




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

Hannah K. D'Apice & Patricia Bromley


To cite this article: Hannah K. D'Apice & Patricia Bromley (2023): Climate change discourse in U.S. history textbooks from California and Texas, Environmental Education Research, DOI: [10.1080/13504622.2023.2206595](https://doi.org/10.1080/13504622.2023.2206595)

To link to this article: <https://doi.org/10.1080/13504622.2023.2206595>

 View supplementary material 

 Published online: 23 May 2023.

 Submit your article to this journal 

 View related articles 

 View Crossmark data 



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

Hannah K. D'Apice and Patricia Bromley

Graduate School of Education, Stanford University, Stanford, CA, USA

ABSTRACT

Anthropogenic climate change is a scientific fact, but U.S. public discourse around the issue remains mired in controversy, including in education. Our study leverages natural language processing methods to give a precise look into the extent to which climate change-related topics are covered in 30 of the most widely used high school history textbooks in California and Texas. We find that history textbooks situate climate change-related topics within narratives 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 in climate discussions. Despite differences in state-level standards, the content of textbooks in California and Texas is surprisingly similar in the extent and nature of climate change-related discourse. Our study indicates that history textbook reform is an important arena for expanding and improving climate change education.

ARTICLE HISTORY

Received 18 July 2022

Accepted 11 March 2023

KEYWORDS


California; climate change; history; Texas; textbooks; scientific consensus

Introduction

Anthropogenic climate change is a scientific fact, agreed upon by nearly all organizations that conduct scientific work (Powell 2017; National Aeronautics and Space Administration [NASA], 2021). However, public discourse around climate change and related environmental issues remains mired in controversy in the United States (U.S.) (Edwards 2013; Lakoff 2010; Pew Research Center 2020; Luo, Card, and Jurafsky 2020). In some cases, portrayals of climate change 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 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. NLP is a subfield of computational methods at the intersection of linguistics and computer science, which leverages artificial intelligence to understand patterns

CONTACT Hannah K. D'Apice  hdapice@stanford.edu  Graduate School of Education, Stanford University, Stanford, CA, USA

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/13504622.2023.2206595>

© 2023 Informa UK Limited, trading as Taylor & Francis Group

in human language. In the cases of 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 and TFNEF, 2020) as well as divergent political leanings since the mid-1990s (Monogan and 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, Farrell, and Sepulveda-Stuardo 1981 for a classic review; more recently, see Tarr et al. 2008). Methodologically, we contribute to the body of literature on environmental education in textbooks by drawing on computational approaches to studying education content (Lucy et al. 2020; McFarland et al. 2021).

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, like history (Gills and Morgan 2021; Biström and Lundström 2021a; Neo and Schneider-Mayerson 2022). Existing studies tend to focus on science classes or environment-specific curricula (e.g., Román and Busch 2016; Vojř and Rusek 2019) rather than general history, civics, or economics courses. While science courses can provide students with essential knowledge about the ecological processes of climate change, social sciences and humanities courses, including history, are important sites of learning about the social and historical dimensions of climate change issues, as well as key locations for socializing students to become active citizens around climate change. Social sciences and humanities can, for example, help us understand resistance to environmentalism from social, political, and economic groups, and show us how citizen-led social movements can promote climate action. 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, Stephens, and White 2019). History's own unique disciplinary expertise is in examining human agency, creating a dialogue between the past and present, and being one of the primary vehicles for political and civic socialization (Langton and Jennings 1968; Hawkey 2014). Scholars have argued history content can contribute to climate education by engaging with the historical roots of climate change, including human activity, and by providing historical context around civic action for change (Hawkey 2014; Hawkey, James, and Tidmarsh 2016; Coles et al. 2017). Both the natural and physical sciences, as well as the social sciences and humanities, are therefore necessary for a well-rounded grasp on sustainability and climate change issues.

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, literature on history education suggests both unique strengths and unique challenges which the discipline may contribute to climate change education.

California and Texas: contrasting cases of climate change content

Environmental and climate change-related topics have experienced increased attention in education systems both in the U.S. and cross-nationally. Bromley, Meyer, and Ramirez (2011) found a dramatic increase in the extent to which social science textbooks around the world emphasized the environment between 1970 and 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 individual empowerment. Additional cross-national work found increased textbook mentions of not only environmental protection and damage, but also of the environmental rights of

individual citizens (Jimenez, Lerch, and Bromley 2017). Rather than finding notable differences between individual countries or regions, these international studies emphasize homogenizing cultural processes that generate similar treatment of environmental issues across diverse contexts.

However, literature on the U.S. suggests that politicized differences may be central in climate change education. 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 has become increasingly politically polarized over the last two decades (Dunlap, McCright, and Yarosh 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 are hard to obtain, some evidence shows that large publishers do tailor some of their paragraphs and images toward one state or the other (Golden 2006; Goldstein 2020). At the same time, neither California nor Texas requires 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 its 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.).

Prior work on the two states' climate education suggests substantial differences between state contexts. In a survey of over 800 secondary science teachers in California and Texas, Khalidi and Ramsey (2021) found significantly divergent views of climate change. For example, with respect to the origins of climate change, higher proportions of California teachers emphasized the scientific consensus around human causes, whereas 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 observing the most recently updated history standards from the two states, there are meaningful differences. California's “History-Social Science Framework” integrates standards from the “California Education and the Environment Initiative” for content in U.S. history (CDE 2017, Chapter 16). The state recommends curriculum units around key environmental principles that

emphasize the interdependence of people and natural systems (CDE, 2017). Meanwhile, Texas's most recent "Texas Essential Knowledge and Skills" for high school social studies incorporates standards relevant to environmental concerns within recommended content for "United States History Studies Since 1877," prompting student understanding of the relationship between population growth and the physical environment (TEA 2018, §113.41.14A and §113.41.14B).

In sum, prior work alongside the states' current history content standards suggest that California and Texas history textbooks will both cover climate change, but may diverge in the extent and form of this coverage.

Opportunities and challenges in history education for climate change

Beyond differences in state standards, the existing literature on environmental education suggests a variety of approaches that history content could take relative to other disciplines. Studies have found some science 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 and 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 and Martin 1993; Román and Busch 2016).

Feinstein and Kirchgasler (2015) further discuss how technocratic approaches may present the false impression that technological advancement will solve climate change and sustainability challenges. They point to technocentrism as part of a framework of "ecological modernization" that over-emphasizes scientific advancement and does not adequately prepare students for navigating ethical and political complexities around climate change and sustainability. Interdisciplinary work by Biström and Lundström (2021b) found that geography and biology textbooks obscured social dimensions of environmental complexity, and contained an anthropocentric focus on human needs. Finally, Noguera-Méndez and Cifuentes-Faura (2022) similarly found that economics textbooks put forth anthropocentric perspectives of economic systems as independent of nature, implicitly maintaining the conceptual dichotomy between the physical and human worlds. Beyond the technical focus of science education, history may provide students with a sense of dialogue between past, present, and future—not only humanity's past actions as related to climate change, but also climate and sustainability issues as challenges in which humans continue to have agency for change (Hawkey 2014).

Research also 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). Misunderstandings of scientific skepticism versus consensus may be exacerbated by norms within history textbooks. A common practice 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). The norm of presenting contrasting viewpoints may therefore legitimize the belief that climate change is a two-sided issue. This becomes problematic in the case of conveying understandings around

scientific consensus, with misconceptions having direct implications for students' future knowledge and action (Choi et al. 2010).

Studies on climate change education in California and Texas suggest reasons we might observe meaningful differences between the two states. Meanwhile, existing literature on both history curricula and textbook content outlines potential contributions or pitfalls with respect to climate change coverage. We contribute to this literature by asking two research questions: (1) In widely used high school U.S. history textbooks, what proportion of textbook content is relevant to climate change and related environmental issues? (2) What are the narratives in content relevant to climate change and related environmental issues? For both questions, we particularly seek to draw out whether there are similarities or differences by state context.

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 and Powers 2008; Yavetz, Goldman, and Pe'er 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

We focus on California and Texas textbooks due to the dominant positions of these states in the overall U.S. textbook market, as well as prior popular work suggesting that their textbook content should substantially diverge due to differences in state politics (Goldstein 2020). These states therefore offer comparative cases that have implications for textbook content nationwide, and provide insight into how the climate change education received by students may vary by context.

Because exact numbers of textbook sales are proprietary to publishers and not publicly available, our team had to approximate which textbooks may be most likely to be used by a wide segment of students in each state. We specifically identified those with wide use at the highest level of U.S. history required for high school graduation (often targeted at 10th grade). 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. 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 was therefore limited by the number that met our criteria for wide usage and included 30 high school history textbooks total: 15 textbooks from California, and 15 from Texas, published between 2004 and 2019¹. 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). Our initial list sought to capture “sustainable development” more broadly, but we narrowed our focus to climate change and climate-relevant environmental issues due to the extremely broad and varied definitions of “sustainable development” (potentially encompassing nearly the entire content of the book). We use this climate change-specific 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 and 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. However, a limitation of this term-based computational approach is that it does not capture the full breadth of content relevant to sustainable development.

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’ (2015) “Sustainable Development Goals,” Boston University’s (2009) “Sustainability Glossary of Terms,” and the U.S. Environmental Protection Agency (EPA)’s (2016) “Glossary of Climate Change Terms.” 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 141 terms is described in [Appendix B](#).

Computational analyses

We use NLP methods to examine the proportion of textbook content which mentions climate change and related environmental issues, as well as the narratives within this content. Prior to analysis, textbooks were scanned, digitized, and underwent minimal pre-processing. We then cleaned and tokenized² the textbook content for a total of 5.8 million tokens across the California corpus, and 7.9 million tokens across the Texas corpus.

To determine the proportion of textbook content mentioning climate change, we extracted counts of terms from our climate change dictionary across all tokens in the textbook corpus. We also extracted every sentence that included at least one of the terms from our climate change dictionary, for an initial sample of 8684 sentences. After manually removing indices, non-sentence content, sentences with fewer than 5 tokens, and sentences that used certain terms in non-climate contexts (e.g., “exhaust” used in terms of being exhausted), we had a final analytic sample of 6372 sentences. To determine the types of narratives that exist around terms broadly related to climate change, we applied Latent Dirichlet Allocation (LDA; Blei, Ng, and Jordan 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 22 substantive topics which appear in the climate

change related sentences in the textbooks. [Appendix C](#) provides additional technical details of the topic generation process.

Qualitative interpretation

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 both the stemmed terms and sentences most associated with a given topic, we apply interpretive labels using domain expertise (Boyd-Graber, Hu, and Mimno 2017). For example, our analyses found that the following word stems were the top 10 stems associated with one topic: global, warm, reduc, atmospher, carbon, emiss, scientist, fuel, climat, gas. We then examined sentences that had higher measures of association with each topic. A sentence with a higher loading for a given topic is interpreted to mean that the sentence is more highly representative of the topic's unique content. In this example, a sentence with one of the highest topic loadings for the "global, warm, reduc..." topic included the following: "During this time, another environmental issue emerged when some scientists warned that global warming could lead to more droughts and other forms of extreme weather" (Appleby et al. 2014, 689). After reviewing the sentences with the highest topic loadings, we labeled this individual topic "Science of global warming." This process was performed across each individual topic in the computational output.

As an additional step in the process, we extended our topic modeling with a qualitative interpretation of the higher-order themes that emerged from the data. Following the logic of a content analysis process, we treated our individual topics as fine-grained codes that are consolidated into higher-order categories. We developed a codebook that associated potential higher-order themes with the finer-grained individual topics, including each topic's interpretive topic label, highly associated terms, and highly associated sentences. Higher-order themes were refined and amended after inter-rater reliability testing, in which our broader lab of social science researchers reviewed and offered feedback on the codebook. The final higher-order themes resulting from this analysis were "Sources of environmental action," "Development," and "Climate change controversies." In the case of the "Science of global warming" example, this topic was included in the higher-order theme of "Climate change controversies."

Discussing the topics in light of these three themes gives additional meaning to the results and facilitates understanding of the implications of the study. We do so in two ways. First, we present the prominence of each topic within the data. Specifically, we identify the number of sentences in each state's corpus that are highly associated³ with a given topic, aggregating these by higher-order theme. This shows the distribution of sentences across each individual theme as well as between states. Second, we discuss substantive language used within each theme. We base our discussion on exemplar sentences which have particularly high associations for each topic, and therefore can be interpreted to be more highly representative of both the topic and higher-order theme's unique content.

Results

Frequencies of climate change-related terms

[Figure 1](#) shows the frequencies with which climate change-relevant terms are mentioned across the textbooks by state per 100,000 tokens. 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 words⁴,

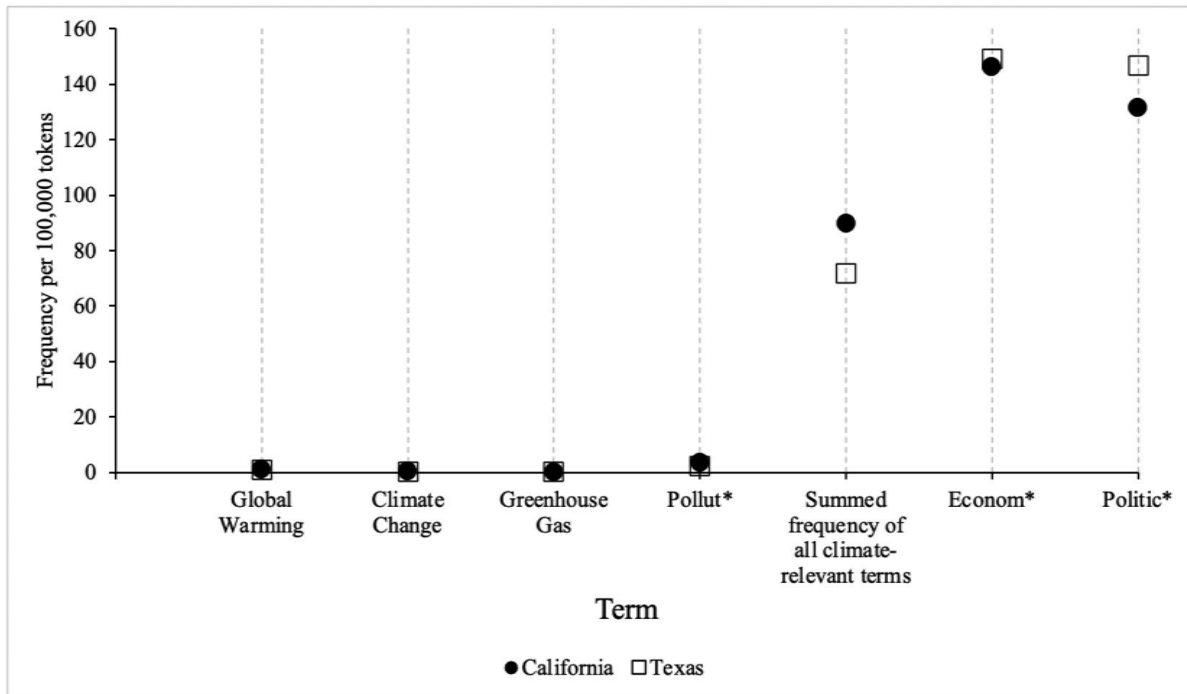


Figure 1. Frequencies of climate change-relevant terms in California and Texas textbooks.

Note. 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 axis labels.

representing less than .01% of words across each states’ textbooks. The most frequently mentioned terms tended to be related to energy use, including “coal,” “mining,” and “energy,” which were each mentioned at least 800 times, with the highest, “energy,” mentioned 1152 times. In both states, “global warming” is mentioned more frequently than “climate change”—in California the terms appear 61 times and 30 times, respectively; in Texas they appear 72 times and 29 times, respectively. Even the summed frequency of all 141 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 core citizenship education content required for high school graduation; and second, that the frequencies between the two states are quite similar.

Narrative content around climate change terms

While the frequencies 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 22 meaningful topics emerging from the climate-relevant sentences in the textbooks.⁵ 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 from the textbooks that the computational modeling identified as having a high association with that topic.

Table 1. Topics found across climate change-relevant sentences in California and Texas textbooks, rank-ordered according to the number of high-loading sentences across the corpus.

Topic label	Top 10 terms associated with the topic	Highly associated (exemplar) sentence from textbook sample
Mining in the west	mine, west, gold, town, camp, silver, colorado, quick, chines, western	"When the first placer (or surface) deposits ran out, California and eastern capitalists bought the claims of the pioneer prospectors and began to use the more difficult process of quartz mining, which enabled them to retrieve silver from deeper veins."
Private industrial innovations	coal, industri, compani, railroad, iron, product, steel, manufactur, factori, materi	"Instead of paying companies for coal, lime, and iron, Carnegie's steel company bought coal mines, limestone quarries, and iron ore fields."
Government action on energy crises	energi, crisi, sourc, carter, economi, problem, foreign, depend, gas, inflat,	"What economic and energy problems plagued the presidencies of Gerald Ford and Jimmy Carter?"
Dust Bowl	dust, bowl, region, area, california, agricultur, famili, south, north, left,	"In the Dust Bowl drought and soil erosion caused massive dust storms across southern and plains states throughout the thirties."
Farming and environmental erosion	drought, great, farm, farmer, plain, eros, soil, crop, fertil, make	"They did not know that destroying biodiversity, which was what farming the plains really meant, opened pathways for exotic, destructive pests and weeds, and that removing native grasses left the soil vulnerable to erosion."
Creation of national parks	nation, park, million, john, system, establish, creat, muir, acr, preserv	"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."
Earth Day and activism	peopl, day, earth, communiti, thousand, part, event, move, spread, transform	"With these 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 the country to express their support for a cleaner, healthier planet."
Progressive environmental policies	roosevelt, presid, conserv, polit, taft, parti, campaign, atmospher, progress, view,	"Franklin Roosevelt also continued the conservation work of his cousin, President Theodore Roosevelt."
Urban pollution	citi, pollut, water, wast, contamin, fire, toxic, diseases, river, trash,	"Flush toilets and sewer systems began to appear in the 1870s, but they could not solve the problem as long as sewage continued to flow into open ditches or streams, polluting cities' water supplies."
Land conservation by private conservationists	includ, women, effort, found, societi, club, group, activ, sierra, organ	"Traditional conservationist societies like the Sierra Club and Audubon Society concentrated on preserving pristine wild habitats from development."
Land conservation by public conservationists	land, natur, resourc, conserv, public, pinchot, forest, gifford, develop, servic	"In 1909 Pinchot accused Secretary of the Interior Richard Ballinger of hurting conservation efforts by leasing public lands to big business."
Key environmental legislation	act, air, congress, law, pollut, clean, pass, standard, set, feder,	"The Clean Air Act, signed into law in 1970, gives the EPA the power to set air quality standards."
Concerns with reliance on foreign oil	oil, state, unit, countri, petroleum, price, opec, organ, trade, percent	"In retaliation the Organization of the Petroleum Exporting Countries (OPEC), an international consortium of oil-producing nations that regulates the price and quantity of oil sold on the world market, announced an oil embargo of the United States."
Government social and economic actions, including around energy issues	govern, feder, support, tax, reform, build, social, plan, regul, hous,	"Breaking with the Reagan-era motto, 'Government is the problem, not the solution,' it anticipated active government support for health care reform, clean energy, and public education, paid for in part by allowing Bush's tax cuts for the wealthy to expire in 2010."
Coal and mining labor controversies	coal, miner, mine, worker, strike, labor, work, union, demand, pennsylvania,	"The previous spring, the United Mine Workers (UMW) union had called a strike of the miners who dug anthracite, or hard coal."

(Continued)



Table 1. Continued.

Topic label	Top 10 terms associated with the topic	Highly associated (exemplar) sentence from textbook sample
Science of global warming	global, warm, reduc, atmospher, carbon, emiss, scientist, fuel, climat, gas	"During this time, another environmental issue emerged when some scientists warned that global warming could lead to more droughts and other forms of extreme weather."
Nuclear energy concerns	power, nuclear, plant, mile, island, began, generat, accid, built, control, eventu	"Environmentalists, however, publicized the dangers of nuclear power plants: a reactor meltdown would be catastrophic, and so, in slow motion, would the dumping of the radioactive waste, which would generate toxic levels of radioactivity for hundreds of years."
Government agencies overseeing regional and energy development	conserv, valley, author, tennesse, work, program, project, administr, deal, civilian, corp,	"Great dams and electricity projects sponsored by the Tennessee Valley Authority, the Works Progress Administration in the West, and the Rural Electrification Administration permanently improved the quality of life for the nation's citizens."
Rachel Carson	carson, led, rachel, danger, public, spring, movement, silent, ddt, environ,	"In 1962, marine biologist Rachel Carson published her book <i>Silent Spring</i> , which warned of the destructive effects of pesticides."
Presidential policy speeches	environment, protect, polici, agenc, issu, nixon, econom, health, epa, kennedi,	"Discuss the significant domestic policy speeches of Truman, Eisenhower, Kennedy, Johnson, Nixon, Carter, Reagan, Bush, and Clinton (e.g. with regard to education, civil rights, economic policy, environmental policy)"
Students analyze physical and human factors	human, develop, effect, econom, impact, environ, growth, analyz, ecolog, technolog	"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."
Henry David Thoreau	henri, call, thoreau, david, civil, individu, write, forc, histori, refus,	"Having studied the writings on peaceful civil disobedience of Henry David Thoreau and Mohandas (Mahatma) Gandhi, as well as the nonviolent protests the Congress of Racial Equality had organized in the 1940s, King outlined a philosophy of struggle in which evil must be met with good, hate with Christian love, and violence with peaceful demands for change."

Note: Topics are rank-ordered according to the number of high-loading sentences across the corpus. We removed five topics out of the original 27 because they were driven by large portions of text related to wartime weapons and rationing, as well as social issues unrelated to climate change or environmentalism. See [Appendix C](#) for further details.

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

	Higher-order theme	Relevant topics
Sources of environmental action	Government and influential figures	Government action on energy crises; Creation of national parks; Progressive environmental policies; Land conservation by public conservationists; Key environmental legislation; Government social and economic actions, including around energy issues; Rachel Carson; Presidential policy speeches; Henry David Thoreau
	Private individuals and organizations	Earth Day and activism; Land conservation by private conservationists
Development	As risk	Dust Bowl; Farming and environmental erosion; Urban pollution; Concerns with reliance on foreign oil; Coal and mining labor controversies; Nuclear energy concerns
	As progress	Mining in the west; Private industrial innovations; Government agencies overseeing regional and energy development
Climate change controversies	As scientific uncertainty	Science of global warming
	As controversial or not anthropogenic	Students analyze physical and human factors

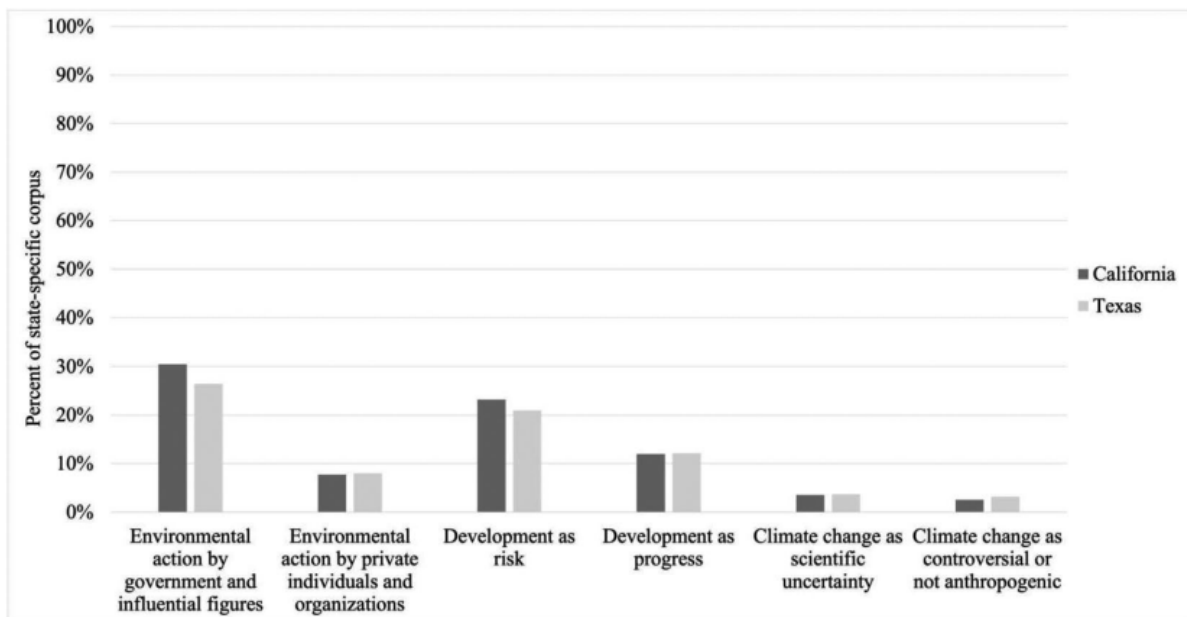


Figure 2. Percent of high-loading sentences within climate-relevant discourse, by theme.

Note. We leverage measures of topic loadings to draw out between-state comparisons in the content of climate-relevant sentences. Specifically, we identify the number of sentences that are highly-associated with each individual topic within each states' climate-relevant corpus. We define having a high association as a topic loading measure that is two standard deviations above the corpus mean. After identifying the number of highly associated sentences per topic, we aggregate these by theme, and divide by the total number of climate-relevant sentences within that state. This provides a measure of the prominence of each theme within the climate-relevant sentences of both California and Texas.

Across the fine-grained topics, we qualitatively identified six themes, and three higher-order themes, to provide additional interpretation of the findings. As shown in [Table 2](#), the topics relate to overarching narratives around the key actors of climate change, themes of nation-state development, and content discussing climate change controversies.

However, these themes are not necessarily uniformly prominent across the content. [Figure 2](#) charts the percent of sentences across each state's corpus that are identified as being highly associated with a given topic within each theme.

In contrast to studies showing differences in teacher knowledge or state standards, there are few notable differences in the case of history textbooks. First, across the climate-relevant corpus of sentences, both states overwhelmingly discuss government and influential figures as sources of environmental action (30.47% of California sentences, and 26.41% of Texas sentences), as compared to private individuals and organizations (7.74% of California sentences, and 8.03% of Texas sentences). Second, both states' content tends to more prominently feature the risks of development (23.16% of California sentences, and 20.92% of Texas sentences), rather than potential progress facilitated by development (11.97% of California sentences, and 12.13% of Texas sentences). Finally, both states tend to discuss climate change controversies with similar prominence, whether in terms of scientific uncertainty (3.52% of California sentences, and 3.69% of Texas sentences) or climate change as controversial or not anthropogenic (2.51% of California sentences, and 3.19% of Texas sentences).

We discuss these higher-order themes in depth below, to provide a deeper analysis of the language linked to each topic.

Government and influential figures as the source of environmental action

The first theme that emerged in history books suggests 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. For example, both states highlighted the creation of the National Park system as a particularly relevant environmental action, as exemplified by this sentence from a California textbook which has a high topic loading for "Creation of national parks": "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" (Lapsansky-Werner et al. 2008, 308).

Outside of discussing government actions, the textbooks tended to focus on particularly influential conservationists and public figures engaged in environmental work. Henry David Thoreau, Rachel Carson, John Muir, Gifford Pinchot, and Theodore Roosevelt were most commonly discussed in our data. For example, both states highlighted the relationship between John Muir and Theodore Roosevelt as a key driver of early environmental conservation efforts. An exemplar sentence for this topic from a Texas textbook is as follows: "He [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" (Lapsansky-Werner et al. 2016, 183).

The emphasis on government as the core climate actor persists in topic narratives that highlight government and international legislation. One topic, on "Earth Day and activism," mentions broader collective civic action in the context of the creation of, and activities around, Earth Day specifically. However, across both states, the emphasis is on prominent government legislation and actors, rather than civic action more broadly.

Development as progress and risk

History textbooks also discussed climate change-related content in the context of U.S. progress and development, including discourse around the benefits of progress as well as the harms and risks. Narratives tended to less frequently mention climate change explicitly, but rather discussed major public agencies and public works linked to environment- or energy-related

projects. Discussion of positive progress tended to especially refer to government work around public structures and energy. For example, this sentence from a California textbook, which has a high association with the topic “Government agencies overseeing regional and energy development,” constitutes a list of public works projects:

“Large public works projects, including the Hoover Dam, the Bonneville Dam, the California Central Valley Project, and the Tennessee Valley Authority, changed the lives of millions of Americans, providing them with flood control, irrigation, and electrical power.” (National Geographic 2019, 379)

A Texas sentence with a similarly high association with the “Government agencies...” topic points to the energy contributions of the federally-owned Tennessee Valley Authority:

“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, Cornell, and O’Donnell 2013, 671)

Across both states, textbooks highlighted the economic, infrastructure, and energy contributions of government-sponsored development projects. While both states discussed potential risks of development in greater prominence than development as progress, the rhetoric was quite tame, identifying development as one of multiple potential sources of observed harm, and maintaining an anthropocentric understanding of these potential harms. The Dust Bowl was a particularly common historical example through which students could discuss how human and environmental issues intertwined. In one California example, “unwise agricultural practices” were situated alongside natural disasters in contributing to the Dust Bowl and its devastation, as illustrated by this sentence highly associated with the topic “Dust Bowl”:

“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, H-SS 7)

Meanwhile, fossil fuel concerns and nuclear energy were two common examples of energy-related projects discussed within the textbooks. An example from a Texas textbook highly associated with the topic “Nuclear energy concerns” references air contamination concerns after a nuclear meltdown: “In 1979, the partial meltdown of a nuclear reactor at the Three Mile Island nuclear power plant in Pennsylvania caused nearly 100,000 panicked residents to flee when radioactive steam poured into the air.” (Keene, Cornell, and O’Donnell 2013, 865)

Overall, both California and Texas textbooks highlight development projects as a source of progress. Potential environmental risks or actual disasters are discussed with greater prominence, but the language tends to be nonspecific and spread responsibility across multiple sources (e.g., both human causes and general “natural disasters”). Our findings parallel studies of science curricula that show educational materials present climate change and relevant environmental issues through an anthropocentric lens, either emphasizing human needs or obscuring how the human and natural worlds are intertwined (e.g., Biström and Lundström 2021b; Noguera-Méndez and Cifuentes-Faura 2022). In our case of history textbooks, the potential risks and harms of development are less clear relative to its benefits.

Climate change controversies

A final theme that emerged was that students seemed to be led to focus on uncertainty and controversies surrounding climate change, in line with prior work on science curricula. Climate change was discussed as anthropogenic, but with language obfuscating 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, 772)

Texas: "To great controversy, the Bush administration announced that it would not abide by the Kyoto Protocol of 1997, which sought to combat global warming, a slow rise in the earth's temperature that scientists warned could have disastrous effects on the world's climate." (Foner 2011, 1173)

On their own, assertions of the agreement amongst scientists might help to clarify students' understanding of the scientific consensus around climate change. However, the books also maintained either explicit frameworks of climate change as controversial, or used language which hedges around the scientific consensus. Multiple textbooks asked a version of the question, "What are the competing views on global warming?" (Keene, Cornell, and O'Donnell 2013, 905), prompting students to consider climate change as a two-sided issue. One Texas textbook prompted students to consider climate change's anthropogenic origins as a matter of opinion: "Differing opinions about climate change, including whether or not humans are causing it, have made it difficult to reach a consensus on what should be done about it" (Danzer et al. 2016, 900). Similarly, framing within a California textbook undermined the consensus around climate change as anthropogenic: "Some deny that our planet is experiencing a period of warming temperatures. Others, while accepting global warming as fact, deny that such warming is the product of human activity" (Lapsansky-Werner et al. 2019, 749).

Assertions of the science of climate change are therefore undermined by inferences of uncertainty and controversy elsewhere in the texts. Only one textbook used in Texas, and two textbooks used in California, clearly asserted the position that anthropogenic climate change is scientific consensus or fact, without additional hedging or unclear framing. As an example of what this looks like, the following passage in a Texas textbook asserted the science of climate change, engaging with the idea of complexity around political challenges rather than opinions about climate change itself: "How to halt, or at least mitigate, climate change has been one of the most pressing issues of the twenty-first century. Arriving at a scientific consensus on climate change has proven easier than developing government policies to address it" (Henretta et al. 2014, 1032).

One consideration is that history textbooks may use hedging or framings of controversy to try and convey complexity. For example, California's science standards were highly rated for their climate coverage, but a theme of controversies around climate change and relevant environmental issues exists in the state's textbook content:

"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, 946)

Prior work has noted that textbooks should not obscure the complexity of social dimensions around climate change (Biström and Lundström 2021b). Discussing the different potential effects on developing versus developed nations has potential for conveying a part of this complexity. However, conveying complexity need not include hedging around or otherwise undermining the scientific consensus of the existence of climate change and its anthropogenic sources.

Finally, the role of politicization appears to be less prevalent in narratives around climate change science than prior literature would suggest. Two Texas textbooks had unusually politicized framing around climate change, relative to other sentences, stating, for example: "Liberals often treated the skeptics as ignorant and venal; many conservatives made denial of global warming a litmus test of true conservatism" (Divine et al. 2013, 787), and "[Bush] pleased

corporate chieftains but angered environmentalists by challenging scientists...” (Kennedy, Cohen, and Bailey 2010, 1067). However, this politicization does not appear to favor any particular political party.

The overarching takeaway is that 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.

Narrative differences between states' content

Our analyses suggest that the frequencies of key climate change-relevant terms are similar across both states' corpora, as are levels of prominence for our higher-order themes. Additional robustness checks underscore that narrative content across the states is more similar than different.⁶ Differences that were found tend to relate to the political actors discussed, as opposed to differences in overall topics or themes. For example, when using topic modeling to identify topics within each states' individual set of climate-relevant sentences, both California and Texas each have eight topics emphasizing environmental action by the government and influential figures, with Texas having slightly greater emphasis on issues related to energy and oil. However, within the broader scope of climate change discourse between the two states, there are ultimately more commonalities than differences.

Discussion

At the outset of this project, our comparative case approach provided the opportunity to potentially draw out differences in climate change education based on two politically divergent states that have outsize influence on the U.S. textbook market. However, our inductive NLP strategy analyzed textbook content without specifying whether similarities or differences would arise. The results are unexpected – 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 and Soysal 2005). In comparison to prior work examining broader textbook differences between the two states (e.g., Golden 2006; Goldstein 2020), we may have also found greater similarities due to our specific focus on climate change-relevant content, which generally received very little attention in either states' books. Because climate change is such an under-emphasized topic in U.S. history textbooks generally, publishers may have less incentive to tailor this specific aspect of textbook content to individual states.

A general lack of coverage and tailoring drives home the utility of precise measurement when examining textbook content, as a complement to existing in-depth qualitative work. However, these explanations also amplify the need for textbook-specific reforms. Our study suggests the link between state standards and climate change content in widely used 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 civic action around climate change. First, 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 and Martin 1993; Román and 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. The general critique of history as an elite, white, and particularly male endeavor (e.g., Wilson and Wineburg 1988) is therefore also present in how climate change-related content is discussed. In this case, individual politicians and high-profile environmentalists tend to dominate textbook narratives, with less emphasis on collective action and civic activism. While dramatic and urgent government action is indeed a central part of addressing climate change, history and other subjects that act as tools of political and civic socialization must make clear, intentional connections between individual citizens' actions and the potential for these large-scale changes, such as voting for political leaders that commit to climate action.

Second, the focus on development projects may perpetuate an anthropocentric approach that emphasizes a linear vision of human progress at the expense of understanding not only the environmental harms of development, but the ways in which both the human and natural worlds are intertwined. While anthropocentrism is not unique to the discipline, history education can rise to meet the challenge of climate change by eliminating the false dichotomy between human and natural history (Hawkey 2014; Hawkey, James, and Tidmarsh 2016).

Third, the textbooks perpetuate the notion that there remains controversy around whether climate change is human-driven and/or solvable through human actions. The presentation of climate change as a controversial or uncertain issue misrepresents the role of scientific skepticism in building consensus, and creates barriers to collective climate action (Hayden 2011; Colston and Vadjunec 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 and Busch 2016). While history curricula can and should engage with social and historical complexities around climate change, presenting students the opportunity to reason through different interpretive perspectives, the scientific consensus around the urgency of climate change must not be questioned or hedged.

However, both complexity and civic action may be more effectively engaged. One example might be to discuss the roles of everyday citizens and organizational actors more, beyond governmental actors and prominent conservationists. Our textbooks had passing mention of the role of corporations in contributing to climate change, such as the BP oil spill, which does not match the outsize role corporations play in contributing to environmental damage (Griffin 2017). At the same time, textbooks also noted the role of the Sierra Club in raising awareness about environmental issues. Further developing content around the role of different types of actors in both contributing to and mitigating climate change could help illuminate complexities in the social dimensions of collective, organized climate action.

A second example would be to feature audience-relevant cases of climate disasters and political/civic responses. As climate disasters across the country become more frequent and severe, U.S. history textbooks might be updated to present examples of climate disasters and responses from different regions of the country. These could both serve to eliminate the false sense of a dichotomy between human and natural worlds, as well as provide cases through which to discuss nuances in how existing inequalities are exacerbated by climate change.

Historical context might also include how the communities most marginalized within historical structures of poverty and sustained racism are also those most at risk of exposure to climate threats and environmental hazards (Chalupka, Anderko, and Pennea 2020). Textbook content may offer meaningful context on human agency leading up to our present climate crisis. History curricula, as a central source of political and civic socialization for youth (Langton and Jennings 1968), is a crucial tool in both contextualizing, understanding, and envisioning action with respect to climate change.

Yet in addition to its potential strengths, history curricula may face unique pitfalls in climate change education. Scholars have argued that history courses must work to reject their present dichotomy between human and physical history, enabling a more holistic understanding of how human activities are consequential for the environment, as well as how subsequent environmental changes may in turn affect humans (Hawkey, James, and Tidmarsh 2016; Coles et al. 2017). Again, history also faces the challenge of moving away from being a story of “great (white) men” (e.g., Wilson and Wineburg 1988). In the case of climate change, such bias may risk the impression that only elites are able to take effective climate action. Furthermore, as a key setting for political socialization, the teaching of history can be highly contentious. Textbook publishers likely seek to avoid polarized issues such as climate change, making change in the field challenging.

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, in order to develop a broader understanding of how scientific consensus is portrayed outside of science education. Finally, we did not systematically sample our textbooks for, or examine trends according to, time-based variation. Future work might examine how textbook treatment evolves over time, both within and across states.

Environmental education is urgently needed in core civics and citizenship courses like required history classes, as well as in science (Rudolph and Horibe 2016). Development, a core focus of U.S. history courses, is at the root of the current climate crisis. Students need to understand how existing economic, political and social arrangements have created the crisis, and learn how to create change for the future. We must teach students to understand their collective power in both voting for leaders that seek to address climate change, as well as in pressing high-polluting firms to evolve. History education can therefore generate awareness of the need for structural shifts in the economy and society that are required for lasting sustainability.

Notes

1. We wanted a portrait of the climate education most students were intended to receive at the time the study was conducted. Because we did not sample by publication year, we also do not systematically examine how the content of these textbooks changes over time. Although publication dates of the textbooks vary slightly, the books share in common their wide usage at the time they were sampled.
2. A token is defined as a sequence of characters grouped together as a useful semantic unit for processing, usually between spaces or punctuation (Manning, Raghavan, and Schütze 2008)
3. Because topic loading measures tend to be right-skewed within each topic, we define a highly associated sentence within a given topic as having a topic loading measure that is two standard deviations above the corpus mean.
4. This frequency estimate excludes common articles, conjunctions, and other terms without content (“stop words”) such as “the,” “and,” “as,” etc.
5. We removed three topics out of an original 27 topics because they were driven by large portions of text related to wartime weaponry involving gasoline, as well as wartime rationing of gasoline, rather than discussing gas and oil as related to climate or environmental issues. An additional two topics were removed because they discussed social controversies unrelated to climate change or environmental issues. We opted to leave terms that pulled these sentences in our key term list despite their dual usage because of their relevance to overall energy and pollution discussions. The omitted topics are discussed in [Appendix C](#).
6. Robustness checks for the topic modeling results were performed in multiple 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, 20 out of 22 climate-relevant topics are comparable between California and Texas, and the higher-order themes are consistent between the two. We examined output from an alternative LDA topic modeling package in Python that leverages the MALLET toolkit (McCallum 2002). Finally, we 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. For both the alternative LDA specification and STM specification, higher-order themes are consistent when examining the resulting topic output.

Acknowledgements

We extend special thanks to Emma Dolan for research assistance with earlier versions of this paper. Our work also benefited from research support provided by Sebastian Andrews and Li Lucy. Members of the Computational Sociology Workshop and Comparative Sociology Workshop at Stanford University contributed valuable comments on earlier drafts.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Stanford Institute for Human-Centered Artificial Intelligence (HAI) and Stanford's Center on Philanthropy and Civil Society (PACS).

Notes on contributors

Hannah K. D' Apice is a PhD 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 of Education and Sustainability at Stanford University and Co-Director of the Center on Philanthropy and Civil Society (PACS). At PACS she directs the Global Civil Society and Sustainable Development Lab. 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.

References

- Appleby, J., A. Brinkley, A. S. Broussard, J. M. McPherson, and D. A. Ritchie. 2006. *The American Vision: Modern Times* (California Ed.). Columbus, OH: Glencoe/ McGraw-Hill.
- Appleby, J., A. Brinkley, A. S. Broussard., J. M. McPherson, and D. A. Ritchie. 2014. *United States History and Geography*. Columbus, OH: McGraw Hill Education.
- Arun, R., V. Suresh, C. E. Veni Madhavan, and N. Murthy. 2010. "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). Berlin: Springer.
- Baumer, E. P. S., D. Mimno, S. Guha, E. Quan, and G. K. Gay. 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. doi:10.1002/asi.23786.
- Bischof, J. M., and E. M. Airoldi. 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/113.pdf>.

- Biström, E., and R. Lundström. 2021a. "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. doi:10.1086/714607.
- Biström, E., and R. Lundström. 2021b. "Textbooks and Action Competence for Sustainable Development: An Analysis of Swedish Lower Secondary Level Textbooks in Geography and Biology." *Environmental Education Research* 27 (2): 279–294. doi:10.1080/13504622.2020.1853063.
- Blei, D. M., A. Y. Ng, and M. I. Jordan. 2003. "Latent Dirichlet Allocation." *Journal of Machine Learning Research* 3 (1): 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., Y. Hu, and D. Mimno. 2017. "Applications of Topic Models." *Foundations and Trends® in Information Retrieval* 11 (2/3): 143–296. doi:10.1561/15000000030.
- Bradshaw, S., and A. Henle. 2021. "The Gender Dimensions of Foreign Influence Operations." *International Journal of Communication* 15: 4596–4618. <https://ijoc.org/index.php/ijoc/article/view/16332>.
- Bromley, P., J. W. Meyer, and F. O. Ramirez. 2011. "The Worldwide Spread of Environmental Discourse in Social Studies, History, and Civics Textbooks, 1970–2008." *Comparative Education Review* 55 (4): 517–545. <https://www.journals.uchicago.edu/doi/full/10.1086/660797>. doi: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>
- California Department of Education (CDE). 2017. "History–Social Science Framework for California Public Schools, Kindergarten Through Grade Twelve." California Department of Education. <https://www.cde.ca.gov/ci/hs/cf/>
- Cao, J., T. Xia, J. Li, Y. Zhang, and S. Tang. 2009. "A Density-Based Method for Adaptive LDA Model Selection." *Neurocomputing* 72 (7–9): 1775–1781. doi:10.1016/j.neucom.2008.06.011.
- Chalupka, S., L. Anderko, and E. Pennea. 2020. "Climate Change, Climate Justice, and Children's Mental Health: A Generation at Risk?" *Environmental Justice* 13 (1): 10–14. doi:10.1089/env.2019.0034.
- Choi, S., D. Niyogi, D. P. Shepardson, and U. Charusombat. 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. doi:10.1175/2009BAMS2625.1.
- Coles, A., J. Dillon, M. Gall, K. Hawkey, J. James, D. Kerr, J. Orchard, C. Tidmarsh, and J. Wishart. 2017. "Towards a Teacher Education for the Anthropocene." In P. B. Corcoran, J. P. Weakland, & A. E. J. Wals (Eds.), *Envisioning Futures for Environmental and Sustainability Education* (pp. 73–85). Wageningen, The Netherlands: Wageningen Academic Publishers. doi:10.3920/978-90-8686-846-9_4.
- Colston, N. M., and J. M. Vadjunec. 2015. "A Critical Political Ecology of Consensus: On 'Teaching Both Sides' of Climate Change Controversies." *Geoforum* 65: 255–265. doi:10.1016/j.geoforum.2015.08.006.
- Danzer, G. A., J. J. Klor de Alva, L. S. Krieger, L. E. Wilson, and N. Woloch. 2016. *The Americans: United States History since 1877*. Boston, MA: Houghton Mifflin.
- Deveaud, R., E. San Juan, and P. Bellot. 2014. "Accurate and Effective Latent Concept Modeling for Ad Hoc Information Retrieval." *Document Numérique* 17 (1): 61–84. doi:10.3166/dn.17.1.61-84.
- DeWaters, J., and S. Powers. 2008. "Energy Literacy among Middle and High School Youth." In 38th ASEE/IEEE Annual Frontiers in Education Conference, October (pp. T2F-6–T2F-11). IEEE. <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4720280&tag=1>.
- Divine, R. A., T. H. Breen, R. H. Williams, A. J. Gross, and H. W. Brands. 2013. *America past and Present* (10th ed.). Boston, MA: Pearson.
- Dunlap, R. E., A. M. McCright, and J. H. Yarosh. 2016. "The Political Divide on Climate Change: Partisan Polarization Widens in the US." *Environment: Science and Policy for Sustainable Development* 58 (5): 4–23. doi:10.1080/00139157.2016.1208995.
- Edwards, P. N. 2013. *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge, MA: MIT Press.
- Feinstein, N. W., and K. L. Kirchgasser. 2015. "Sustainability in Science Education? How the Next Generation Science Standards Approach Sustainability, and Why It Matters." *Science Education* 99 (1): 121–144. doi:10.1002/sce.21137.
- Foner, E. 2011. *Give Me Liberty! An American History* (3rd ed., Vol. 2). New York, NY: W. W. Norton & Company.
- 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. doi:10.1177/0042098016651554.
- Gills, B., and J. Morgan. 2021. "Teaching Climate Complacency: Mainstream Economics Textbooks and the Need for Transformation in Economics Education." *Globalizations* 18 (7): 1189–1205. doi:10.1080/14747731.2020.1808413.
- Golden, D. 2006. "Aiming for Diversity, Textbooks Overshoot." *Wall Street Journal*, August 19. A1. <https://www.wsj.com/articles/SB115595234477240157>.
- Goldstein, D. 2020. "Two States. Eight Textbooks. Two American Stories." *The New York Times*, January 12. 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., and M. Steyvers. 2004. "Finding Scientific Topics." *Proceedings of the National Academy of Sciences* 101 (suppl_1): 5228–5235. doi:10.1073/pnas.0307752101.
- Halliday, M. A. K., and J. R. Martin. 1993. *Writing Science: Literacy and Discursive Power*. Bristol/London: The Falmer Press.
- Hawkey, K. 2014. "A New Look at Big History." *Journal of Curriculum Studies* 46 (2): 163–179. doi:10.1080/00220272.2013.778331.
- Hawkey, K., J. James, and C. Tidmarsh. 2016. "Greening the Curriculum? History Joins 'the Usual Suspects' in Teaching Climate Change." *Teaching History* (162): 32–41. <https://www.history.org.uk/publications/resource/8762/teaching-history-162-scales-of-planning>.
- 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>.
- Henretta, J. A., E. Hinderaker, R. Edwards, and R. O. Self. 2014. *America's History for the AP Course* (8th ed.). Bedford: St. Martin's.
- Heyneman, S. P., J. P. Farrell, and M. A. Sepulveda-Stuardo. 1981. "Textbooks and Achievement in Developing Countries: What we Know." *Journal of Curriculum Studies* 13 (3): 227–246. doi:10.1080/0022027810130306.
- Jimenez, J. D., J. Lerch, and P. Bromley. 2017. "Education for Global Citizenship and Sustainable Development in Social Science Textbooks." *European Journal of Education* 52 (4): 460–476. doi:10.1111/ejed.12240.
- Jorgenson, S. N., J. C. Stephens, and B. White. 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. doi:10.1080/00958964.2019.1604478.
- Keene, J. D., S. T. Cornell, and E. T. O'Donnell. 2013. *Visions of America: A History of the United States* (2nd ed.). Boston, MA: Pearson.
- Kennedy, D. M., L. Cohen, and T. A. Bailey. 2010. *The American Pageant* (14th ed., Vol. 1 & 2.). Boston, MA: Houghton Mifflin.
- Khalidi, R., and J. Ramsey. 2021. "A Comparison of California and Texas Secondary Science Teachers' Perceptions of Climate Change." *Environmental Education Research* 27 (5): 669–686. doi:10.1080/13504622.2020.1838447.
- Lakoff, G. 1996. *Moral Politics*. Chicago, IL: University of Chicago Press.
- Lakoff, G. 2010. "Why It Matters How we Frame the Environment." *Environmental Communication* 4 (1): 70–81. doi:10.1080/17524030903529749.
- Langton, K. P., and M. K. Jennings. 1968. "Political Socialization and the High School Civics Curriculum in the United States." *American Political Science Review* 62 (3): 852–867. doi:10.2307/1953435.
- Lapsansky-Werner, E. J., P. B. Levy, R. Roberts, and A. Taylor. 2016. *United States History: 1877 to Present*. Boston, MA: Pearson Education, Inc.
- Lapsansky-Werner, E. J., P. B. Levy, R. Roberts, and A. Taylor. 2008. *United States History: Modern America*. Boston, MA: Pearson Prentice-Hall.
- Lapsansky-Werner, E. J., P. B. Levy, R. Roberts, and A. Taylor. 2019. *United States History: The Twentieth Century*. New York, NY: Pearson Education, Inc.
- Lucy, L., D. Demszky, P. Bromley, and D. Jurafsky. 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): 1–27. doi:10.1177/2332858420940312.
- Luo, Y., D. Card, and D. Jurafsky. 2020. "Detecting Stance in Media on Global Warming." *Findings of the Association for Computational Linguistics: EMNLP 2020*: 3296–3315. <https://arxiv.org/abs/2010.15149>.
- Maier, M., J. Milde, S. Post, L. Günther, G. Ruhrmann, and B. Barkela. 2016. "Communicating Scientific Evidence: Scientists', Journalists' and Audiences' Expectations and Evaluations regarding the Representation of Scientific Uncertainty." *Communications* 41 (3): 239–264. doi:10.1515/commun-2016-0010.
- Manning, C. D., P. Raghavan, and H. Schütze. 2008. "Tokenization." In *Introduction to Information Retrieval*. Cambridge, UK: Cambridge University Press. <https://nlp.stanford.edu/IR-book/html/htmledition/tokenization-1.html>.
- McCallum, A. K. 2002. MALLET: A machine learning for language toolkit. <http://mallet.cs.umass.edu>
- McFarland, D. A., S. Khanna, B. W. Domingue, and Z. A. Pardos. 2021. "Education Data Science: Past, Present, Future." *AERA Open* 7 (1): 233285842110520. doi:10.1177/23328584211052055.
- Merton, R. K. 1973. *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago, IL: University of Chicago Press.
- Miller, K. P. 2020. *Texas vs. California: A History of Their Struggle for the Future of America*. Oxford, UK: Oxford University Press.
- Monogan, J. E., and A. C. Doctor. 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) & Texas Freedom Network Education Fund (TFNEF). 2020. "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*. Chicago, IL: National Geographic School Publishing, Inc.
- Nelson, L. K. 2020. "Computational Grounded Theory: A Methodological Framework." *Sociological Methods & Research* 49 (1): 3–42. doi:10.1177/0049124117729703.
- Neo, X., and M. Schneider-Mayerson. 2022. "Nature, Disappeared: Anti-Environmental Values in Singapore's History Textbooks, 1984–2015." *Environmental Education Research* 28 (1): 56–74. doi:10.1080/13504622.2021.1968350.
- Nikita, M., and N. Chaney. 2020. "ldatuning: Tuning of the Latent Dirichlet Allocation Models Parameters." R package version 0.2-0. <https://CRAN.R-project.org/package=ldatuning>
- Noguera-Méndez, P., and J. Cifuentes-Faura. 2022. "Environmental Sustainability in Economics Teaching: Analysing Spanish Upper Secondary Economics Textbooks." *Environmental Education Research* : 1–18. doi:10.1080/13504622.2022.2069680.
- Perry, W. G. 1970. *Forms of Intellectual and Ethical Development in the College Years*. New York, NY: Holt, Rinehart, & Winston.
- Pew Research Center. 2020. "As Economic Concerns Recede, Environmental Protection Rises on the Public's Policy Agenda: Partisan Gap on Dealing with Climate Change Gets Even Wider." <https://www.pewresearch.org/politics/2020/02/13/as-economic-concerns-recede-environmental-protection-rises-on-the-publics-policy-agenda/>
- Porter, M. F. 1980. "An Algorithm for Suffix Stripping." *Program: Electronic Library and Information Systems* 14 (3): 130–137. <https://asset-pdf.scinapse.io/prod/2098162425/2098162425.pdf>. doi:10.1108/eb046814.
- Powell, J. 2017. "Scientists Reach 100% Consensus on Anthropogenic Global Warming." *Bulletin of Science, Technology & Society* 37 (4): 183–184. doi:10.1177/0270467619886266.
- Quinn, K. M., B. L. Monroe, M. Colaresi, M. H. Crespin, and D. R. Radev. 2010. "How to Analyze Political Attention with Minimal Assumptions and Costs." *American Journal of Political Science* 54 (1): 209–228. doi:10.1111/j.1540-5907.2009.00427.x.
- Reid, A., J. Dillon, N. Ardoin, and J. A. Ferreira. 2021. "Scientists' Warnings and the Need to Reimagine, Recreate, and Restore Environmental Education." *Environmental Education Research* 27 (6): 783–795. doi:10.1080/13504622.2021.1937577.
- Roberts, M. E., B. M. Stewart, and D. Tingley. 2019. "stm: An R Package for Structural Topic Models." *Journal of Statistical Software* 91 (2): 1–40. doi:10.18637/jss.v091.i02.
- Roberts, M. E., B. M. Stewart, D. Tingley, and E. M. Airoldi. 2013. "The Structural Topic Model and Applied Social Science." In *Advances in Neural Information Processing Systems Workshop on Topic Models: Computation, Application, and Evaluation* 4, 1–20.
- Román, D., and K. C. Busch. 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. doi:10.1080/13504622.2015.1091878.
- Rudolph, J. L., and S. Horibe. 2016. "What Do we Mean by Science Education for Civic Engagement?" *Journal of Research in Science Teaching* 53 (6): 805–820. doi:10.1002/tea.21303.
- Schissler, H., & Soysal, Y. N. (Eds.) 2005. *The Nation, Europe, and the World: Textbooks and Curricula in Transition*. Oxford, UK: Berghahn Books.
- Stahl, S. A., C. R. Hynd, B. K. Britton, M. M. McNish, and D. Bosquet. 1996. "What Happens When Students Read Multiple Source Documents in History?" *Reading Research Quarterly* 31 (4): 430–456. doi:10.1598/RRQ.31.4.5.
- Stevenson, K. T., T. L. King, K. R. Selm, M. N. Peterson, and M. C. Monroe. 2018. "Framing Climate Change Communication to Prompt Individual and Collective Action among Adolescents from Agricultural Communities." *Environmental Education Research* 24 (3): 365–377. doi:10.1080/13504622.2017.1318114.
- Tarr, J. E., R. E. Reys, B. J. Reys, Ó. Chavez, J. Shih, and S. J. Osterlind. 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). 2018. Texas Essential Knowledge and Skills for Social Studies: Subchapter C High School. Texas Education Agency. <https://tea.texas.gov/about-tea/laws-and-rules/texas-administrative-code/19-tac-chapter-113>
- Texas Education Agency (TEA). n.d. *The Review and Adoption Process*. <https://tea.texas.gov/academics/instructional-materials/review-and-adoption-process/the-review-and-adoption-process>
- Tulkens, S., L. Hilde, E. Lodewyckx, B. Verhoeven, and W. Daelemans. 2016. "A Dictionary-Based Approach to Racism Detection in Dutch Social Media." doi:10.48550/arXiv.1608.08738.

- U.S. Environmental Protection Agency (EPA). 2016. "Glossary of Climate Change Terms." https://19january2017snapshot.epa.gov/climatechange/glossary-climate-change-terms_.html
- United Nations. 2015. "Sustainable Development Goals." <https://sdgs.un.org/goals>
- Vojříř, K., and M. Rusek. 2019. "Science Education Textbook Research Trends: A Systematic Literature Review." *International Journal of Science Education* 41 (11): 1496–1516. doi:10.1080/09500693.2019.1613584.
- Wilson, S. M., and S. S. Wineburg. 1988. "Peering at History through Different Lenses: The Role of Disciplinary Perspectives in Teaching History." *Teachers College Record: The Voice of Scholarship in Education* 89 (4): 525–539. doi: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. doi:10.2307/1163146.
- Yavetz, B., D. Goldman, and S. Pe'er. 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. doi:10.1080/13504620902928422.