CLIMATE CHANGE EDUCATION IN PRIMARY SCHOOL CLASSROOMS

An Impact Study of a SubjectToClimate Educational Unit

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CITATION

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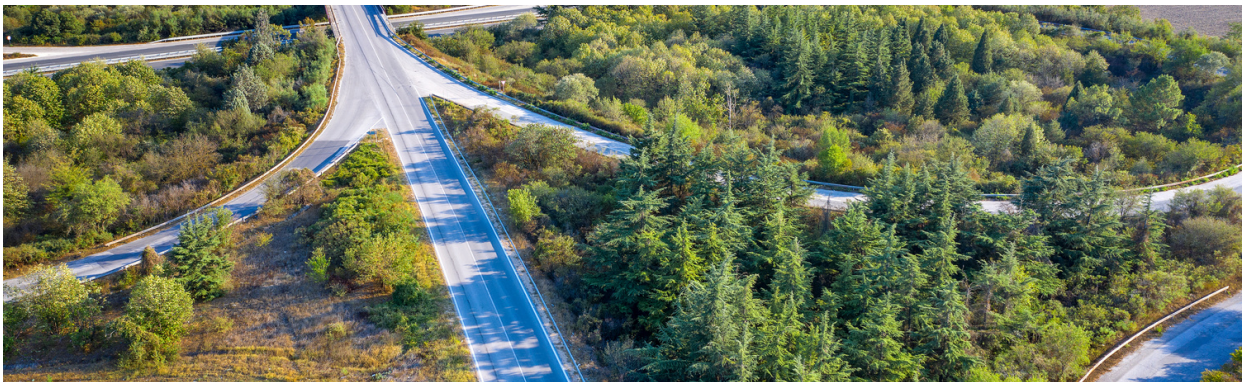
OBJECTIVES



In January 2022, Amber Medina and her class of 25 third graders began a new unit on "Green Transportation" as part of the curriculum at Dr. Owen Lloyd Knox Elementary School, a Visual and Performing Arts magnet and Title I school[1] in Los Angeles. The “Green Transportation” unit is part of the online resource database provided by SubjectToClimate, where Amber also works as a content creator.

SubjectToClimate is a nonprofit online connector for K–12 educators of all subjects to find credible and engaging materials on climate change at no cost.

Through this case study, SubjectToClimate aims to discover how student knowledge, attitudes, and behaviors regarding climate change may be influenced when a teacher uses an interdisciplinary unit from SubjectToClimate’s database in their classroom. Using Amber’s classroom as a pilot group, we are able to gain insights into the successes and limitations of SubjectToClimate’s lesson plans. These results may inform future large-scale studies.

1 Title I schools receive extra funding if at least 40% of their students qualify for a free lunch program.

BACKGROUND

Many experts agree that education remains a powerful and virtually untapped resource for climate change action; former UNESCO Director-General Irina Bokova says: “On a planet under pressure, education is the best way to drive change, to build resilient, green societies.” UN Sustainable Development Goals 4.7 and 13.3 call for climate change education to meet global sustainability targets.

Research[2] finds that interdisciplinary climate change education is very effective, as it highlights the importance of drawing conclusions and making connections beyond the science classroom. It also emphasizes the development of a better conceptual understanding of climate change by applying it to subjects outside of the hard sciences—e.g., social sciences, languages, and arts (Jain, 2020). If students are to imagine solutions to climate change problems, they need to develop a multidisciplinary perspective (Poullaouec-Gonidec, 2020).

Prior to teaching the "Green Transportation" unit in the winter, Amber taught a unit entitled "Green Spaces" in the fall of 2021. The "Green Spaces" unit provided background knowledge on photosynthesis to help students build a foundational understanding of the greenhouse effect. In this unit, students explored the green spaces at their school and discovered the correlation between green spaces and air quality. Amber notes that demonstrable and observable behavior changes occurred as a result of this first SubjectToClimate unit; for example, an exciting result of the unit was a change in students’ behaviors at school. They showed more interest in flowers and shrubs and stopped uprooting them. They even became environmental ambassadors, stopping other students in the school from harming the trees and bushes.

2 To find out more, check out one of the submissions to a UNESCO created commission on climate change education. See also: Transdisciplinarity: letting arts and science teach together (Burnard, et al, 2021.) and Education and Climate Change pp 1–44: The Role of Universities Building an Ecosystem of Climate Change Education (Reimers, 2020).

The "Green Transportation" unit was composed of six lessons focused on the impact of transportation choices, media messages, and the power of innovation. Some highlights of the unit are:

- It is project-based and includes access to lesson plans, videos, vocabulary cards, printable worksheets, and a grading rubric.[3]
- Each lesson plan is comprised of three sections:[4] 'Inquire', 'Investigate', and 'Inspire'.
- This unit is designed to build an understanding of how transport systems are designed in the students' local communities and around the world, so that students will be better equipped to strategize solutions that may reduce carbon emissions from the transportation sector.
- The unit is interdisciplinary: in science, they learn about the greenhouse effect and use mathematics skills to analyze transit systems and their carbon emissions. Through interdisciplinary learning, students develop an understanding of the complexities involved in 'choosing' a green alternative and see what it takes to build an attractive public transportation system in Los Angeles (LA) by interviewing a guest speaker from the LA Metro. They go on to design and advertise their own solution to improve the LA metro system.

3 See Appendix A for each lesson breakdown.

4 The teacher, Amber, wrote a blog to describe the process.

METHODOLOGY

SubjectToClimate began designing this impact study at the end of 2021 and sent the school agreement (see Appendix B) and consent forms (see Appendix C) in both Spanish and English to the students' parents in February 2022. We examined changes in student learning, behavior, and action by comparing the results of surveys taken before and after the unit (see Appendix D), as well as examining student work samples and collecting observations from Amber, their teacher.

The pre and post test questions were taken from the Yale Climate Opinion Map 2021's 30 survey questions. We selected and adapted the wording of eight of the questions[5] and added four climate change knowledge questions that were specifically covered in the "Green Transportation" unit used in the classroom.

Measuring behavior change amongst students presents a challenge, as a substantial change in behavior necessitates that it is sustained over a long period of time. In this case, there is also a cap on behavior changes due to the fact that a third grader does not yet have complete self-agency and is not in control of all of their decisions.[6]

5 See Appendix E for the questions and answer key, and Appendix F for how we planned to measure each aspect of student learning.

6 See Appendix G for the list of questions from the interview protocol for behaviors and actions we were looking for.

RESULTS

Students showed a substantial increase in their knowledge about climate change.

As seen in figure 1, at least 25% of the class showed an improved understanding of reducing carbon footprints, and approximately 86% of the students grasped at least a basic definition of the greenhouse effect after completing the SubjectToClimate unit.

Class improvement in knowledge of climate change concepts

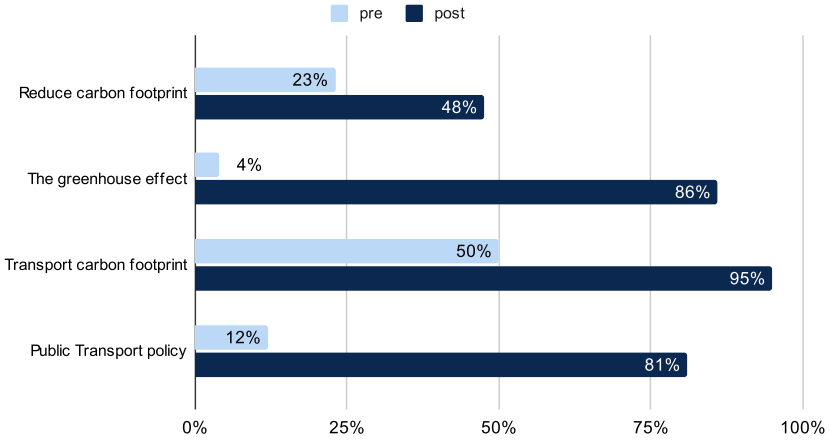


Fig. 1

THE POSTTEST REVEALED A SUBSTANTIAL CHANGE IN THE STUDENTS' BELIEFS ABOUT CLIMATE CHANGE.

27% more students believe that global warming is happening

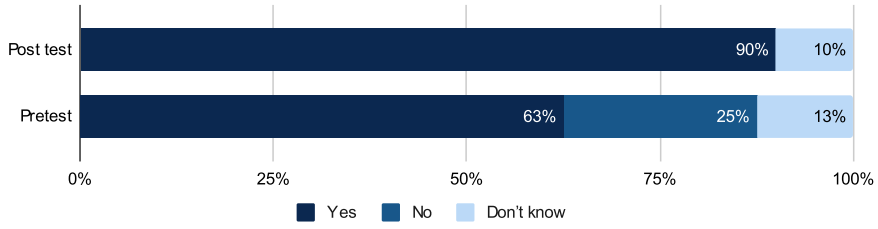


Fig. 2

45% more students attribute global warming to human activity

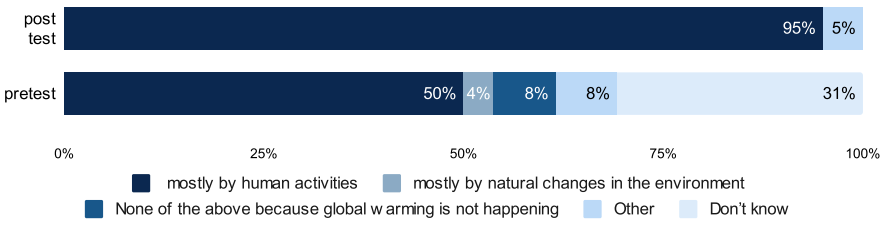


Fig. 3

After completing SubjectToClimate's "Green Transportation" unit in class, an additional 45% more students attributed human activity as the cause of climate change (see fig. 2), and 27% more students believe that climate change is happening (fig.3).

Amber was not surprised by the results of the pretest for these two belief questions, as student responses generally reflected their parents' beliefs, which contain mixed opinions on the validity and causes of climate change.

She also notes that students regularly mentioned their parents' opinions in classroom discussions.

Many more students became worried about global warming and believed that it is harming humans, plants, and animals after completing the unit (see table 1).

Table 1

Student Risk Perception Regarding Global Warming

	Pre	Post
Percent of students worried about global warming	27%	77%
Global warming will harm plants and animals	42%	90%
Global warming will harm humans	52%	65%
Global warming is harming humans now	38%	84%

It is worth noting that risk perception is challenging for an eight or nine year old to assess, given their stage of development. In particular, question six[7]—"When do you think global warming will start to harm people in the United States?"—requires them to consider the far-ranging consequences of climate change (e.g., what are the effects now, what will they be in 10 years, 25, 50, 100, never).

After completing this unit, 95% of the students in the class believed that schools should teach about global warming, which is 18 points above the national average[8], and 43% of students from this classroom are now discussing climate change with family or friends.

7 See Appendix D and Appendix G for more information about how this data was collected and analyzed.

8 See Appendix H & Appendix I for a full comparison with the Yale Climate Survey results.

It is worth noting that the Yale Climate survey participants are all adults. The Yale Climate Opinion Maps (YCOM) survey identified these points (see table 2) as indicators of actionable behavior in adults, but very little guidance exists for interpreting survey data from young children and extrapolating their answers to estimate behavior change.

Table 2

Students scored well above the national average from the YCOM Survey

	Pre	Post	National	CA	LA
Schools should teach about global warming	73%	95%	77%	81%	81%
I talk about global warming	35%	43%	35%	43%	41%

Color legend

>0% >5% >10% >15% >20% >25% >30% >35% >40% >45% >50% >55% >60% >65% >70% >75% >80% >85% >90% >95%

Based on data from the Pew Research Center, individuals from the Gen Z and millennial generations tend to have a more positive attitude towards climate change policies, regardless of party lines, so that can be an explanation for the difference between the CA and national averages.

95% of the students in the class believed that schools should teach about global warming

Further, there is qualitative and anecdotal evidence supporting the notion that the students in the class are changing and inspiring others to take action. For example, when a new student joined the class in January, having no prior climate change education, he tended to leave the water running. One day, another student witnessed this action and asserted, “You have to know that water is precious.” The student proceeded to provide an in-depth explanation of water scarcity. The new student was quite surprised, as he had never been reprimanded for not turning water off all the way, particularly from one of his peers.

The interdisciplinary nature of the unit had a positive influence on student participation and motivation.

Shy students felt more comfortable taking on authoritative roles during the unit by sharing their ideas with a small group or finding alternative ways to contribute to classroom discussions such as drawing or note taking. Students were more eager to write in general, since the writing task was designed as an open-ended assignment that proved to be more stimulating than test prep. In particular, the non-writers in the class were more vocal during note taking sessions and asked for help with skills that they normally lack, such as spelling, as opposed to relying on the usual writer of the group to lead the discussion.

Students connected the impacts of lifestyle changes to climate change and better understood how individual choices impact the rest of the world.

During the unit, students heard from a guest speaker who worked for the LA Metro system. After listening to their speech, students were able to ask the speaker questions, many of which revolved around expanding access to public transport and exploring ways to use public transportation to help meet energy and emissions targets. This experience stimulated creativity amongst the students and enabled them to better understand the impact of personal choice when it comes to climate change, as making the decision to use public transit can have an impact on mitigating the effects of climate change.

LESSONS LEARNED

From this impact case study, we find that teaching climate change across multiple disciplines increases student knowledge of the topic, alters their beliefs about climate change, and impacts student behavior both in and out of the classroom.

Teaching interdisciplinary units that are rooted in inquiry-based learning can be time consuming and difficult, particularly in early education classrooms where students may not have experience with open-ended independent work. Time must be invested up front to model this type of work and go through introductory exercises that will guide students through the process of independent inquiry. In addition, educators must set clear expectations for productive independent work environments.

In particular, Amber found that teaching more than one interdisciplinary unit about climate change is especially helpful. Amber was surprised that the pretest before the "Green Transportation" unit yielded such a low percentage of belief in climate change amongst the students, since she already taught the "Green Spaces" unit that fall. However, she notes that the high percentage of correct answers to the question asking if the greenhouse effect relates to photosynthesis (which it does) reflects that students retained some of the information taught in the first unit, which may have provided useful foundational knowledge to understand climate change on a deeper level during the "Green Transportation" unit. Nevertheless, these data show that ensuring long-term retention of climate change knowledge is an ongoing difficulty.

TOPICS FOR FURTHER EXPLORATION

We hope to conduct more rigorous case studies in the future that will better assess the impacts of interdisciplinary instruction on climate change education via SubjectToClimate lesson plans and units.

Further studies will collect data over a longer period of time to test whether students' knowledge and opinions about climate change as a result of learning a SubjectToClimate unit are retained throughout the students' lives and academic careers. Future studies should consider following a class for a minimum of one academic year, and should examine shifts that take place after completing multiple units of study on climate change. In addition, case studies will need to gather information about whether students have received consistent climate change education and compare results with those from students who only experienced climate change education in one grade level, semester, etc.

As seen in this case study, setting expectations for observable behavior changes from younger age groups can be difficult; more rigorous case studies with a broader sample size may help us to set realistic expectations and discover better metrics to observe behavior changes of elementary students that partake in SubjectToClimate units or lesson plans.

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APPENDIX A
LESSON BREAKDOWN

Lesson and Duration	Subjects	Synopsis
What Are Carbon Emissions? 45 minutes	Science, Language Arts, English, Interdisciplinary	Students are introduced to carbon emissions and the idea of carbon and ecological footprints.

Inquire: Students reflect on what they know about photosynthesis and how plants transform carbon dioxide into oxygen.
Investigate: Students learn about the greenhouse effect and calculate their ecological footprint.
Inspire: Students generate ideas on how to reduce carbon footprint and impact on the environment.

Emissions by Mode of Transportation 50 minutes	Science, Math, English, Language Arts, Interdisciplinary	Students compare and contrast emissions from different modes of transportation and explore the concept of transportation planning.

Inquire: Students analyze a bar graph of carbon dioxide emissions by different modes of transportation and calculate environmentally conscious modes of travel based on emissions.
Investigate: Students analyze commuter survey results of the top concerns with public transportation and complete real-world math problems based on different transportation scenarios, calculating the difference in carbon emission outputs.
Inspire: Students reflect on how transportation systems are created and are introduced to the role of transportation planners and Hong Kong's world-class transit.

Into the Mind of a Transportation Planner 50 minutes	English, Language Arts Interdisciplinary, Engineering	Students explore different transit systems around the world and unpacks the decision-making process behind transportation planning.

Inquire: Students analyze the transit route maps of four different cities.
Investigate: Students explore in greater depth the elements and features of different transit systems.
Inspire: Students recall rider concerns and reimagine a metro system to appeal to more riders.

Lesson and Duration	Subjects	Synopsis
Understanding the Power of Media 55 minutes	English Language Arts Interdisciplinary	Students understand the power and influence of the media. Students will leverage this understanding to develop their own media campaigns for their reimagined metro systems.
Metro Campaign Creation Time 55 minutes	English Language Arts Interdisciplinary, Engineering	Students explore critical media literacy and begin creating their advertisements.
Media Campaign Presentations 55 minutes	English Language Arts Interdisciplinary, Engineering Climate Action	Students feature the final advertisement presentations and provide students with the opportunity to think about how to use these projects to impact real life.

Inquire: Students reflect on how their reimagined metro systems address the top ten concerns riders had with the metro.
Investigate: Students think critically about how different transportation advertisements get consumers to want to use their services or purchase their products.
Inspire: Students brainstorm an advertisement for their reimagined metro system.

Inquire: Students explore the definition and guiding questions of critical media literacy.
Investigate: Students analyze a video about car-free cities.
Inspire: Students begin creating their own advertisement for their metro designs.

Inquire: Students reflect on the advertisement process and their role in small groups.
Investigate: Students present their final advertisements to their peers.
Inspire: Students brainstorm what to do with their ideas in order to increase metro/public transit ridership in their community.

APPENDIX B
SCHOOL AGREEMENT

School Name
Dr. Owen Lloyd Knox Elementary

School Address
8919 S Main St Los Angeles, California 90003

Name of Head of School
Maria Vazquez (principal)

Grade Level
3

Email Address of Head of School
NA

Number of Students
25

Who We Are

SubjectToClimate is a nonprofit online connector for K-12 leaders of all subjects to find credible, unbiased, and engaging materials on climate change at no cost.
We provide a hub of credible and engaging teaching materials on climate change for educators to easily find the resources they need. This consists of:

- Resources from other organizations that we curate and add synopsis, teaching tips, and scientists notes.
- Inquiry-based lesson plans are developed internally (also known as SubjectToClimate Lesson Plans).

Purpose

We would love to collaborate with [Amber Medina] and her classroom at your school. We are interested to see how using SubjectToClimate in your classroom is helping:

- enhancing climate change knowledge & inspiring action in your students

Amber has been creating, implementing, and improving SubjectToClimate lessons. We felt she would be an amazing candidate.

What Will the Project Involve?

- [Amber Medina] will teach their regular lesson plan and identify SubjectToClimate resources they are planning to use.

- We will administer a pre-and post test survey designed in collaboration with [Amber Medina] to measure change in student attitudes and beliefs about Climate Change

- [Amber Medina] will share student work with us from the unit

How Will We Support You?

We will be available to support teachers during the planning process, and help them identify appropriate resources to use. We (optional) will be available to be interviewed by students to help with their research.

Timeline	Deliverables
Week 0	SubjectToClimate to send survey draft and letter to parents.
Week 1 pre-survey	SubjectToClimate to send pre-survey.
Week 2 start of lesson	Amber to send results.
Weeks 3-6 continue lesson	
Week 7 science project	Midway interview.
Week 8 post survey	SubjectToClimate to send post survey.
Week 9 share student work	Amber to send results.
Week 12 SubjectToClimate to share draft for approval	SubjectToClimate shares draft.

How Will We Protect Your School's & Students' Privacy?

- The school name and location will only be used if the school consents to do so.
- Students and parents will be informed of the purpose of the collaboration. It will be made clear that the purpose is to evaluate the effectiveness of SubjectToClimate, and NOT student performance.
- Interviewing students or getting access to their work will be optional, and will not be done without student and parent consent. Sharing student work on our platform will only be done with written consent from both parents and students.
- All data collected from the surveys will be anonymized in our data collection process, data analysis and findings (we will never have access to who the answers are coming from).
- The published materials—including video, audio, images, quotes, anecdotes, and report—will be shared with the school for approval prior to publication.
- The school/teacher/student can pause, cancel, or stop participation at any time.

APPENDIX C
PARENT CONSENT FORMS

Dear parents,

I am excited to let you know that we students in grade three will be participating in a study on how learning about climate change can influence their attitudes, beliefs, and behavior.
We are working with SubjectToClimate, a nonprofit online connector that provides K-12 students and teachers access to find credible, unbiased, and engaging materials on climate change of all subjects at no cost.

SubjectToClimate is interested to see how using SubjectToClimate in their classroom is helping in: Enhancing climate change knowledge & inspiring action in your students

What will the project involve?

1. We will administer a pre-and post test survey designed in collaboration with SubjectToClimate to measure change in student attitudes and beliefs about Climate Change
2. After parent consent, will share student work with SubjectToClimate

How will we protect your child's privacy?

All data collected from the surveys will be anonymized in our data collection process, data analysis and findings. (we will never have access to who the answers are coming from)

When sharing your child's work, their first name and age will only be displayed after we receive your consent to do so.

Interviewing students or getting access to their work will be optional, and will not be done without student and parent consent. Sharing student work on our platform will only be done with written consent from both parents and students.

Please sign and return the form on the next page.

PARENT CONSENT FORM

Please sign and return the form below:

I, _____ give my consent for _____ to
guardian's name *child's name*

(Check all that apply)

- ☐ Participate in the pre and post survey.
- ☐ Share their work with SubjectToClimate.
- ☐ Have their first name and age shared on SubjectToClimate publications*.

*The school/teacher/student can pause, cancel, or stop participation whenever it suits their needs.

_____
guardian's name

_____
guardian's signature

APPENDIX D
DATA COLLECTION AND ANALYSIS

Test:
Twenty-six students responded to the pretest on Feb. 11, 2022, prior to the start of the unit with five incomplete, and 21 students responded to the post-test on May 15, 2022 with four incomplete responses. The difference in respondent numbers is due to COVID-related absences. The data collected did not include personal identifiers.

Teacher interview:
The classroom teacher, Amber, was interviewed at the following times: prior to the start of the unit, halfway through the unit (to get qualitative insight on observable changes in student behavior, learning and attitudes), and after the completion of the report draft (to gain insight on the results and discuss their presentation in this impact case study).

The teacher interview provided evidence of:

1. Changes in student action and behavior related to climate change;
2. Increased interest amongst students to learn, discuss or inquire about climate change;
3. Increased motivation to participate in school work as a result of studying about climate change; for example, students were more eager to participate in writing, editing and publishing their writing when it pertained to climate change, in comparison to more pedantic writing tasks often given in other English classes.

Student work samples fall into two categories:

1. Work completed as part of the unit;
2. Work that was completed outside of instructional time.

Student work samples were used purely as evidence or examples.

APPENDIX E
PRE AND POST TEST
WITH ANSWER KEY

Adaptation of Yale Climate Opinion Maps 2021
ANSWER KEY: Correct: **BOLD** Incorrect: Underlined

1. Assuming global warming is happening, do you think it is… ? (Belief)
    a. **Caused mostly by human activities**
    b. Caused mostly by natural changes in the environment
    c. None of the above because global warming is not happening
    d. Other
    e. Don't know
2. Do you think that global warming is happening? (Belief)
    a. **Yes**
    b. No
    c. Don't know
3. How worried are you about global warming? (Risk Perception)
    a. **Very worried**
    b. **Somewhat worried**
    c. Not very worried
    d. Not worried at all
4. How much do you think global warming will harm plants and animals? (Risk Perception)
    a. Not at all
    b. Only a little
    c. **Somewhere in the middle**
    d. **A great deal**
    e. Don't know
5. How much do you think global warming will harm people in the future? (Risk Perception)
    a. Not at all
    b. Only a little
    c. **Somewhere in the middle**
    d. **A great deal**
    e. Don't know
6. When do you think global warming will start to harm people in the United States? (Risk Perception)
    a. **They are being harmed right now**
    b. **In 10 years**
    c. In 25 years
    d. In 50 years
    e. In 100 years
    f. Never

PRE AND POST TEST
WITH ANSWER KEY

Adaptation of Yale Climate Opinion Maps 2021
ANSWER KEY: Correct: **BOLD** Incorrect: Underlined

7. Schools should teach children more about the causes, effects, and solutions to global warming. (Policy Support)
   a. **Strongly agree**
   b. **Somewhat agree**
   c. Somewhat disagree
   d. Strongly disagree
8. How often do you discuss global warming with your friends and family? (Behaviors)
   a. **Often**
   b. **Sometimes**
   c. Rarely
   d. Never
9. How can I reduce my ecological footprint? (Knowledge)
   a. Walk to school
   b. Take public transportation
   c. Bike to school
   d. **Any of the above**
10. What is the greenhouse effect? (Knowledge)
   a. the cooling of the Earth because of air pollution
   b. **the warming of the Earth because of trapped radiation**
   c. when a solid turns into a liquid
   d. the life cycle of a plant
11. What form of transport has the largest carbon footprint? (Knowledge)
   a. Bike
   b. Ferry
   c. Car
   d. **Plane**
12. How can you get more people to take public transport? (Knowledge)
   a. make it more safe
   b. make it faster
   c. make it nice and clean
   d. **any of the above**

APPENDIX F
PLANNING DATA COLLECTION

Our study aimed to measure the effects of interdisciplinary climate change education on knowledge, opinions and behavior. As such, we mapped out the survey questions that would address each metric.

Research Question	Method
Change in Beliefs	Pre & Post test q. 1-2 & 4-6 Teacher interview
Change in Attitudes	Pre & Post test q. 3 & 7 Teacher interview
Change in Behavior	Pre & Post test q. 8 Student work sample Teacher interview
Change in Knowledge	Pre & Post test q. 9-12 Student work sample Teacher interview

The test was analyzed based on similar criteria to the YCOM survey (beliefs, risk perception, policy support, and behavior) with an added section addressing knowledge of climate change. The pre and post results were compared to the National, CA and LA YCOM 2021 results.
Correct and incorrect responses will follow the same scale. For example, in question three ("Are you worried about global warming?"), the answer options "very worried" and "somewhat worried" were collapsed into one category—"worried." Similarly, "not so worried and "not worried at all" were condensed into "not worried."

School Background

We did not collect demographic data from the class, but according to the California Department of Education (CDE), Knox Elementary School has 767 students; 30.9% of these are English language learners and 96.2% qualify for free or reduced lunch. In this particular class, 20 students were English Language Learners, one student was unenrolled, and six were chronically absent (this includes COVID-related absenteeism).

APPENDIX G
INTERVIEW PROTOCOL (AMBER)

Let us start with you going over how the lesson has been going with you so far.
How often do you teach interdisciplinary units?
We'll now take a step back to look at the test and discuss the results.
Were you surprised by the results of the pre test, or did you expect similar results?
Can you share some of your students' work so far? Feel free to share your screen and review their work for evidence of increased knowledge of climate change.

Did you observe any change in student behavior/ beliefs about climate change? Please discuss/ provide examples (allow Amber to speak, and use these follow up questions to elaborate as needed):

- Did the example of student action to reduce their carbon footprint/take care of their environment take place at school or at home?Did the students show more engagement in the lesson/ subjects at the end of the unit compared to their engagement level at the beginning of the unit?
- In what ways did the students reveal that they had acquired new knowledge of climate change during the unit?
- Did the students take action on climate change? If so, what sorts of actions?
- Did the student talk about climate change amongst themselves during or after the unit?
- Are students asking more questions about climate change after completing the unit?
- Do the students seem motivated to do further research on climate change topics?

APPENDIX H

A. Pre & Post results with responses in support of climate change in bold.

1: Assuming global warming is happening, do you think it is...

	Pre	Post
Caused mostly by human activities	**50%**	**95%**
Caused mostly by natural changes in the environment	4%	-
None of the above because global warming is not happening	8%	-
Other	8%	5%
Don't know	31%	-

2: Do you think that global warming is happening?

	Pre	Post
Yes	**63%**	**90%**
No	25%	-
Don't know	13%	10%

3: How worried are you about global warming?

	Pre	Post
Worried	**27%**	**77%**
Not Worried	73%	23%

4&5: How much do you think global warming will harm...

	Plants & Animals		Humans	
	Pre	Post	Pre	Post
Will harm	**42%**	**90%**	**52%**	**65%**
Don't know	25%	5%	16%	15%
Will not harm	33%	5%	32%	20%

6: When do you think global warming will start to harm people in the United States?

	Pre	Post
Is harming them now	**38%**	**84%**
Will harm them later	62%	16%

A. Pre & Post results with responses in support of climate change in bold.

7: Schools should teach children more about the causes, effects, and solutions to global warming.

	Pre	Post
Agree	**73%**	**95%**
Disagree	27%	5%

8: How often do you discuss global warming with your friends and family?

	Pre	Post
Discuss	**35%**	**43%**
Do not discuss	65%	57%

9: How can I reduce my ecological footprint?

	Pre	Post
Walk to school	46%	33%
Take public transport	4%	-
Ride a bike	27%	19%
Any of the above	**23%**	**48%**

10: What is the greenhouse effect?

	Pre	Post
Cooling of the Earth ∵ of air pollution	23%	-
Warming of the Earth ∵ of trapped radiation	**4%**	**86%**
When a solid turns into a liquid	8%	10%
*The life cycle of a plant	65%	5%

*The teacher noted that the life cycle of a plant was covered in the previous unit “Green Spaces” and was perhaps why so many chose that answer choice.

11: What form of transport has the largest carbon footprint?

	Pre	Post
Bike	-	-
Ferry	-	-
Car	50%	5%
Plane	**50%**	**95%**

12: How can you get more people to take public transit?

	Pre	Post
Make it more safe	58%	14%
Make it faster	4%	-
Make it nice and clean	27%	5%
Any of the above	**12%**	**81%**

APPENDIX H

B. We observed improvement in knowledge of climate change amongst the class as a whole; below are the percentage differences of students who answered correctly.

Change in % of students with correct answers for knowledge questions.

	% Change
Assuming global warming is happening, do you think it is?	45%
Do you think that global warming is happening?	27%
How worried are you about global warming?	49%
How much do you think global warming will harm plants & animals?	48%
How much do you think global warming will harm humans?	13%
When do you think global warming will start to harm people in the US?	46%
Schools should teach children more about global warming.	22%
How often do you discuss global warming with your friends and family?	8%
How can you reduce your Carbon Footprint?	25%
What is the greenhouse effect?	82%
What form of transport has the largest carbon footprint?	45%
How can you get more people to take public transport?	69%

C. Results as they compare to the Yale Climate Opinion Map Survey 2021 results (uses color legend provided on the YCOM website).

Color legend

>0% >5% >10% >15% >20% >25% >30% >35% >40% >45% >50% >55% >60% >65% >70% >75% >80% >85% >90% >95%

Beliefs results compared to Yale Climate Opinion Map 2021 results

Questions	Pre	Post	National	CA	LA
Global Warming is caused by human activity	50%	95%	57%	63%	64%
Global warming is happening	63%	90%	72%	77%	76%

Risk Perception results compared to national and local results

	Pre	Post	National	CA	LA
I am worried about global warming	27%	77%	65%	73%	73%
Global warming will harm animals	42%	90%	71%	77%	78%
Global warming will harm humans	52%	65%	71%	77%	77%
Global warming is harming people right now	38%	84%	59%	66%	65%

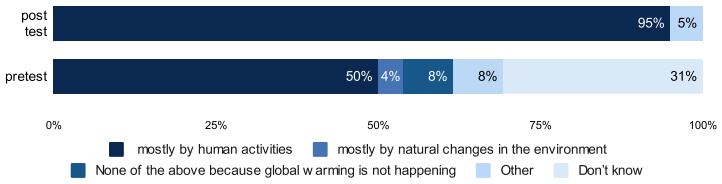
Behavior results compared to YCOM Survey

	Pre	Post	National	CA	LA
Schools should teach about global warming	73%	95%	77%	81%	81%
I talk about global warming	35%	43%	35%	43%	41%

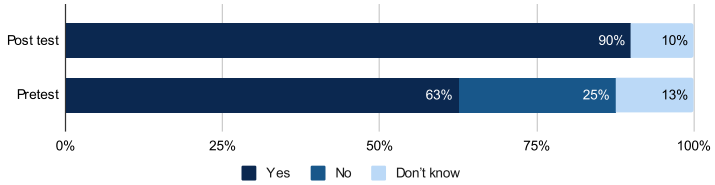
APPENDIX H

D. Graphs showing differences between pre and posttest data.

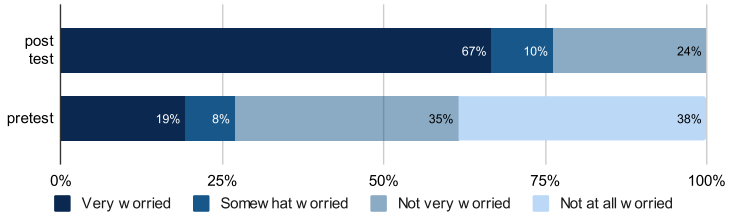
Question 1: 45% more students attribute global warming to human activity



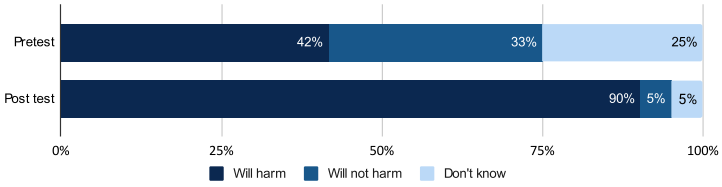
Question 2: 27% more students believe that global warming is happening



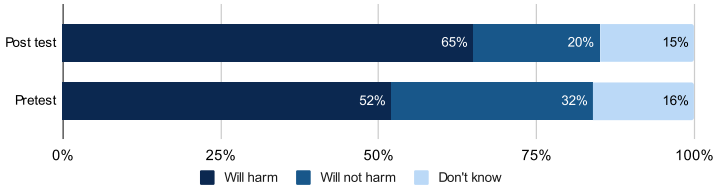
Question 3: 77% of students are worried about global warming



Question 4: Belief that global warming will harm plants & animals

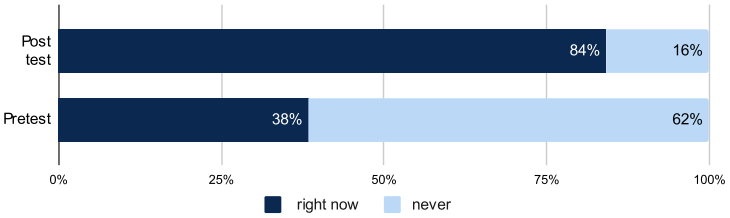


Question 5: Belief of harm to humans from global warming

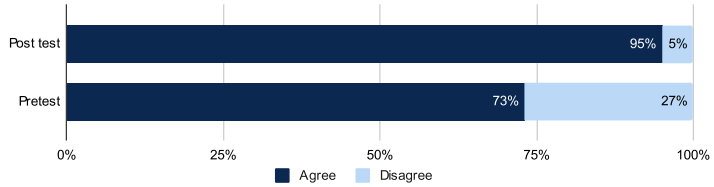


D. Graphs showing differences between pre and posttest data.

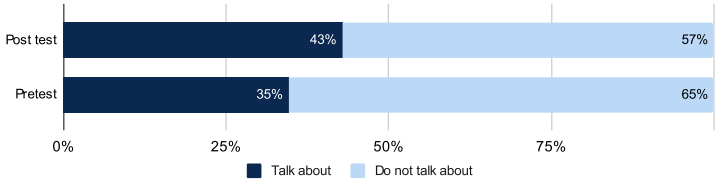
Question 6: When do you think global warming will start to harm people in the United States?



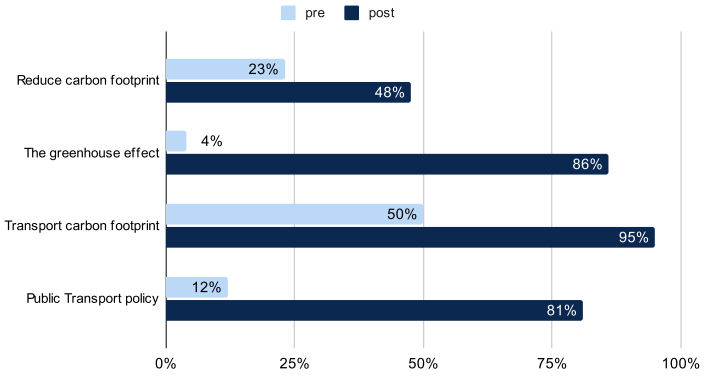
Question 7: Should schools teach about global warming?



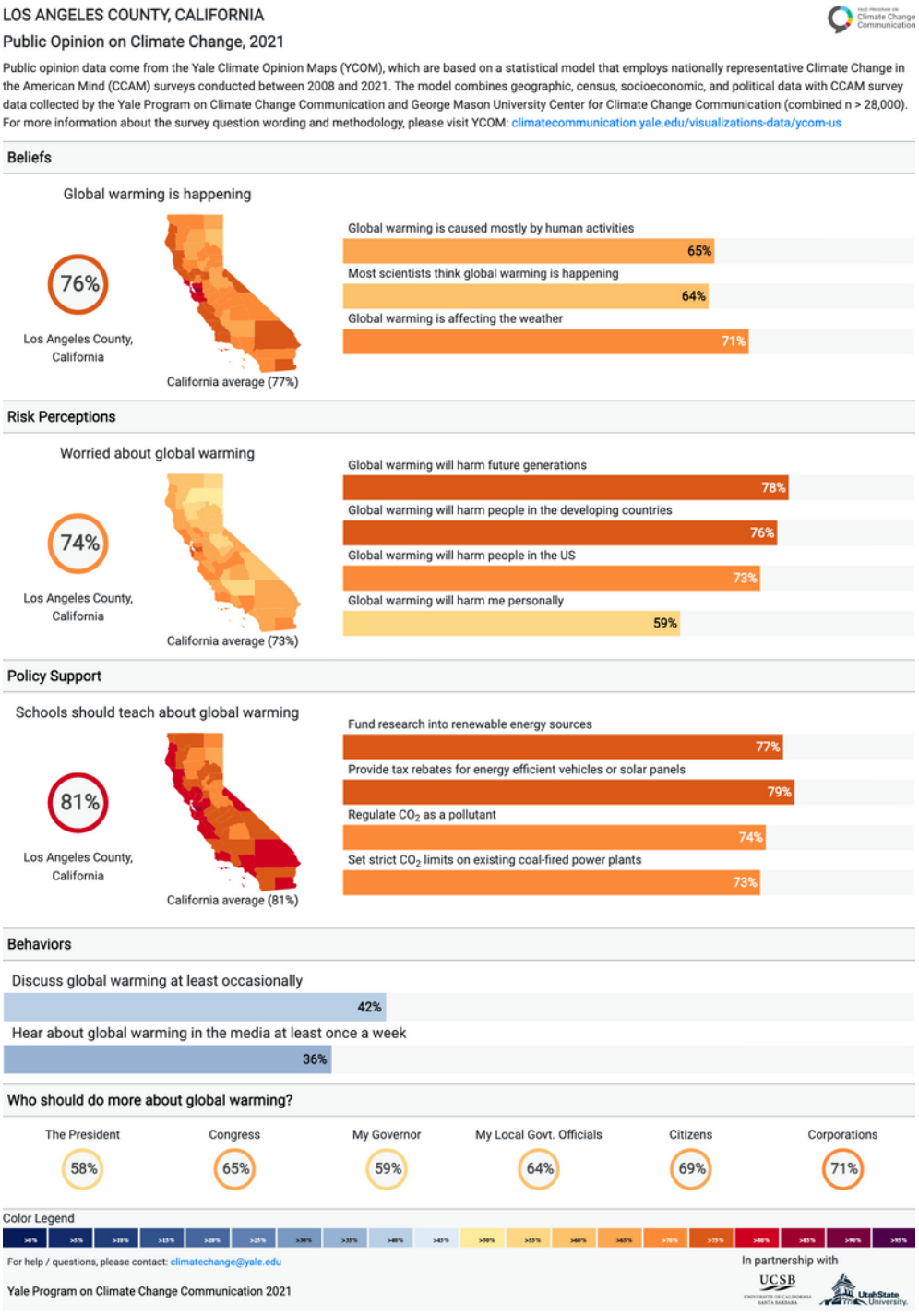
Question 8: Students start to talk more about global warming



Q. 9-12: Class improvement in knowledge of climate change concepts



APPENDIX I
CALIFORNIA YCOM FACT SHEET



LOS ANGELES COUNTY, CALIFORNIA

Public Opinion on Climate Change, 2021

Public opinion data come from the Yale Climate Opinion Maps (YCOM), which are based on a statistical model that employs nationally representative Climate Change in the American Mind (CCAM) surveys conducted between 2008 and 2021. The model combines geographic, census, socioeconomic, and political data with CCAM survey data collected by the Yale Program on Climate Change Communication and George Mason University Center for Climate Change Communication (combined n > 28,000). For more information about the survey question wording and methodology, please visit YCOM: climatecommunication.yale.edu/visualizations-data/ycom-us