THE EFFECTS OF GUIDING CLIMATE CHANGE EDUCATION THROUGH A SOCIAL JUSTICE LENS

by

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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 2023

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ABSTRACT

Climate change is one of the largest environmental and justice issues facing our world. Many young people are listening to the science and taking action, but many more are not. This project addressed climate change through exploring consequences on society, addressing public health, and impacts on societal infrastructure and stability. The social inequality of climate impacts was highlighted throughout to better engage students. Baseline, survey data was collected before we addressed climate change. After learning about public health concerns, students took the survey again and completed a short reflection. Students finished the study, after learning about impacts on societal infrastructure by taking a third survey, completing a second reflection, and with an interview. Results varied due to inconsistent participation throughout the study. Many students demonstrated an increase in understanding of climate change, but evidence to demonstrate their depth of understanding examples of people most disproportionately affected by climate change was inconsistent. Finally, students underreported eco-anxiety in survey results compared to interview results.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of the Study

Science education has been transitioning away from traditional means of content delivery to make learning experiences more immersive, and centered around real-world application and technology. This shift in thinking and teaching has motivated me to find ways to connect with students, especially in my intro level life science courses. My personal journey of teaching for the last six years has highlighted deep challenges in engaging students in science content, and has motivated me to integrate real world, cross curricular connections. Additionally, in those six and a half years, inequalities in our community and greater society have pushed me to find ways to link science education with social justice and has increased my awareness of social emotional wellbeing in the classroom. This action research (AR) project is intended to implement new ways for students to interact with content to improve students' experiences. The intent is to bridge science content, centered around climate change, with a curriculum that emphasizes a solutions approach to the wide-reaching effects of inequality in a global social context in Biology classes at Davenport West.

Davenport West is a high school that serves students in grades nine through twelve and is located in Davenport, Iowa. The student population is a mix of urban and rural students with an enrollment of 1,562 (NCES, n.d.). This number has been going down for a few years due to redrawing of district lines and recent state legislation, which allows students to open enroll at

other high schools, out of the district (Richardson, 2021). According to the National Center for Education Statistics (2021), Davenport West is 64% White, 16% Hispanic, 11% Black, 6% two or more races, 3% Asian, 0.4% American Indian / Native Alaskan and 0.1 % Native Hawaiian or Pacific Islander. Davenport West is a Title 1 school with 59% economically disadvantaged students. Our student body has a 78% graduation rate, well below the state average of 91% (IDOE, n.d.) and below the national average of 86% (NCES, n.d.). Additionally, our reading and math scores lag behind national averages and are well below the state average (U.S. News, n.d.).

Davenport West is known for having excellent career readiness programs that include: (a) Biomedical Training, (b) Engineering, (c) Computer Science, (d) Welding, (e) Business, and (f) Construction. Despite our unique career readiness class offerings, West maintains a negative association within our school district and the greater Iowa and Illinois, Quad Cities area. We are known as a rough school, with low academic achievement. Part of the stigma surrounding our school comes from the confluence of low socioeconomic students coming from the urban West end of Davenport combined with several small, rural towns that do not have high schools, such as Bluegrass, Walcott, and Buffalo. Many of our students come to high school underprepared, partially due to low academic standards in middle schools, where students may move to the next grade level even if they do not meet proficiency standards.

In addition to traditional challenges in student preparedness for high school, the COVID pandemic exacerbated the number of students below proficiency, and even fewer students are willing to put in the work expected of them. In the pandemic, many students who chose to go fully online were not successful and lost the opportunity to earn credits. These students and those

that maintained in-person learning on a hybrid schedule for the 20-21 school year (SY) have missed out on the structure and workload of school. Students that were on the hybrid schedule went to school half-time for most of the 20-21 SY, experienced lowered standards for achievement, and many struggled to adjust back to a traditional schedule. Additionally, anxiety and stress has been at an all-time high for students. Even before the pandemic, the frequency and intensity of anxiety among high school students was alarming (Flannery, 2018). Since the COVID-19 pandemic, stress and anxiety levels have only gotten worse (Peterson, 2020).

Prior to and after the pandemic, the Davenport School District has emphasized professional development training for teachers to incorporate social and emotional health topics with our students, including identification and management of anxiety and stress. The ambiguous rollout of these interventions has motivated the researcher to investigate ways to address social emotional wellbeing in biology curriculum. Addressing students' social emotional needs includes identifying challenges (such as anxiety), identifying coping techniques, and developing classroom approaches to better engage students. Considering the long-standing and recent challenges with engaging students in school, educators must adapt in ways to better motivate students with meaningful content. This AR is an effort to relate life science content with the experience of underrepresented populations to establish more meaning and connection with the world around us.

This AR project was implemented with two sections of intro to Biology in the Spring semester of 2023. This is a required course, taken by students in the 10th grade. Our classes are structured in a block format, meaning this course lasts half of a school year, but would be a

yearlong course in a traditional schedule. Classes meet 5 days a week for an average of an hour and twenty minutes each day. My AR was implemented in the first term of this course in which we studied three units including:

1. Form and function (hierarchy of life, cells, body systems and homeostasis)
2. Energy and matter (photosynthesis, cellular respiration, carbon cycle)
3. Ecological interactions

To build a foundation for expanding into social issues while emphasizing a solutions-based approach, climate change was introduced progressively throughout the units.

Climate change is a challenging topic for many of our students to connect with, for a number of different reasons. Some reasons I have identified at West include: (a) message fatigue, (b) recycling of the same examples, and (c) confusion over misinformation. This AR project helped me pursue my passion to teach cross-curricular topics, centered around infrequently discussed topics in social injustice. Social justice may be integrated into science curriculum in many ways (Mackenzie, 2020), but this project emphasized climate change, in part because of the direct crossover in content, but especially due to the weight of these topics in making sense of our world. Students were not exposed to the term social justice in this AR but small group research directed them to various topics relating to inequity intensified by climate change. By developing a curriculum to allow students to dig into the social connections to climate change, develop solutions, share findings with classmates and reflect through feedback, I aimed to reinforce the magnitude of climate change and social injustice to motivate students to make connections and take action through this study.

Focus Questions

My focus question was, How does using social justice as a guiding framework in teaching the science and significance of climate change motivate students to take action and affect anxiety levels in the biology classroom?

My sub-questions include the following:

1. Does exploration of injustice centered around climate change increase student understanding of climate change?
2. How are students motivated to participate in solutions to climate change after exploring examples of injustice?
3. How does highlighting societal effects and solutions to climate change affect students' anxiety levels?

CHAPTER TWO

CONCEPTUAL FRAMEWORK

Social Justice in the Science Classroom

Climate change and social justice are pressing issues of local and global proportions. As populations expand, energy consumption continues to rise, demand for global products grow, and socioeconomic disparity gaps continue to broaden. Our youth, especially those on the lower end of the socioeconomic scale, stand to feel the wide range of effects more than anyone else. Students receive a spectrum of information on climate change and social justice ranging from being insulated from the realities to being fatigued with too much reused information. In addition, many high school aged students struggle to connect with and develop meaning from science content, such as climate change. Climate change and social justice are challenging topics to effectively address in high school education, but bridging science education with social justice may help students develop connections with both topics in more meaningful ways.

To effectively bring social justice into the science curriculum, all students should have a sense of place and belonging in the classroom. Science plays a significant part of the functional, societal power structure (Upegui et al., 2021). Bang et al. (2017) described the historical failure of society to teach science to underserved communities in a “meaningful, challenging and engaging” way (p. 33). This failure leaves students feeling uninterested and disconnected from their lived realities and leads to further disengagement in the classroom (Bang et al., 2017; Finkel, 2018). Upegui et al. (2021) similarly notes that pervasive inequitable education practices

serve to perpetuate injustice and underprepares students to participate in society in meaningful ways. By not reaching students from underserved populations, we are continuing to feed into systematic oppression and inequality in society (Upegui et al., 2021). Therefore, if the goal is to teach and engage ALL students, then there are opportunities for teachers to reevaluate how we teach as we continue to transition into full NGSS standard integration. The flexibility of these standards offers broad opportunities for creating more inclusive classrooms and content.

Many techniques have been described to create inclusion and sense of place in the classroom through culturally responsive teaching practices, but studies are limited in how to implement culturally responsive practices in secondary science classrooms. In the process of working to create more inclusive classrooms, emphasis should shift from science-heavy content to a focus on preparing scientifically literate citizens that can think critically, with a solutions mentality about topics important to their communities and society at large (Finkel, 2018; Mackenzie, 2020). One way to embrace that shift in the classroom is to create real-world problem-solving opportunities (Engels et al., 2019). Limited examples are available which address both social justice and climate change in the classroom. Bridging these topics can create opportunities for students to connect with both local and global issues, bringing human connections to the science classroom.

Climate Change and Social Justice

Climate change is widely viewed as the most significant global health issue of our time (Coffey et al., 2021) and is a topic that affects all people. Cultivating climate change literacy and change through critical thinking and developing solutions hinges on effective communication

and teaching of climate change. Stapleton (2018) emphasized the need for more than a scientific understanding of climate change in order to "affect the massive social and political changes needed to mitigate and adapt to climate change" (p. 733). Traditional scientific explanations are not enough to reshape the way Western culture views and interacts with nature (Morrison, 2018), which applies both to understanding climate change and societal injustices. Focusing strictly on the science of climate change can have a silencing effect on social issues. Recycling the same images of retracting ice sheets and polar bears can create message fatigue, leaving students disengaged (Stapleton, 2018). Stapleton's 2018 study found that creating personal connections regarding climate change engaged students much more directly. Personal connections are not limited to local and regional examples when talking about climate change or social justice, but integration of the human aspects and the layers of inequality interconnected with these issues has potential to draw students in.

Climate change and social justice directly interrelate in the study of climate justice; a social movement which frames climate change as a social justice issue (Stapleton, 2018). This association provides a wide range of connections for our students to associate more deeply on a societal level. The connection between science and social justice can "potentially be a revelation" in contrast to students' all too common view of science as dry and disconnected from societal realities (Douglas, 2022, p. 199). Underrepresented groups; impoverished, racial minorities and women bear an unequal burden of climate change (Douglas, 2022; NPWH.ORG, 2021), and these stories are too rarely heard in science classrooms.

Climate justice directly addresses disproportionate impacts that climate change has on the

world's most socioeconomically and demographically challenged. At the same time drawing attention to accountability of the wealthiest nations to enact meaningful change (Stapleton, 2018). Climate justice fundamentally parallels ecojustice, described by Morrison (2018) as a reframing of a Western-centric mindset about nature and society. This reshaping involves how our culture connects with our environment including how humans relate with the Earth, between sexes, with those different from us. The reframing of this Western-centric mindset also includes a consideration of how our definitions of progress and culture impact our understanding of the world around us. Ecojustice education draws from a variety of disciplines, including but not limited to: ecofeminist philosophy, critical race theory, and place-based education (Morrison, 2018). In these movements to address social inequality and climate change, the question remains: how do we effectively teach climate change through a social justice lens without making students, especially those most disproportionately affected, feel more alienated or stressed out? There is mounting evidence that young people are feeling the effects of eco-anxiety more and more, and highlighting human injustice may create additional anxiety.

Eco Anxiety and Education

Effective teaching of climate change should consider the increased incidence of eco-anxiety. Eco-anxiety is described by Coffey et al. (2021) as "the distress caused by climate change where people are becoming anxious about their future" (p. 1). Although eco-anxiety has become a more common topic, the phenomenon is not well understood, partly due to the non-standardized definition and broad nature on the topic (Coffey et al., 2021). The broad-based concept of eco-anxiety extends to climate crisis themes such as: (a) environment contamination,

(b) environmental disasters, (c) species extinction and loss of biodiversity, (d) degradation of ecosystems, and (e) impacts on society (Foster, 2022). More Americans are accepting that global warming is happening, which evidence suggests is partially due to the increased media attention (Benoit et al., 2022). A survey by ReachOut.com in 2019, including 1500 students ages 14-23, reported that 80% of respondents experience some anxiety about climate change (ReachOut, 2019).

Eco-anxiety is often described from the perspective of people most directly affected by climate change, but there are also indirect and inequitable impacts on mental health, specifically in young demographics (Mellor et al., 2022). There is significant documentation of eco-anxiety in the most vulnerable populations, but the impacts on individuals less directly impacted by climate change are not studied as much (Benoit et al., 2022), and most of the data is from Western countries (Coffey et al., 2021). The impacts on populations indirectly affected by climate change are less understood. It can be argued that climate change is going to affect all people, with certain demographics and socioeconomic groups feeling the effects more significantly. More research is needed to gauge anxiety levels of individuals less directly affected by climate change and ultimately strategies need to be developed to help our youth deal with heightened levels of anxiety. Moving forward, it will be important to address the human connection to climate change and social justice with sensitivity toward the mental health of young generations.

Conclusion

When it comes to education, teachers do their best to engage all of their students in the content of their class. However, the traditional approaches to teaching climate change are not effectively reaching our youth. In fact, Upegui et al. (2021) stated that we are perpetuating injustice and underpreparing students to participate in society in meaningful ways. We need to help students make meaningful connections with our content if we expect to see significant change. On top of these challenges, the ability for teachers to speak freely or teach students about social injustices are being challenged by recent legislation in the state of Iowa. Additionally, a knowledge-action gap exists where learning about science topics does not translate into action (Mooney et al., 2022). With the added challenge of navigating local legislation, my action research project aims to develop a curriculum that allow students to engage with social connections of climate change and examine them with a solution mindset. Bridging these topics may help shed light on these two massively significant issues in society and help students think about science and life in different ways. By challenging students to develop solutions to these issues, the intent is to increase students understanding, increase meaningful connections with content, and encourage action steps, while monitoring levels of eco-anxiety.

CHAPTER 3

METHODOLOGY

Demographics

The purpose of this research was to engage and track student engagement with social issues surrounding climate change. The research questions addressed by this study were:

1. Does exploration of injustice centered around climate change, increase student understanding of climate change?
2. How are students motivated to participate in solutions to climate change after exploring examples of injustice?
3. How does highlighting societal effects and solutions to climate change affect students' anxiety levels?

To measure student growth, this action research involved establishing baseline data before we studied climate change and tracking reactions in the middle and the end of the study period by summarizing each student's individual journey throughout the study. The study included student research into the effects of climate change on human health and societal effects on specific communities or populations. The research of these topics offered extensions of typical research conducted in our biology courses and served as a bridge between climate change, human health, ecology, taking action, and social justice.

The study was conducted in my 10th grade Introduction to Biology courses. Our biology courses are two term, block schedule classes, which is the equivalent to taking a year-long course

in a semester. In the Spring semester of 2023, I taught two sections of Biology, which began in mid-January. Of the students (*N*=55) in the two biology classes, 14 had IEPs, five had 504 plans and three were ELL students. Eight of the students were labeled as ADHD, two were autistic, and one student was identified with anxiety and depression. Of the students in these classes, 61% identified as White, 22% as African American, 15% as Hispanic, and 2% as Asian. These demographics are similar to the school-wide representation with the exception of Black students, which are twice as represented in my classes compared to school statistics (Infinite Campus, 2022).

Due to the small sample size of students in this study, both classes were considered treatment groups and no true control group was established. All students studied climate change while emphasizing effects on vulnerable human populations. This research approach was established based on surveys and questioning of former students (2021-2022) and ongoing conversations with colleagues regarding the need to realign our focus on teaching climate change to better reach students. Finding ways to reach students will help them better understand climate change and could encourage climate action. Connecting climate change and social inequality is an approach I researched and developed, driven by social issues in our district and society at large, with the intention of better reaching students. In previous semesters, my colleagues and I have noted our students' lack of interest in issues surrounding climate change and a reluctance to engage in issues beyond surface level. Students have reported symptoms of fatigue with the issues of climate change and regularly assume we are covering the same topics they have been hearing about since grade school. To realign their understanding and prevent the recycling of the

traditional discussions about climate change, effects on humans with an emphasis on social justice linked to climate change was woven into the curriculum throughout this study. The research methodology for this project received an exemption by Montana State University's Instrumental Review Board and compliance for work with human subjects was maintained (Appendix A).

Treatment

The research design treatment incorporated content connected to climate change in the first three units of study in biology. This approach aimed to spread out the content to help students build their understanding while tracking comprehension and interaction progress throughout the study. Typical unit 1 expectations include demonstrating the role of body systems in maintaining homeostasis. In a typical semester, we study health conditions as they relate to homeostasis and feedback loops. The classes in this study did the same, except they followed up the research project with an extension study to demonstrate how their studied health disorders have increased in frequency as a result of climate change. We analyzed our findings and linked those most directly affected, connecting social injustice with ways we can get involved to lower human impacts affecting climate change. This extension offered a phenomenon-based transition to unit 2, which covers matter and energy. Typically, the matter and energy unit involve studying the carbon cycle and greenhouse effect with a light dose of climate change. In the treatment groups, we connected CO2 emission data of developed and undeveloped countries to highlight which groups are most contributing and those that stand to feel the effects most directly. In unit 3, Ecology, we traditionally do a project related to biodiversity and ecological interactions. In

this study the treatment groups connected climate change phenomena to changing ecosystems that affect biodiversity. As an extension to this project, students researched direct impacts of climate change on human populations, including past, present, and projected affects with an emphasis on demographics most impacted.

Data Collection and Analysis Strategies

Data collection throughout the three units of study involved a mixed-methods approach with quantitative data as the foundation and with qualitative data to better understand and elaborate on the quantitative patterns that emerged (Johnson et al., 2007). Data collection was conducted in three phases:

1. At the beginning of our course, prior to instruction.
2. After completion of an extension project on the effects of climate change and health.
3. After researching societal impacts from climate change.

The data collection included three main instruments: (a) Student Climate Surveys, (b) Student Reflection, and (c) Student Interviews. Each data collection instrument collected data on all three research sub-questions, including student understanding, levels of anxiety associated with climate change, and motivation to take action on climate change (Table 1).

Table 1. Data Triangulation Matrix.

	Focus Questions		
Data Collection Instruments	Does exploration of injustice, centered around climate change, increase student understanding of climate change?	How are students motivated to participate in solutions to climate change after exploring examples of injustice?	How does highlighting societal effects and solutions to climate change impact students' anxiety levels?
Pre and Post Student Climate Survey	X	X	X
Student Reflection	X	X	X
Student Interviews	X	X	X

Data Collection Methods

Student Climate Surveys. A Student Climate Survey (Appendix B) using rating scales was conducted for quantitative data analysis in each of the three phases of data collection. In phase 1, a pretest established a baseline for students' understanding, connection, motivation to participate in solutions, and anxiety levels regarding climate change. The same Student Climate Survey was used a second time in phase 2 to gauge perceived changes in each category from the beginning of the course. The 3rd and final phase of the survey built a more complete, baseline picture of students' interactions with the content based on comparison of all three phases of study. The survey incorporated a rating scale to help compare results at each check point.

The rating scales were modeled after a Likert, 5-point scale, which facilitates understanding the strength, extent or degree of participant understanding (Mertler, 2020, p. 146) at each of the three phases of the study. Having this quantitative data provides quick, analysis of changes in students' understanding, connection, motivation to participate in solutions, and anxiety levels regarding climate change rooted in their interactions with justice-based content

(Joshi et al., 2015). The three sub-questions of this study rely on observing how student responses from the Student Climate Survey change after working with justice-centered content and the observed changes in responses from the survey will provide baseline data to build upon. This baseline quantitative data represented a starting point in data collection and analysis and was followed up with quantitative data collection through student reflection and interviews to provide more details on student experiences.

Student Reflection. Reflection questions (Appendix C) with short answer responses elicited details from students to better understand and build upon Student Climate Survey responses. These reflection questions were incorporated at phase 2 and phase 3 of the study, following research projects related to effects of injustice and climate change. Reflection was intended to help students tie a wide range of concepts together while eliciting reasoning and justification (Yadav & Bhatia, 2022) to better assess their current understanding, connection, motivation to participate in solutions, and anxiety levels as they dive deeper into effects of climate change. In addition, the reflection process is designed to help students conceptualize a larger picture of climate change and related effects while making more meaningful connections, and to develop more personal relationships with the content (CNALS, n.d.). The process of revisiting their own work and their classmates' work was intended to help me better understand and analyze how students are interacting with the content with a side benefit of increasing their retention of climate change concepts (Yadav & Bhatia, 2022). This reflection provided individual and class qualitative data for analysis.

The data obtained from reflection was sorted with the Student Climate Survey results to build a more complete pattern of change throughout the study for each student. Reflection in phase 2 and 3 was specific to the content covered in individual student research and addressed the study focus questions to help facilitate the final data collection, Student Interviews. The data collected from surveys and reflection drove the direction of in-person Student Interview questions.

Student Interviews. In-person Student Interviews (Appendix D) were developed throughout the study based on individual and class responses to the Student Climate Surveys and Student Reflections and were conducted at the end of phase 3. Some of the interview questions were written vaguely as a means to tailor each interview in reference to previous student responses with some additional questions to expand on students' interaction with the content. These interviews represent the final and culminating instrument in the study and provided an interactive means of expanding on individual and group experiences throughout this research. Interviews "provide an understanding of the participants' experiences from their own perspectives because it allows them to voice their ideas, opinions, values and knowledge on issues related to the investigation" (Efron & Ravid, 2020, p. 98). The interviews were personalized to build more detailed qualitative data on student and group growth throughout the study and elicited final takeaway understanding, connection, motivation to participate in solutions, and anxiety levels. The interviews served as the most comprehensive qualitative data collection and students had time to reflect and prepare specifically for the interviews.

Students received copies of their survey responses and reflections, with feedback, and a list of questions to expect in their interview. The interviews took place in a quiet, one-on-one environment where the researcher wrote summaries of student responses. Student Interview responses were sorted among previous data to build deeper understanding of each students' personal journey to better report on student and group experiences in this study. The combination of Student Surveys, Student Reflection, and Student Interviews provided structure for tracking participant progress throughout the study period and offered flexibility to evaluate the data as it accumulated rather than in predetermined categories.

Analysis Strategies

Distribution Analysis. The data analysis approach started with quantitative analysis by categorizing phase 1 Student Survey results, and then comparing progress, using Student Survey results from phase 2 & 3. Categories were analyzed using distribution to compare mean Student Survey results at three phases of assessment. These measurements are used to identify central tendencies highlighting the most typical scores and represent a summary of group scores. Mode represents the most frequently occurring answer to a question and is considered descriptive and less functional in analysis compared to median and mean. The median divides student responses in to top 50% and bottom 50% of responses. Calculating the mean, or average of scored responses, will best summarize group responses (Efron & Ravid, 2020). Calculating mean class data facilitated change comparison over the three phases of assessment. These changes were analyzed for significance using Hake normalized gains.

Hake Normalized Gains. Normalized gains were calculated from percent changes in survey results from phase 1 to phase 3 of the study. Hake normalized gains analysis is a standardized method for measuring low, medium, and high gains in test scores over a period of time. Normalized gains values below 0.3 percent were low, gains between 0.3 and 0.7 were medium, and gains above 0.7 were high (Hake, 1998). Normalized gains were measured to compare changes in student responses to pre and post surveys regarding student understanding of climate change and student willingness to get involved with solutions to climate change. Using normalized gains laid a foundation for group correlational analysis.

Correlational Analysis. Correlation was then used to compare the degree of statistical relationship or association between research questions within this study (Mertler, 2020, p. 99). Specifically, correlation design in this AR was used to gauge the strength of effect of one research question as it relates to others (Chen & Popovich, 2002). Correlational analysis provides tools for quantifying the direction of relationships, whether positive (improvement) or negative (regressive), and strength of relationships (Efron & Ravid, 2020). Based on the three research questions in this project, we were better able to understand our students' interaction with the content by analyzing their likelihood to engage with climate change action if they are well informed on the current and long-term impact on human populations. A second correlation analysis involved how eco-anxiety, a common response when exploring the effects of climate change (Coffey et al., 2021), relates to students' willingness to take action and their overall understanding. To better identify correlation, the constant comparative method was used throughout the research period.

Constant Comparative Method. The constant comparative method was used to build an understanding of the test group continually throughout the research, which allowed for "emerging themes to guide the data collection" (Mertler, 2020, p. 97). Survey results were expanded upon understanding with phase 2 and phase 3 reflection data collected to track student growth throughout the project. The constant comparative method is well suited for mixed-method studies and opens up analysis to a wide variety of perspectives, which are expected in this research, and supports varying perceptions of topics by systematically comparing these varieties of viewpoints (Mathison, 2005). Using the constant comparative method helps build on the findings within the context of this action research to build common themes for analysis that will guide the following steps of evaluation (Flick, 2006). Guiding questions were established prior to the project, but the framework for post interviews and reflection were developed more fully based on the observations and direction of the research group. This method of analysis is geared to find out more specifically about student perspective and the progression is guided by the patterns that unfold throughout the project, specifically using inductive analysis.

Inductive Analysis. Inductive analysis was the central method of analyzing qualitative data from Student Reflection and Student Interviews. Data reduction and identifying central themes and relevant patters (Mertler, 2020) allowed students' responses to dictate the final report, in alignment with the constant comparative method. As the project progressed, interview and reflection data was summarized and categorized with thematic analysis to identify patterns of response (Braun et al., 2019), which was critical for sorting through student responses included in all three sub-questions. Thematic analysis provides flexibility, accessibility to the

researcher and general public, helps summarize qualitative data while highlighting similarities and differences, and offers a means to extrapolate unexpected insights (Braun & Clarke, 2006). After students' responses were collected, they were printed and cut into strips and organized into categories on boards to find connections with student responses. Summaries were established and sorted on a board for organization and visualization.

As the project unfolded, the central themes were reevaluated. True to the constant comparative method, themes that surfaced throughout the project guided further questioning to gain deeper insights to student perspectives and understanding (Flick, 2006). Inductive analysis is appropriate in this non-controlled study and brought the analysis of my students' responses to a general conclusion represented in the tables and graphs presented in the following section.

CHAPTER FOUR

DATA ANALYSIS

Results

Student Participation Was Inconsistent

Quantitative data was analyzed from student climate surveys (SCSs) at three phases of this study. Data from these surveys is represented in two ways throughout this chapter; data set A and data set B. Data set A represents responses from the beginning to the end of the study from all participating students. Data set B was established due to the inconsistent number of students that participated in the surveys throughout the study period, from the pre-survey (phase 1) to the post-survey (phase 3). The number of students that participated in the first phase of SCSs (n=49) dropped in the second phase (n=31) and again in the third phase (n=29). Data set B includes only students that participated in SCSs from phases 1 and 3 (n=27). Most of group (n=23) participated in SCSs from all 3 phases of the study, but anyone that didn't participate in the pre-survey or the post-survey, were removed from data set B. Graphs in this chapter compare pre and post survey data from both data set A and B for side-by-side comparison (Figures 1, 2, & 3; Tables 3, 4, & 5).

Qualitative data, collected from student reflections from phases 2 and 3, and student interviews from phase 3 were not obtained from all participating students. Of the students in participating classes (N=55), 40 students turned in the phase 2 student reflection and 28 students turned in the phase 3 student reflection. Student interviews were conducted with 27 of the

original participating students. Reflections and interviews revealed some important details about students' experiences and their perspectives on learning about climate change from a social justice lens, but the fragmented participation leaves some gaps in understanding the perspectives of the whole group.

Student Understanding of Climate Change

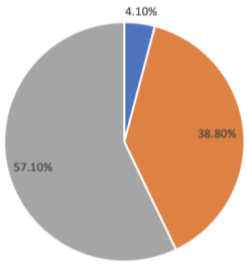
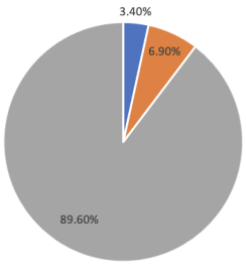
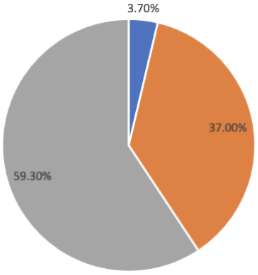
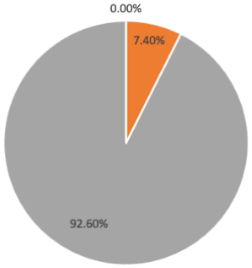
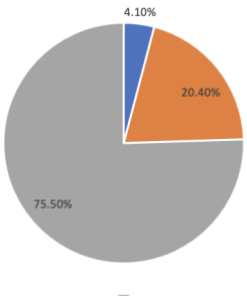
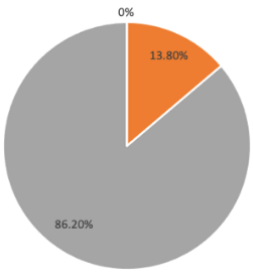
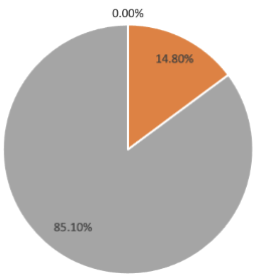
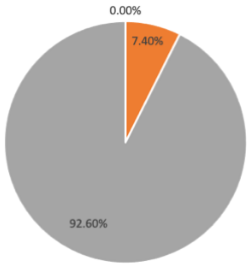
Student climate surveys (SCSs) administered at the beginning of the study (phase 1), indicated the majority of students started this class with a baseline understanding that climate change is well documented, humans have contributed significantly, poses threats to humans now and in the future, and human actions can slow the change (Table 2).

Table 2. Pre-project student climate survey results, questions 1a-5a, (*n*=49).

	Agree or strongly agree	Unsure	Disagree or strongly disagree
Climate Change is well documented (1a)	57.1%	38.8%	4.1%
Humans have contributed significantly to Climate Change (2a)	75.5%	20.4%	4.1%
Climate Change poses threats to current human populations (3a)	67.3%	28.6%	4%
Climate Change poses threats to future human populations (4a)	73.5%	16.3%	10.2%
Humans can make choices to slow Climate Change (5a)	57.1%	24.5%	18.4%

Data from the same SCSs administered at the end of the study period (phase 3) indicated the average number of students that disagreed or were unsure about the climate change statements

dropped and the number of students that agreed with the statements increased in both data set A and B (Figure 1).

Data Set A Pre-test	Data Set A Post-test	Data Set B Pre-test	Data Set B Post-test
1a. Climate change is well researched and well documented			
			
			
2a. Humans have contributed significantly to Climate Change			
			
			
3a. Climate Change has and is posing threats to current human populations			

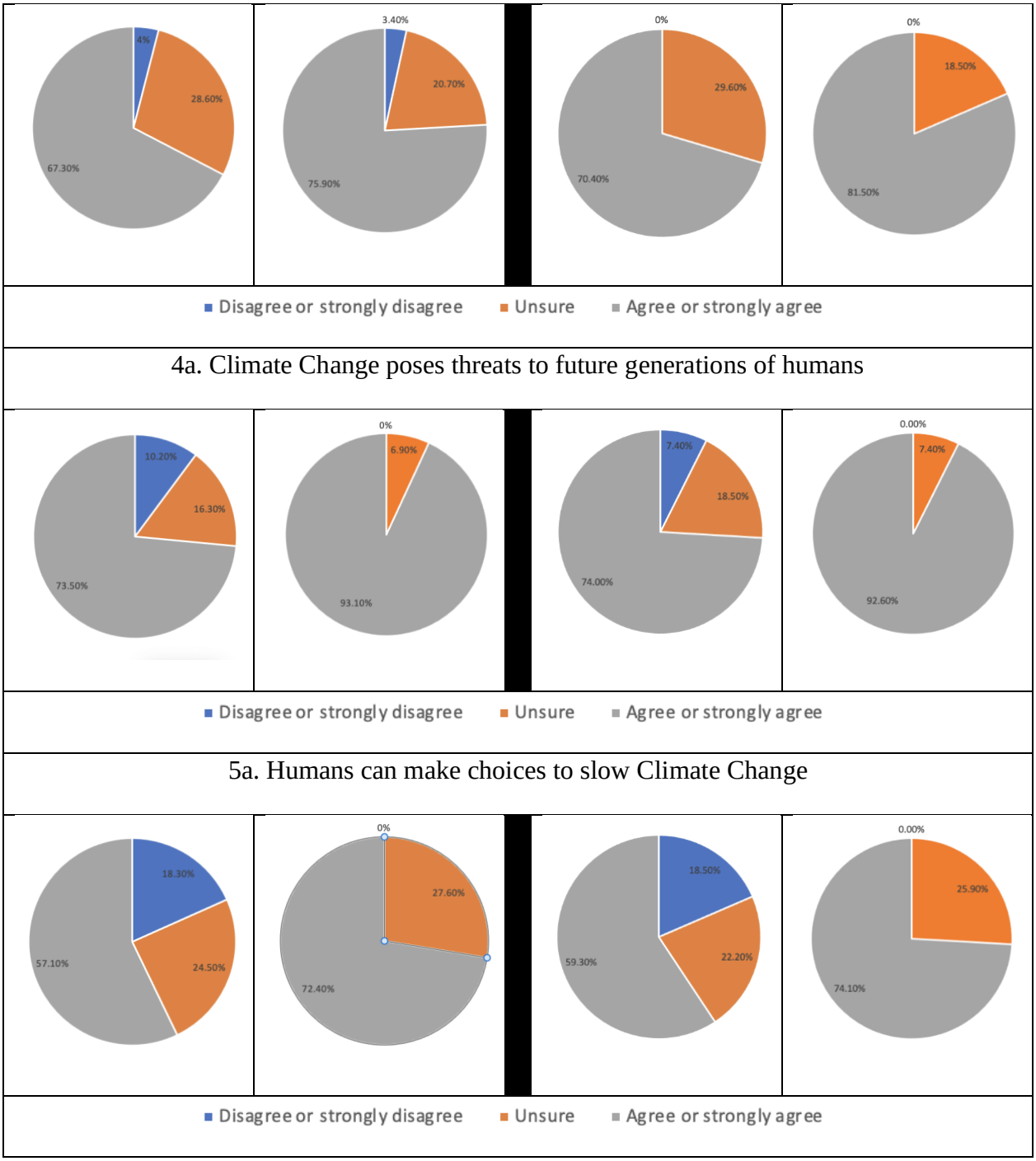


Figure 1. Student climate survey summaries, questions 1a – 5a comparing changes in students' understanding of climate change between phase 1 and phase 3, from data sets A and B.

In both data sets, the percentage of students agreeing with all five statements increased from start to finish. The percentage change of students who agreed with statements in pre-test SCSs was compared post-test in Table 3. Changes in the five questions relating to student understanding of climate change shifted from as high as +33.3% agreeing, to as low as +8.6%. Changes in student perspective from data set A and B appear similar (Table 4). Change in responses in data set B averaged +17.3% and average change in data set B was +17.1%.

Table 3. Comparing average percent change in SCS responses from questions 1a-5a for Data set A and B.

Questions	Data Set A	Data Set B
1a	+32.5%	+33.3%
2a	+10.7%	+7.5%
3a	+8.6%	+11.1%
4a	+19.6%	+18.6%
5a	+15.3%	+14.8%

Normalized gains were calculated to determine the degree of gains in students understanding of climate change for questions 1a-5a, where values under .3 represent low gains, 0.3 to 0.7 are medium, and gains above 0.7 are considered high (Hake, 1998). Using Hake's model, we see higher gains in data set B (Table 4).

Table 4. Hake normalized gains for questions 1a-5a.

Questions	Data set A	Level of Change	Data set B	Level of Change
1a	0.76	High	0.82	High
2a	0.43	Medium	0.5	Medium
3a	0.26	Low	0.375	Medium
4a	0.74	High	0.72	Medium
5a	0.36	Medium	0.36	Medium

Two additional, notable changes were observed in questions 4a and 5a. These two questions had the highest percentage of students disagreeing with the statements about climate change from the pre-survey. In statement 4a, climate change poses threats to future generations, 26.5 % in data set A and 25.9 % in data set B either disagreed or were unsure in the pre-test. In the post-test no respondents disagreed, 6.9% in data set A were unsure and 7.4% in data set B were unsure (Figure 1, 4a). In statement 5a, humans can make choices to slow climate change, 42.8% of data set A and 40.7% of data set B disagreed or were unsure. In the post-test, no respondents disagreed, while 27.6% in data set A were unsure and 25.9% in data set B were unsure (Figure 1, 5a). In addition, the post-test (phase 3) revealed only 1 student disagreed with any of the statements and data set B had zero responses that disagreed in the post-test statements about climate change.

In addition to student climate surveys, student climate reflection provided qualitative data to gauge student understanding after studying effects of climate change on humans. In phase 2, students were asked to “describe how climate change is a factor affecting public health…

including examples from the public health issue you researched." Of the participants in the phase 2 student climate reflections (*n*=38), only 18.4% of respondents successfully explained how climate change relates to their public health research topic from class. However, 79% of the students made statements that indicated climate change was involved with disparities in public health. One student response was, "climate change isn't the cause of the health problems, but there are many ways it can make things worse." In phase 3, students were asked to "describe how climate change is negatively affecting society… include examples from the societal issue you researched." Of the participants in phase 3 (*n*=28), one student (6.25%) successfully related impacts on society with climate change and their research topic form class. In this final reflection 75% of respondents responded with statements linking climate change to negative societal change. One student commented, "I didn't realize how drought doesn't just go away after it rains. It's more complicated than that."

Student climate reflections were followed with student climate interviews (*n*=27). When students were asked about their incomplete or lack of responses to linking climate change to the public health and societal issues from their research, some responses did not clarify connections but provided some additional evidence of student understanding. One student commented on not realizing before the study how ocean level rise can have "so many effects on drinking water" (based on an example we used from Bangladesh). Another student commented on knowing that coral reefs were going away, but they didn't realize they function to slow tidal surges during storms, which can affect people. They also commented that the increased ocean temp is also causing more frequent intense storms.

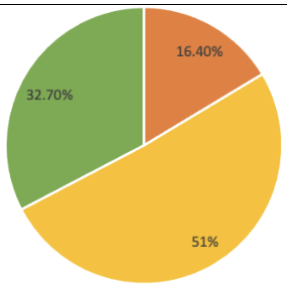
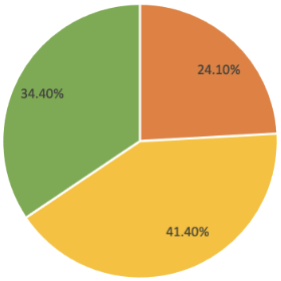
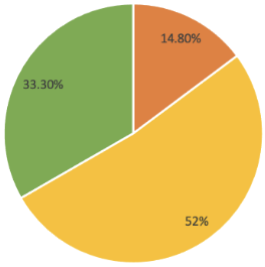
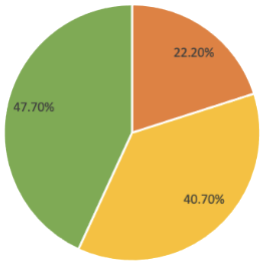
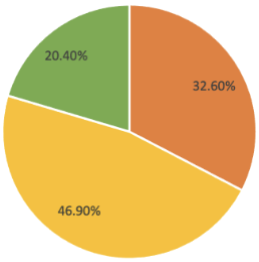
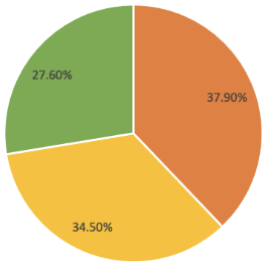
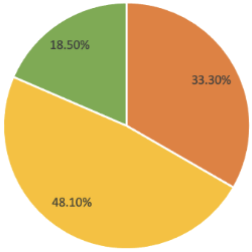
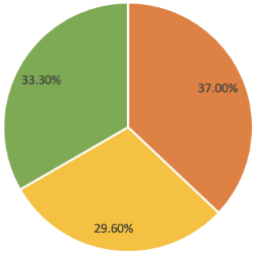
Student interviews revealed studying impacts on humans was more engaging than other ways respondents had learned about climate change. Close to 75% of students reported learning about climate change in new ways. Some students made personal connection and many others acknowledged they don't personally feel the impacts but they can see more clearly how some populations are being affected. One student described "so many aspects of life are affected," another acknowledged "some of it I knew but it made me think differently about the world" and another stated "it's more engaging to focus on how impacts are connected." There was a strong correlation to students starting the study period with a strong background in climate change and still describing learning something different or new.

Student Willingness to Get Involved with Solutions to Climate Change

Based on student climate surveys from pre to post surveys, students' willingness to get involved with solutions to climate change indicated mixed results. In data set A, some positive shift towards agreeing with statements about taking action were observed in three of the four questions, but these positive shifts were low on the Hake scale. Data set B showed positive shifts in students agreeing with questions 1b and 2b, but questions 3b and 4b showed a negative shift, moving more towards disagreeing (Table 5). In some cases, average student responses indicated less likelihood of students getting involved with solutions after studying climate change. In data set A, the percent of students agreeing to statement 3b dropped by 5.5%. In data set B, the percent of students agreeing to statement 3b dropped by 3.8% and 4b dropped by 11.1%. Data set A and B showed significant variation between questions 1b-4b.

Table 5. Average percent change in SCS, questions 1b-4b.

Questions	Data Set A	Data Set B
1b	+1.7%	+14.4%
2b	+7.2%	+14.8%
3b	-5.5%	-3.8%
4b	+3.2%	-11.1%

Data Set A Phase 1	**Data Set A Phase 3**	**Data Set B Phase 1**	**Data Set B Phase 3**
1b. You are making decisions in your own life to slow the pace of climate change			
			
■ Disagree or strongly disagree ■ Not Sure ■ Agree or strongly agree			
2b. You plan to take action on climate change on a day to day, personal level			
			
■ Disagree or strongly disagree ■ Not Sure ■ Agree or strongly agree			

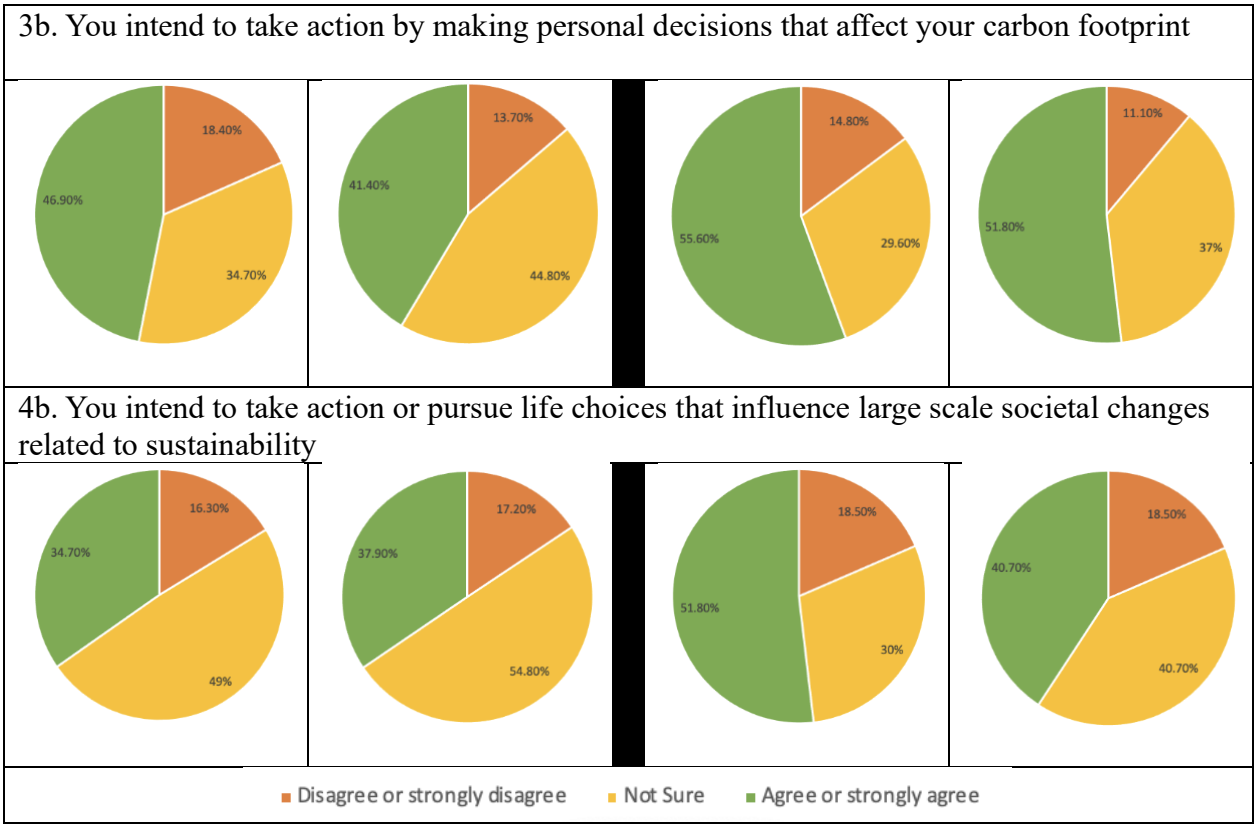


Figure 2. Student climate survey summaries, questions 1b – 4b comparing changes in students' willingness to get involved with solutions to climate change between phase 1 and phase 3 from data sets A and B.

Student climate reflections from phase 2 of this study asked students if "learning about human health effects from climate change motivate you to get involved in lowering your carbon footprint or advocating for a more sustainable society." Of the respondents (*n*=38), 44.7% replied yes, 39% said no, and 18.3% did not directly answer the question. Student climate reflections from phase 3 of the study asked students if "learning about impacts on society from climate change motivate you to get involved in lowering your carbon footprint or to advocate for a more sustainable society." Of the respondents (*n*=28), 41% replied yes, 53.6% said no, and 7.1% did not directly answer the question.

Student reflections that revealed students uninterested in making personal life changes to curb climate change fell into one of two reoccurring sub groups. a) Students who think individuals cannot make significant change, or b) students simply do not care about climate change. Some responses from the first category included “I don’t think about it too much because there’s nothing I can do about it,” “no because either way, I can’t stop it,” “I’m only one person but important to talk about if big change is going to happen,” “I don’t think by myself I can change it,” and “I would consider doing it if people in my house would do it too… if I change and other people don’t it doesn’t do any good.” Responses from the second category included, “I’m not interested, it seems pretty boring,” “climate change isn’t really my thing,” and “I don’t care much about climate change, I’m a kid.”

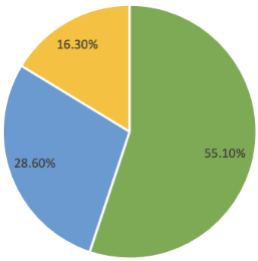
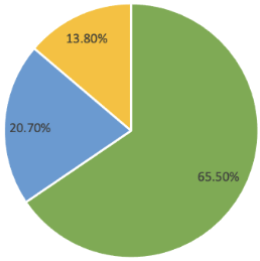
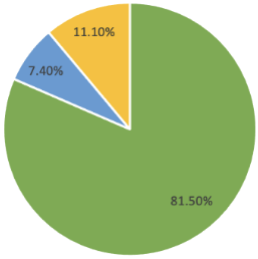
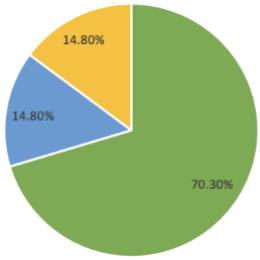
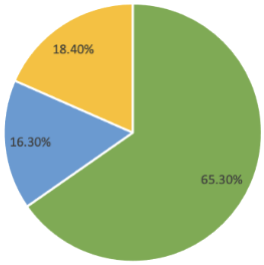
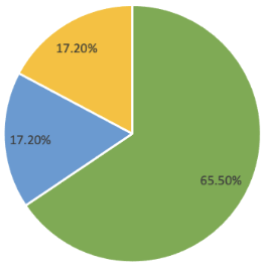
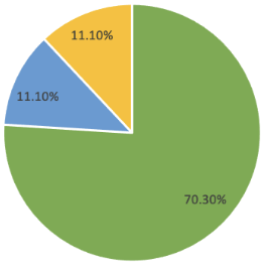
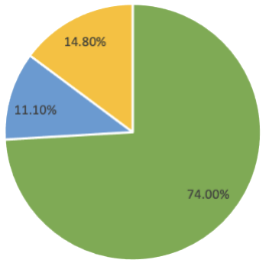
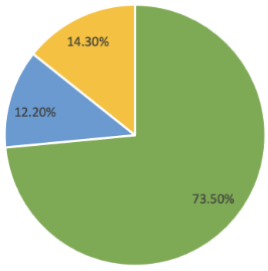
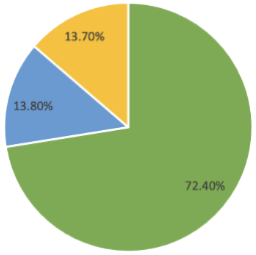
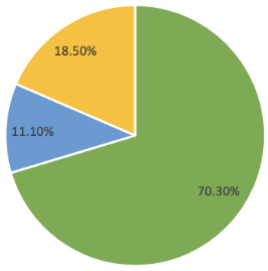
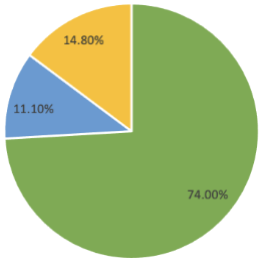
Of the student reflections that indicated willingness to get involved, some statements centered around doing something rather than sitting back and letting things happen. One student commented “I would feel good to know I’m doing something rather than ignoring what’s going on,” another said “if I don’t do something, I will feel even more frustrated.” Others commented about wanting to help future generations. One person commented, “I worry about the next generation.” Other responses that justified why respondents would get involved included; “I don’t want to be alive to see everything get bad,” and “I am motivated but I think all humans should be mandated to change or we won’t see real change.”

Student interviews revealed some students that do not want to get involved in solutions feel threatened by the prospects of change. One student, a family farmer, said “all of these changes are just going to cost me more and small-time farmers won’t be able to keep up with the

costs." Another student who operates a small lawn care business was defensive about climate change, feeling like they couldn't really do anything and they "couldn't afford to change." Both of these students felt the system is not set up for them to afford the change that is ahead. Other interviews indicated many students want to learn more about how to be involved with more meaningful change.

Students' Levels of Eco Anxiety

In measuring eco anxiety, student responses elicited mixed results. In the student climate surveys, less than 20% of students agreed to all of the eco anxiety statements after the post-survey. Students' responses to having difficulty concentrating when thinking about climate change (1c) showed an opposite shift between Data set A and B (Figure 3, 1c). Data set A indicated 2.5% fewer students agreed with the statement and 10.4% shifted to disagreeing while data set B indicated 3.7% more students agreed and 11.2% fewer disagreed after the study period. The most significant change in student responses came from question 4c (Figure 3), regarding negative emotions emerging when learning about climate change. In both data set A and B students shifted around -11% from agreeing to being unsure.

Data Set A Phase 1	Data Set A Phase 3	Data Set B Phase 1	Data Set B Phase 3
1c. Thinking about climate change makes it difficult for me to concentrate			
			
			
2c. Thinking about climate change makes me feel nervous, agitated, or anxious			
			
			
3c. You feel down, depressed or hopeless when thinking about climate change			
			
			

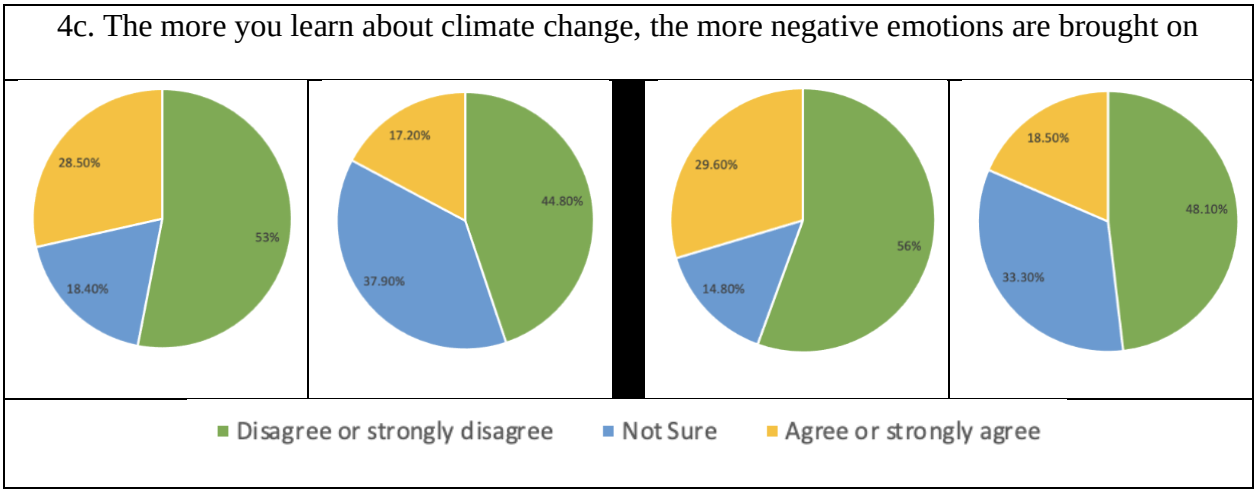


Figure 3. Student climate survey summaries, questions 1c – 4c comparing changes in students' eco anxiety associated with climate change between phase 1 and phase 3 from data sets A and B.

Student reflection provided some additional details about students' anxiety associated with learning about climate change. The question; how do you feel about climate change included a list of emojis ranging from frowning to neutral to smiling (Appendix C). In phase 2 (*n*=38), 10.5% of respondents selected a frowny face, 81.6% selected a neutral face, and 7.9 % selected a smiling face. In phase 3 (*n*=28), 21.4% selected a frowny face and 78.6% selected a neutral face. The emoji question was designed to include student clarification of why they feel the way they do, but many students neglected to answer this question and few students reflected on their emotions in their responses. Some reflections expressed anger and frustration about climate change, including: "I get frustrated because most people don't care about climate change because it doesn't affect them directly," "I feel like there is little I can do about things and it just makes me more angry at the rich," and "it infuriates me even more since the project." Other responses, "I learned some things but they didn't make me feel anxious, but I like learning about this so I better understand," and "I know about climate change and it is what it is."

Interviews revealed more details about student anxiety levels. Most students that do not report feeling anxious about climate change either don't care about it or do not feel they will be negatively affected. Some lack of caring responses included, "I just don't care much about these things," "I don't pay attention to climate change," "I don't pay attention to that stuff," and "it's inevitable so I'm not worried about it." Responses about not feeling the effects included, "I don't think climate change will affect my lifetime," "the negative majority affects will not affect me in my lifetime," and "it can be upsetting but we will likely all be dead before the world really feels the effects."

Interviews also revealed more students are experiencing a variety of anxiety related to climate change than was led on by surveys and reflection. Two students that did not participate in the surveys and reflection stated the questions made them feel anxious and they don't like to get too much into climate change. One of these students stated "I don't really want to deal with it because it stresses me out so I avoid it completely." Other students were reluctant to admit to being anxious, but they clearly have concerns and get worried about climate change. One student reported they "know more now, but I've always been worried about climate change." Another student that did not previously report being anxious reported learning about climate change impacts "makes me a little anxious, but more angry and frustrated." Some students in the study indicated they aren't much concerned with the future, but others clearly are, as one student stated, "I am worried about how it will turn out in the future."

Climate Change and Social Justice

Students were asked directly in interviews “how impactful was learning about climate change as it relates to impacts on vulnerable human populations, those most directly affected by climate change.” The majority of students interviewed (63%) identified feeling more connected to the topic when relating to populations most directly affected, while 11% of students said they didn’t understand the question and never really answered when the question was reworded. Some students responded to the prompt by saying “it’s more impactful and emotional, people shouldn’t have to deal with the issues,” “I feel bad about third world countries and people that have a hard time dealing with changes,” “I feel bad, it feels unfair,” and “I don’t like the idea of ruining things people need to live.”

CHAPTER FIVE

CLAIMS, EVIDENCE, AND REASONING

Claims From the Study

Claims from this study include: (a) eco-anxiety is experienced more than students originally reported (b) students' understanding of climate change improved, but not conclusively, and (c) student participation was inconsistent and made data analysis challenging.

Eco-anxiety

Data from this study indicates eco-anxiety is experienced more than students reported in class pre and post surveys. Class survey data indicated approximately 15.5% of respondents felt anxious in various ways after the study. However, 1/3 of students interviewed reported feeling anxiety around climate change. These data, from interviews, is closer to national averages based on a recent survey from the EdWeek Research Center, which found that "37% of teenagers feel anxious when thinking about climate change and its effects, and more than a third feel afraid" (Will, 2022).

Evidence on a global scale continues to show youth are increasingly becoming anxious about climate change. A study conducted in Fall of 2021 with over 10,000 16–25-year old's, from 10 different countries, indicated 60% of respondents feel very worried or extremely worried about climate change (Thompson, 2021), which is much higher than our class data. The international study reported the highest percentage of students experiencing anxiety are from countries most directly affected. Considering many students in Davenport, Iowa report they do

not directly feel the effects of climate change and even reported they do not worry because they do not feel the effects directly, it makes sense that the averages are lower. The study from EdWeek Research Center also reported higher incidents of eco-anxiety in regions of the United States where climate change is more directly affecting populations (Will, 2022).

Linking eco-anxiety and students taking action, dealing with eco-anxiety can take the form of getting involved with solutions to climate change (Bauden & Jachens, 2021; Collier, 2022; Wright & Osterloff, n.d.). This does not suggest that taking action alone will deal with eco-anxiety, but it can help people cope with their anxiety along with talking about the issues and how they make individuals feel, and connecting with people about the issues (Bauden & Jachens, 2021; Collier, 2022; Wright & Osterloff, n.d.). The study group has not spent any significant time looking at solutions to climate change, but the last couple weeks of the school year will focus more on solutions to human impacts.

Student Understanding of Climate Change

Data collected to gage student understanding of climate change from student climate surveys, student reflection, and student interviews showed improved student understanding of climate change, but the results are not conclusive for the whole study group. Responses to surveys shifted to indicate students understanding improved over the study period. However, students that participated in surveys throughout the study (n=27) were more representative of the higher achieving portion of the study group. The average growth of understanding climate change provides evidence that learning about climate change effects on humans, with an emphasis on those most disproportionately affected, helps students that typically engage in

coursework better understand climate change. The lack of engagement from other students in the surveys does not allow for a complete picture of student growth in understanding. Although many teachers talk about engagement issues post pandemic, we're not just dealing with the pandemic, "we're living amid multiple and interrelated global crises, from climate change, to rampant wealth inequality to attacks on Democracy. Our schools cannot educate students well if we ignore the world around them" (Hargreaves, 2021).

Student reflection responses established that many students were engaging with climate change content in different ways in this study and learning about climate change effects on humans was more effective than other means. Student reflections in phase 2 and 3 demonstrated the majority of students that participated could identify public health and other societal concerns and know there was a connection to climate change. Students' inability to more deeply connect these societal issues with climate change was disappointing, but making these connections was more challenging than originally anticipated. Students did interact with climate change in a different way than they had prior to the study and evidence shows many of them are thinking differently compared to before the study. The study period provided ample time for students to investigate connections to climate change with societal issues, but even with supports provided, students will need more scaffolding to make deeper connections in 10th grade, Intro to Biology.

Student interviews provided further evidence of students' improved understanding of climate change, as many students did indicate learning about climate change from the perspective of people most directly affected did get them thinking in different ways and did show evidence that they understand better how some people will be much more directly and indirectly

affected by climate change. It was also apparent, some of these students made the connections in the interview, but failed to report the connections while we were studying climate change.

Student Participation was Inconsistent

Inconsistent student participation made data analysis challenging and incomplete. Participation in the student climate survey in phase 1 of the study was 89%, which dropped to 56% in phase 2, and 53% in phase 3. The survey appeared simple and approachable at first, but a number of students found the one-page survey to be overwhelming and more work than they were willing to put time into. A number of students took the time to read the surveys and thoroughly answered the questions, but as the study progressed and fewer students completed the surveys, more students were quickly circling answers without taking the time to completely read the surveys. Three surveys were stricken from the study due to all "unsure" answers, option 3 on the Likert-scale style survey, being circled. Additionally, in phase 2 and phase 3 of the surveys, students commented on having to take the same survey again and some questioned why they had to do it, expressing their frustration.

Student reflections from phase 2 were turned in by 73% of students and 51% completed phase 3. This drop in participation is partially attributed to the expectation of students to write responses to questions and explain their responses. The overall participation was low, but the quality of responses was especially lacking. Some important insights were gained from student reflection, but more often than not, the responses were vague and incomplete, lacking the detail being sought through reflection.

Student interviews, in phase 3 of this study were conducted with 60% of the original participants. The interviews were originally scheduled to take place at the end of term 3, but they were delayed till the beginning of term 4. Due to the unusually high number of students that failed the previous term of biology, and others who missed excessive days of school, my roster changed significantly and I was unable to interview the students whose schedules had changed.

The drop in participation was partially due to students progressively realizing the surveys and reflections were not graded and not worth points. A regular question from students, as they received a paper copy of the survey or reflection was “is this worth points?” Students were told, each time, in advance that the questions were part of my research for my graduate degree and were not worth points. The reoccurrence of asking if they were worth points is evidence of students lack of listening to instruction in the sections of biology being studied. Additionally, a number of students progressively stopped doing course work or even showing up to class as the term progressed. These factors lead to questions about just how many students took the study seriously and what percentages of the responses were thoroughly thought out. According to my peers and based on my own observations, this lack of engagement has become much more common post pandemic. A study from the National Study for Educational Statistics indicated 87% of public schools report disruptions socio-emotional development of students in the 2021-2022 school year (NCES, 2022).

Value of the Study and Consideration for Future Research

Two significant limitations in this study were time and sample size. Additionally, these groups of students were particularly challenging to motivate to get to do basic work, and

especially challenging to get them to make connections on their own and to build on what they learned while studying climate change. This study will motive further adaptation to climate change education through the lens of effects on the most vulnerable populations and further work to better understand students understanding of climate change, their willingness to get involved with solutions, and their levels of eco-anxiety. Although using human examples was intended to better engage students, and was met with some success, it is clear more than topics and assignments are required to engage students. Classroom culture and communication are crucial for reaching all students, especially those disconnected with school and society.

Eco-Anxiety

As we learn more about students' experiences with anxiety and socio-emotional wellness, it will continue to be important to connect with students, to build relationships, and to find ways to get them to interact with real world content. Additional attention should focus on curriculum that directly and indirectly addresses identifying socio-emotional health and encourages students to dig into real world problems and provide opportunities to explain how they feel. This study will continue with future biology courses by gauging anxiety of students as they come to class and comparing how they feel after we study climate change. Continuing this study of eco-anxiety related to humans most impacted by climate change could include more streamlined assessment of anxiety levels. These assessments could be done independent of other variables, such as understanding and willingness to get involved. In addition, the experience from this action research may guide improvements in how to ask the questions and elicit more participation in responses. The article, Young People's Climate Anxiety Revealed in Landmark Survey

(Thompson, 2021), introduced a simpler survey with the prompt “climate change makes me feel…” The following emotions listed; sad, afraid, anxious, angry, powerless, guilty, optimistic, and indifferent. Keeping surveys simple and to the point could encourage more consistent student participation.

The structure of climate change education in future studies can benefit from this action research as many different examples were used to highlight societal implications of climate change. Some of these examples worked well, some fell flat, and many opportunities were missed to make larger connections between the various issues. Using a continuous improvement mindset, the ripple effects of this study have the potential to build much more meaningful experiences for students, while connecting them to the world around us.

Student Understanding of Climate Change

Although evidence supports some students engaged with this climate change content in different and meaningful ways, reaching more students, especially the less traditionally successful students, will be an emphasis in the future. Part of the motivation of this study involved engaging students from marginalized groups, and the reality that disparities in education are only growing from the pandemic (Goldberg, 2021). Emphasis must be directed to the importance of reaching marginalized groups. This study did not succeed in building bridges or bringing students into the conversations that traditionally would not be involved, highlighting the need for more study of how to better engage marginalized students. The need to reach underrepresented students has become even more imperative since the pandemic has widened disparities and achievement gaps. Goldberg (2021) shared

> We have a rare moment as a country to take stock and begin the hard work of building our schools back better and stronger – with the resolve necessary to ensure that our nations' schools are defined not by disparities but by equity and opportunity for all students.

Unfortunately, even with significant funds designated to narrowing the gaps in education, widened by the pandemics, my community has made few large-scale efforts to strive for equity in education.

The overall drop in and lack of participation is characteristic of the current climate in education. More emphasis should be placed on getting students to engage in general, in addition to focusing on large topics such as climate change. Many of my students either started the course checked out or progressively checked out throughout the term. Finding ways to draw them into the class will be vital to success at larger initiatives like addressing climate change through a social justice lens.

Future studies would revisit how effective the message of disproportionate effects from climate change is reaching students. This study did attempt to gauge if the message got through in student research and my instruction on climate change and to think about how to better prioritize learning about marginalized groups. More time and more student participation would help me better understand how teaching climate through a social justice lens impacts students, and I would expand this research into other content areas relating to social justice, such as ecology and resource depletion, health care, health impacts, and genetics.

Impact of Action Research on the Author

This action research has stirred up more questions than answers. A significant realization while conducting this research was that the scope of the study was ambitious for the time frame and the number of students involved, and any one of the three sub questions addressed in this study could have been the focus of their own action research project. Attempting to gauge three drastically different sub questions had an overwhelming effect on students and getting clear answers was challenging throughout the study. In the spirit of action research, I have learned more about my students and what can be improved in my school culture. This process has connected me with my students in a different way and has spurred new questions and motivations to help engage with students in more meaningful ways. Using real world examples, like climate change, has motivated me to identify more real-world applications to better engage students. Real world problems can be more meaningful and apply to our students' lives, directly and indirectly.

Interviews and Reflection

This project has motivated me to work on reflection with my students. Students' inability to draw on their experiences and summarize what we did and why we did it is concerning. Ideally, we would shift assessment away from multiple choice and incorporate more reflection type summaries, but this will require shifting student thinking and this project shows evidence that many of my students are not prepared to summarize their understanding of complex concepts through reflection. In future studies, reflection could be incorporated into student research or used for peer review and feedback. Preparing students for this type of assessment will

take time but will be valuable in the long run. For general education courses, we need to encourage more thinking, reasoning, problem solving, and the connecting of concepts.

Student interviews represented a significant challenge in this study. Finding the balance of what to ask and avoiding using leading questions or responses to try to elicit more detail created compounding challenges. This study was set up for interview questions to be flexible and to developed based on previous student responses, but for the scope of this study, establishing consistent questions from the start could have made the process much smoother. However, these interview discussions were quite valuable. Beyond gaining data vital to better understand students in this study, sitting down and talking to students one on one, outside of the class, was enriching. Students shared personal stories and, in some cases, opened up about things going on in their lives I may have never learned. Interviews are time consuming and logistically challenging, especially if it involves leaving the classroom to gain some privacy, but this study has reinforced the power of genuine conversation with students. The value of making connections with students is not to be underestimated and will be critical to reach acceptable levels of student engagement.

Social Justice in the Science Classroom

The implementation of this project has raised the question: how can we more effectively emphasize disproportionate effects on humans in biology education? The process of this research has further motivated me to implement social justice into other aspects of my biology curriculum. This will not be a quick transition, as plenty of effort should be directed at improving climate change education. However, the process of improving climate education through a social

justice lens will provide valuable experience for expanding the scope of real-world studies. In the long term, finding ways to engage students with real-world problems, with an emphasis on people most directly affected, will open up curriculum for students to engage in meaningful issues of their time with the intention of developing solutions to address injustice.

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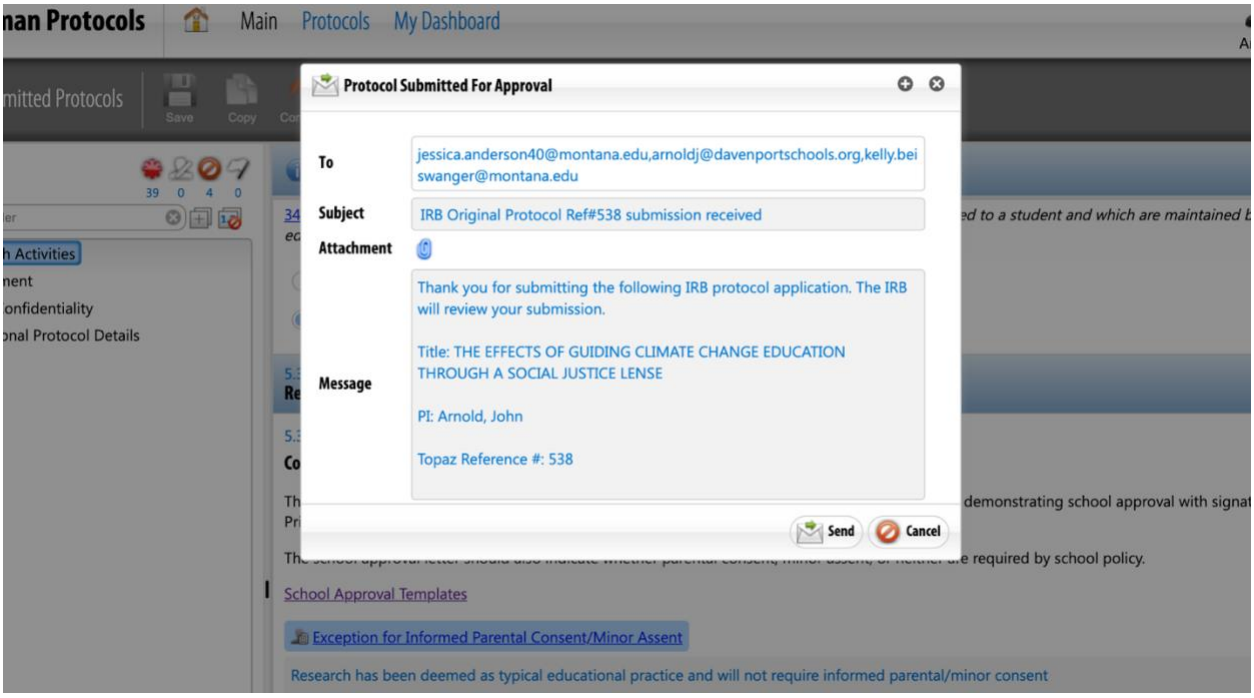
APPENDICES

APPENDIX A

IRB APPROVAL


nan Protocols
Main
Protocols
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mitted Protocols
Save
Copy
Protocol Submitted For Approval
To
jessica.anderson40@montana.edu,arnoldj@davenportschools.org,kelly.beiswanger@montana.edu
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Attachment
Message
Thank you for submitting the following IRB protocol application. The IRB will review your submission.
Title: THE EFFECTS OF GUIDING CLIMATE CHANGE EDUCATION THROUGH A SOCIAL JUSTICE LENSE
PI: Arnold, John
Topaz Reference #: 538
Send
Cancel
School Approval Templates
Exception for Informed Parental Consent/Minor Assent
Research has been deemed as typical educational practice and will not require informed parental/minor consent

APPENDIX B

STUDENT CLIMATE SURVEY

Name _____

***Read each statement carefully and choose the response that best fits your understanding**

1a. Climate change is well researched and well documented
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

2a. Human actions have contributed significantly to climate change
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

3a. Climate change has and is posing threats to current human populations
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

4a. Climate change poses threats to future generations of humans
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

5a. Humans can make choices to slow down climate change
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

1b. You are making decisions in your own life to slow the pace of climate change
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

2b. You plan to take action on climate change on a day to day, personal level
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

3b. You intend to take action by making personal decisions that affect your carbon footprint
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

4b. You intend to take action or pursue life choices that influence large scale societal changes related to sustainability
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

1c. Thinking about climate change makes it difficult for me to concentrate
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

2c. Thinking about climate change makes me feel nervous, agitated or anxious
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

3c. You feel down, depressed or hopeless when thinking about climate change
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

4c. The more you learn about climate change, the more negative emotions are brought out
1) Strongly disagree 2) disagree 3) not sure 4) Agree 5) Strongly Agree

APPENDIX C

STUDENT REFLECTION

Student Reflection (Phase 2) *Climate Change and Effects on Human Health

How does learning about human health effects from climate change make you feel? Circle the emoji that best fits your feelings and explain why you feel that way.

Do you feel differently about climate change since the beginning of this course? Explain / justify your answer by drawing from both your own research and your classmates.

Does learning about human health effects from climate change motivate you to get involved to lowering your own carbon footprint or advocating for a more sustainable society? Explain your answer (why or why not).

For the following examples, list ways an individual can get involved with solutions to climate change?

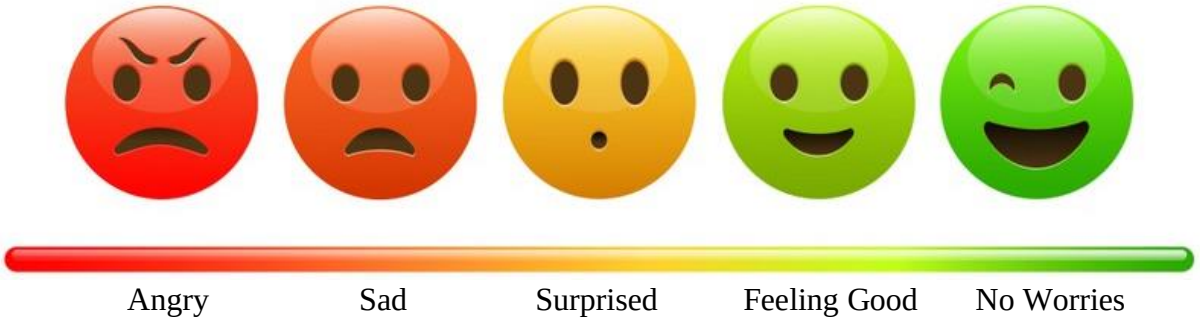
1. Personal lifestyle

2. Larger scale societal change

Describe how climate change is a factor affecting public health. Be specific by including examples from the public health issue you researched and at least one topic from a different group presentation.

Student Reflection (Phase 3) *Climate Change and Effects on Society

How does learning about negative effects on society from climate change make you feel? Circle the emoji that best fits your feelings and explain why you feel that way.



Do you feel differently about climate change since the human health project? Explain / justify your answer (draw from both your own research and your classmates).

Does learning about human health effects from climate change motivate you to get involved to lowering your own carbon footprint or advocating for a more sustainable society? Explain your answer (why or why not).

For the following examples, list ways an individual can get involved with solutions to climate change?

1. Personal lifestyle

2. Larger scale societal change

Describe how climate change is negatively affecting society. Be specific by including examples from the public health issue you researched and at least one topic from a different group presentation.

APPENDIX D

STUDENT INTERVIEW

***Individual interviews will be specific to student responses to surveys and reflection**

Part 1)

Based on your survey results of eco-anxiety levels (questions 1c-3c), why have your responses changed or stayed the same?

How would you describe anxiety?

What are specific ways you experience eco anxiety?

Part 2)

Based on your survey results of your willingness and/or desire to get involved in solutions to climate change, what specifically are you doing or what would you like to do in the future?

Part 3)
Describe to me how humans are involved with climate change (cause of and affected by)

In response to your reflection on your health impacts of climate change (insert project topic), expand on your answer(s) regarding…

In response to your reflection on researching the impact of climate change on human populations (insert project topic), expand on your answer(s) regarding…

How impactful was learning about climate change as it relates to impact on vulnerable human populations? Why?