**Climate change discourse in U.S. history textbooks from California and Texas**

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Word count: 5770 words, excluding abstract, footnotes, references, tables/figures, acknowledgements, disclosures, and biographical notes

#### **ABSTRACT**

Anthropogenic climate change is a scientific fact, but U.S. public discourse around the issue remains mired in uncertainty, including in education. Our study leverages natural language processing methods to give an unprecedented look into the precise extent to which climate change-related topics are covered in 30 of the most widely-used history textbooks in California and Texas. We find that history textbooks situate climate change-related topics within the narrative of U.S. progress and development, and focus on the role of government in climate action. Consistent with analyses of science curricula, we also find that history textbooks emphasize controversy and uncertainty in climate discussions. Despite differences in state-level standards, the content of textbooks in California and Texas are surprisingly similar in the extent and nature of their climate change-related discourse. Our study shows that history textbook reform is an important arena for expanding and improving climate change education.

**Key words:** California, climate change, history, Texas, textbooks, scientific consensus

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#### **INTRODUCTION**

Anthropogenic climate change is a scientific fact, agreed upon by nearly all organizations that conduct scientific work, and with clear metrics that reject non-anthropogenic hypotheses (National Aeronautics and Space Administration [NASA], 2021). However, U.S. public discourse around climate change and related environmental issues remains mired in uncertainty, contradiction, and political interests (Edwards, 2010; Lakoff, 2010; Pew Research Center, 2015). In some cases, portrayals of climate change can be lightning rods that project political interests at the expense of accurate climate science (Lakoff, 2010; National Center for Science Education [NCSE] and Texas Freedom Network Education Fund [TFNEF], 2020). Education is a key driver of environmental knowledge (Reid et al., 2021), acting as both a diffuser for environmental concerns (Bromley et al., 2011) as well as a source for misconceptions around climate science (Choi et al., 2010). As the environmental crisis deepens, it is increasingly important to critically assess the variety of ways climate change and environmental issues may be conveyed across education content and systems (Reid et al., 2021).

Using natural language processing (NLP) methods, we examine the ways in which climate change-related topics are portrayed in 30 of the most widely used high school history textbooks from California and Texas. These states’ dominant positions in the national U.S. textbook market make their content decisions consequential for students across the country. Moreover, their differing treatment of climate change in state standards (NCSE & TFNEF, 2020) as well as divergent political leanings since the mid-1990s (Monogan & Doctor, 2017) make them ripe sites for comparison. Textbooks are an important context to study as they remain the most widely used educational tools in history and civics classes (National Assessment of Educational Progress [NAEP], 2014), and we have long known that their content influences students net of teacher effects (see Heyneman et al., 1981 for a classic review; more recently, see Tarr et al., 2008). Methodologically, we contribute to the body of literature on research on environmental education in textbooks by drawing on computational approaches to studying textbook content (Lucy et al., 2020).

Substantively, we join a small but growing group of scholars that emphasizes the importance of studying environmental education within mainstream social science and humanities courses (Gills & Morgan, 2021; Biström & Lundström, 2021; Neo & Schneider-Mayerson, 2022). Existing studies tend to focus on science classes or environment-specific curricula (e.g. Román & Busch, 2016; Vojíř & Rusek, 2019) rather than general history, civics, or economics courses. Science courses are likely to be the best place for students to learn about the technical processes of climate change. But social science and humanities courses, including history, are critical sites for learning our rights and duties as citizens. Social sciences and humanities can, for example, help us understand resistance to environmentalism from social, political, and economic groups. Some segments of society have vested interests in maintaining the status quo, while others are deeply suspicious of technocratic expertise due to generations of marginalization. In addition, the social sciences and humanities offer unique opportunities for conveying the importance of collective action around environmental issues, which prior work has found to be necessary for engendering action and hope in children and youth (Stevenson et al., 2018; Jorgenson et al., 2019). Both the hard sciences and social sciences/humanities lenses are therefore necessary for a well-rounded grasp on sustainability.

##### ***The inconsistent treatment of climate change in education and textbooks***

Education systems vary in the extent to which the content of curricula addresses climate change, and they vary in the way climate change is portrayed. In terms of depictions of climate change, existing literature suggests a few critical dimensions we may expect to observe. First, prior work suggests potential divergence in coverage of these topics according to social and political context. Second, the human causes and costs of climate change, as well as the potential solutions to climate change, are important dimensions of environmental education. Finally, climate change is variably described as reflecting a scientific consensus.

###### Contrasting cases of climate change content

Environmental and climate change-related topics have experienced increased attention in education systems both in the U.S. as well as cross-nationally. Bromley et al. (2011) found a dramatic increase in the extent to which textbooks around the world emphasize the environment between 1970 to 2011. The authors argue that this shift occurs not only due to the rise in environmentalism over time, but also because of global cultural emphases on individuals as empowered agents, which makes the environmental education of individual students more urgent. Indeed, additional cross-national work has found increased textbook mentions of not only environmental protection and damage, but also of the environmental rights of individual citizens (Jimenez et al., 2017). Rather than finding notable differences between individual countries or regions, these studies emphasize homogenizing cultural processes that predict similar treatment of environmental issues across diverse contexts.

However, literature on the U.S. in particular suggests that politicized differences may continue to exist. Seminal work by cognitive linguist George Lakoff (1996) suggests that conservative and progressive politics in the U.S. use fundamentally different conceptual models of morality, which translate to divergent political frameworks for various policy issues. Extending his argument to the case of climate change, Lakoff (2010) suggests that conservative frameworks understand nature as made by God for human use; see the free market as both natural and moral; and think in terms of direct rather than systemic causation. Meanwhile, progressive frameworks emphasize empathy and social responsibility for other beings, including in the natural world; reject market fundamentalism in favor of government as a necessary agent; and acknowledge systemic causation (Lakoff, 2010).

The logic of Lakoff’s (1996/2010) work would suggest that California and Texas may emphasize climate change to different extents and use different discourses as a result of their divergent politics and cultural patterns. While the two states are quite similar on multiple social demographics—population diversity, share of immigrant population, urbanization—the turn of the millennium ushered in an “age of polarization” in which Democrats and Republicans achieved one-party, state-level political hegemony in California and Texas, respectively (Miller, 2020). Climate change, in particular, has become increasingly politically polarized over the last two decades (Dunlap et al., 2016). More instrumentally, the divergent political and cultural patterns might drive the textbook markets in the two states towards different content preferences, especially in the case of politically polarizing topics (Foss, 2018). Although data on the internal operations of textbook publishers is hard to obtain, some evidence shows that large publishers do tailor some of their paragraphs and images towards one state or the other (Golden, 2006; Goldstein, 2020). At the same time, neither California nor Texas require the use of specific textbooks, leaving a good deal of authority to local districts and actors. In California, the governing board of a local district either runs its own adoption process by forming a selection and approval committee, or leaves the adoption process to their high schools (California Department of Education [CDE], n.d.). Meanwhile, in Texas, the elected State Board of Education selects lists of materials through a centralized deliberation process, but does not mandate the adoption of selected materials statewide (Texas Education Agency [TEA], n.d.).

In terms of actual curricular content, prior work on the two states’ climate education suggests that the subject’s treatment in textbooks should diverge substantially between state contexts. In a survey of over 800 secondary science teachers, Khalidi and Ramsey (2021) found that counterparts in California and Texas had significantly divergent views of climate change. For example, with respect to the origins of climate change, significantly higher proportions of California teachers emphasized the scientific consensus around human causes, while higher proportions of Texas teachers emphasized natural causes. In terms of pedagogy, higher proportions of California teachers reported discussing potential climate solutions. Indeed, the primary commonality across both states was that both sets of teachers lacked adequate overall knowledge. Meanwhile, in a 2020 report by the National Center for Science Education (NCSE) and Texas Freedom Network Education Fund (TFNEF), the two states received very different “grades” for their state standards with respect to scientifically accurate climate change education. Texas received the lowest possible ratings—“D” and “F” grades—for being less likely to acknowledge the reality of climate change, identify human activity as a source, and propose potential solutions, among other criteria (NCSE & TFNEF, 2020). In contrast, California was one of the higher-rated states, with its standards receiving “B” and “B+” grades across the same criteria. In sum, this work suggests that California and Texas history textbooks will diverge in the extent to which they incorporate mentions of climate change and relevant environmental issues.

###### The nature of climate change education

The states may differ not only in how much they discuss climate change related content, but also in the nature of those discussions. For example, studies have found some educational materials use highly technocratic discourses, which suggest that climate change can only be solved by specialized scientists, with regular individuals having little to no potential for impact (Halliday & Martin, 1993). In an analysis of sixth grade science textbooks from California, Román and Busch (2016) found that textbooks primarily portrayed scientists as the human agents involved in addressing climate change. In addition, while the books discussed different potential actions humans could take to reduce their greenhouse gas production, they did not use the pronoun “you” to explicitly tell students how they could take action. Román and Busch (2016) argue that this type of abstraction in the context of climate discourse might undermine understanding of human agents as responsible for the accumulation of greenhouse gases. Moreover, it creates the technocratic perception that only scientists can solve climate change, which may disempower students (Halliday & Martin, 1993; Román & Busch, 2016). Wynes and Nicholas (2017) identify high-impact actions that individuals can take, including having fewer children, living car-free, avoiding airplane travel, and eating a plant-based diet. However, the authors find that government resources on climate change from the United States and other high-income countries focus on lower-impact actions.

Beyond individual-level activities, organizations, especially large corporations, have a role in both causing and mitigating climate change. At the curricular level, materials produced by pro-free-market political environments may omit corporations as a major source of greenhouse gases (Lakoff, 2010). Climate scientists have found that corporations are enormously consequential producers of greenhouse gases, with 100 fossil fuel companies producing over 70% of global greenhouse gas emissions between 1988 and 2017 (Griffin, 2017). Yet research tends to focus on governments and communities as key actors in addressing climate change, with substantially less focus on the impact and outcomes of corporate actors (Wright & Nyberg, 2015; Averchenkova et al., 2016). Prior work has found that high school social science textbooks in the U.S. and Canada increasingly treat organizations, including corporations, as positive social actors over time (Choi et al., 2021). However, it is unclear whether similar textbooks recognize the role of corporations in causing climate change, and the necessity for changes in corporate activity to reduce greenhouse gas emissions.

Lastly, much research in environmental education emphasizes variation in the extent to which curricular materials depict climate change as controversial or anthropogenic. While skepticism is an important norm in the scientific community (Merton, 1973), this norm may be manipulated or misinterpreted by other institutions to convey scientific consensus as controversial or uncertain (Maier et al., 2016). Román and Busch (2016) found that California science textbooks discussed anthropogenic climate change in various levels of uncertainty rather than scientific consensus, using modal verbs like “could,” “may,” or “might.” Moreover, explicit references to terms such as “research,” “data,” and “evidence” occurred less than a handful of times. This has direct implications for students’ knowledge and action. For example, Choi et al. (2010) found that student misconceptions about climate change emerged from limited or inaccurate coverage within earth and environmental science textbooks.

Within the humanities and social sciences, misunderstandings of scientific skepticism versus consensus may also be exacerbated by norms within history textbooks in particular. A norm in historical reading comprehension is the use of multiple texts to convey contrasting viewpoints on a historical event or issue (Stahl et al., 1996). This practice has been found to be beneficial for developing essential skills of corroboration, sourcing, and contextualization (Wineburg, 1991). However, conflicting information presented without context may also suggest that knowledge is entirely dependent on perspective (Perry, 1970). This becomes problematic in the case of conveying understandings around scientific consensus, since the norm of presenting contrasting viewpoints may legitimize the belief that climate change is a two-sided issue.

Overall, this literature suggests several plausible arenas where we might observe meaningful differences in the extent and nature of climate change-related content in California and Texas textbooks. As we describe next, we approach the textbooks inductively, allowing themes to emerge from the content rather than searching out specific approaches to climate change education. Although several instruments for measuring climate literacy or related topics exist (e.g. DeWaters & Powers, 2008; Yavetz et al., 2009), there is not a widely agreed-upon framework suitable for the context of history curricula. Given the limited analysis of environmental education in history courses, an inductive approach provides a baseline description.

#### **DATA AND METHODS**

##### ***Textbook selection***

The 30 textbooks in our sample were identified based on their wide usage in their respective states. Widely-used California textbooks were identified using information on district-level adoptions from the 20 largest districts by population in 2019. Books were incorporated in the sample if they were either approved in two or more of the 20 largest districts, or if they were approved in any of the top five largest California districts specifically. Meanwhile, widely-used Texas textbooks were identified using district-level textbook purchase data made available online by the Texas Education Agency (n.d.). Books were selected for the sample if they were included in at least 10 district-level transactions between 2015 and 2017, which were the most recent years available during our data collection in 2019. Our final sample included 15 textbooks from California, and 15 from Texas, published between 2004-2019. A full list of textbooks is available in Appendix A.

##### ***Developing a climate change dictionary***

Our analytic strategy began with identifying terms and sentences within each textbook focused on climate change and related issues. To do this, we developed a broad dictionary of terms that could be extracted using machine-readable text files. Rather than focusing narrowly on the exact phrases “climate change” or “global warming,” our dictionary includes climate change-related terms, including relevant environmental issues, in order to provide insight into a general discourse related to climate change (for example, to capture discussions of the energy industry and environmental activism). We use this list to determine the proportion of words in the text that relate to topics linked to climate change, and to pull the relevant sentences for deeper content analysis. Purposeful selection and iterative review of key terms in a sampling strategy tends to prioritize precision over comprehensiveness (Tulkens et al., 2016; Bradshaw & Henle, 2021). In our case, this precision serves as a strength when examining a case that we anticipate may receive overall less coverage in our text corpus, such as climate change.

We constructed our dictionary beginning with terms from climate change glossaries and documents from prominent agencies and organizations engaged in climate work, including the United Nations’ “Sustainable Development Goals” (2015), Boston University’s “Sustainability Glossary of Terms” (2009), and the U.S. Environmental Protection Agency (EPA)’s “Glossary of Climate Change Terms” (2017). These lists were supplemented by a review of words appearing more than 150 times in our textbook data, to identify potential dictionary terms not covered by existing glossaries. After generating an initial dictionary of 203 terms, we then iteratively eliminated terms that tended to appear in textbook sentences unrelated to climate change and related environmental issues, such as “lead” in sentences discussing “leaders” rather than the element. A full description of the dictionary generation process and finalized list of 143 terms is described in Appendix B.

##### ***Computational analyses***

Prior to analysis, textbooks were scanned, digitized, and underwent minimal post-processing, including removing non-sentence text (e.g. indices, timelines). We then cleaned and tokenized[[1]](#footnote-1) the textbook content for a total of 6.9 million tokens within 241,932 sentences across the California corpus, and 7.6 million tokens within 291,446 sentences across the Texas corpus.

To determine the types of narratives that exist around terms broadly related to climate change we first extracted every sentence that included at least one of the terms from our climate change dictionary, yielding 2815 sentences. We applied Latent Dirichlet Allocation (LDA; Blei et al., 2003) topic modeling across the sentences to reveal latent content structures that emerge in the sentences. Topic modeling reveals groups of terms that most frequently appear together without making a priori assumptions about the linguistic patterns in the corpus. In this, it is conceptually akin to inductively allowing themes to emerge from text analysis using qualitative, grounded theory, and in some studies has been found to produce comparable results (Baumer et al., 2017; Nelson, 2020). The topics arise from patterned co-occurrences among all words in the sentences, so the findings are not directly driven by the frequency of terms in our dictionary. In fact, very few of our dictionary terms appear in the topic keywords, further reducing the concern that our results are solely driven by the terms that were used to generate the sample of sentences. Our analyses revealed 17 topics which appear in the climate change related sentences in the textbooks. Appendix C provides additional technical details of the topic generation process.

The topic modeling reveals latent linguistic structures in the text corpus, but it does not provide guidance into the meanings of the word groupings. Instead, researchers provide an interpretive framework to make sense of the results. After reviewing the top terms and sentences associated with a given topic, we apply interpretive labels using domain expertise (Boyd-Graber et al., 2017). For example, our analyses found that the following word stems were the top 10 stems associated with one topic: global, warm, carbon, fuel, increas, dioxid, fossil, time, greenhous, scientist. After examining sentences that were highly associated with this topic, we labeled it “Science of global warming” and included it in the higher-order theme of “Frameworks of climate change.”[[2]](#footnote-2)

##### ***Qualitative interpretation***

As a final step in the process, we extend our topic modeling with a qualitative interpretation of the topics that emerged from the data. Following the logic of a content analysis process that begins with fine-grained codes that are consolidated into higher order categories, we grouped the topics that emerged inductively from the computational analysis into three higher order themes (“Development,” “Sources of environmental action,” and “Frameworks of climate change”). Discussing the topics in light of these three themes gives additional meaning to the results and facilitates understanding of the implications of the study.

#### **RESULTS**

##### ***Frequencies of climate change-related terms***

[Figure 1 about here]

Figure 1 shows the frequency with which climate change-relevant terms are mentioned across the textbooks by state per 100,000 words. Across the corpus of California and Texas textbooks, we observe that terms such as “climate change,” “global warming,” and “greenhouse gas,” as well as the word stem “pollut,” occur in similarly low frequencies across both states. Specifically, the frequencies of these individual terms are lower than 10 instances per 100,000 words[[3]](#footnote-3), representing less than .0001% of words across each states’ textbooks. The most frequently mentioned terms tended to be related to energy use, including “coal,” “waste,” “mining,” and “energy,” which were each mentioned at least 1000 times, with the highest, “coal,” mentioned 2049 times. In both states, “global warming” is mentioned more frequently than “climate change”—in California the terms appear 76 times and 41 times, respectively; in Texas they appear 69 times and 30 times. Even the summed frequency of all 143 terms and stems in our climate change-relevant dictionary remains lower than those of other stemmed terms relevant to history such as “econom” and “politic.” These findings reveal two key points: first, that climate change-relevant terms are rarely discussed in the core citizenship education course required for high school graduation; and second, that the frequency findings between the two states are quite similar.

##### ***Narrative content around climate change terms***

While the frequency counts show the proportion of textbook content dedicated to climate-related topics, topic modeling reveals underlying narratives of this limited content. Our results, shown in Table 1, yielded 17 meaningful topics emerging from the climate-relevant sentences in the textbooks.[[4]](#footnote-4) Recall that in this process a computational model identifies groups of words that co-occur across sentences, revealing latent topics in the discourse. The first column of Table 1 is the topic label that is assigned using researcher expertise. The second column contains the top keywords associated with each topic revealed in the computational analysis, and the third column contains an exemplar sentence that the computational modeling identified as having a high association with that topic. The topics are ordered in terms of their prevalence in the corpus, from most to least prevalent. Topics appear in the same relative prevalence across states (i.e. “building public works” is most common and “Thoreau” is least prevalent), and the majority of topics are emphasized either with similar prevalence or similar sentence content in the Texas corpus and the California corpus.[[5]](#footnote-5)

[Table 1 about here]

Across the fine-grained topics, we qualitatively identified three higher-order themes to provide additional interpretation of the findings. As shown in Table 2, the topics relate to overarching themes of nation-state development, narratives around the key actors of climate change, and frameworks for understanding climate change.

[Table 2 about here]

###### Development as progress and risk

History textbooks mainly discuss climate change-related content in the context of U.S. progress and development, including discourse around both the benefits of progress and, to a lesser degree, the harms and risks. Within the theme of development, sentences that discussed positive progress primarily referred to government work around public structures and energy. For example, this sentence from a California textbook constitutes a list of projects by the Public Works Administration (PWA):

“The PWA was responsible for building many important structures that are still in use today, such as New York City’s Triborough Bridge, the Overseas Highway linking Miami and Key West, Florida, and the Bonneville Dam on the Columbia River in the Pacific Northwest.” (National Geographic, 2019, p. 324)

Similarly, this sentence from a Texas textbook points to the energy contributions of the federally-owned Tennessee Valley Authority (TVA):

“Begun in 1933, the Tennessee Valley Authority (TVA) was a government-owned utility company that provided thousands of jobs as it built dams that generated power, provided flood relief, and created recreational lakes throughout the seven states (Tennessee, Alabama, Mississippi, Kentucky, Virginia, North Carolina, and Georgia) serviced by the Tennessee River.” (Keene et al., 2013, p. 671)

Across both states, textbooks highlighted the economic, infrastructure, and energy contributions of government-sponsored development projects. When potential risks of development were discussed, the rhetoric was quite tame, identifying development as one of multiple potential sources of observed harm. For example, one of California book situates “unwise agricultural practices” alongside natural disasters in contributing to the Dust Bowl and its devastation:

“Discuss the human toll of the Depression, natural disasters, and unwise agricultural practices and their effects on the depopulation of rural regions and on political movements of the left and right, with particular attention to the Dust Bowl refugees and their social and economic impacts in California.” (Lapsansky-Werner et al., 2008, p. H-SS 7)

Meanwhile, this example from a Texas textbook vaguely references “environmental problems” in the Gulf of Mexico caused by the BP oil spill: “The 2010 Deepwater Horizon spill in the Gulf of Mexico (often referred to as the BP oil spill) created environmental problems in Louisiana, Alabama, Mississippi, and Florida” (Davidson & Stoff, 2016, p. 709).

Overall, both California and Texas textbooks highlight development projects as a source of progress. Potential environmental risks or actual disasters are mentioned, but the language tends to be vague and spread responsibility across multiple sources (e.g. both human causes and general “natural disasters”). Parallel to studies of science curricula that show educational materials cast doubt on the scientific consensus around anthropogenic causes of climate change (e.g. Román & Busch, 2016), our findings show that, in the case of history textbooks, uncertainty is conveyed around the potential risks and harms of development relative to its benefits.

###### Government and “Great Men” as the source of environmental action

The second major theme that emerges in history books shows that the primary actors engaged in climate change-relevant action are the government, politicians, and prominent individual conservationists, with little discussion of groups or individuals in which students may see themselves represented. Here, the term “great men” here is meant to be less about gender—although the figures are often men—and more about the idea that exceptional figures drive history.

The emphasis on government and “great men” as primary agents is also present in the prior theme on development. For example, both states highlight the creation of the National Park system as a particularly relevant environmental action, as exemplified by this sentence from a California textbook: “Although funds were short, the government set aside about 12 million acres of land for new national parks, including Shenandoah National Park in Virginia, Kings Canyon National Park in California, and Olympic National Park in Washington State” (National Geographic, 2019, p. 340).

Similarly, within the topic on conservationists, both states highlighted the relationship between John Muir and Theodore Roosevelt as a key driver of early environmental conservation efforts: “Roosevelt was pleased that the federal government had established Yellowstone National Park in 1872 to protect wildlife, and he admired California naturalist John Muir, whose efforts had led Congress to create Yosemite National Park in 1890” (Davidson & Stoff, 2016, p. 183).

The emphasis on government as the core climate actor persists in topic narratives that highlight government and international legislation, including the Clean Air Act and the Kyoto Protocol. The teaching of history as mainly a story of “great (white) men” is well-recognized in the discipline (e.g. Wilson & Wineburg, 1988). Although there are many efforts to diversify the teaching of history and use it as a tool to promote critical thinking rather than rote memorization, in our polarized times these efforts are also routinely met with resistance and controversy. The general critique of history as an elite, white, male endeavor is also present in how climate change-related content is discussed.

###### Climate change controversies

A final theme that emerges is that students are led to focus on the controversies surrounding climate change, in line with prior work on science curricula. Climate change is discussed as anthropogenic, but using language which obfuscates the overwhelming nature of scientific consensus. For example, the following two exemplar sentences assert human causes of climate change as part of the consensus of science and experts:

California: “These scientists believe this warming is causing climate change and is largely due to human activities.” (National Geographic, 2019, p. 772)

Texas: “Many experts think that the carbon dioxide gas released when people use fossil fuels is building up and warming Earth’s climate.” (McDougal, 2016, p. 900)

On their own, assertions such as these might help to clarify students’ understanding of the scientific consensus around climate change. However, the books also routinely treat climate change and global warming as controversial. A common question was to ask students, “What are the competing views on global warming?” (Keene et al., 2013, p. 905). Assertions of the science of climate change are therefore undermined by inferences of uncertainty and controversy—or even benefits—elsewhere in the texts. For example, in the Texas corpus, the following sentence presents global warming as having provided agricultural benefits: “Global warming enabled an agricultural revolution, particularly of maize, that allowed former hunter-gather peoples to settle and build empires, such as that of the Mexica, whose Aztec Empire included subjugated peoples and a vast system of trade and tribute.” (Shi & Tindall, 2016, p. 52)

In addition, both states’ corpora situate environmental damage within the contributions of fossil fuels to U.S. energy and economy, which undermines the assertion of their harms relative to the environment: “Fossil fuels such as oil provided 84 percent of the energy in the United States in 2009 but also contributed to poor air quality, acid rain, and global warming.” (in California edition, McDougal, 2010, p. 881; in the Texas edition, McDougal, 2016, p. 881)

And while California’s science standards were highly rated for their climate coverage, one of the state’s U.S. history standards—present in one of the most recently published books in the sample—explicitly prompts students to consider controversies associated with environmental action: “Trace the impact of, need for, and controversies associated with environmental conservation, expansion of the national park system, and the development of environmental protection laws, with particular attention to the interaction between environmental protection advocates and property rights advocates” (National Geographic, 2019, p. xxviii).

An emphasis on the controversies around climate change and relevant environmental issues similarly exists in California’s textbook content, such as this example presenting a conflict between addressing global warming versus pursuing economic development:

“Some question whether global warming even exists. The issue is very controversial because the cost of controlling emissions would affect the global economy. Industries would have to pay the cost of further reducing emissions and those costs would eventually be passed on to consumers. Developing nations trying to industrialize would be hurt the most, but economic growth in wealthier nations would be hurt, too.” (Appleby et al., 2006, p. 946)

Therefore, both states contain language which may obfuscate understanding of the scientific consensus around climate change. Taken together, the findings suggest that California and Texas are quite similar in actual textbook content, based on both the frequency with which climate-relevant terms are incorporated, as well as the narrative content around these terms.

#### **DISCUSSION**

Unlike most comparative work, which is designed to draw out differences between cases, our approach started from an inductive strategy that treated textbook content holistically and remained agnostic as to whether similarity or differences would arise. The results are surprising – using computer-assisted methods to include every word and sentence in the book in our analyses, we observe great similarity between California and Texas.

One explanation to account for this extensive similarity may relate to our choice of analyzing textbooks in U.S. history, rather than state-specific courses (e.g. California history). A general U.S. history course may seek to provide an overarching narrative for the entire country, not to amplify within-country differences (Schissler & Soysal, 2005). However, this explanation only amplifies the need for textbook-specific reforms. Our study suggests the link between state standards and climate change content in textbooks is weak, as shown by the similarities in textbooks across California and Texas despite different standards and political contexts. Consequently, efforts toward institutional change should directly include textbook publishers rather than indirectly relying on standards to shape textbook content or putting the burden entirely on overloaded teachers to independently seek out appropriate curricular materials.

Our findings further suggest that history textbooks tend to maintain three themes that may act as barriers to effective climate change action. First, the textbooks perpetuate the notion that there remains controversy and uncertainty around whether climate change is human-driven and/or solvable through human actions. While skepticism is indeed an important norm of the scientific community (e.g. Merton, 1973), here, the presentation of a two-sided issue misrepresents the role of scientific skepticism in building consensus, and creates barriers to collective climate action (Hayden, 2011; Colston et al., 2015 ). These findings are consistent with prior studies examining how textbooks may use language of scientific uncertainty rather than scientific consensus with respect to climate change (Román & Busch, 2016).

Second, the textbooks’ focus on political leaders and less than a handful of particularly prominent environmental actors perpetuates an elitist vision of climate action, albeit politically elitist rather than technocratic per se (Halliday & Martin, 1993; Román & Busch, 2016). In other words, even if students were to understand climate change as solvable through human action, the underlying content structure of the textbooks would suggest that mainly government actors can address climate change and related environmental issues, and primarily through large-scale public works projects. Individual politicians and high-profile environmentalists tend to dominate textbook narratives, with less emphasis on collective action. Moreover, while dramatic and urgent government action is indeed a central part of addressing climate change, the textbooks do not appear to make connections between individual citizens’ actions and the potential for these large-scale changes, such as voting for political leaders that commit to climate action.

A third observation is that the textbooks nearly entirely omit organizational actors from the discussion. At best, textbooks have a passing mention of the role of corporations in contributing to climate change, such as the BP oil spill, or of the role of the Sierra Club in raising awareness about environmental issues. Organizations, especially corporations, do not receive attention that matches their outsize role in contributing to environmental damage; this may create barriers to understanding companies as the overwhelming producers of greenhouse gases (Griffin, 2017). These findings are consistent with prior literature that textbooks may overlook corporations as a contributor to climate change (Lakoff, 2010), and that textbooks are increasingly likely to emphasize organizations as positively contributing social actors (Choi et al., 2021).

Our study presents certain limitations that offer guidance for future research directions. First, while we cover the most widely-used textbooks in California and Texas, we do not cover the full sample of textbooks available in these states, much less textbooks across the country. Future research should expand the variety of states examined in order to better understand how state-level variations might predict textbook content. Second, history textbooks represent only one aspect of students’ core subjects and education in citizenship. Future research should examine the presentation of climate change and other scientific controversies in a wider array of core humanities and social science courses and textbooks, in order to develop a broader understanding of how scientific consensus is portrayed outside of science education.

Environmental education is urgently needed in core civics and citizenship courses like required history classes, as well as in science (Rudolph & Horibe, 2016). We need to teach students to understand their collective power in voting for leaders that seek to address climate change, and in pressing high-polluting firms to change, in addition to individual-level behaviors like reducing one’s own carbon footprint. Although many stress the uncertainty of climate change and climate action, there is no doubt that citizen activism to promote pro-environment leaders and firm responsibility will do far more for climate change than teaching students to turn out the lights at home.

#### **ACKNOWLEDGEMENTS AND FUNDING DETAILS**

We wish to thank Sebastian Andrews for outstanding research assistance. We appreciate feedback on early versions of this paper from members of the Computational Sociology Workshop and Comparative Sociology Workshop at Stanford University. We are particularly grateful to members of the Global Civil Society & Sustainable Development Lab at the Stanford Center on Philanthropy and Civil Society for comments on drafts at various stages. This work was supported by a Seed Research Grant from the Human-Centered Artificial Intelligence (HAI) at Stanford University.

#### **DISCLOSURE STATEMENT**

The authors report there are no competing interests to declare.

#### **REFERENCES**

Appleby, J., Brinkley, A., Broussard, A. S., McPherson, J. M., Ritchie, D. A. (2006). *The American vision: Modern times* (California Ed.). Glencoe/McGraw-Hill.

Arun, R., Suresh, V., Veni Madhavan, C. E., & Murthy, N. (2010, June). On finding the natural number of topics with Latent Dirichlet Allocation: Some observations. In *Pacific-Asia conference on knowledge discovery and data mining* (pp. 391–402). Springer, Berlin, Heidelberg.

Averchenkova, A., Crick, F., Kocornik-Mina, A., Leck, H., & Surminski, S. (2016). Multinational and large national corporations and climate adaptation: Are we asking the right questions? A review of current knowledge and a new research perspective. *Wiley Interdisciplinary Reviews: Climate Change*, *7*(4), 517–536. <https://doi.org/10.1002/wcc.402>

Baumer, E. P., Mimno, D., Guha, S., Quan, E., & Gay, G. K. (2017). Comparing grounded theory and topic modeling: Extreme divergence or unlikely convergence?. *Journal of the Association for Information Science and Technology, 68*(6), 1397–1410. <https://doi.org/10.1002/asi.23786>

Bischof, J., & Airoldi, E. M. (2012). Summarizing topical content with word frequency and exclusivity. In *Proceedings of the 29th International Conference on Machine Learning* *(ICML-12)* (pp. 201-208). <https://icml.cc/Conferences/2012/papers/>

Biström, E., & Lundström, R. (2021). Action competence for gender equality as sustainable development: Analyzing Swedish lower secondary level textbooks in biology, civics, and home and consumer studies. *Comparative Education Review, 65*(3), 513–533. <https://doi.org/10.1086/714607>

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *Journal of Machine Learning Research, 3*(Jan), 993–1022. <https://www.jmlr.org/papers/volume3/blei03a/blei03a.pdf>

Boston University (2009). Sustainability Glossary of Terms. *Sustainability @ BU*. <https://www.bu.edu/sustainability/reference/glossary-of-terms/>

Boyd-Graber, J., Hu, Y., Mimno, D. (2017). Applications of topic models. *Foundations and Trends in Information Retrieval, 11*(2–3), 143–296. <https://doi.org/10.1561/1500000030>

Bradshaw, S., & Henle, A. (2021). The gender dimensions of foreign influence operations. *International Journal of Communication, 15*, 4596–4618. <https://ijoc.org/index.php/ijoc/article/view/16332>

Brinkley, A. (2016). *The unfinished nation: A concise history of the American people* (8th Ed., Vol. 1). McGraw-Hill Education.

Bromley, P., Meyer, J. W., & Ramirez, F. O. (2011). The worldwide spread of environmental discourse in social studies, history, and civics textbooks, 1970–2008. *Comparative Education Review, 55*(4), 517–545. <https://doi.org/10.1086/660797>

California Department of Education (CDE). (n.d.). Standards maps for grades nine through twelve. *California Department of Education.* <https://www.cde.ca.gov/ci/cr/cf/gr912stmap.asp>

Cao, J., Xia, T., Li, J., Zhang, Y., & Tang, S. (2009). A density-based method for adaptive LDA model selection. *Neurocomputing, 72*(7-9), 1775–1781. <https://doi.org/10.1016/j.neucom.2008.06.011>

Cayton, A. R. L., Perry, E. I., Reed, L., & Winkler, A. M. (2005). *America: Pathways to the present modern American history*. Pearson Prentice Hall.

Choi, M., D’Apice, H. K., & Skinner, N. A. (2021). The rise of the organisational society in Canadian and U.S. textbooks: 1836–2011. *Globalisation, Societies and Education*, *19*(1), 7–22. <https://doi.org/10.1080/14767724.2020.1814700>

Choi, S., Niyogi, D., Shepardson, D. P., & Charusombat, U. (2010). Do earth and environmental science textbooks promote middle and high school students’ conceptual development about climate change? Textbooks’ consideration of students’ misconceptions. *Bulletin of the American Meteorological Society, 91*(7), 889–898. <https://doi.org/10.1175/2009BAMS2625.1>

Colston, N. M., & Vadjunec, J. M. (2015). A critical political ecology of consensus: On “teaching both sides” of climate change controversies. *Geoforum, 65*, 255–265. <https://doi.org/10.1016/j.geoforum.2015.08.006>

Davidson, J. W., & Stoff, M. B. (2016). *United States history: 1877 to present*. Pearson Education, Inc.

Deveaud, R., San Juan, E., & Bellot, P. (2014). Accurate and effective latent concept modeling for ad hoc information retrieval. *Document Numérique, 17*(1), 61–84. <https://doi.org/10.3166/DN.17.1.61-84>

DeWaters, J., & Powers, S. (2008, October). Energy literacy among middle and high school youth. In *2008 38th Annual Frontiers in Education Conference* (pp. T2F-6). IEEE. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.515.8484&rep=rep1&type=pdf>

Dunlap, R. E., McCright, A. M., & Yarosh, J. H. (2016). The political divide on climate change: Partisan polarization widens in the U.S. *Environment: Science and Policy for Sustainable Development, 58*(5), 4–23. <https://doi.org/10.1080/00139157.2016.1208995>

Edwards, P. (2010). *A vast machine: Computer models, climate data, and the politics of global warming.* MIT Press.

Foss, A. (2018). Divergent responses to sustainability and climate change planning: The role of politics, cultural frames, and public participation. *Urban Studies, 55*(2), 332–348. <https://doi.org/10.1177/0042098016651554>

Gills, B., & Morgan, J. (2021). Teaching climate complacency: Mainstream economics textbooks and the need for transformation in economics education. *Globalizations*, *18*(7), 1–17. <https://doi.org/10.1080/14747731.2020.1808413>

Gladwin, T. N., Kennelly, J. J., & Krause, T. S. (1995). Shifting paradigms for sustainable development: Implications for management theory and research. *Academy of Management Review, 20*(4), 874–907. <https://doi.org/10.5465/amr.1995.9512280024>

Golden, D. (2006, Aug 19). Aiming for diversity, textbooks overshoot. *Wall Street Journal*, A1. <https://www.wsj.com/articles/SB115595234477240157>

Goldstein, D. (2020, Jan 12). Two states. Eight textbooks. Two American stories. *The New York Times*, 12. <https://www.nytimes.com/interactive/2020/01/12/us/texas-vs-california-history-textbooks.html>

Griffin, P. (2017). *The Carbon Majors Database: CDP Carbon Majors Report 2017*. CDP Worldwide. <https://cdn.cdp.net/cdp-production/cms/reports/documents/000/002/327/original/Carbon-Majors-Report-2017.pdf?1501833772>

Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National academy of Sciences, 101*(suppl 1), 5228–5235. <https://doi.org/10.1073/pnas.0307752101>

Halliday, M. A. K., & Martin, J. (1993). *Writing science: Literacy and discursive power.* University of Pittsburgh Press.

Hayden, M. (2011). Pedagogies of empowerment in the face of climate change uncertainty. *Journal for Activist Science and Technology Education, 3*(1), 118–130. <https://jps.library.utoronto.ca/index.php/jaste/article/view/21202>

Heyneman, S. P., Farrell, J. P., & Sepulveda-Stuardo, M. A. (1981). Textbooks and achievement in developing countries: What we know. *Journal of Curriculum Studies, 13*(3), 227–246. <https://doi.org/10.1080/0022027810130306>

Jarrett, M., Zimmer, S., & Zilloran, J. (2012). *Mastering the grade 8 social studies TEKS & Mastering the TEKS in United States history Since 1877*. Jarrett Publishing Company.

Jasanoff, S. (2010). Testing time for climate science. *Science, 328*, 695–696. DOI: 10.1126/science.118942

Jimenez, J. D., Lerch, J., & Bromley, P. (2017). Education for global citizenship and sustainable development in social science textbooks. *European Journal of Education, 52*(4), 460–476. <https://doi.org/10.1111/ejed.12240>

Jorgenson, S. N., Stephens, J. C., & White, B. (2019). Environmental education in transition: A critical review of recent research on climate change and energy education. *The Journal of Environmental Education, 50*(3), 160–171. <https://doi.org/10.1080/00958964.2019.1604478>

Keene, J. D., Cornell, S. T., & O’Donnell, E. T. (2013). *Visions of America: A history of the United States* (2nd Ed.). Pearson.

Khalidi, R., & Ramsey, J. (2021). A comparison of California and Texas secondary science teachers’ perceptions of climate change. *Environmental Education Research, 27*(5), 669–686. <https://doi.org/10.1080/13504622.2020.1838447>

Lakoff, G. (1996). *Moral politics: What conservatives know that liberals don’t.* University of Chicago Press.

Lakoff, G. (2010). Why it matters how we frame the environment. *Environmental Communication, 4*(1), 70–81. <https://doi.org/10.1080/17524030903529749>

Lapsansky-Werner, E. J., Levy, P. B., Roberts, R., & Taylor, A. (2008). *United States history: Modern America*. Pearson Prentice Hall.

Lucy, L., Demszky, D., Bromley, P., & Jurafsky, D. (2020). Content analysis of textbooks via natural language processing: Findings on gender, race, and ethnicity in Texas U.S. history textbooks. *AERA Open, 6*(3). <https://doi.org/10.1177/2332858420940312>

Maier, M., Milde, J., Post, S., Günther, L., Ruhrmann, G. & Barkela, B. (2016). Communicating scientific evidence: Scientists’, journalists’ and audiences’ expectations and evaluations regarding the representation of scientific uncertainty. *Communications*, *41*(3), 239–264. <https://doi.org/10.1515/commun-2016-0010>

Manning, C.D., Raghavan, P., & Schütze, H. (2008). Tokenization. In *Introduction to Information Retrieval.* Cambridge University Press. <https://nlp.stanford.edu/IR-book/html/htmledition/tokenization-1.html>

McDougal, H. (2010). *The Americans: Reconstruction to the 21st century*. Houghton Mifflin.

McDougal, H. (2016). *The Americans: United States history since 1877*. Houghton Mifflin.

Merton, R. K. (1973). *The sociology of science: Theoretical and empirical investigations*. University of Chicago Press.

Miller, K. P. (2020). *Texas vs. California: A history of their struggle for the future of America.* Oxford University Press.

Monogan, J. E., & Doctor, A. C. (2017). Immigration politics and partisan realignment: California, Texas, and the 1994 election. *State Politics & Policy Quarterly*, *17*(1), 3–23. DOI: 10.1177/1532440016645655

National Aeronautics and Space Administration (NASA). (2021). *Scientific consensus: Earth’s climate is warming*. NASA.gov. <https://climate.nasa.gov/scientific-consensus/>

National Assessment of Educational Progress (NAEP). (2014). *The nation’s report card: U.S. history, civics, and geography at grade 8.* <https://www.nationsreportcard.gov/hgc_2014/#civics>

National Center for Science Education (NCSE) and Texas Freedom Network Education Fund (TFNEF). (2020, October). *Making the grade? How state public school science standards address climate change*. <https://ncse.ngo/files/MakingTheGrade_Final_10.8.2020.pdf>

National Geographic. (2019). *America through the lens: 1877 to the present.* National Geographic School Publishing, Inc.

Nelson, L. K. (2020). Computational grounded theory: A methodological framework. *Sociological Methods & Research, 49*(1), 3–42. <https://doi.org/10.1177/0049124117729703>

Neo, X., & Schneider-Mayerson, M. (2022). Nature, disappeared: Anti-environmental values in Singapore’s history textbooks, 1984–2015, *Environmental Education Research, 28*(1), 56–74. <https://doi.org/10.1080/13504622.2021.1968350>

Nikita, M. (2016). *ldatuning: Tuning of the Latent Dirichlet Allocation models parameters. R package version 0.2-0*. [https://CRAN.R-project.org/package=ldatuning](https://cran.r-project.org/package%3Dldatuning)

Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years.* Holt, Rinehart, & Winston.

Pew Research Center. (2015). *Public and scientists’ views on science and society*. <http://www.pewinternet.org/2015/02/15/how-scientists-engage-public/>

Porter, M. F. (1980). An algorithm for suffix stripping. *Program*. Chicago

Quinn, K. M., Monroe, B. L., Colaresi, M., Crespin, M. H., & Radev, D. R. (2010). How to analyze political attention with minimal assumptions and costs. *American Journal of Political Science, 54*(1), 209–228. <https://doi.org/10.1111/j.1540-5907.2009.00427.x>

Reid, A., Dillon, J., Ardoin, N., & Ferreira, J. A. (2021). Scientists’ warnings and the need to reimagine, recreate, and restore environmental education. *Environmental Education Research, 27*(6), 783–795. <https://doi.org/10.1080/13504622.2021.1937577>

Roberts, M. E., Stewart, B. M., Tingley, D., & Airoldi, E. M. (2013, December). The structural topic model and applied social science. In *Advances in neural information processing systems workshop on topic models: Computation, application, and evaluation* (Vol. 4), 1–20.

Roberts, M. E., Stewart, B. M., & Tingley, D. (2014). stm: R package for structural topic models. *Journal of Statistical Software, 10*(2), 1–40.

Román, D., & Busch, K. C. (2016). Textbooks of doubt: Using systemic functional analysis to explore the framing of climate change in middle-school science textbooks, *Environmental Education Research, 22*(8), 1158–1180. <https://doi.org/10.1080/13504622.2015.1091878>

Rudolph, J. L., & Horibe, S. (2016). What do we mean by science education for civic engagement?. *Journal of Research in Science Teaching, 53*(6), 805–820. <https://doi.org/10.1002/tea.21303>

Schissler, H., & Soysal, Y. N. (Eds.). (2005). *The nation, Europe, and the world: Textbooks and curricula in transition.* Berghahn Books.

Shi, D.E., & Tindall, G.B. (2016). *America: A narrative history* (10th Ed.). W. W. Norton & Company.

Stahl, S. A., Hynd, C. R., Britton, B. K., McNish, M. M., & Bosquet, D. (1996). What happens when students read multiple source documents in history?. *Reading Research Quarterly, 31*(4), 430–456. <https://doi.org/10.1598/RRQ.31.4.5>

Stevenson, K. T., King, T. L., Selm, K. R., Peterson, M. N., & Monroe, M. C. (2018). Framing climate change communication to prompt individual and collective action among adolescents from agricultural communities. *Environmental Education Research, 24*(3), 365–377. <https://doi.org/10.1080/13504622.2017.1318114>

Tarr, J. E., Reys, R. E., Reys, B. J., Chavez, O., Shih, J., & Osterlind, S. J. (2008). The impact of middle-grades mathematics curricula and the classroom learning environment on student achievement. *Journal for Research in Mathematics Education*, *39*(3), 247–280. <https://www.jstor.org/stable/30034970>

Texas Education Agency (TEA). (n.d.) *The review and adoption process.* Texas Education Agency. <https://tea.texas.gov/academics/instructional-materials/review-and-adoption-process/the-review-and-adoption-process>

Tulkens, S., Hilte, L., Lodewyckx, E., Verhoeven, B., & Daelemans, W. (2016). A dictionary-based approach to racism detection in Dutch social media. *ArXiv Preprint*. <https://doi.org/10.48550/arXiv.1608.08738>

United Nations (2015). *Sustainable Development Goals*. <https://sdgs.un.org/goals>

U.S. Environmental Protection Agency (EPA). (2017). *Glossary of climate change term*s. <https://19january2017snapshot.epa.gov/climatechange/glossary-climate-change-terms_.html>

Vojíř, K., & Rusek, M. (2019). Science education textbook research trends: A systematic literature review. *International Journal of Science Education, 41*(11), 1496–1516. <https://doi.org/10.1080/09500693.2019.1613584>

Wilson, S. M., & Wineburg, S. S. (1988). Peering at history through different lenses: The role of disciplinary perspectives in teaching history. *Teachers College Record, 89*(4), 525–539. <https://doi.org/10.1177/016146818808900403>

Wineburg, S. S. (1991). On the reading of historical texts: Notes on the breach between school and academy. *American Educational Research Journal*, *28*(3), 495–519. <https://doi.org/10.2307/1163146>

Wright, C., & Nyberg, D. (2015). *Climate change, capitalism, and corporations*. Cambridge University Press.

Wynes, S., & Nicholas, K. A. (2017). The climate mitigation gap: education and government recommendations miss the most effective individual actions. *Environmental Research Letters*, *12*(7), 074024. <https://iopscience.iop.org/article/10.1088/1748-9326/aa7541>

Yavetz, B., Goldman, D., & Pe’er, S. (2009). Environmental literacy of pre-service teachers in Israel: A comparison between students at the onset and end of their studies. *Environmental Education Research, 15*(4), 393–415. <https://doi.org/10.1080/13504620902928422>

####

#### **TABLES**

##### ***Table 1. Topics found across climate change-relevant sentences in California and Texas textbooks, rank ordered from most to least prevalent***

|  |  |  |
| --- | --- | --- |
| *Topic label* | *Top 10 terms associated with the topic* | *Highly associated (exemplar) topic sentence* |
| Building public structures | american, area, build, earli, west, home, import, citi, worker, question, today | “The PWA was responsible for building many important structures that are still in use today, such as New York City’s Triborough Bridge, the Overseas Highway linking Miami and Key West, Florida, and the Bonneville Dam on the Columbia River in the Pacific Northwest.” |
| Land conservation | govern, conserv, feder, industri, land, public, creat, establish, work, administr | “Private groups, such as the Nature Conservancy and local land trusts, have raised money to purchase forest and watershed lands and keep forest and watershed lands pristine.” |
| Human toll of natural & man-made disasters | effect, region, movement, california, natur, econom, agricultur, left, disast, impact | “Discuss the human toll of the Depression, natural disasters, and unwise agricultural practices and their effects on the depopulation of rural regions and on political movements of the left and right, with particular attention to the Dust Bowl refugees” |
| Earth Day & activism | day, earth, peopl, support, million, activ, event, celebr, point, april, commun | “With three major events serving as catalysts, environmentalism became a certifiable mass movement on the first Earth Day, April 22, 1970, when 20 million people gathered in communities across this country to express 20 million people's support for a cleaner, healthier planet.” |
| Kyoto Protocol | presid, kyoto, climat, protocol, emiss, reduc, sign, call, countri, treati | “In 1997, representatives of the major industrial nations met in Kyoto, Japan, and agreed to a broad treaty to reduce carbon emissions to slow or reverse global warming.” |
| Fossil fuel concerns | natur, oil, resourc, coal, environ, year, spill, gener, price, mexico | “Supporters of nuclear energy hailed it as a cleaner and less expensive alternative to fossil fuels, such as coal, oil, and natural gas, which are in limited supply.” |
| Students analyze physical & human factors | human, polici, issu, analyz, environ, result, modif, student, impact, physic | “Analyze the impact of physical and human geographic factors on the settlement of the Great Plains, the Klondike Gold Rush, the Panama Canal, the Dust Bowl, and the levee failure in New Orleans after Hurricane Katrina.” |
| Students analyze environmental protection | environment, protect, agenc, epa, law, advoc, controversi, nixon, creat, safeti | “Trace the impact of, need for, and controversies associated with environmental conservation, expansion of the national park system, and the development of environmental protection laws, with particular attention to the interaction between environmental protection advocates and property rights advocates” |
| Creation of national parks | nation, park, establish, yellowston, servic, system, part, includ, creation, acr | “The government set aside about 12 million acres of land for new national parks, including Shenandoah National Park in Virginia, Kings Canyon National Park in California, and Olympic National Park in Washington State.” |
| Science of global warming | global, warm, carbon, fuel, increas, dioxid, fossil, time, greenhous, scientist | “During this time, another environmental issue emerged when some scientists warned that global warming could lead to more droughts and global warming an increase in average world temperatures over time.” |
| Nuclear energy concerns | nuclear, power, energi, plant, mile, island, sourc, accid, pennsylvania, oppon | “Opponents of nuclear energy contended that nuclear plants, and the waste opponents of nuclear energy produced, were potentially dangerous to humans and opponents of nuclear energy’s environment.” |
| Key environmental legislation | act, air, clean, water, pollut, congress, standard, qualiti, pass, set | “Following a new Clean Air Act that added several amendments to the Clean Air Act of 1963, Congress also passed a new Clean Air Act that added several amendments to the Clean Air Act of 1963, in addition to laws that limited pesticide use and curbed strip mining the practice of mining for ore and coal by digging gaping holes in the land.” |
| Dust Bowl | dust, bowl, great, plain, farmer, famili, drought, oki, depress, farm | “Write two to three paragraphs: describing the Dust Bowl, the Dust Bowl's causes, the Dust Bowl’s effect on people, and how the Dust Bowl made the Great Depression worse for those living on the Great Plains.” |
| Conservationists (public & private) | john, muir, roosevelt, club, sierra, pinchot, gifford, forest, yosemit, naturalist | “Through naturalist John Muir (1838-1914)'s friendship with President Theodore Roosevelt, naturalist John Muir (1838-1914) persuaded President Theodore Roosevelt to greatly increase the amount of protected public land.” |
| Rachel Carson | carson, rachel, silent, spring, book, pesticid, publish, marin, biologist, chemic | “In 1962, marine biologist Rachel Carson published marine biologist Rachel Carson’s book Silent Spring, which warned of the destructive effects of pesticides.” |
| Government agencies overseeing regional and energy development | valley, tennesse, author, tva, develop, dam, project, electr, program, deal | “Works Progress Administration, Social Security, National Labor Relations Board, farm programs, regional development policies, and energy development projects such as the Tennessee Valley Authority, California Central Valley Project, and Bonneville Dam” |
| Henry David Thoreau | thoreau, david, henri, civil, live, emerson, walden, disobedi, tax, life, ralph, refus, societi | “In Henry David Thoreau’s 1849 essay ‘Resistance to Civil Government,’ Henry David Thoreau extended Henry David Thoreau’s critique of artificial constraints in society to government, arguing that when government required an individual to violate Henry David Thoreau's or her own morality, it had no legitimate authority.” |

Note: Topics are rank-ordered by most to least prevalent across the corpus. We removed one topic out of the original 18 because it was driven by large portions of text related to the potential for nuclear war with the Soviet Union, rather than by discussions of nuclear energy.

######

##### ***Table 2. Higher-order themes across climate change-relevant corpus topics in California and Texas textbooks***

|  |  |
| --- | --- |
| *Higher-order theme* | *Relevant Topics* |
| Development | as progress | Building public structures; Government agencies overseeing regional & energy development |
| as risk | Human toll of natural & man-made disasters; Fossil fuel concerns; Nuclear energy concerns; Dust Bowl |
| Sources of environmental action | government and “great men” | Building public structures; Government agencies overseeing regional & energy development; Land conservation; Kyoto Protocol; Creation of national parks; Key environmental legislation; Conservationists (public & private); Henry David Thoreau; Rachel Carson |
| private individuals and organizations | Land conservation; Earth Day & activism; Conservationists (public & private) |
| Frameworks of climate change | as scientific uncertainty | Science of global warming |
| as controversial or not anthropogenic | Students analyze physical & human factors; Students analyze environmental protection |

Note: The theme “great men” here is meant to be less about gender (although the figures are often men) and more about the idea that exceptional figures drive history.

#### **FIGURES**

##### ***Figure 1. Frequencies of Climate Change-Relevant Terms in California and Texas textbooks***A picture containing chart  Description automatically generated

#### **FIGURE CAPTIONS**

##### ***Figure 1. Frequencies of Climate Change-Relevant Terms in California and Texas textbooks***

Figure 1. Across the corpus of California and Texas textbooks, we observe that climate change-relevant terms such as climate change, global warming, and greenhouse gas, as well as climate change-relevant stems such as ‘pollut,’ occur in similarly low frequencies across both states, illustrated by the overlapping state markers. Meanwhile, the summed frequency of all terms and stems in our climate change-relevant dictionary remains lower than those of other stemmed terms relevant to social studies such as ‘econom’ and ‘politic.’ These findings serve to illustrate the overall low frequency of climate change-relevant terms, as well as the similarity of frequencies between the two states. Note that stemmed terms include an asterisk (\*) in the above axis labels.

#### **BIOGRAPHICAL NOTES**

Hannah K. D’Apice is a doctoral candidate studying International and Comparative Education at Stanford University’s Graduate School of Education. Her work examines the development and diffusion of global norms around education, as well as the institutional conditions that enable marginalized groups to have greater visibility and leadership in education. Prior to her doctoral studies, she managed multi-state randomized controlled trials evaluating K-12 education curricula and programming, as well as worked as a teacher in Texas and Singapore. She has an M.A. in Sociology and an M.A. in International Education Policy Analysis, both from Stanford University, as well as a B.A. in Political Science from Columbia University.

Patricia Bromley is an Associate Professor at Stanford University’s Graduate School of Education (GSE) and Co-Director of the Center on Philanthropy and Civil Society (PACS). At PACS she directs the Global Civil Society and Sustainable Development Lab. At the GSE she teaches courses related to the sociology of education, nonprofit organizations, and global education policy in the International and Comparative Education Program. Her research spans a range of fields including organization and management theory, comparative education, and the sociology of education, covering the substantive topics of sustainable development, minority and human rights, nonprofits/civil society, and globalization.

Emma Dolan recently graduated with an M.S. from the Sustainability Science and Practice program at Stanford University’s School of Earth, Energy, and Environmental Sciences. Her background is predominantly in data science, and she is particularly interested in sustainable food systems and the myriad social and environmental costs associated with industrial animal agriculture. She also received a B.S. in Symbolic Systems from Stanford in 2020.

1. A token is defined as a sequence of characters grouped together as a useful semantic unit for processing, usually between spaces or punctuation (Manning et al., 2008) [↑](#footnote-ref-1)
2. Robustness checks for the topic modeling results were performed in two ways. First, we performed the topic modeling separately by state, to ensure that no individual state dominated the across-corpus themes discussed above. When topics are generated by state individually, 14 out of 17 are directly comparable between California and Texas. We also tested an alternative topic modeling algorithm, Structural Topic Modeling (STM; Roberts et al. 2013), which allows the incorporation of a state-identifying covariate to differentiate between state corpora. Higher-order themes in the topics are robust to this alternative specification when examining 18 topics. [↑](#footnote-ref-2)
3. This frequency estimate excludes common articles, conjunctions, and other terms without content (“stop words”) such as “the,” “and,” “as,” etc. [↑](#footnote-ref-3)
4. We removed one topic out of the original 18 topics because it was driven by large portions of text related to the potential for nuclear war with the Soviet Union, rather than by discussions of nuclear energy. We opted to leave the word “nuclear” in our key term list despite this dual usage because of its relevance to energy discussions. The omitted topic, which we labeled, “Soviet Union” did not contain environment-related terms; they are: state, unit, world, war, histori, decad, women, begin, largest, move. [↑](#footnote-ref-4)
5. Seven out of the seventeen topics occurred at statistically significantly different levels between the states, but these differences were not substantively large and did not yield a meaningful pattern of differences. For example, in California, 35% of sentences from our climate-relevant corpus are highly associated with the topic of “Human toll of natural & man-made disasters” and in Texas, 30% of sentences are highly associated with this topic. Or, in California, 27% of sentences from our climate-relevant corpus are highly associated with the topic of “Science of global warming,” while in Texas, 29% of sentences are highly associated with this topic. Our interpretation is that fewer than half of the topics show any statistical differences, and of the statistical differences that exist there is little systematic substantive meaning. [↑](#footnote-ref-5)