"If We Try, It Will Change": How Berkeley 4th and 5th Graders Understand Climate Change

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ABSTRACT

As climate change becomes more of a pressing environmental issue, climate change education becomes a crucial component of developing future environmental scientists, engineers and activists. Berkeley, California represents a uniquely environmental microcosm in which citizens actively try to reduce green house gas emissions and waste and whose public schools do their part in teaching their students about climate change. Through 31 interviews with Berkeley 4th and 5th graders I was able to assess the level of their climate change knowledge as well as the misconceptions that existed around this topic. Ultimately, the level of climate change understanding of these students was impressive with the majority of them acknowledging the anthropogenic nature of climate change and several of its major causes. Even more encouraging, however, was how optimistic the students I interviewed were about their ability to curtail the future of climate change. This optimism is perfectly encapsulated by the quote in the title of this thesis: "If We Try, It Will Change."

KEYWORDS

Environmental education, global warming, childhood science narratives, elementary science education

INTRODUCTION

Over the past three decades, media publication of climate science has shifted from the confident and clear presentation of facts to the formation of a controversial issue with two equally validated sides (Anderegg et al. 2010). This shift—which has been largely motivated by pressure from lobbyists who represent carbon-rich industries like oil and gas—has caused American opinion regarding the anthropogenic nature of climate change to fall dramatically below other first world countries (Global Trends 2014). The controversy surrounding the reality of anthropogenic climate change has impacted many areas of life, including science education in primary and secondary schools. For example, a school board in Los Alamitos, California required teachers in the spring of 2011 to teach a "balanced" curriculum on climate change because they believed the subject to be controversial (Reardon 2011). Along the same lines, a nationwide study of middle and high school students found that 30% of teachers incorporate climate denial arguments into their curriculum and 50% allow students to discuss these arguments without introducing the facts backing climate science (Luhn 2016). Because the scientific community recognizes the anthropogenic nature of climate change, allowing opposition arguments in the classroom does a disservice to students who will form the backbone of future mitigation and adaptation efforts.

In California, a state often celebrated for its progressive environmental policy, the majority of citizens believe in the existence of climate change and over fifty percent believe that, "it is a very serious threat" (Baldassare et al. 2015). And yet, as mentioned previously, the controversy surrounding climate change has made teaching it a challenge for teachers in places like Los Alamitos. Nevertheless, Tom Torlakson, the State Superintendent of Public Instruction created an Environmental Literacy Task Force in 2015 that has already started implementing improvements to California's environmental curriculum. According to Torlakson, "Students need to learn about the environment so they can make informed choices and help to maintain our clean water and air, and preserve our scenic resources" (California Department of Education 2015). While Torlakson has obvious passion for integrating environmental science into all levels of California curriculum, climate change is still not explicitly mentioned in the mandatory curriculum of 4th and 5th graders. Instead, only a few concepts loosely related to climate change are sparingly included. For example, California's 4th and 5th grade curriculum mentions

renewable energy sources, the fact that fuel "affects the environment in multiple ways" and states that, "human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space" (2015). However, climate change—perhaps, because of its controversial reputation—is nowhere to be found.

In Berkeley, California, my research site, environmental concern is commonplace. 65% of residents are registered Democrats, 37% regularly walk or bike to work and the City of Berkeley has an impressive recycling and waste management program that recycles, re-uses and composts 76% of its waste (About Berkeley: How We Live). These environmental ideals have trickled down into Berkeley's public elementary schools. For instance, last year's topic for the Chavez Huerta Art Poetry and Essay Contest was Climate Change and there was 100% participation among all eleven elementary schools (BUSD Chavez Huerta Art Poetry and Essay Contest 2016). Due to Berkeley's role as a community of standout environmental activism in a state already commended for its environmental concern, its teachers, parents and other residents should have a firm grasp on the reality of anthropogenic climate change. Thus, because climate change awareness is highly associated with the stimuli students are surrounded with, one would believe Berkeley 4th and 5th grade students should be uniquely well versed in climate change compared to their peers in other areas of the country (Hestness 2016).

Little research exists on elementary school students' understanding of climate change even though the reality of greenhouse gas accumulation and temperature change means the effects of climate change will have a larger impact on younger generations than on the lives of current adults (Currie & Deschenes 2016). Because current children have a much larger stake in the Earth's future environmental quality, it is critical to understand to what extent young minds are grasping climate change. I have chosen to study Berkeley students because of the fact that they represent a uniquely environmentally aware microcosm. In my thesis, I will work on expanding this knowledge gap by determining the level and depth of understanding of climate change in Berkeley elementary school students.

My research was centered on a broad inquiry: How well do Berkeley elementary school students understand climate change? In order to account for the multitude of ways that this question can be answered, I posed additional questions, specifically: Have students heard of the terms "climate change" and "global warming"? Do students agree that climate change is currently happening and understand its anthropogenic causes? Do students believe that climate

change will affect them in the future? Do students believe that they can positively impact climate change in the future?

Berkeley Public Schools

My research takes place in The Berkeley Unified Schools District, which according to its website, values diversity, equity, and enrichment and was the first school district in the nation to willingly desegregate its schools in 1968. This district educates 4,040 elementary (Kindergarden-5th grade) students at eleven different elementary schools. On average, Berkeley elementary schools have 375 students and a student teacher ratio of 26:1. Both of these values are below average for the state of California (Berkeley Unified At a Glance). 11% of Berkeley students speak a language other than English at home. This 11% represents more than 40 different languages—the most common of which are Spanish, Japanese and Arabic. Berkeley Unified School District also has an Ethnic Diversity Index value of 63 out of 100, which is 13 points higher than California Public Schools as a whole (Ed-Data). These statistics demonstrate that while Berkeley is a larger school district, it uniquely values and maintains small class sizes and a rich diversity of students.

Climate Change: A Hot Button Issue

While climate change is currently seen as a divisive issue, the denial of climate change has been gaining slow popularity since the 1980's when climate scientists began to publically speak about anthropogenic climate change. In the mid-to-late 1980's, politicians, scientists and journalists alike expressed "certainty" about climate change's anthropogenic nature (Taylor 2014). However, almost immediately industries invested in maintaining high carbon emissions began to craft messages of climate change denial. Seemingly unqualified scientists were employed, lobbyists were sent to Capital Hill and messages questioning the validity of climate change were spread through the various channels of mass media (Moser 2010). Furthermore, although there is a near consensus among scientists in climate-related fields on the occurrence of anthropogenic climate change, American mass media has positioned this issue as a balanced debate between two equal, validated sides (Anderegg et al. 2010). Seeing an equal representation

of skeptics and proponents of climate change has caused the public to get caught in the crossfire between fact and doubt. Ultimately, this has led to a public understanding of climate change that is both, "superficial and vulnerable to frequent revision" (Moser 2010). For example, while 63 percent of Americans agree that global warming is occurring, most do not understand why climate change is happening or agree that it has anthropogenic causes (Leiserowitz et al. 2010).

Additionally, the divisive media portrayal of climate change has caused the United States to become ideologically split on this issue with liberals being far more likely than conservatives to believe in the existence of anthropogenic climate change. A study highlighting this fact found that only 15% of conservative republicans agree that climate change is due to human activity, compared to 79% of liberal democrats. Also, merely 11% of conservative republicans acknowledge the climate scientists understand the causes of climate change, while 54% of liberal democrats recognize this fact (Funk et al. 2016). Despite these statistics, American concern for climate change is growing. A study conducted soon after the 2016 presidential election found that the number of Americans "very worried" about climate change has reached an all-time high at 19%. The number of Americans "very" or "somewhat" concerned is also substantial at 61% (Leiserowitz et al. 2016).

While increasing American concern for climate change is encouraging, these statistics still fall far below the concern of other countries and several psychological principles—beyond the influence of media sources—may be to blame (Wike 2016). One of these principles is the notion of psychological distance or the separation of events and concepts from one's direct experience (Scharks 2016). Essentially, if something cannot be observed or experienced first hand, it is difficult to comprehend, let alone fear. Psychological research demonstrates that direct experience repeatedly triumphs over displaced experiences or intangible data. This is true of both temporal and spatial experiences (Spence et al. 2012). For instance, it is difficult for people to fear the effects of increased carbon dioxide emissions when the science of atmospheric gas accumulation demonstrates that visible effects won't be seen for some time. Furthermore, most of the contemporary, visible effects of climate change are occurring in places like the Artic where people are less likely to live or tropical areas outside of American borders (Moser 2016).

Another challenge when effectively contemplating climate change is the enormous scale of the issue (Scharks 2016). This demonstrates the psychological concept of self-efficacy or the decreased likelihood of an individual to act when they believe that they will have little to no

impact on an outcome (Gifford 2011). Put into an environmental context: if the atmospheric carbon dioxide concentration has increased by nearly 50% from pre-industrial levels, some may wonder how personal decreases in fuel and energy use will make much of a difference. Self-efficacy and psychological distance work together with notions of uncertainty to maintain low levels of American concern for climate change. In turn, this makes American students less likely to understand climate change or agree that it has anthropogenic causes.

Relevant Literature

While very little research exists on the climate change knowledge of American elementary school students, I have crafted my thesis methodology using related research that covers different age ranges or locations outside of the United States. Shepardson et al. (2009) formed a baseline for my study by explaining how 7th graders understand climate change at a rudimentary level, but lack, "a rich conceptualization of the issue." Based on this finding, I began my study with the assumption that some 4th and 5th graders would have a surface level understanding of climate change, and few would likely understand it in-depth. Hestness (2016) motivated me to use Berkeley as a backdrop for my research by demonstrating that varying lifestyles of 6th graders affected the depth at which they understood climate change. For instance, exposure to media, technology, environmental education, parental opinions and cultural messages about climate change correlated with more confidence in and concern for its' implications. Harker-Schuch, I., and C. Bugge-Henriksen (2013) also found that increased knowledge about climate science is associated with greater confidence in climate change. Based on these findings, Berkeley students should have a greater understanding of and confidence in climate change because of the greater amount of environmental awareness that they are surrounded with in the Berkeley community. Christensen & Knezek's (2015) survey of a wide range of American middle schoolers about climate change formed the foundation of a handful of my survey questions (2015).

METHODS

I interviewed Berkeley 4th and 5th grade school students to gain insight into their understanding of climate change and its anthropogenic causes. I enlisted the help of Dr. Kathleen Metz, a professor at UC Berkeley's Graduate School of Education, to develop interview questions that would be easy for students to understand and would yield detailed results.

Student Interviews

From November to January of 2017, I conducted 31 interviews with elementary school students in the Berkeley LEARNS after school program at Le Conte Elementary in Berkeley, California. I recorded and transcribed each interview, and documented students' grade level and teacher. Each interview began by showing the students a picture of a polar bear hunting for food on a muddy shore (Appendix A). I begin by telling them that for a long time scientists have observed that the Earth is getting warmer. Berkeley is warmer than it used to be and places like the Artic are warming so much that ice is melting. Then I referenced the picture and explained that polar bears like this one now have to hunt for food on muddy shores instead of hunting for seals on ice, like they have for centuries. Then I asked why the student believes the Earth might be getting warmer and we would have a conversation about their thoughts as I tried to probe deeper and deeper into their understanding by repeatedly asking, "Why does that make the Earth warmer? I want to make sure I understand your thinking." Next I would ask, "Is there anything that humans are doing that is making the Earth warmer?" and "Is there anything that humans are doing that is making the Earth less warm?" After students have been asked the above questions and have been thinking hard about the Earth getting warmer, I would ask if they have ever heard of the terms "climate change" or "global warming." If they had, I asked them to define these terms. Then I would ask if they believe these will affect them in their lifetime and if they believe there is a way that they can personally improve climate change or global warming.

Interview Analysis

Once all of my interviews were completed, I transcribed each interview. From these transcriptions, I created an Excel document in which I charted common terms and themes that students brought up. From this document, I was able to determine how often students offered certain explanations or solutions to climate change. Further details of this analysis are described below in my results section.

RESULTS

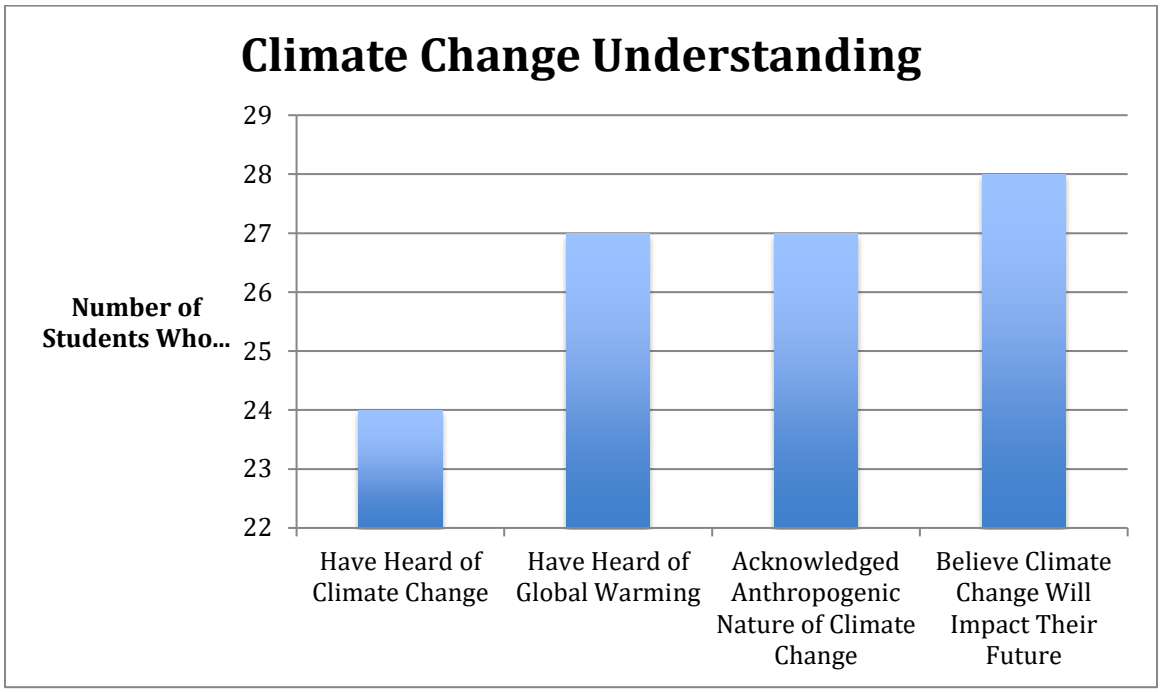
Basic Knowledge

A majority of students have heard of "climate change" and "global warming", can define these terms and understand that they describe a phenomenon that is environmentally concerning. More specifically, 77% of students had heard of "climate change" and 87% had heard of "global warming." Impressively, 26% of students were able to describe the phenomenon of climate change correctly in some detail. One fourth grader demonstrated this by describing the green house effect in his own words: "All of the heat comes in [the atmosphere]…and instead of it bouncing back it keeps going around and around the Earth."

Whether human activity is linked to climate change has been vigorously debated within the media and political sphere. And yet, 52% of students mentioned human activity as a cause of climate change without being prompted. This shot up to 87% of students when asked directly if humans were doing anything to make the Earth warmer. When asked for ways in which humans are contributing to climate change, another fourth grader mentioned the widespread use of cars and the smoke expelled from factories and then frustratingly concluded, "We're not stopping it."

When forced to look to the future, 90% of 4th and 5th graders believe that climate change will impact them in their lifetime. When asked to describe this impact, most students looked to the definition of global warming: temperatures will increase which will mean warmer weather, and some students pointed out that this will be "annoying." Five students further concluded that increases in heat will cause subsequent increases in evaporation and therefore water shortages. Five other students were concerned about increasing air pollution and how this will decrease the

quality of the air they breathe. One 4th grader commented, "the air is going to get infected and is going to go into me and my family and friends."



Environmental Connections

While most of the Berkeley students were able to acknowledge the basic components of climate change described above, when probed for its causes the students provided a wide range of answers. More specifically, the most commonly named causes for climate change were driving cars, air pollution, littering and factory emissions, in that order. Although 90% of students gave some cause of climate change, only 74% of students mentioned at least one cause that directly impacts climate change such as green house gases, car emissions, and other causes of air pollution. Examples of causes that are not directly related to climate change, but were mentioned by the students I interviewed, include littering, smoking cigarettes and killing animals (Table 2).

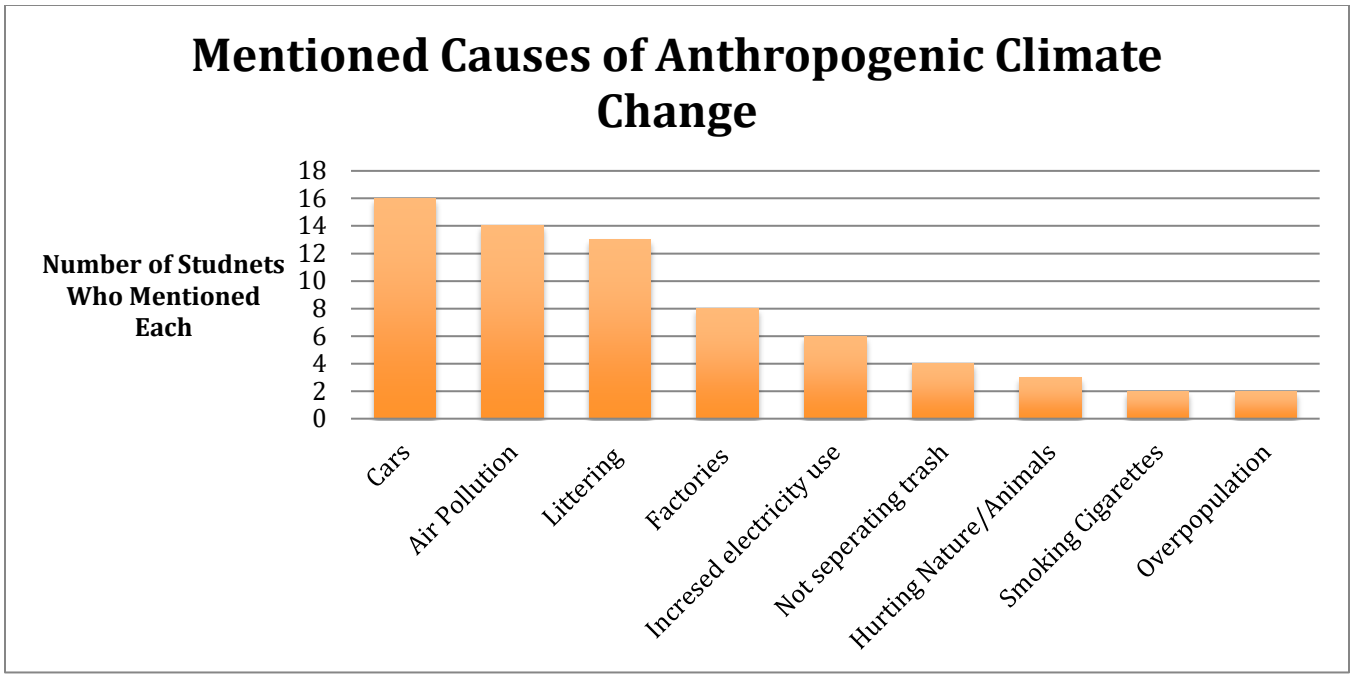


TABLE 2—Note: Many students mentioned more than one cause

74% of students described ways in which they could personally combat climate change by altering their lifestyles in more carbon conscious ways like driving less or using less energy. A handful of students proposed innovative solutions to climate change such as utilizing more materials "to bounce sunlight off of" or becoming a nature photographer who captures "how the world is changing." But others felt that they could be little help in solving climate change. When asked if they could assist in curbing climate change in the future, one 4th grader commented, "No. There's no way. Because you can't just like 'go to space', push the Earth farther away from the sun. That's impossible." Another student sadly said, "I'd try if I was a little smarter."

Climate Change Misconceptions

Although the majority of students understood the relationship between climate change and human activity, 48% of students mentioned an incorrect cause of climate change at some point during their interview. An incorrect cause of climate change is defined as a cause that cannot directly be tied to climate change. Examples include the fact that some students incorrectly believed that increasing temperatures are caused by "the sun getting bigger" or

"because it's getting closer to spring." Other students incorrectly correlated cigarette smoking or not recycling with global warming.

Differences Between 4th and 5th graders

All in all, there was little difference in knowledge and beliefs between the 4th and 5th graders I interviewed. In general, 4th graders knew less about climate change and its causes the 5th graders, but were slightly more confident that climate change would impact their future. More specifically, 67% of 4th graders had heard of "climate change" compared to 88% of 5th graders. 67% of 4th graders mentioned an incorrect cause of climate change, while only 44% of 5th graders did the same. 75% of 5th graders were able to give an anthropogenic cause of climate change without being prompted, while only 53% of 4th graders were able to do so. However, 93% of 4th graders believe climate change will impact their future, while only 81% of 5th graders agree.

DISCUSSION

The goal of my research was to determine how Berkeley 4th and 5th graders understood climate change and its anthropogenic nature. As demonstrated above, the majority of students had heard of climate change, were able to connect this phenomenon with human activity and believed it will impact their future. However, 48% of students also mentioned at least one incorrect cause of climate change. This demonstrates an encouraging level of environmental awareness combined with significant confusion. Comparison of my findings with other studies of similar populations suggests that Berkeley students understand climate change at a similar level to their slightly older peers. Most notably, it is important to understand the significance of the common misconceptions brought up in my interviews, which mirrored the confusion found in other studies. Ultimately, my findings suggest that climate change should be included in curriculum earlier than 6th grade in California public schools.

Level of Climate Change Understanding and Confidence

Comparison of Berkeley 4th and 5th graders' understanding of climate change with that of students across the United States suggests that Berkeley students had similar knowledge to and were more optimistic about the future than their older peers. A study that examined the knowledge of North Carolina 5th through 8th graders served as an intriguing comparison to my own because both student populations had limited mandatory climate change curriculum. For instance, when compared to North Carolinian 5th through 8th graders in this study, the Berkeley students I interviewed were slightly less likely to have heard of climate change or global warming, but had more confidence that they could do something to curtail them. More specifically, 92% of the NC students had heard of climate change or global warming, while 87% of the Berkeley students had heard of these terms. When students were asked to think about future implications of climate change, 63% of NC students believed that they could make a positive impact on mitigating climate change, while 74% of Berkeley students believed the same (Apple 2007).

Perhaps the older age of the North Carolina students allowed them a greater opportunity to come across the terms "global warming" or "climate change" in some facet of their lives, whether it be school, media or friends and family. On the other hand, the high level of environmental awareness that is unique to Berkeley may have made Berkeley students more likely than their North Carolina peers to believe they can positively impact the future of this environmental issue. As an Australian study on environmental education found, increased knowledge about climate change gave students greater confidence that they could positively combat climate change with their personal actions (Taber and Taylor 2009). However, student emphasis on the importance of climate change and its future was not unique to Berkeley and North Carolina students. A study of over 1500 middle school students across the US found that the majority of students believed that climate change was currently happening and that they can make a positive impact on curtailing climate change (Christensen et al. 2015). Similarly, 80% of students at San Jose State University identified climate change is an important environmental issue (Cordero et al. 2008).

When students were asked to identify top causes and effects of climate change, students across the US mentioned similar phenomena. As a reminder, the most commonly stated causes of

climate change by the students I interviewed were cars, air pollution and littering in that order. 94% of Bay Area college students identified automobile or factory emissions to be a major source of climate change (Cordero et al. 2008). The most common causes identified by a survey of almost 100 Midwestern 7th graders found the most commonly given climate change causes were driving (43%), air pollution (34%), factories (32%) (Shepardson et al. 2009). By comparison, the most commonly stated causes of climate change by the students I interviewed were cars, air pollution and littering. When it came to identifying only correct causes, 22% of North Carolina middle schoolers achieved this compared to 52% of Berkeley 4th and 5th graders (Apple 2007). Overall, because most of the available research involves middle school and older students, it is impressive that Berkeley students were able to identify similar causes as their older peers and even in some cases were able to do so with far greater accuracy. This suggests that Berkeley students are gaining greater environmental literacy outside of the classroom than other American students who live in communities with less emphasis on the environment than Berkeley. Perhaps, this finding even serves as another reason why "green" programs like composting and bike paths are so beneficial to communities.

Climate Change Misconceptions

Because many American adults and teenagers find climate change to be a confusing concept to grasp, I was not surprised that the 4th and 5th graders I interviewed made some incorrect assumptions. In fact, students in several other studies proposed similarly false causes of climate change. For instance, littering was "commonly" mentioned as a cause of climate change in a survey of middle schoolers in North Carolina (Apple 2007) and by 4% of high school students in another survey (Gowda et al. 1997). Taber and Taylor (2009) also found that students incorrectly linked unrelated unfriendly environmental acts—like water pollution—to climate change (2009). Additionally, research of New Zealand 6 to 11 year-olds found "considerable confusion" when students were asked to distinguish between renewable and non-renewable energy sources (Boylan 2008). The motivation for students to clump environmental issues together documented in all of these studies may explain why students have difficulty differentiating between the environmental causal relationships that exist.

The Argument for Climate Change Education Earlier

According to Cordedo et al. (2008), "Misconceptions, once formed, are difficult to unravel, even for educated adults." This is true for some learners even when new information that contrasts misconceptions is introduced (Taber and Taylor 2009). The persistence of misconceptions is reflected in elementary school students and college students alike holding similar misconceptions about climate change, despite the education and life experience that separate these groups.

Introducing environmental concepts like climate change earlier in the curriculum can serve to improve environmental literacy and rid students of false conceptions. The concepts of both weather and climate are included in California curriculum for Kindergarteners and perhaps climate change should be added at this level so that climate and climate change are always linked in student's minds (*California Department of Education*). Of course, a complex explanation of climate change would be confusing to 5 and 6 year olds, but a simple "our climate is changing right now in a unique way and scientists think this is because of how many people drive cars and do other activities" would serve as a nice introduction. This way, by the time students hear "climate change" or "global warming" from sources outside of school, they already have a basic understanding of these topics, making them likely to believe inaccurate information.

Introducing the concept of climate change earlier into the curriculum will not only limit future misconceptions but will also create a more motivated group of future scientists and environmental activists. As Apple wrote, "Education at a young age is the best way to instill an appreciation for the environment, the nature of science, and an individual's responsibility for a global problem" (2007). Essentially, providing better environmental education to our youth is significant way to ensure a healthy future for our planet and our children.

Limitations

As is the reality of most research, there were a handful of limitations to my study. First off, gaining access to elementary school students was a challenge that required persistence and luck and resulted in me being able to only complete 31 interviews with 4th and 5th graders at only one Berkeley elementary school. I did not have time or approval to conduct any more interviews,

which may have skewed the results I obtained. This means that the particular school I researched may have had below or above average climate change awareness compared to other Berkeley elementary schools. My interviews were conducted during the Berkeley BEARS after school program, which means that most of the students I interviewed had two working parents and no nanny or other caregiver to pick them up after school. This reality may have affected how much knowledge students who did and did not participate in Berkeley BEARS obtained outside the classroom.

Future Directions

Given my findings and the limitations of my study, I believe that earlier climate change education would greatly beneficial to the future environmental scientists and engineers who will create innovative mitigation efforts. Of course, further research would need to be done in order to make my suggestion a reality. Research needs to be completed on how to remove the controversy surrounding climate change so that it can be taught in a more clear and consistent way across the US. Education research that determines the best way to teach young minds about climate change would also be helpful. And finally, conducting more interviews, similar to the ones I did, would help educators determine the biggest misconceptions that need to be addressed in each region or age group.

Conclusion

Without significant intervention, climate change will continue to escalate and impact the lives of everyone. As citizens of the world, it is our duty to ensure that the future minds of our society are properly educated about environmental issues and the ways that they can be mitigated. With a national government that has been unsupportive of environmentalism and media sources that have perpetuated the idea that climate change is a debatable phenomenon, this is an uphill battle. Berkeley, California represents a community that uniquely values the environment, and while my interviews of Berkeley 4^{th} and 5^{th} graders revealed a lot of encouraging knowledge and optimism for the future, it also revealed a lot of misconceptions

surrounding climate change. This demonstrates that even in the best of circumstances, there is room for great improvement in terms of climate change education and awareness.

Based on my research, I believe that it would be beneficial to introduce climate change into California curriculum before 6th grade, as is the current requirement set by the California Department of Education. Perhaps climate change could be included as early as Kindergarten when the topics of weather and climate first appear in the curriculum. If we can introduce climate change in an effective and timely manner, we can limit misconceptions from forming and create a more knowledgeable and empowered citizenry. As one 4th grader put it, "if we try, it will change." If we work on improving environmental education, it will get better. And more importantly, if we can alter the climate change narratives of society as a whole, our environmental future could be much brighter than anyone ever imagined.

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APPENDIX A

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