate literacy and understanding. As shown in my analysis in Chapters 4 and 5, the texts from Bangladesh, Ghana and the United Nations portray climate change as settled science, and they try to balance local and global impacts and policy solutions. However, it is important to state that when it comes to the textbooks, Bangladesh incorporates local perspectives more successfully than Ghana. The portrayal of climate change as settled in the texts from Bangladesh, Ghana and in the widely disseminated

UN document means that students in these jurisdictions likely receive the factual education on climate change. However, we know that including climate change content in the textbooks is insufficient for the robust teaching and learning of climate change particularly in countries in the global South where schools lack scientific resources, such as labs and other infrastructure, which support students' parsing and understanding of the evidence. To this end, I argue that textbooks and documents used in teaching from the global South should embrace the format of an "educative" curriculum. An educative curriculum is one that is designed to support teacher learning and knowledge (Schneider et al., 2002; Davis et al., 2005 & 2017; Krajcik & Delen, 2017) by providing content, exercises and assessments that increases teachers understanding and resourcefulness on any subject matter.

Applying the concept of an educative curriculum to the textbooks from Bangladesh and Ghana and the UN document means that the text should embody some affordances that deepen teacher knowledge about climate change. This would require having teacher and student editions of textbooks, which are now absent from Bangladesh and Ghana. Historically, teacher editions of textbooks have mostly contained answers to the exam questions used to assess students. I propose a different model and one that includes disciplinary core ideas, activities and experiments that strengthen teacher content knowledge on climate change. The teachers' edition of the textbooks that I recommend would include multiple exercises on causes, impacts and policy solutions to climate change. For instance, content associated with causes of climate change would include analysis and interpretation of long-term climate data collected from reputable scientific organizations and local research agencies from the global South. Here, the text would help teachers analyze and interpret the data before engaging in classroom instruction. In the case of Bangladesh and Ghana, this would mean the texts would include local climate data

from research agencies such as the Bangladesh Meteorological Department and the Ghana Meteorological Agency.

While the causes of climate change can be evaluated through data, experiments and models, considering impact and policy alternatives require human elements that add many layers of complexity. As shown in my analysis in Chapters 4 and 5, the texts from Bangladesh, Ghana and the United Nations attempted to balance local and global perspectives when it comes to the impacts and policies of climate change. While there are some absences related to issues such as gender, robust instruction could fill in the omissions from the text. However, as argued before, this will require significant content knowledge, nuance, and understanding of the affordances and contradictions of climate policy on the part of the teacher. Once again and as argued before, the learning resources, such as labs and fieldtrips, which support robust climate change instruction are mostly unavailable to schools in Bangladesh and Ghana. This means that the textbooks in this case becomes the single de-facto document and learning resource to teach students about climate change impacts, mitigation and adaptation. Hence, teacher editions of the textbooks would embody local and relevant case studies that would support teacher learning and subsequent instruction to students. For instance, instead of listing and briefly discussing policy solutions to climate change, as is the case in the Ghana text, the text would instead present case studies and scenarios related to topics such as cattle farming and its contribution to carbon dioxide. This can set up discussions or debate about agriculture, livelihoods and alternatives to livestock farming.

As argued earlier, the UN text did not attend to the complexity of local politics and climate change. Here an educative UN curriculum that supports teacher learning and challenges student thinking could present scenarios related to revenues from fossil fuels and the challenges of development. For instance and using Ghana as a case study, the curriculum could address

concerns related to the need for tax dollars for development activities in healthcare and education as well as aggressive capitalist exploration of fossil fuels that contribute to climate change and with deleterious impacts/consequences for the country. It is important to mention that the United Nations and its educational agendas do not attend seriously to *partisan* politics and sometimes its pernicious influence on educational policy in the global South. In recent times, the UN has adopted indigenous knowledge and local understandings of education as evidenced in its recent seminal educational policy document. However, I argue that the UN has failed to contend with *partisan* politics in the global South. As argued before, in the global South, political party platforms and agendas are de-facto national policy when political parties assume office. Moreover, because some of these countries such as Bangladesh and Ghana operationalize centralized educational systems, it would behoove the UN to engage and perhaps challenge the partisan agendas of the countries in which they operate. Some may argue that engaging with partisan politics changes the image of the UN as a neutral body. However, the challenge to that argument is that partisan politics interfere with the UN's educational agendas, and this raises questions as to whether countries in the global South should enact policy based on local political agendas or based on the United Nations educational goals and vision for global education. Recently Bromley et al. (2020) observed that the influence of international organizations such as the United Nations is waning in educational policies and reform across the globe. The authors attribute this to "a weakening of liberal and neoliberal world culture, which has contributed to educational expansion on grounds of individual rights and development" (p.14). This is evident in the case of Bangladesh, which asserts its national identity and individualized and particularized notion of liberation in the prefaces of the science textbooks analyzed in this dissertation. Some may ask why a science textbook asserts a "liberatory" history and national

identity. Here I argue, as Bromley et al. (2020), Apple (1992) and Hess (2009) have also observed, that the text is partly an embodiment of the vision and interests of nation states. However, the extent to which state/national/partisan agendas will prevail over global education reform remains to be seen.

United States (California, Heartland and Paleontological Research Institution)

As shown in chapter 4, my analysis revealed that the textbooks from California acknowledged the contribution of human activity to climate change. However, when it came to the notion of scientific consensus, the text presented mixed messaging on the topic. And that is, the text framed the scientific consensus as debatable in some of the elementary textbooks. Unlike the California textbooks, the Paleontological Research Institution simultaneously reported the role of human activity as well as acknowledged the scientific consensus on climate change. In contrast to both the California Textbooks and the Paleontological Research, Heartland rejected claims that climate change is caused by human activity and that scientists have reached a consensus on the subject matter. The wide variations on climate change representation in the materials from California, Heartland and the Paleontological Research Institution suggest that at least in the United States, climate change remains a polarized subject and this has implications for teacher instructional practices.

Unlike the textbooks from Bangladesh and Ghana, the California textbooks and the material from both Heartland and the Paleontological Research Institution are educative with several features that both support teacher and student learning. These three texts include examples, data, experiments and resources that support teacher instruction and student learning. However, the challenge with climate change education in the United States is largely with political polarization and with implications for how textbooks frame climate change and how

teachers instruct about the subject. Plutzer and Lee (2018) observed that ideological leanings influence whether teachers present climate change as settled or open. The authors noted that teachers who identified as liberal were most likely to present climate change as settled whiles teachers with conservative beliefs mostly focused on the causes of climate change for debate. In addition, while teachers' ideological orientations are important, I still recommend that at least the official textbooks frame the causes of climate change in clear terms stating the role of human activity and the scientific consensus that backs that position. Nevertheless, we know that textbooks are proxies for competing agendas (Apple, 1992; Hess, 2009).With a decentralized educational system, there are multiple sites of engagement that fuels curriculum controversies. Hence, teachers and textbooks that uphold the settled perspective on climate change are still subject to the polarized nature of the climate change debate. Along these lines, Kamenetz (2020) reported that a third of teachers sampled across the United States are reluctant to teach about climate change for fear of parental complaint. Textbooks cannot mitigate these concrete issues related to social polarization. Hence in a polarized climate such as the United States and unlike Bangladesh and Ghana, the textbook content may matter less in certain jurisdictions. This means that textbooks and teachers' instructional practices need to be supported and upheld by school administrations with respect to polarized topics such as climate change. However, school administrations and school boards are also representations of certain political constituencies and interests and with competing agendas.

Recent controversies over the teaching of race in schools have highlighted the tensions that exist among curriculum, teachers, parents and school administrations. Along these lines, while my findings show that materials from California and the Paleontological Research Institution frame climate change as settled, the fraught nature of the climate change debate

means that some teachers may still present the causes of climate change as a debatable topic. Some may argue that there is pedagogical benefit to presenting both sides to foster inquiry among students. After all, debate and contestation are part of the scientific process. But presenting multiple sources of evidence and data to support the causes of climate change is different from teaching climate change as an issue that scientists are still debating. To present climate change as a debatable topic between two sides leans into Heartland's narratives and framing. As argued previously, Heartland and its allies are a social and political constituency whose messages and framing contribute to the rancor surrounding the teaching and learning of climate change. The Next Generation Science Standards and the National Science Teachers Association (NSTA) have sought to provide instructional practices that help teachers navigate the tension surrounding controversial issues such as climate change as well as helping teachers engage students in modern scientific practices. However, I would argue that these scientific standards and instruction have not yet engaged with the scale of the partisan politics and polarization fomented by Heartland and its allies. For instance, official statements, instructional materials and resources from the NSTA were released as a counter strategy only after years of aggressive campaigns from conservative leaning legislatures across the country and from Heartland. This suggest that scientific organizations, colleges, and universities must be more proactive in messaging and in climate communication to the American public.

The debate over teaching climate change reflects varying ideological viewpoints in American society and hinges on different versions of American identity. These identities are steeped in culture, geography, politics, religion and economics. Hence, they produce a complex and intractable milieu, which can be difficult to navigate as educators and stakeholders. This chapter returns to the frames and logics of that complex milieu: American identity, ideology, and

climate change education. Without a comprehensive understanding of the framing and logic of the discourse on climate change education, it is very difficult to support teachers in their efforts to teach human induced climate change. Unpacking the frames and logics of the textbooks and supplementary materials provides a critical lens for facilitating professional development workshops on climate change as well as supporting student learning and engagement with climate change. As we have seen with the recent controversies surrounding critical race theory and the renewed debates over Roe v Wade, curriculum is form of cultural politics subject to legislation, partisan politics, and different notions of what it means to be an American.

Implications for Research

As shown in Chapter 4, when it comes to the causes of climate change, textbooks in Bangladesh, California and Ghana portray climate change as settled and discuss the role of human activity. While my research supports this conclusion about the textbooks, there are still gaps that need to be addressed through further research. First with the knowledge that these textbooks present the subject of climate change as caused by human activity, it will be interesting to study how human activity is discussed in the textbooks in relation to environment-related topics such as agriculture, forestry, ecosystems, and soils. The point about these topics is that they are impacted by climate change and hence, unpacking how they are framed in relation to human activity presents a fuller picture of the need for sustainability and environmental conservation. Taken as a whole, this would give students a comprehensive understanding of environmental sustainability and the interconnectedness of ideas/concepts in science.

Student activism, capacity and propensity to act as change agents in the fight against climate change should be weighed in relation to the national or state context in which students live and exist as living beings. Along these lines, state and national climate change frameworks

have the capacity to guide and potentially constrain student climate activism, engagement or behavioral choices. As a corollary, it is important that the governments of Bangladesh, Ghana, and California have taken climate change seriously by adopting and implementing national/state climate change policies. These policies include strategic goals related to climate change adaptation and mitigation. The extent to which these climate policies and strategic plans will succeed depends partly on how various demographic populations/constituencies of countries/state understand, perceive and comprehend them. Of particular relevance are school-going children and youth. As Lawson et al., (2018) observed, "Children have unique perspectives on climate change, represent an audience that is easily reached through schools, and are arguably best equipped to navigate the ideologically fraught topic of climate change with older generations in ways that inspire action" (p.1).

Congruence between intended national/state climate policies and climate change education, as manifested in the curriculum, is crucial to supporting state/government efforts in climate change adaptation and mitigation. Any form of social change in an institution or nation state requires multiple actors playing various roles in the macro-system. As Schofer and Hironaka (2005) argue, "Institutional structures and culture directly influence actors at all levels of a social system: such as the individuals, associations, and firms within nations. When neo-institutional models and culture penetrate throughout a system, outcomes often improve – in part because actors at lower levels of the system are often directly responsible for implementation" (p. 30). In this case, school-going children and youth are perceived as lower level actors in the institutional structures (nation state) and climate change education is conceptualized as a form of cultural diffusion, penetration and reproduction. Therefore, an important research agenda will be

to examine the alignment or misalignment between national/state climate policies and climate change curriculum in Bangladesh, Ghana and United States (California).

Conclusion

This dissertation examined official curriculum and supplementary materials produced and used in three different jurisdictions- Bangladesh, California and Ghana. The study sought to contribute to our understanding of the framing of climate change in widely used curriculum materials in the three places named above. Here and focusing on both national/state approved textbook materials (Bangladesh, California & Ghana) and supplementary materials produced by non-establishment actors (Heartland, PRI & UN), this study cast a wide net in terms of the ideological orientation (Human Induced Climate Change vs Climate Denial), geography (Global North vs Global South) and reach of the curriculum materials. To the best of my understanding and as discussed in the literature review section, this is the first study that examines curriculum materials across broad geographical, contextual, and economic differences. Previous research on climate change curriculum has tended to focus on either the global North or the global South. In fact, Meehan et al., (2018)'s seminal work focused exclusively on textbooks and curriculum materials produced in the United States. My analysis of the curriculum materials show some uniform messaging regarding the settled scientific perspective but with some distinct differences across contexts. This means that students across the globe may be receiving information about climate change that is more or less factual despite omissions regarding local impacts, economics etc. However, the perspectives of organizations such as Heartland pose a major challenge to climate change education now and in the future. Heartland has succeeded in raising concerns about the economic fallout that would accompany a reduction in dependence of fossil fuels. This means that to counter Heartland's framing, the climate change education that students in

Bangladesh, California and Ghana and across the world need, is one that emphasizes the scientific consensus and the role of human activity, but at the same time provides context for the complexities of climate change impacts and policies (mitigation & adaptation). My major point about policy solutions, which features prominently in my critique of the theoretical frameworks and the textbooks and supplementary materials, is that the texts and other materials, omit the importance of local and regional scale. To this end, states/governments and non-governmental organizations responsible for curriculum development and enactment must attend to questions/concerns related to local realities whether ecological, economical or cultural values. In recent times, at least in the United States, there has been a clash over what I will call contrasting value systems and different viewpoints about the teaching of race and sexuality. But as argued previously, these controversies are not new. They are never settled issues; rather, curriculum controversies are subject to the politics of the times. In light of this, the framing of controversial issues and specifically, climate change in textbooks must be clear, coherent, and factual to support teaching and learning. The curriculum/textbooks must also attend to local cultures and this include race, ethnicity and the specifics of geography. Finally, global perspectives on climate change in the curriculum should discuss structural challenges in the global South and market demands of goods and services that fuel climate change.

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APPENDIX

APPENDIX A: CODES FOR BANGLADESH

Frame	Description
Climate Adaptation- Local	Coastal Afforestation, Infrastructure, education,
Climate Mitigation- Generic	Here, the final Code is also the Category/Frame. The initial codes include- reducing carbon dioxide emission, reduce energy consumption, reduce burning of coal, planting of trees.

Frame	Description
Climate Related Impacts Relationship to Local	Sea Level Rise, Typhoons, Cyclones, floods, droughts, storm surges, tornadoes, river erosions,
Human Activity	Atmosphere, warming the earth, greenhouse gases, greenhouse effect, Fossil fuel, Deforestation, increased carbon dioxide, trapping gases, increase in earth's temperature, burning of fossil fuels, industrial revolution.
Scientific Consensus	This category/frame captures scientist observations and conclusions about human induced climate change.

APPENDIX B: CODES FOR GHANA

Frame	Description
Generic Impacts- Middle School	Melting of Icebergs, Sea Level Rise, Flooding, Diseases, Incidence of bush fires, Bad Weather Events,
Adaptation- Generic	Planting of trees
Human Activity	Burning, Smoke from Car Exhaust, Deforestation
Life style- Local (Elementary School)	Recycle, walking to school, joining the school bus, riding bicycles to school

Local Impacts- Elementary School	Floods, Drought, Change in Seasons, Diseases,
Plant More Trees- Generic (Middle School)	
Plant More Trees-Local (Elementary School)	Legislation, environmental protection clubs, community engagement, education

APPENDIX C: CODES FOR CALIFORNIA

Name	Description
Climate Mitigation	Technology, Bio-Fuels, Alternative Energies, Legislation
Human Activity	Greenhouse, Carbon Dioxide Concentrations, Greenhouse Effect, Fossil Fuels, Polar Bears, Cold Climate Ecosystems
Impacts	Sea level Rise, Flooding, Wildfire, Bad weather
Climate Adaptation	San Francisco, Urban, Infrastructure
Scientific Consensus	Scientists observed, Scientist collect, Scientist theorize

Name	Description
Scientific Consensus- Inconsistent one	"Scientist are Still"

APPENDIX D: CODES FOR PALEONTOLOGICAL RESEARCH INSTITUTION

Name	Description
Causes of Climate Change- Human Activity	Aerosols, Natural variation, Greenhouse Gases, Earth Cycles, Increased Carbon dioxide, fossil fuels, cutting down forests, cement production
Causes of Climate Change- Scientific Consensus	Phenomena, Unknown Variation, Equal Weight, Uncertainty, Variation, Data, Greenhouse

APPENDIX E: CODES FOR HEARTLAND INSTITUTE

Frame	Description
No Consensus	IPCC, Greenhouse Gases, Flaws, Projection, Obama, Disagreement, Fossil Fuels, References, Phil Jones, Alarmist, Media

Frame	Description
Doubt Category	Scientific Method, Politics, John Kerry, Obama, Greenhouse, Man Made, IPCC, Crippling, Disagreement, Climate Alarmist,
Causes of Climate Change- Villain Frame	Disagreement, Al Gore, Obama, John Kerry, Media, IPCC, Scientists, Conflict, Bias, Increasing CO2, Greenhouse, Millennia, Tunnel Vision, AGU

APPENDIX F: CODES FOR THE UNITED NATIONS

Name	Description
Adaptation With	Education, Formal Education, Informal Education, youth participation, community engagement, Government,
Adaptation for	Children, Infrastructure, Alternative Energy, Policy, Education. Government, Livelihoods,
Climate Mitigation	Greenhouse Gases, Efficient Energy, Reducing Emissions,