

HOW PARTICIPATING IN CLIMATE ACTION PROJECTS AFFECTS STUDENTS'
UNDERSTANDINGS AND PERSPECTIVES ABOUT GLOBAL CLIMATE CHANGE

by

Julia Renée Rose

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2024

©COPYRIGHT

by

Julia Renée Rose

2024

All Rights Reserved

ACKNOWLEDGEMENTS

I would like to acknowledge my team for their support, encouragement, and expertise. Jim Rose and Eimi Andrews, my parents who happen to be two of my best friends, have always been my on my team but added extra support lending their language expertise. April Rewerts, a teaching colleague, graciously agreed to collaborate with me on this project. My advising team of Dr. Walt Woolbaugh, Robyn Gotz and Amanda Mello handed out support, kind encouragement, and their expertise along the way. Finally, I am so grateful to my husband for his continued love, support, and patience as I pursue this goal.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND	1
Context of the Study	1
Focus Questions	2
2. CONCEPTUAL FRAMEWORK	3
Introduction and Background.....	3
Urgency and Why Teaching Climate Change is Important	4
Pedagogy for Teaching Climate Change	7
Engagement Strategies and Action Projects	9
Conclusion and Hope.....	11
3. METHODOLOGY.....	14
Treatment	14
4. DATA ANALYSIS.....	18
Organization of Data.....	18
5. CLAIM, EVIDENCE, AND REASONING.....	26
Pre- and Post-Survey Analysis.....	26
Opportunity for Further Study	32
Value and Impact of Action Research on Author	32
REFERENCES CITED.....	35
APPENDICES	38
APPENDIX A: Montana State Science Standards Related to Climate Change	39
APPENDIX B: Investigation: Climate Change Solutions and Rubric	42
APPENDIX C: Climate Action Project Plan	45
APPENDIX D: Climate Action Project Examples	47
APPENDIX E: Climate Action Project Reflection.....	49
APPENDIX F: Focus Group Questions and Responses	51
APPENDIX G: Pre- and Post-survey	54
APPENDIX H: Institutional Review Board Exemption.....	57

LIST OF TABLES

Table	Page
1. Data Collection Matrix.....	16
2. Student Understanding of the Difference between Climate and Weather	19
3. McNemar's Test Applied to Student Responses	19
4. Terms and Phrases Used to Complete the Sentence	30

LIST OF FIGURES

Figure	Page
1. Student Understandings of the Trend of Climate Change.....	20
2. Student Understandings of the Cause of Climate Change.....	21
3. Student Understandings of Who is Affected by Climate Change.....	22
4. Student Perceptions About Climate Change.....	23
5. Student Levels of Interest in Taking Action Regarding Climate Change	24

ABSTRACT

I recognized I have avoided teaching climate change as an entire unit due to the uncomfortable nature of the subject and the fear of push-back from both students and parents. I also recognized the students in my district have had little to no exposure to climate science in any curriculum and understand that, if our goal is to support scientific literacy in our students, climate literacy needs to be a part of the program. I developed a climate science unit for four physical science classes which included the science behind climate change, investigations into climate solutions and participation in climate action projects. Research has shown that participation in climate action helps to improve attitudes regarding climate change. I wanted to find out how student understandings and perspectives about climate change might improve following the implementation of the unit. Students took pre- and post-surveys regarding their understanding of climate trends, cause and effects of climate change, their own perspectives of climate change, and their levels of interest in taking action regarding climate change. Other data was collected through pre- and post-focus group interviews, student reflections to prompts at different stages of the unit development, teacher journaling and communication with a collaborating teacher. Overall, student responses from the surveys, interviews, and reflections showed an increased understanding and appreciation for the impacts of climate change. A notable improvement was seen in the number of students who understood that current global climate change is not caused by natural processes. A second notable improvement was in the number of students who felt empowered to take actions to help reduce climate change. It is difficult to determine the impact that participating in the climate action projects alone had on student attitudes about climate change, but the gains I saw give me encouragement to incorporate this unit into my curriculum and to share what I have learned with colleagues to develop a cross-curricular approach to global climate change.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of the Study

Libby Middle High School is located in Lincoln County Montana which is in the far Northwest corner of the state. Libby is a historical logging and mining community. Today those industries make up only 8.5% of the employment while the fields of education, health care and social assistance make up the highest employment sector at 18.7% (U.S. 2020 Census). According to the U.S. Census Bureau (2020) the median household income in Libby is \$41,429 with a poverty level of 14.5%. The percentage of the population with a bachelor's degree or higher is 16.4% (U.S. 2020 Census). Libby Middle High School has an enrollment of 529 students in grades seven through twelve. The percentage of students who qualify for free and reduced lunch is 50% of the school population.

A number of years ago the high school booster club sold t-shirts with "Loggers" and a tree stump on the front with "Don't worry, I hugged it first" written on the back. Such was the response towards anything related or perceived as an environmental sentiment. In 2020 Donald Trump received 78.8% of the vote in Lincoln County (Politico, 2020). These demographics help to explain the culture of our community especially in a time when particular science topics have become so political. Teaching science in a strongly conservative community has been challenging, especially during and following the COVID-19 pandemic. My experience has bolstered my resolve to give my students tools they can use to face future challenges. I hope to build their understanding that science and scientific information is based on the best available data and not on politics or any belief system.

My goal as a science teacher is to help my students become scientifically literate. With a changing climate and its impact on our planet, scientific literacy must include climate literacy. I have taught climate change in parts and pieces in different units such as the carbon cycle in biology class and energy sources in physical science but not as an entire, focused unit. My students need to understand not only the science behind climate change but what is being done and can be done to help slow climate change and/or lessen its impact. Students also need to feel a sense of hope which I attempted to promote through their participation in a climate action project.

Focus Questions

My main research question was, How does participation in a climate change unit incorporating solutions and action projects affect students' understanding of, and perceptions about, climate change?

My sub-questions include:

1. How does participation in action projects affect a student's perception about their future with regard to climate change?
2. Will students be motivated to continue their action project or other activities following the completion of this unit?
3. What are the challenges and successes experienced by the teacher throughout the treatment and upon completion of the unit on climate change?

CHAPTER TWO

CONCEPTUAL FRAMEWORK

Introduction and Background

Covering climate change in the classroom is both urgent and difficult. While students need to learn the basics of climate science which, by its nature, is scary, they also must envision hope for their future by learning that there are things that can be and are being done to help mitigate the impact of climate change. I have found it all too easy to shy away from controversial topics but cannot shy away from the climate crisis because I understand the current and future impacts it is having on living things on our planet. I wanted to put together a climate change unit for my high school students that covers the basics but also builds hope through a solutions and action-based approach. For this review I have looked at literature that supports the various aspects of my intended project. Although the basics of climate science are insufficiently covered in our classroom texts, current climate science information is readily available in a variety of sources. This literature review covers three areas: 1) the urgency of climate literacy and why teaching climate change is important, 2) pedagogy for teaching climate change, and 3) ways to engage students through action projects.

Urgency and Why Teaching Climate Change is Important

The urgency of teaching climate change varies according to several factors including the following: what media platforms a person pays attention to, one's political leanings, geography, level of education and other personal experiences. As a science teacher, I find the data that has been collected by scientists highly credible and understand the urgency the data demands. Evidence of the urgency of climate change is readily available to anyone who looks. Climate change is costing us money, has a disproportional effect on people with the least resources across the globe and will continue to have a lethal impact on the most vulnerable and least resilient (NOAA, 2023; IPCC, 2023). According to the National Oceanic and Atmospheric Administration (2023), from 2005 through 2019 in the United States there were 156 separate weather or climate disasters costing a combined \$1.16 trillion. In the latest report submitted by the Intergovernmental Panel on Climate Change (IPCC) in March of 2023, we have reached an increase of 1.1⁰C above pre-industrial temperatures. One of the IPCC authors, Aditi Mukherji, urges that "Climate justice is crucial because those who have contributed least to climate change are being disproportionately affected" (IPCC, 2023, p.1). Yoshi Shimizu says the World Health Organization predicts that "between 2030 and 2050, climate change [will] cause approximately 250,000 additional deaths per year from malnutrition, malaria, diarrhea and heat stress alone" (Shimizu, 2023, p. 1).

Young people are recognizing and feeling the impact of climate change. According to a Lancet survey completed in December of 2021, out of 10,000 children surveyed in ten countries, 59% of all respondents were very or extremely worried and an additional 25% were at least moderately worried about climate change (Hickman et al., 2021). In the Philippines, 45% of the one thousand young people surveyed were moderately to very worried and 49% were extremely

worried about climate change. Comparatively, in the United States, 56% of the one thousand surveyed were moderately to very worried while only 19% were extremely worried about climate change. At the same time, according to an article written by Renee Cho (2023) for the Columbia Climate School, a UNESCO study found that less than half of 50 countries surveyed made any mention of climate change in their educational policies. Seventy percent of the youth from this same UNESCO study of 17,500 young people from 33 countries said that they “cannot explain, can only explain the broad principles, or do not know anything about climate change ” (UNESCO, 2022, p. 6).

I am encouraged by the efforts of the authors of the Next Generation Science Standards (NGSS) which has included language recognizing the human impact on global climate (NGSS 2013). Montana science standards do closely align to the NGSS (Appendix A). I am dismayed however, that one of the performance expectations left out of the Montana standards was HS-ESS3-6 along with the related disciplinary core ideas (ESS2.D and ESS3.D) (Office of Public Instruction, Montana, 2023):

HS-ESS3-6 Use computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

ESS2.D Weather and Climate... The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year...

ESS3.D Global Climate Change...Important discoveries are still being made about how the ocean, atmosphere and biosphere interact and are modified in response to human activities.

Montana’s omission of an anthropological cause for climate change was accounted for in the report by the National Center for Science Education and the Texas Freedom Network

Education fund “Making the Grade” that came out in 2020. Montana scored a “C” grade because, although it managed to address the reality of climate change, it failed to “connect the dots to anthropogenic climate, the seriousness of anthropogenic climate, or a solution-based skill set.” (NCSE, 2020, p.16). This omission may allow teachers to avoid potential controversy at the price of doing a disservice to our students. If we ignore that climate change is anthropogenic then there is less reason to think we can do anything to slow down its impact (the solution-based skill set). We need our young people to have the information and tools to make informed decisions. We need a scientifically literate society. None of the six science textbooks currently being used at Libby Middle High School come close to meeting the NGSS on climate change. The National Science Teaching Association, as part of its position statement, *The Teaching of Climate Science*, put a team together that wrote *An Exploration of Ideas Related to the Understanding and Teaching of Climate Science and Climate Change* in 2018. In this document they state, “Even if we are successful in achieving enough climate change mitigation, education must also play a vital role in helping citizens adapt by building their knowledge and skills and changing behaviors in ways that enable society to reduce its vulnerability to impacts that are now inevitable” (Pyle et al., 2018, p. 12). The warning signs are clear and visible to anyone paying attention. We need to prepare our students for the immediate future, not only for their adult future.

Pedagogy for Teaching Climate Change

A common theme in the literature reviewed for this project involved the necessity for curriculum integration between teachers, acknowledging the emotional aspect of climate change, and the empowerment of action projects. Climate change is not isolated as a scientific endeavor but impacts all aspects of society. Climate change education should be a combined effort between science teachers and social studies teachers, at least. This can happen. New Jersey schools, for example, are required to teach climate change across all subjects at all grade levels (Cho, 2023). Students (and people of all ages) are more likely to act on climate change if they have a sense of hope. These aspects of teaching climate change - curriculum integration, action projects and communicating hope - are the focus of the following reviews.

Ajay Sharma from the University of Georgia argues that “global climate change is primarily a societal issue that needs a societal response much more than a technological one” (Sharma, 2011, p.33). In his paper *Global Climate Change: What has Science Education Got to Do with it?* Sharma works to “re-envision science education for the global climate change era” (Sharma, 2011, p. 35). He first discusses why science education matters, referring to studies by the Fourth Assessment Report of the IPCC focusing on risks and impacts. Next, he explains the social origins of global climate change as being capitalistic in nature. Then, he addresses meeting the challenge of global climate change through technology and education. He argues that science literacy is linked to learning socially relevant science which includes eco-justice, place-based education, and socio-scientific issues. He suggests that science education about global climate change have a sustainability science orientation which would involve ecosystem energetics, biochemical cycles, and links between social and natural systems. Curriculum integration would be necessary to accomplish these tasks. Finally, Sharma calls for including environmental action

as a part of science education. Environmental action needs to be presented as: “Action that can be initiated by ordinary citizens. Action that is both local and global. Action that needs to be both individual and collective” (Sharma, 2011, p. 48). This holistic approach is powerful and was incorporated into my action project, in part by coordinating with the geography teacher who emphasized the global impact of climate change in her classes.

People have different ways of coping when faced with a crisis like climate change. How they cope is affected by the degree of hope they feel. Maria Ojala (2012) describes two types of hope people may feel about climate change. Constructive hope is based on trust that people can and will work to reduce the impact of climate change. Hope based on denial occurs when someone is hopeful because they do not think that climate change is as big of a problem as scientists claim (Ojala, 2012a). How teachers communicate climate change to their students can impact their level of hope and optimism and the way they cope with the crisis (Ojala, 2015). When teachers used a gloom and doom approach to the subject of climate change students experienced hope based on denial, whereas, if the teachers approached climate change with a focus on solutions, students showed more hope that led to a more positive approach and to pro-environmental behaviors. Maria Ojala (2012b) offers meaning-focused coping as the most effective way to tackle the climate crisis. In meaning-focused coping the gravity of the situation is understood and acknowledged but then the crisis is reframed in a positive way to find meaning in the struggle. This coping mechanism offers more hope which is correlated with working to find solutions and take action. Maria Ojala and Hans Bengtsson (2019) did a survey study that involved 702 students from 32 different schools in Sweden. Their study found that “problem-focused coping—that is, searching for information and making plans about what an individual can do about climate change—and meaning-focused coping—that is, having the ability to switch

perspectives and see both negative and positive trends, and putting trust in other societal actors—are positively related to pro-environmental behavior” (Ojala & Bengtsson, 2019, p. 925). The emotional aspect of climate change needs to be acknowledged and addressed in the classroom. Teachers need to present the subject of climate change as solution-focused to offer hope and support their students in meaningful and empowering action projects.

Engagement Strategies and Action Projects

It is well established that action projects do increase engagement and improve attitudes about science in general. I am looking for activities and action projects that will specifically enhance students’ knowledge of climate science as well as increase their level of hope for the future. Giving students knowledge to carry forward into their adult life when they will be making decisions about climate policies is not enough. The urgency of this global climate crisis demands a societal transformation towards ecological sustainability beginning now, not at some abstract future time. Students need to know that they have a voice, that they can make a difference now. I have looked at two papers that describe action and action research projects carried out by high school students as that is the age group I am working with.

The first publication is a master’s thesis by Sally Elizabeth Neas completed in 2019. She worked with students at a boarding school in Northern California. The students piloted a curriculum that introduced the basics of climate change but also included topics such as climate justice, mitigation strategies, and case studies of community adaptation projects (Neas, 2019). The students produced three- to five-minute-long digital stories with the prompt “to produce a film that they thought would inspire others to take action on climate change.” The students selected some of their films to be shown to larger audiences in other high schools and made them available on YouTube. Ms. Neas measured the development of positive affect towards climate

change by asking students to list three to five words that describe how they feel about climate change both before and after completing the program. Forty-five students participated in the survey. Following the program there was an increase in the number of positive words used increasing from 15% to 38%. The number of students who were able to list at least one positive word also increased from 27% to 64% (Neas, 2019). There are several ideas that appeal to me about this project. First of all, I like the idea of using the 3-5 words to describe their feelings about climate change. I also conducted a pre-survey and post-survey and collected additional information but I like the idea of incorporating this word list. It would be one way to assess the effectiveness of the program. Secondly, the chance to share their thoughts, feelings and knowledge with others allows students to participate in a solutions-based project where they can make a difference.

The second publication looks at the master's action research project completed by Erin Anna Quintia in 2011. Quintia's goal was to incorporate environmental education in her biology and integrated science curriculums and help students develop skills for action. After the students worked through the basics of climate change, they participated in a variety of activities and action projects. The activities involved exploring personal interviews and stories of people from around the world giving their climate change perspectives. Action projects involved reducing solid waste. The solid waste project had students looking at the daily amount and type of waste at school as well as at their home. The climate change action project focused on a variety of actions that could be taken to reduce their carbon footprint. Quintia's findings were somewhat mixed. Her data did not show a significant change in her students' attitudes toward the environment. Although only 35% of her approximately 60 students completed the action projects at home, her data did show a positive effect on the environmental behaviors of the participating students. One

positive outcome of the overall project was the reduced use of Styrofoam cafeteria trays by both the students and other staff members. Regrettably, she notes that not all the parents were supportive of their students' climate change action projects. The lack of support at home may have been a factor in the low completion rate among her students. This is a phenomenon I am all too familiar with in my community. I am sure some of my students may have little support from home, which may have influenced their degree of buy-in to any portion of the unit. The action projects Quintia implemented are certainly ones I consider adding to my toolbox. Whereas Quintia designed specific projects for the students to complete, I like the idea of giving students the opportunity to design and/or choose their own projects.

Conclusion and Hope

In reviewing the literature supporting why teaching climate change is important, I found the disparity in urgency felt by students in the United States compared to those in other countries like the Philippines striking, although not completely surprising (Hickman et al., 2021). I am both discouraged and empowered by the discovery that Montana's state science standards fail to include the seriousness of the anthropogenic causes for climate change (NCSE, 2020). The feeling of discouragement stems from knowing that teachers across the state have less incentive to teach the full story of climate change which will leave a large part of our student population without the necessary information to tackle the issue. (Of course, I do not really have a sense for how many teachers across the state are addressing climate change in any form.) I am empowered to make sure that my students leave my classroom at least having been exposed to the scientific data showing anthropogenic cause for climate change.

Ajay Sharma (2011) makes a strong and logical case for using an integrated curriculum approach to climate change. He also calls for the environmental action projects to be both local

and global, both individual and collective, as this is what it will take to make a difference.

Having students design action projects that could meet these standards would be ideal but I know that I will need to start a bit smaller. I am inspired and excited to coordinate with other teachers regarding the students' action projects.

Maria Ojala's studies on coping mechanisms (Ojala, 2012b, 2015, 2019) were not something I originally had on my radar. Reading about her studies significantly reshaped my thoughts on teaching climate change. I want to read more about her work and figure out how I can incorporate coping mechanisms in the discussion of climate change in my classroom. My initial thoughts are that identifying these different coping strategies with my students would be a helpful way to recognize the importance of the emotional aspects of climate change and be able to move forward. Perhaps more students could adopt a meaning-focused coping mechanism if they understood the power it holds. My goal is that my students will have or will develop a sense of hope about their future. Productive ways of coping will help them find that hope.

The action projects such as the digital stories of Neas (2019), solid waste and climate change action projects of Quintia (2011), have also been added to my resources. I especially like the idea of the students making digital stories or media of some sort that can be shared with other students, community members and/or groups like the school board which could be very powerful. Students need to have their voice be heard. Sharing their ideas on how to reduce their individual carbon footprint or the carbon footprint of our school or community could also be meaningful.

CHAPTER THREE

METHODOLOGY

Treatment

The participants in this study were students enrolled in my four physical science classes. The students included 83 freshmen, seven sophomores, and one junior. Six of the sophomores were taking the course for the second time. One sophomore and the junior were transfer students taking the course because they needed the credit to graduate. The Likert survey data used for this study is limited to 79 students who took both the pre- and post-survey. The treatment of this action research project was a climate change unit completed in three phases: 1) instructional background on the basics of climate science, 2) a short research investigation on a climate change solution or mitigation and how climate change is affecting people worldwide, 3) completion of a climate action project.

During the instructional phase students participated in interactive lecture, notes and activities focusing on the following elements:

- Differentiating between weather and climate
- Photosynthesis, respiration, and the carbon cycle
- Earth's energy budget
- History and timeline of climate science
- How we know what we know about Earth's climate trends and data collection

During the mini research phase, the students chose a solution from Project Drawdown's table of solutions at their website to research and report on (Project Drawdown, 2023) (Appendix B). Simultaneously, in their geography classes, as part of a collaborative cross-curricular activity,

students reviewed climate change stories and reported to their classmates how climate change is affecting people around the world.

The final phase of the treatment involved the students planning and carrying out a climate action project (Appendix C). Students worked individually or in groups of two or three to complete their projects. Students were given five weeks to complete their projects. The projects included making posters to hang up around the school building, creating a children's story book and reading it to students in an elementary classroom, and working with the school administration to improve the school's recycling program. Several students did home research projects such as starting a composting bin, looking at their electric bill before and after implementing energy saving activities in the home, and analyzing how recycling more consistently would reduce the amount of household waste. (For a complete list of projects see Appendix D). After completing their projects, the students reflected on their learning and success in a written assessment (Appendix E).

Instrumentation

Before, during and following the climate science unit I collected data to assess students' understandings, feelings, and attitudes about global climate change. Prior to the climate science instructional phase, a randomized group of six students took part in a focus group. To select the randomized group students' names were grouped by classroom grade percentages and three were chosen from each percentage level. The six students in the focus group were the students from this randomly selected list who agreed to be part of the group. The questions asked during the focus group are given in Appendix F. Following the focus group interview all students in four physical science classes completed the pre-survey (Appendix G). Following the action project phase students completed the post-survey and I conducted a post-interview with my focus group

students. The early data collection pieces were compared to the same pieces done at the end of the treatment. I used a variety of sources to assess the research questions (Table 1).

Table 1. Data triangulation matrix.

Research Questions	Pre survey	Pre-Interview	Student work	Post survey	Post Interview	Teacher Journal
Primary Question: 1. How does participation in a climate change unit incorporating solutions and action projects affect students' understanding of, and perspective about, climate change?	✓	✓	✓	✓	✓	✓
Sub Questions: 1. How does participation in action projects affect students' perspective about their future with regard to climate change?	✓	✓	✓	✓	✓	✓
2. Will students be motivated to continue their action project or other activities following the completion of this unit?			✓	✓	✓	✓
3. What are the challenges and successes experienced by the teacher during and following the treatment?		✓	✓	✓	✓	✓

The pre- and post-surveys were identical and Likert in style to gauge students' feelings and attitudes about global climate change. Two colleagues previewed the survey and offered suggestions. One of the colleagues was the geography teacher with whom I collaborated. I added new questions to the post interview that were not in the pre interview to gain an understanding of the students' feelings and attitudes about their action projects. Throughout the treatment I collected student work that would help me determine their understandings of climate

science concepts and kept a journal of my own challenges and successes throughout the treatment. The treatment was completed as part of routine classroom activities and assessment. This project received IRB approval which can be accessed in Appendix H.

CHAPTER FOUR

DATA AND ANALYSIS

Organization of Data

This analysis includes data collected on pre- and post-surveys completed by seventy-nine students in four physical science classes. The pre-survey included a Likert survey where students chose from the responses of ‘strongly agree, agree, disagree, strongly disagree or other.’ If students chose ‘other’ they were asked to explain why (Appendix G). The pre-survey also asked students to complete the sentence, “Climate change makes me feel...” (Table 6). I have grouped student responses into the following categories:

1. Understandings of the difference between climate and weather
2. Understandings of climate change trends
3. Understandings about the cause of climate change
4. Understandings of who is affected by climate change
5. Students’ own perceptions about climate change
6. Level of interest in taking part in actions to reduce the effects of climate change

The first question on the survey was a multiple-choice question designed to assess students’ understanding of the difference between climate and weather (Table 2).

Table 2. Student understanding of the difference between climate and weather, (N=79).

Multiple Choice	% Pre	% Post
Climate is a long-term average of changes in the atmosphere while weather is day to day changes.	77	92
Climate is seasonal change while weather is day to day differences.	23	8
There really is no difference between weather and climate	0	0
	100.0%	100.0%

The percentage of students who correctly understand that climate is a long-term average of changes in the earth's atmosphere while weather is day to day changes improved from 77% on the pre-survey to 92% on the post-survey. McNemar' test (Table 3) for a significant change in responses pre and post treatment showed a significant difference in student responses. Applying the McNemar exact p-value binomial test results in a p-value of 0.17 (Szczepanek, 2024). Therefore, the null hypothesis that the treatment (participation in the climate science unit) will have no effect on the proportion of students with the correct response, is rejected at the 5% significance level.

Table 3. McNemar's test applied to student responses to the difference between climate and weather, (N=79).

	Post-survey Correct Responses	Post-survey Incorrect Responses	Sum
Pre-survey Correct Responses	56	5	61
Pre-survey Incorrect Responses	17	1	18
Sum	73	6	<i>N</i> = 79

The first group of Likert survey questions looked at student understanding of the cause and trend of climate change as seen in Figure 1 below.

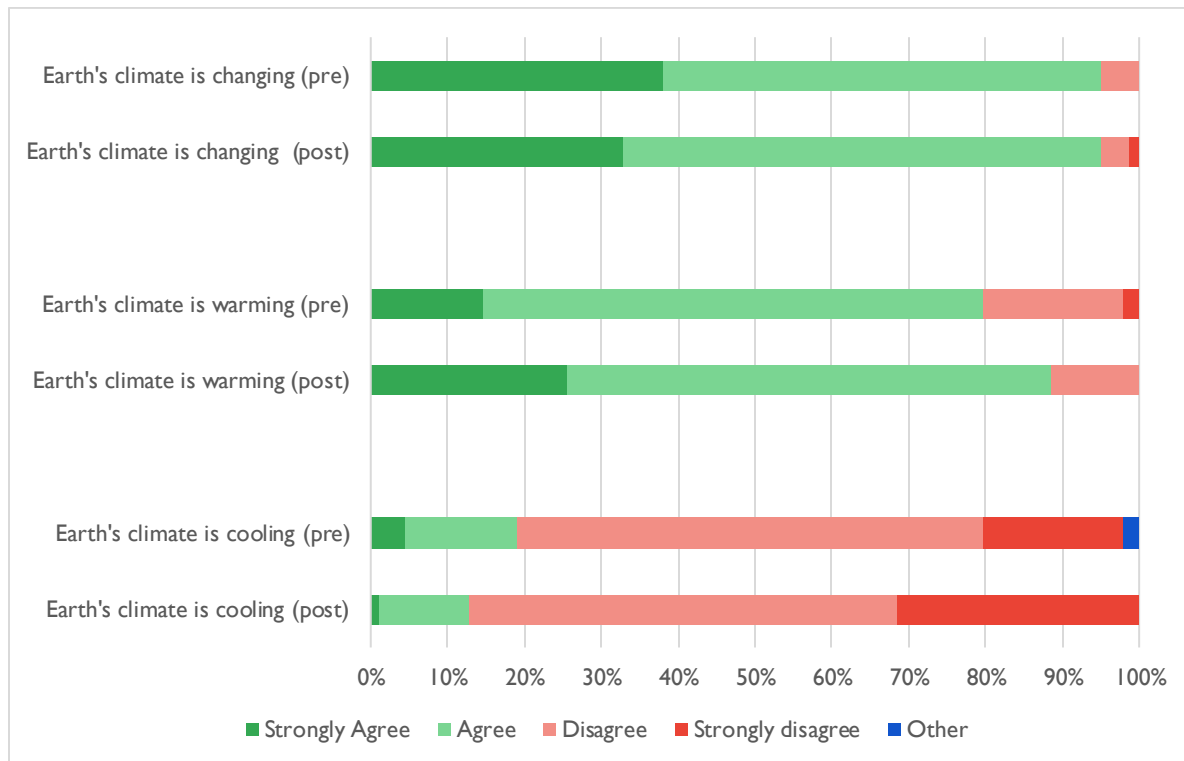


Figure 1. Student understanding of the trend of climate change, ($N=79$).

Regarding students' understanding of the trend of climate change there was not a big change from pre- to post-survey responses. Over 90% of students on both pre- and post-surveys strongly agree or agree (SA/A) that the climate is changing. The number of students who agree (SA/A) that the climate is warming increased from 80% to 88% on the post-survey while the number of students who strongly agree or agree that the Earth is cooling dropped by 7%. Interestingly, five students who chose SA/A on "Earth's climate is warming" also chose SA/A for "Earth's climate is cooling" suggesting that there are outliers embedded in the data.

Figure 2 looks at student understandings of the cause of climate change.

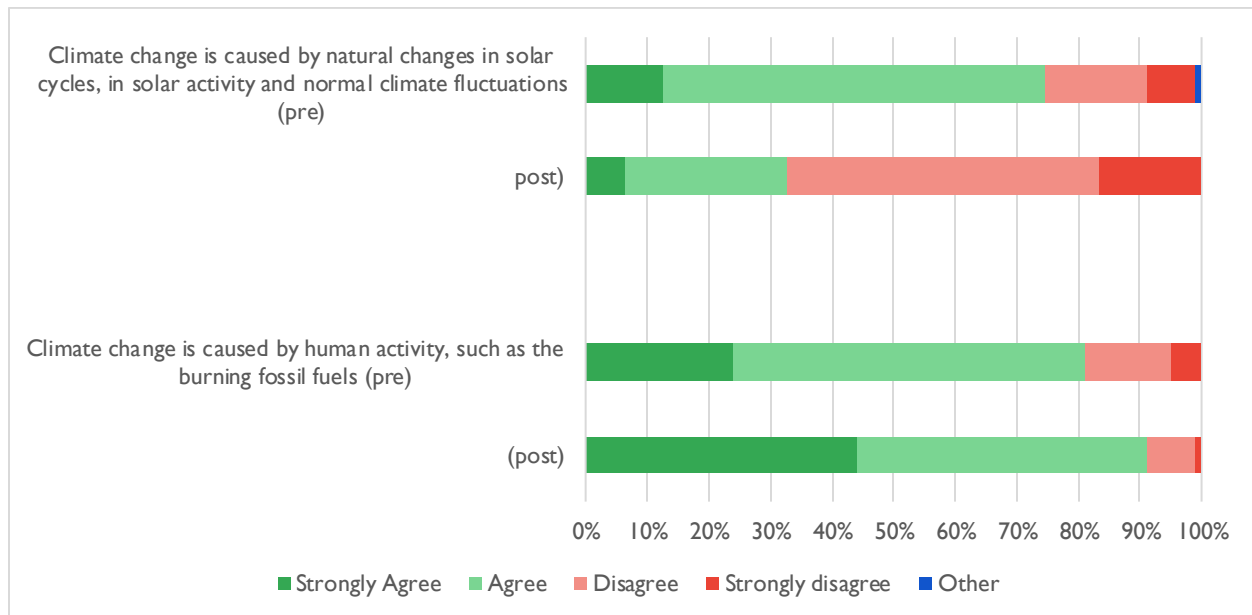


Figure 2. Student understandings of the cause of climate change, ($N=79$).

From pre- to post-survey there was an increase in the understanding of the cause of climate change. While a majority of the students (75%) said that climate change was caused by natural changes on the pre-survey only 33% chose SA/A for this statement on the post-survey. On the pre-survey a majority of the students (81%) also chose SA/A for the statement “Climate change is caused by human activity...” suggesting that a number of students felt that climate change could be attributed to both natural and human causes. On the post-survey, while 91% of the students agreed (SA/A) that climate change was caused by human activity, 33% still agreed (SA/A) that climate change was due to natural causes. Because I did not use the term *only* in my statements for the causes of climate change it was reasonable for the students to agree with both options.

Figure 3 shows the student responses to how climate change affects different groups of people.

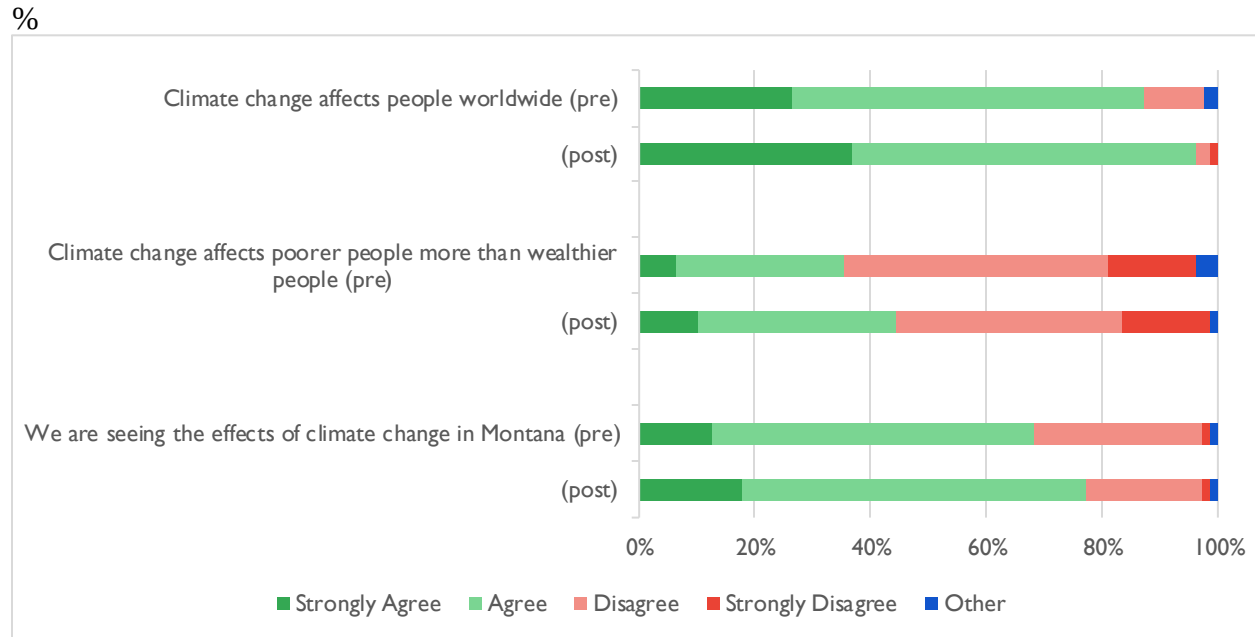


Figure 3. Student understandings of who is affected by climate change, (N=79).

The results for the questions regarding student understandings of who is affected by climate change did not vary widely between the pre- and post-surveys with only slight gains in understandings. On the post-survey 96% of students agreed (SA/A) that climate change is affecting people worldwide which was a gain of 9% over the pre-survey responses. Seventy-seven percent of the students agreed (SA/A) that we are seeing the effects of climate change in Montana which is a 9% gain in understanding. Finally, on the post-survey, only 44% of the students agreed that climate change affects poorer people more than wealthier people. This was an increase of 11.6%. Three students who chose ‘other’ gave responses such as “I don’t have enough knowledge to truly know.” The slight increase (9%) in the number of students who agreed (SA/A) that they are seeing the effects of climate change in Montana may be attributed to activities done in class.

Figure 4 shows the results from student responses identifying their perceptions about climate change on the pre- and post-surveys.

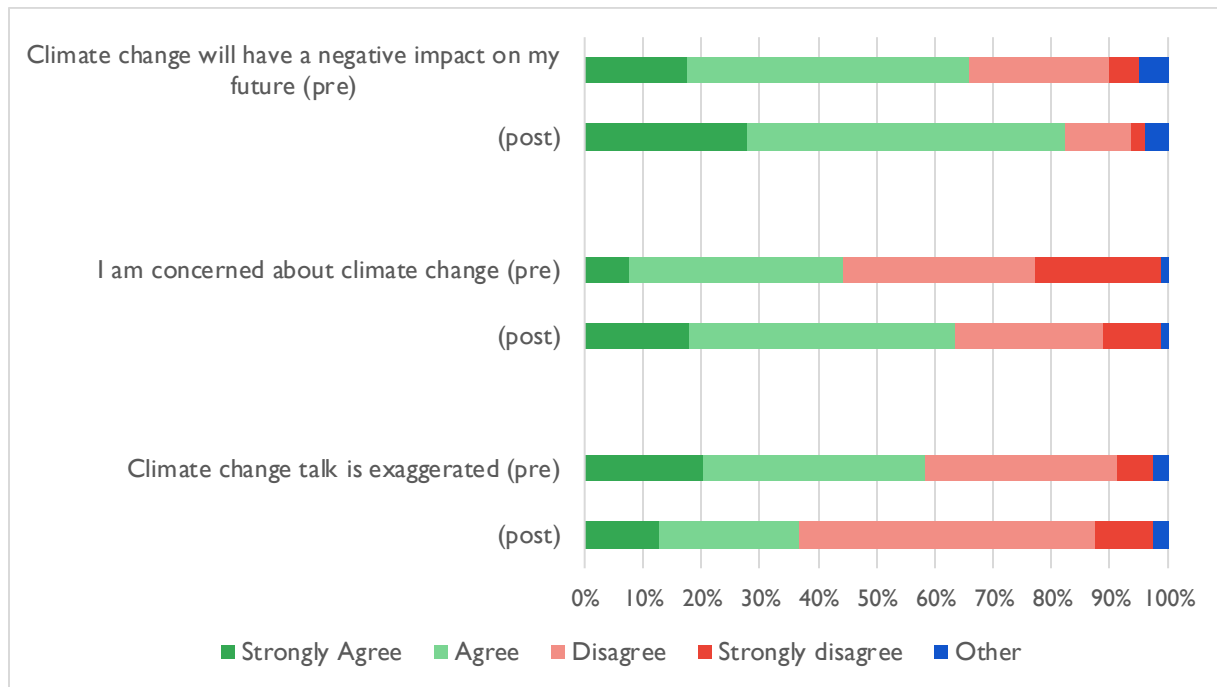


Figure 4. Student perceptions about climate change, (N=79).

Student perceptions about climate change varied slightly on the post-survey as compared to the pre-survey. Eighty-two percent of students agreed (SA/A) that climate change would have a negative impact on their future compared to 66% on the pre-survey. On the pre-survey students' concerns about climate change leaned slightly towards disagree or strongly disagree (D/SD) with 56% disagreeing (D/SD) to "I am concerned about climate change." Students who chose 'other' responded with, "I can't tell how bad it will be in the future." Another student responded with, "I think climate change will have an affect [sic] but we will learn to cope with it." On the post-survey the percentage of students who chose SA/A to being concerned about climate change increased by 13%. Fewer students felt that "climate change talk is exaggerated" with the percentage of SA/A responses decreasing from over 58% to 37% on the post-survey.

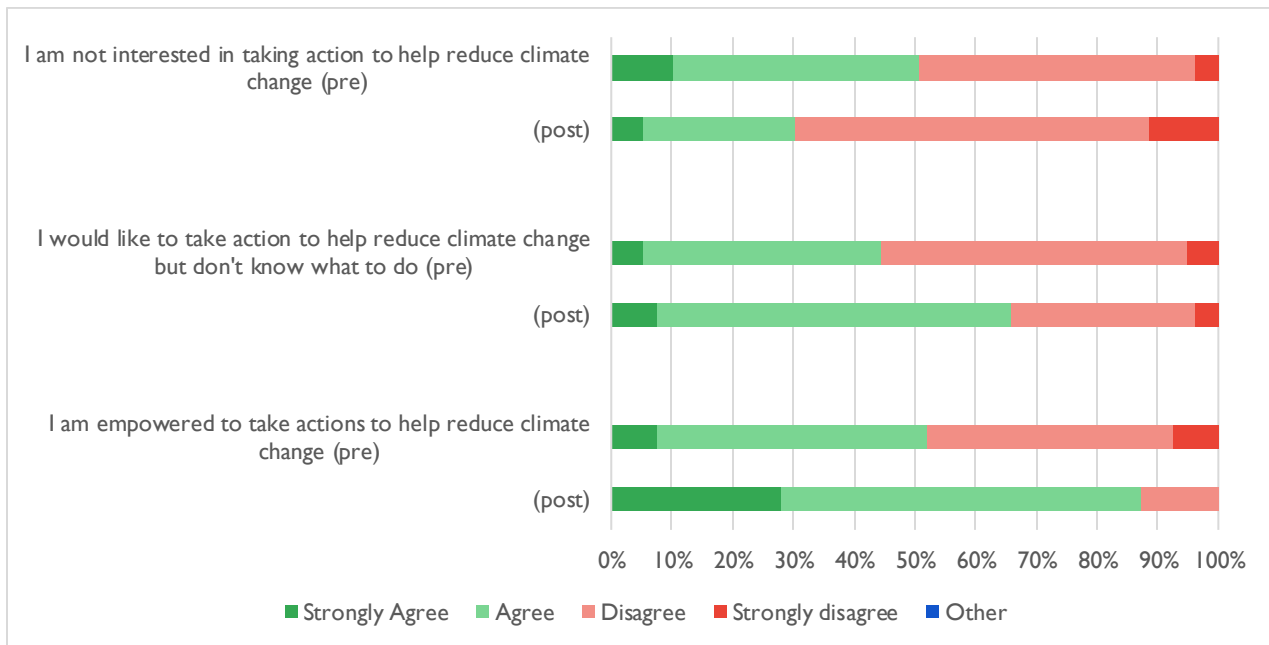


Figure 5. Student levels of interest in taking action regarding climate change, (N=79).

A close look at the questions in Figure 5 reveals some interesting information. For these three questions I have grouped the students into three categories: 1) those who are interested in taking action to reduce climate change, 2) students who are not interested in taking action to reduce climate change, and 3) students who are confused. On the pre-survey, 35 students fall into the group #1 having selected strongly agree or agree (SA/A) for being “empowered to take action” and/or “would like to take action but they don’t know what to do,” while selecting disagree or strongly disagree (D/SD) for “I am not interested in taking action to reduce climate change.” Twenty-five students fall into group #2 having selected D/SD for the questions about being “empowered to take action” and/or “would like to take action but don’t know what to do,” while selecting SA/A for “I am not interested in taking action.” Twenty-two students fall into the ‘confused’ category having selected either SA/A or D/SD for both being “empowered to take action” or “would like to take action” and “I am not interested in taking action to reduce climate change” which seems contradictory. I wonder if they were confused, did not read the questions

carefully, were just careless, or actually felt empowered but still were not interested in taking action.

There seemed to be less confusion on the post-survey with student responses being more consistent across the three questions. Overall, the responses suggest that students have an increased interest in taking action to help reduce climate change. The percentage of students who responded that they were empowered to take actions to help reduce climate change increased from 52% (SA/A) on the pre-survey to 87% (SA/A) on the post-survey.

CHAPTER FIVE

CLAIM, EVIDENCE AND REASONING

Pre- and Post-Survey Analysis

To answer my main research question - How does participation in a climate change unit incorporating solutions and action projects affect students' understanding of, and perceptions about, climate change? – I looked at the survey responses, focus group responses, and the teacher notes taken throughout the climate science unit.

The following analysis looks at the responses to the survey questions broken down into categories: understandings of climate vs weather, understandings of the cause of climate change, understandings about who is affected by climate change, students' perceptions about climate change and climate action, and finally, terms and phrases used to complete the sentence, "Climate change makes me feel..."

The first multiple choice question on the survey determines the level of students' understanding between climate and weather. On the pre-survey all the students correctly understood there is a difference between climate and weather, 23% of the students held the misunderstanding that climate is a seasonal change. Seventy-one of the 79 students are also currently taking geography in which the topic of climate was recently covered. Six of the eight upper classmen who are not currently taking geography chose "Climate is a long-term average of changes in the atmosphere while weather is day to day changes." The post-survey shows an increase in understanding with an additional 15% of the students choosing "Climate is a long-term average of changes in the atmosphere while weather is day to day changes" over "Climate is seasonal change while weather is day to day differences." Curiously, five students who had the

correct answer on the pre-survey chose the incorrect answer on the post-survey. While most students were already aware of the difference between climate and weather, the reinforcement of that concept likely helped to improve understanding.

There was not much difference between the pre- and post-survey responses on the concept involving the trend of climate change. Most students were already aware of the global warming trend. Understandings of the causes of climate change did see an increase in understanding. Ninety-one percent of the students on the post-survey agreed (SA/A) that climate change was caused by human activity: a 10% increase over the pre-survey responses. Within this 10% increase there was an increase of 20% in students who chose “strongly agree” to the statement. There were still a number of students who chose both causes (natural and human activity) possibly because the wording of the survey statements gave them the option to do so.

Looking at the understanding of who is being affected by climate change, the percentage of students who agreed (SA/A) that climate change affects people worldwide increased by 9% on the post-survey to 96%. Even after participating in a climate story activity that involved looking at how climate is affecting people in different parts of the world, only 44% of the students understand that climate change is affecting poorer people more than wealthier people. Interestingly, on the post-survey 77% of the students agreed (SA/A) that we are seeing the effects of climate change in Montana which was an 11% increase over the pre-survey. Other than an increase in temperature I am unaware of any noticeable climate change impacts in Montana and am curious as to what effects they are thinking about. Students may have picked up information from the climate change stories they researched in their geography classes and from the investigation into the *Held vs Montana* lawsuit (Jullin, 2024). The stories researched in geography class included narratives from people who live in Montana and other places around

the world explaining how climate change was impacting their lives. I was hoping that the experiences and activities in the climate science unit and their geography classes might improve students' world view of the effects of climate change to a greater degree.

My first sub question was how participation in action projects would affect student perspectives about their future. Regarding students' perceptions about climate change and their future there was not a large difference in the pre- and post-survey responses to the statements "climate change will have a negative impact on my future" and "I am concerned about climate change." Although the concern increased slightly (13%) this suggests that participation in the climate science unit did not alter student perceptions very much. Interestingly, 22 of the 46 students who suggested they are not concerned about climate change, also feel that climate change will have a negative impact on their future. I would like to find out what these 22 students are thinking. It might be that even if they feel that climate change is going to negatively impact their future they are not worried about it. I wonder if this might be an example of Maria Ojala's 'constructive hope scale' which suggests that, although there is cause for concern the students have hope that something can be done about it (Ojala, 2012a).

On the post-survey the percentage of students who responded that they were empowered to take actions to help reduce climate change (SA/A) increased by 35% from the pre-survey to 87%. I suspect that the increase may have been due to several factors. Following the implementation of the climate science unit students likely had a clearer idea of what "take actions" involved. I would like to think that actually doing an action project themselves may have increased their empowerment but cannot measure this with fidelity. I also wonder how many students, throughout the entire survey, were answering questions honestly or were answering with what they thought I wanted to see.

It is interesting to compare the responses of individual students who chose SA/A for “Climate change talk is exaggerated” with the same students’ responses to the statement “I am empowered to take actions to help reduce climate change.” As expected, most of the students who chose ‘disagree’ or ‘strongly disagree’ (D/SD) for “Climate change talk is exaggerated” chose SA/A for “I am empowered to take actions to help reduce climate change.” I would have expected students who chose SA/A for “Climate change talk is exaggerated” to have less incentive to do any action to help reduce climate change. However, a majority of the students who chose SA/A for “Climate change is exaggerated” also indicated they were empowered to do something to reduce climate change. It gives me hope that students may feel empowered to take action even if they feel that climate change talk is exaggerated.

Prior to implementation of the climate science unit, the terms and phrases students used to complete the sentence, “Climate change makes me feel...” split fairly evenly into two categories labeled “concerned/worried” and “indifferent/disinterested” with eight responses in a third category categorized as “empowered” (Table 4). Post-treatment many responses shifted from the “indifferent/disinterested” category to the “concerned/worried” category with fewer comments I would consider as glib. The number of responses that fit into the “empowered” category increased. Because students had not been exposed to much, if any, climate science in their school career prior to this unit, I hypothesize that the student responses to the pre-survey statements were based largely on conversations and attitudes from people in their home and social environment. It is hard to know what aspect of the climate science unit or activities shifted student responses to the prompt.

Table 4. Terms and phrases used to complete the sentence, “*Climate change makes me feel...*” The number of students with similar responses is given for both pre- and post-surveys. Pre-survey ($N=77$) and post-survey ($N=75$).

Concerned/Worried	Pre (n=37)	Post (n=49)	Indifferent/Disinterested	Pre (n=33)	Post (n=12)
Angry/Disgusted	2	2	Annoyed	1	1
Anxious/Nervous/Scared	3	3	Cold/cool	3	
Concerned for future	2	12	Disinterested/Normal	7	6
Confused/Conflicted	10	9	Good/Happy/Warm	2	
Disappointed	1		It's natural/not real	2	1
I care but am not scared	1	1	It's not people's fault	1	
Sad	5	4	It won't affect me	15	
Worried about the future	9	15	We will adapt	1	1
Exhausted/tired		1	Weird	1	
Curious as to what the long-term effects will be		1	It's over-exaggerated		1
I want to worry about climate change when I am an adult – not now		1	Neutral – I am not sure what I can do		2
Total (%)	48%	65%	Total (%)	43%	16%
Empowered				Pre (n=8)	Post (n=14)
We need to/can do something about climate change				3	9
I am interested in finding out what can be done				5	1
I am determined to do something about climate change					2
I am hopeful that we can do something about climate change					2
Total (%)				10%	19%

Multiple studies have been done that discuss the importance of climate change action projects and how these activities work towards moving attitudes and mindsets towards a more climate literate and conscious society. Examples of these studies include Ajay Sharma (2011), Maria Ojala and Hans Bengtsson (2019) and Sally Elizabeth Neas (2019). Because of this I was motivated to make this a part of the climate science unit. I was very encouraged to see my students get excited about their climate action projects. The opportunity to work with partners of their choosing or work independently was a positive aspect. The project options were varied enough that most students were able to land on an idea that appealed to them. The most popular project choice was making posters to display around the school building. Twelve groups of students wrote and illustrated a children's storybook which they then read to students at the

elementary school. The posters and storybooks were put up for display again during the week of Earth Day. All high school students were invited to complete a scavenger hunt that used facts from the posters and storybooks. Several students put together slide presentations with a climate change solution or mitigation focus. One student interviewed two students from Whitefish who participated in the climate lawsuit *Held vs Montana* (Jullin, 2024) and published her interview in a couple of the local newspapers. Examples of student climate action projects can be found in Appendix D.

My second sub question was if students would be motivated to continue their action project following the completion of the unit. I do know that some students have continued their activities but many of the action projects were one-and-done activities. Making posters, slide presentations, children's story books are all single-activity action projects. The student who started composting at home is still composting. The students who started consciously reducing energy use at home report that they are still practicing these behaviors. It would be interesting to survey all the students a year from now to see if they have implemented any change in lifestyle behaviors to reduce their carbon footprint.

Opportunity for Further Study

Because I chose to implement the full treatment (climate science, solution research and climate action) in all of my physical science classes I had no control from which to compare the impact of the treatment. It would be interesting to compare classes that received the climate science without the solution research or climate action phases with classes that received the full

implementation to see how these aspects may have impacted student perceptions of climate change. I felt the value of the full implementation outweighed the opportunity to make this comparison.

As previously mentioned, it would be interesting to survey these same students a year from this study to see how their perceptions and lifestyle behaviors regarding climate change compare to their responses on the post-survey.

Value and Impact of Action Research on Author

One of my biggest takeaways from completing this action project was the lack of exposure the students previously had to the subject of climate change. For most of my students, climate change was far from their daily concerns. And, if they had been hearing about climate change, their level of understanding was minimal. I was originally inspired by work that Maria Ojala (2012a, 2012b) had done looking at the types of hope students felt about climate change to look at how student feelings and attitudes might change before and after implementation of this unit. I changed the direction of focus and the language I used when I discovered that many of my students had no particular feelings or attitudes about climate change because it was not something they thought much about. Student *perspectives* seemed to better fit the reality of what I was working with.

A positive aspect of implementing the climate science unit was the opportunity to collaborate with a colleague making this unit a cross-curricular project. The students enthusiastically shared what they learned in geography class with me and what they have learned in my class with the geography teacher. This collaboration was a reminder of how powerful cross-curricular activities can be. It is difficult to organize cross-curricular activities at the high

school level because the students do not often have similar teachers or courses as they move up grade levels. This worked particularly well for me because the geography teacher and I have all the ninth graders for our classes. Cross-curricular collaboration was especially important for the topic of climate change because it affects so many aspects of human life and blends science with the social aspects of society and cultures across the world. Ajay Sharma (2011) reinforces the idea that global climate change cannot be taught in just one discipline because it needs a societal response.

I recognize the advantages of teaching this unit in biology over physical science. Implementation of climate science as a comprehensive unit meant developing background knowledge of concepts taught in biology (carbon cycle, photosynthesis, and respiration), and energy concepts which are usually taught later in the year in physical science. The biology curriculum lends itself more easily to concepts of climate science – especially if the students already have background in Earth’s energy budget.

Finally, I now recognize the careful thought and planning that needs to be a part of designing Likert survey questions in order to get meaningful responses. For example, careful use of terms like ‘only’ might eliminate some discrepancies. I also discovered that allowing young teenagers to complete a prompt with any type of response did not always yield useful information. Next time I will give the students a set of terms or phrases from which to choose. Pre-teaching how to take a Likert survey may also have helped to encourage the students to put serious thinking and authenticity into their responses.

I cannot claim that the climate action projects students participated in had a significant impact on their perspectives about climate change. However, the results of this study do suggest that students made important gains in understanding about the cause and effect of climate

change. Building the best future possible means helping students build their knowledge and skills to reduce climate change and mitigate the inevitable impacts that will come. Climate literacy is an integral part of all scientific literacy. I am motivated to incorporate this unit every year moving forward.

REFERENCES CITED

- Cho, R. (2023, February 9). Climate change in the United States: Where it stands and why it matters. *Columbia Climate School*.
<https://news.climate.columbia.edu/2023/02/09/climate-education-in-the-u-s-where-it-stands-and-why-it-matters/>
- Hickman, C., Marks, E., Pahu, P., Clayton, S., Lewandowski, R. E., Mayall, E.E., Wray, G., Mellor, C., van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *The Lancet Public Health*. [https://doi.org/10.1016/S2542-5196\(21\)00278-3](https://doi.org/10.1016/S2542-5196(21)00278-3)
- IPCC. (2023, March). Intergovernmental Panel on Climate Change assessment report 6 synthesis report: climate change 2023. *Press release*.
https://www.ipcc.ch/report/ar6/syr/downloads/press/IPCC_AR6_SYR_PressRelease_en.pdf
- Jullin, E. (2024, February). State files appeal to supreme court in Held vs Montana case. Montana Public Radio. <https://www.mtpr.org/montana-news/2024-02-18/state-files-appeal-to-supreme-court-in-held-v-montana-case>
- NCSE. (2020, October). Making the grade? How state public school science standards address climate change. *A report from the National Center for Science Education and the Texas Freedom Network Education Fund*. <https://climategrades.org/>
- Neas, S. E. (2019). *Fostering affective climate engagement among youth through digital storytelling* (13904329) [Master's thesis, University of California Davis]. ProQuest.
- NGSS Lead States. (2013). *Next generation science standards: For states, by states*. The National Academies Press, 282-288.
- NOAA. (2023, March 10). Climate. <https://www.noaa.gov/climate>.
- Office of Public Instruction, Montana. (2023) Comparison NGSS to Montana science standards. *Montana science standards*. Retrieved March 20, 2023:
<https://opi.mt.gov/Educators/Teaching-Learning/K-12-Content-Standards/Science-Standards#88989723-science-content-standards>.
- Ojala, M. (2012a). Hope and climate change: The importance of hope for pro-environmental engagement among young people. *Environmental Education Research*, 7(5), 625-642.
- Ojala, M. (2012b). Regulating worry, promoting hope: How do children, adolescents, and young adults cope with climate change? *International Journal of Environmental and Science Education*, 7(4), 537-561.
- Ojala, M. (2015). Hope in the face of climate change: Associations with environmental engagement and student perceptions of teachers' emotion communication style and future orientation. *The Journal of Environmental Education*, 46(3), 133-148.

- Ojala, M., & Bengtsson, H. (2019). Young people's coping strategies concerning climate change: Relations to perceived communication with parents and friends and pro-environmental behavior. *Environment and Behavior*, 51(8), 907-935. <https://doi-org.proxybz.lib.montana.edu/10.1177/0013916518763894>
- Politico. (2021, January). *Voting Results by County, Montana*. <https://www.politico.com/2020-election/results/montana/>
- Project Drawdown. (2023). *Table of Solutions*. <https://drawdown.org/solutions/table-of-solutions>
- Pyle, E., Niepold, F., Haas, D., Wyssession, M., Manning, C. (2018, September 13). An exploration of ideas related to the understanding and teaching of climate science and climate change. *The Teaching of Climate Science*. NSTA. <https://static.nsta.org/pdfs/anexplorationofideasrelatedtotheunderstandingandteachingofclimatescienceandclimatechange.pdf>
- Quintia, E.A. (2011, June). Impacting the environmental awareness and personal environmental behaviors of high school biology students through action projects. [Master's thesis, Montana State University]. Montana State University Scholar Works.
- Sharma, A. (2011). Global climate change: what has science education got to do with it? *Springer Science and Education*, 2012, vol 21(1), 33-53. <http://doi-10.1007/s11191-011-9372-1>
- Shimizu, Yoshi. World Health Organization (2023). Climate change. https://www.who.int/health-topics/climate-change#tab=tab_1
- Szczepanek, A. (2024, June). McNemar's test calculator. <https://www.omnicalculator.com/statistics/mcnemars-test>.
- UNESCO. (2022). Youth demand for quality climate change education. Document Code: ED-2022/WS/33. <https://unesdoc.unesco.org/ark:/48223/pf0000383615>
- United States Census Bureau. (2020). *Libby CCD, Lincoln County, Montana*. Retrieved November 20, 2023, from https://data.census.gov/profile/Libby_CCD,_Lincoln_County,_Montana?g=060XX00US3005392058

APPENDICES

APPENDIX A

MONTANA OFFICE OF PUBLIC INSTRUCTION SCIENCE STANDARDS RELATING TO
CLIMATE CHANGE

(OPI, Montana, 2023)

- Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, biodiversity, and investigate and explain how some American Indian tribes use scientific knowledge and practices in managing natural resources.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Next Generation Science Standards (NGSS) standards not adopted by Montana listed by the identifying codes:

- HS-ESS3-6 Use computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity
- ESS2.D Weather and Climate... The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year...
- ESS3.D Global Climate Change...Important discoveries are still being made about how the ocean, atmosphere and biosphere interact and are modified in response to human activities.

APPENDIX B

INVESTIGATION: CLIMATE CHANGE SOLUTIONS AND RUBRIC



Purpose:

- Research and describe a climate change solution that is realistic and currently being implemented.
- Give the advantages and disadvantages of the solution.
- Make a claim as to whether or not you support this solution or effort.
- Support your claim with evidence.

Slide Presentation:

- Slide #1: **Your Name** and...
 - The **Name** and/or brief description of your chosen **solution**.
 - Include the location or locations where this activity is being implemented
 - Include a photo or diagram representing the activity
- Slide #2: **Description** of the solution
 - Include the sector this solution is a part of
 - Include a photo/diagram
- Slide #3: **Advantages** of solution
 - Include amount of CO₂ kept from the atmosphere (reduced/sequestered)
 - Include cost in savings over long term
 - Other advantages (optional)
 - Include a photo/diagram
- Slide #4: **Disadvantages** and/or **challenges** of this solution.
 - Include cost and difficulties of implementation
 - Include a photo/diagram
- Slide #5: **CER**
 - **Claim** - Do you support this solution or effort? Why or why not?
 - **Evidence** - List what you learned as far as advantages and disadvantages
 - **Reasoning** - Tie it together. Support your claim with evidence.
- Slide #6: **Resources** - Specific websites or resources you used.

Resources:

- <https://drawdown.org/solutions/table-of-solutions>
- [Plant-based Fiber Solutions](#)

Presenter: _____ Evaluator: _____		
Climate Change Solutions Criteria by Slide	Points Possible	Points Earned
#1. Chosen solution or mitigation effort is realistic and is currently being implemented. - Brief explanation is given - Location of the activity is given - Photo/diagram is appropriate and helps the reader understand the activity.	4	
#2. The activity is described clearly. Photo/diagram is appropriate and adds to the understanding	3	
#3. Advantages are clearly explained - Amount of CO₂ reduced/sequestered is given (if possible) - Amount of money saved (if possible) is given - Photo/diagram is included and appropriate	3	
#4. Disadvantages and Challenges are clearly explained. Disadvantages and challenges might include: - Cost of implementation - Difficulties in implementation - Photo/diagram is included and appropriate	3	
#5. CER Claim Evidence Reasoning - Claim is clearly stated - do you support this solution? - Evidence is listed - Reasoning is clearly stated and includes the evidence to support the claim.	5	
#6. Resources Used Links given take the reader directly to your sources	2	
Format and Layout of slides - Font size and color is appropriate and easy to read - All text is stated in author's own words (no copy and paste) - Slide layout enhances the presentation - Photos and diagrams enhance and help to explain the text	5	
Total	25	
One (at least) Positive aspect of the slide presentation and/or presenter		

APPENDIX C

CLIMATE ACTION PROJECT PLAN



Name: ____

1. What my action project is about ____
2. Background research:
 - a. What I already know about this idea ____
 - b. What I need to know about this idea ____
3. The questions I have about this idea include ____
4. Who I need to help me ____
 - a. Who I need to talk with and/or plan with to make this happen ____
5. What resources or materials I need ____
6. What steps I need to take ____
7. My biggest concern is ____

APPENDIX D

EXAMPLES OF CLIMATE ACTION PROJECTS

- Interview someone involved in climate action, solutions, or mitigation activities
- Write and illustrate a children's storybook and read to students at the elementary school.
- Design a slide presentation with a focus on a climate solution or mitigation project. Share this with the class.
- Work with school administrators to improve/implement a recycling program.
- Work with school administrators to reduce the amount of plastic waste in the breakfast and lunch program.
- Design posters with climate change fun facts and/or reduce, reuse, recycle themes.
- Update the local waste management facility brochure including the items that can be recycled. Distribute the brochure.
- Design a board game with climate change focus and share with other classrooms.
- Design a brochure to encourage people to donate unused clothing and shop at local thrift stores. Distribute the brochure.
- Begin composting at home.
- Compare your home electric bill before and after implementing energy reduction efforts.
- Begin recycling at home.

APPENDIX E

CLIMATE ACTION PROJECT REFLECTION

1. **Describe** your project in detail.
 - a. **What** did you do? **Who** did you work with?
 - b. **Attach your work** to this assignment in Google Classroom. (photos, videos, reports...)
2. **How successful** was your project? Explain how you know.
3. What kind of **feedback** did you receive and from whom?
4. Looking back now, what would you do differently to **improve** your project or the impact of your project?
5. Is there any part of your project that you plan to carry into the **future**?
 - a. If so, explain what that might look like.
 - b. If not, explain why.
6. How has the climate action project affected your thinking about climate change?
7. **CER**
 - a. **Claim:** "I earned a _____% (grade %) on this project."
 - b. **Evidence:** List all the evidence that supports your claim.
 - c. **Reasoning:** Tie it all together - "I earned a grade of ____ because _____.
(REALLY convince me here that you earned this particular grade.)"

APPENDIX F

FOCUS GROUP QUESTIONS AND RESPONSES

Pre-treatment

1. What questions do you have about climate change?
2. What is your biggest concern when it comes to climate change?
3. Who is being affected by climate change?
4. Do you feel climate change is affecting your life now? If so, in what ways?
5. Do you feel climate change will affect your future? If so, in what ways?
6. Do you feel that you can or should take action regarding climate change?
7. What final thoughts or ideas would you like to share regarding climate change?

Post-treatment

1. Did you change any terms or phrases on your notecard?
2. What is your biggest concern when it comes to climate change? Why?
3. Is there anything that you understand now that you did not know prior to this unit?
4. Do you feel climate change is affecting your life now? If so, in what ways?
5. Do you feel climate change will affect your future? If so, in what ways?
6. How did your action project go? How do you think it impacted your thinking about climate change?
7. Do you think you might continue to act or make changes regarding climate change?
8. What final thoughts or ideas would you like to share regarding climate change?
9. What aspects of this unit worked well for you? What aspects did not work as well for you? Why?

Focus Group Interview: Terms to describe climate change (N=5)		
Student	Pre-Interview	Post-Interview
1	Global warming Ice age Acid rain Pollution CO2 End of the world Extinction of animals	Warming Melting ice caps Acid rain Fossil fuels CO2 Methane Animal extinction
2	Responsible/responsibility Deforestation Catastrophic	Important Responsible Fossil fuel Fighting Methane CO2 Upsetting
3	Temperature Melting Hot Too cold Vary Complicated Problems sun	Temperature Weather/climate Melting permafrost Releasing of CO2 Heating of atmosphere Species dying Thickening greenhouse atmosphere Carbon footprint Human interaction Fossil fuels Deforestation
4	Warming up Getting cold Change Bad/good	Global warming Human caused Activists
5	Weather Climate Its changing Change is necessary	Climate change is bad Its all over We would be in an ice age CO2 is worst greenhouse gas Animals are going extinct

APPENDIX G

PRE- AND POST-SURVEY

- A. Which of the following explains the difference between climate and weather?
1. Climate is seasonal change while weather is day to day differences.
 2. Climate is a long-term average of changes in the atmosphere while weather is day to day changes.
 3. There is really no difference between climate and weather.
- B. For each of the statements below, mark whether you strongly agree, agree, disagree, or strongly disagree with the statement. If you choose 'other' please explain why in the following section.

	Strongly Agree	Agree	Disagree	Strongly Disagree	Other
1. The earth's climate is changing.					
2. Overall, the earth's climate is warming.					
3. Overall, the earth's climate is cooling.					
4. I am concerned about climate change.					
5. We are already seeing the effects of climate change in Montana					
6. Climate change affects people worldwide.					
7. Climate change only affects people in certain places.					
8. Climate change affects poorer people more than wealthier people.					
9. Climate change affects all people equally.					
10. Climate change is caused by natural changes in solar cycles, in solar activity and normal climate fluctuations.					
11. Climate change is caused by human activity (such as burning fossil fuels.)					
12. Climate change will have a negative impact on my future.					
13. Climate change talk is exaggerated.					

C. If you chose 'other' in any of the previous questions please explain why here: _____

D. For each of the statements below, mark whether you strongly agree, agree, disagree, or strongly disagree with the statement.

E. If you chose 'other' in any of the previous questions please explain why here: _____

F. Please complete the following sentence: The topic of climate change makes me feel ____

	Strongly Agree	Agree	Disagree	Strongly Disagree	Other
1. I am empowered to take actions to help reduce climate change.					
2. I would like to take action to help reduce climate change but don't know what to do.					
3. I am not interested in taking action to help reduce climate change.					

APPENDIX H

INSTITUTIONAL REVIEW BOARD EXEMPTION

Protocol Detail Report

Printed By: Rose, Julia
1/23/2024 10:16:22 PM

Report Comments

Protocol Information

Version # 1

Reference Number: 1111

Protocol Number: 2024-1111-EXEMPT

Protocol Title: How does participation in an action project affect a student's feelings and attitudes about climate change?

Protocol Type: Original

Principal Investigator: Rose, Julia

Approval Date: 1/12/2024

Submittal Date: 1/12/2024

Effective Date: 1/12/2024

Author: Rose, Julia

Renewal Date: 1/12/2029

Status: Approved

Next Review Date: 1/12/2029

Inactive Date:

Expiration Date: 1/12/2029

Protocol Information

1

Definition of Human Subjects Research

1.1

Only human subjects research studies require IRB review. If you have questions about whether your work qualifies as human subjects research, contact the IRB Office at 406-994-4706 or irb@montana.edu for determination assistance.

Human Subjects Research Qualification

1.2

Does the intent and scope of your proposed study meet the definition of **human subjects research**?

☒ Yes

☐ No

☐ Unsure - determination assistance requested

Yes

1.2.1

No

1.2.2

Unsure - determination assistance requested

1.2.3

Exempt Review

1.3

Use this form for research studies that will be reviewed at the *Exempt* level in accordance with 45 CFR 690.104(d).

>Some topics or methods are typically **NOT** eligible for *Exempt* Review - See Review Level Determination.

>Do not use this form for research that falls into an *Expedited* or *Full Committee Review (FCR)* category. See Types of Review.

>For students: Only certain in-class projects require IRB review. See Student Research and Class Projects.