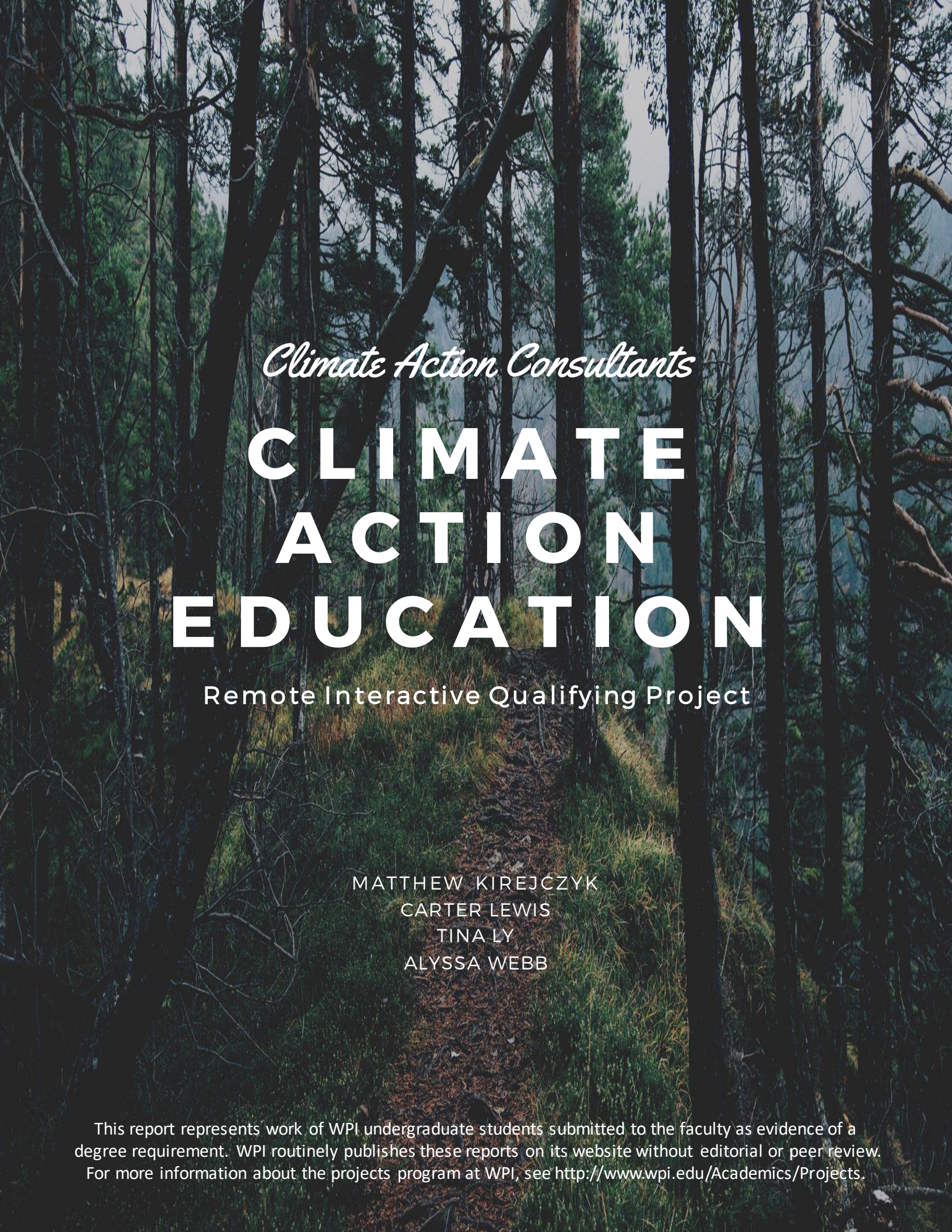

*Climate Action Consultants*

# CLIMATE ACTION EDUCATION

Remote Interactive Qualifying Project

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# ABSTRACT

The purpose of this project was to work with middle school teachers to co-create a climate change curriculum to appear on an interactive website in an effort to educate and motivate their students. The website was evaluated with several surveys to determine its effectiveness in educating students about the climate change crisis and motivating them to change. After completing modules on the website, most students learned more about climate change and were more likely to participate in climate action. The participating teachers thought some strengths of the website were the interactive elements, such as the videos and games, and its organization. They mentioned some weaknesses including the large amount of content. The teachers then listed some opportunities and possibilities of the website, such as using the website next year and expanding it beyond middle school students.

# CLIMATE CHANGE WARRIORS

Climate change warrior Ridhima Pandey became the youngest petitioner to the National Green Tribunal (NGT) at age nine. NGT is a statutory body in India that oversees cases related to environmental issues. Pandey stood before a green panel and demanded the government prepare a 'carbon budget' to limit the amount of carbon emissions (TNN, 2019). Pandey states, "We need to focus on 'needs' rather than 'wants. This could be key to conserving our environment." At just nine years old, Pandey was adamant on her thoughts about climate change and tried to make a difference in her community.

Pandey, now age 11, continues to express her opinions about climate change. She is an exemplary middle schooler that understands the urgent need to change human behavior to better the climate. From ages 11-13, children begin to develop their feelings and opinions about the world around them. It is also at this age that students can master and understand the complex concept that is climate change (Christensen, 2019). The actions of Pandey prove this fact and prove that children *can* make a difference in the world.

*(TNN, 2019)*

# MIDDLE SCHOOLERS VS. CLIMATE CHANGE

Middle school aged climate change warriors around the globe have shown that pre- and early teenagers can understand the severity of current practice towards the Earth's climate. A climate change warrior's actions are driven by knowledge, so education is essential in the efforts to both recruit more climate change activists and reduce negative climate change related behaviors of all children. Teaching children to save energy and produce less waste will help to save the environment, mitigate climate change, and therefore create a better place for future generations to live. At this age, students understand that they affect the world and the world affects them (Morin, 2019). By showing adolescents the effects their actions have on climate change, they are likely to be moved by this knowledge and improve their behavior.

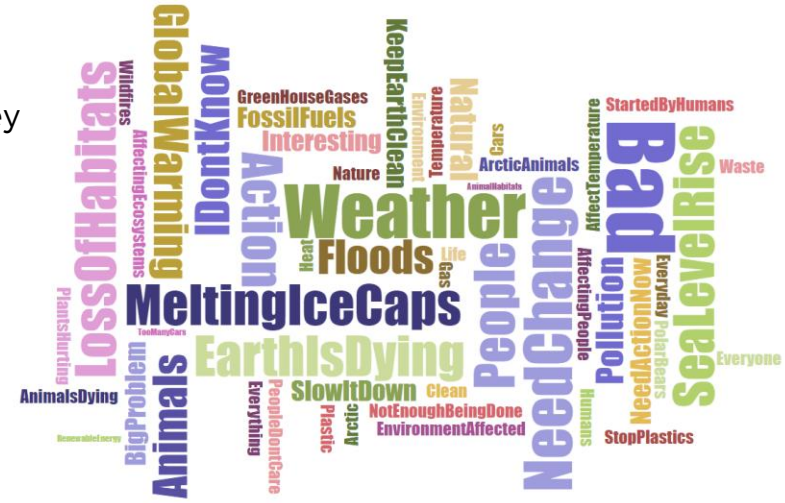



*Figure 1: Word Cloud of middle school children's thoughts and feelings about climate change*

While middle school students may not have learned about climate change formally in the classroom, many are familiar with the science or effects of climate change. In a survey, over 100 middle school students in Worcester county were asked their thoughts about the climate change crisis based on their prior knowledge. The most common responses included "bad", "Earth is dying", or "need change." In the word cloud shown in Figure 1 these thoughts are represented the largest, surrounded by less mentioned thoughts. The negative connotations observed in these responses indicates that students are aware of the consequences of climate change.

To effectively educate middle school students and provide examples of ways they can help, we must dive into the causes of climate change. The effects of climate change will appeal to these students and drive them to make change in their own lives. It is up to their generation to mitigate the climate change crisis before it is too late.

(NASA, 2019)

## WHAT IS CLIMATE CHANGE?

Climate change is a phrase that refers to the long-term change of the weather patterns in the Earth's climate. These changes are dominated by the irresponsible human activity of producing and burning fossil fuels. The climate continues to change due to these human behaviors (NASA, 2019). We must rely on the future generations to change their actions.

The changes that are occurring in Earth's climate started in the early 20$^{th}$ century, primarily driven by human activities (NASA, 2019). Humans are constantly mass producing and releasing extensive amounts of carbon dioxide ($CO_2$) into the atmosphere. The rise of Earth's average surface temperature, or global warming, is the result of this increase amount of $CO_2$. The rise in temperature causes glaciers to melt and therefore the rising of sea levels.

## WHY DO WE NEED TO ACT NOW?

The glaciers are melting. Arctic sea ice is disappearing. The global temperature continues to rise. The average temperature of Earth's surface in 2017 was 58.62 degrees Fahrenheit (Sharp, 2018). The melting of ice is now inevitable. Since then, temperatures have risen 1-2 degrees every year. We must reduce $CO_2$ emissions to decrease the Earth's temperature and slow the ice from melting. These changes are needed to prevent the sea levels from rising 16 more feet (Welch, 2015).

The consequences of climate change are severe. The students must understand the impact the climate crisis is having on the world in order to start mitigating it. People, as the main cause of the climate change crisis, are the ones that must take responsibility. By appealing to middle school students, we hope to motivate their efforts to prevent further climate change and to influence the adult authority.

For people to change their behavior, their mind will go through several stages. To understand this, we looked at Prochaska's change model to determine the steps that need to be taken to alter the actions of routine-oriented people.

# CHANGE MODEL

Prochaska's model of change involves five main stages (see Figure 2). First is **precontemplation**- A person is not aware a problem exists, so they do not think about changing.
The next stage is **contemplation**- A person recognizes a problem and are thinking about changing but have not committed to change yet.
The following stage is **preparation**- A person has decided to change and are thinking about the ways to start.
The next stage is **action**- A person has a plan to change their behavior and is following the plan.
The last stage is **maintenance**- A person has changed their behavior and need to be aware of temptation to relapse. At any stage in the model, people can **relapse** and start to move backwards through the stages of change.

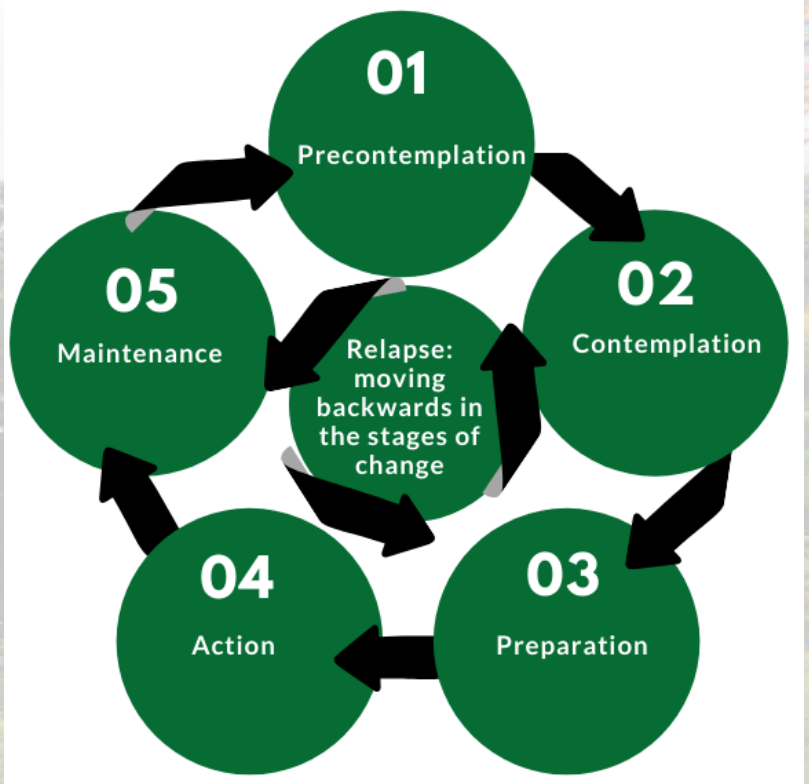
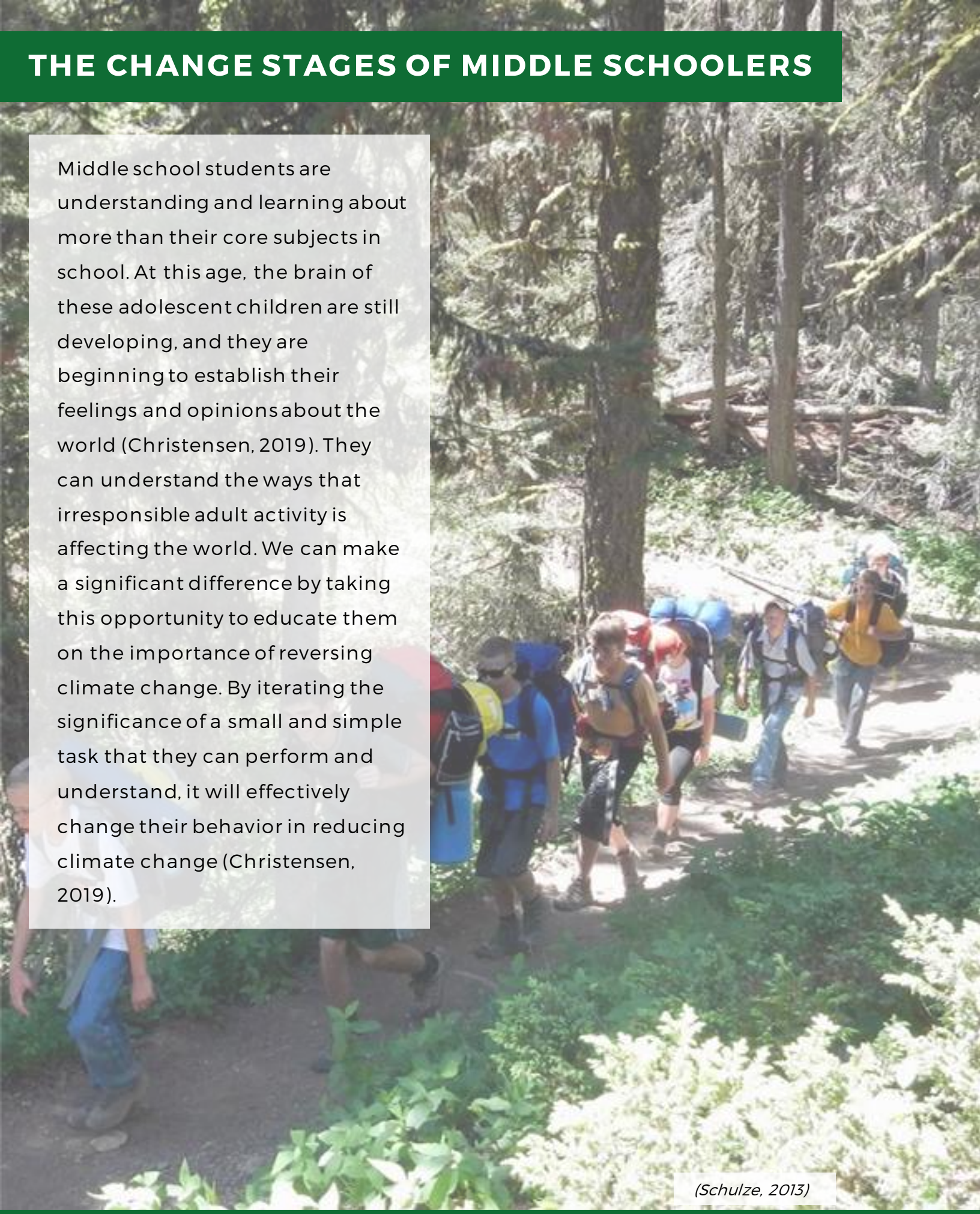



*Figure 2: Prochaska's Change Model*

In the context of climate change, precontemplation is the state of being unaware of the climate crisis or rejecting that the climate is rapidly changing due to human activity. Contemplation is recognizing the problem of climate change, but not taking steps to change their behaviors. Many middle school students are likely to be in the precontemplation or contemplation stages. Preparation is the decision to start taking small steps to mitigate climate change while a person that is actively changing their behavior is in the action stage. Maintenance is continuing their changed behavior into the future to reduce their own carbon emissions and to make a difference in climate change (Prochaska & Velicer, 1997).

# THE CHANGE STAGES OF MIDDLE SCHOOLERS

Middle school students are understanding and learning about more than their core subjects in school. At this age, the brain of these adolescent children are still developing, and they are beginning to establish their feelings and opinions about the world (Christensen, 2019). They can understand the ways that irresponsible adult activity is affecting the world. We can make a significant difference by taking this opportunity to educate them on the importance of reversing climate change. By iterating the significance of a small and simple task that they can perform and understand, it will effectively change their behavior in reducing climate change (Christensen, 2019).



*(Schulze, 2013)*

# WHY WORK WITH MIDDLE SCHOOL STUDENTS?

Most people know the phrase "STOP DROP AND ROLL". This phrase affects all generations no matter their age. But why is that? The students and young children taught this to their parents. Even if they cannot convince their parents to suddenly change their habits, they can move them from the pre-contemplation stage to contemplation, or from contemplation to preparation. Several studies have found that middle school children are the ideal age to inspire change in the adults around them. This idea will remain the same while talking about climate change. If middle school students are fascinated by climate change, they will bring their lessons home and encourage their parents and other adults to fight against climate change (Christensen, 2019).

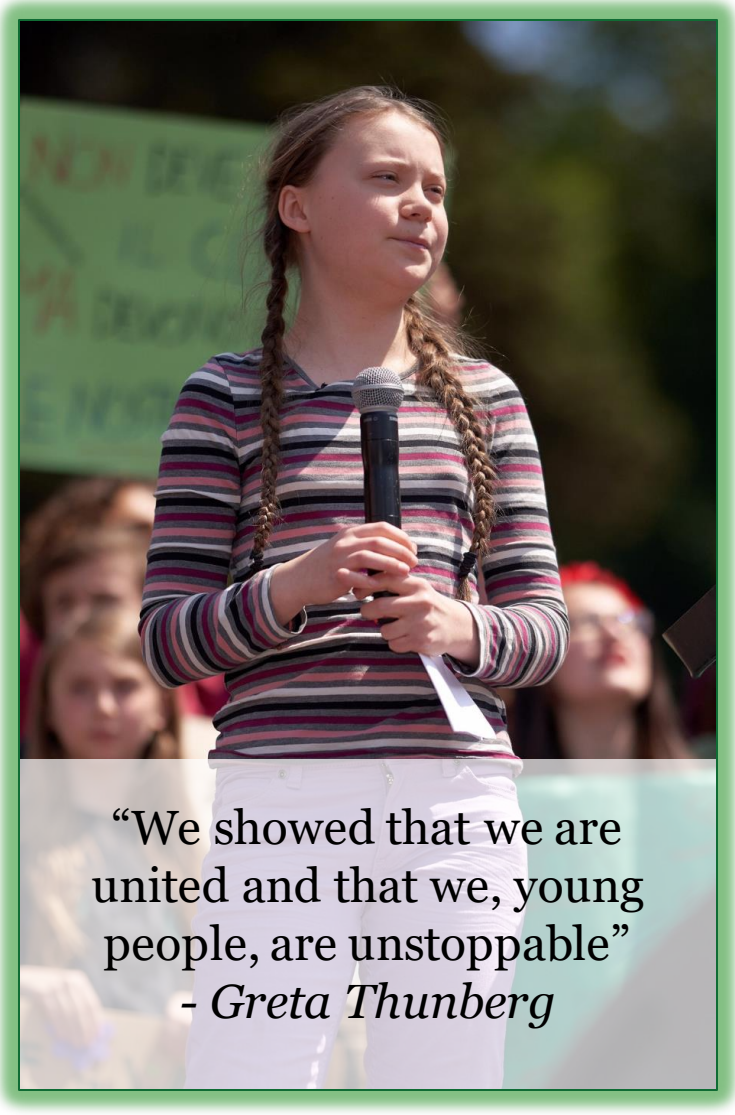
Middle school students are influential

At this point in their life, middle school students are beginning to enter the metacognition stage of brain development. During this phase, skills are developed such as deductive reasoning, problem solving, and generalizing. Informing them about climate change in an interactive way will strengthen their problem-solving skills as well as plant a seed of climate change action (Sloan, 1961). With their newly developed cognitive skills, middle school students can think about the effect their actions have on climate change. Students may become worried about climate change since they have limited options if they try to fight against climate change (Morin, 2019). It is important to supply them with ideas on ways they can make a difference.

If middle school students do not yet know about climate change then this is the perfect time to introduce the topic. During early adolescence, information in their short-term memory has begun to move into their long-term memory. For this reason, educating and changing the behavior of middle schoolers will lead to greater climate awareness as they grow up. Middle school students can make a difference at their age by reducing their waste and energy usage, or by joining clubs focused on mitigating the climate crisis. Promoting sustainable behaviors will lead to less emissions in

the future (Lorain, n.d.). After all, climate change will be affecting these students more than the older generations. The crisis will not be solved by the Generation Y or Generation X. It will be up to the younger generations such as Generation Z, and following Generation Alpha (NYP Holdings, 2020).

In order to inform and motivate middle school students, it is necessary to understand the ways they learn and process information. This may be challenging since young adolescence may be at different stages of development (Morin, 2019).




*(Hillemann, 2019)*

It is important to use multiple methods of conveying information as it taps into students' preferences for learning. The Universal Design for Learning Guidelines showed that providing multiple means of engagement results in a learner who is purposeful and motivated. We can increase our engagement by removing distractions and providing timely and informative feedback. Options for expression and communication included providing multiple types of media. By utilizing these guidelines, we can further motivate middle school students to participate in climate action (CAST, 2018).

# HOW TO EDUCATE MIDDLE SCHOOLERS

Studies performed by the National Education Association have assessed that middle school students prefer to engage in intense interests, but for a short period of time. In addition, middle school students prefer to have interactions with their peers and active learning environments instead of passive learning environments. (Lorain, n.d.)

As we developed the climate change curriculum, we wanted to keep several points in mind to ensure that the sponsors' middle school students had the best educational experience.

1. We wanted to present a limited amount of information to keep kids engaged.

2. We wanted to allow the students to process the new information while reinforcing prior knowledge.

3. We wanted to provide an interactive experience to stimulate their brain. This creates an active learning scenario instead of passive learning.

4. We wanted to provide lessons that required problem solving and critical thinking.

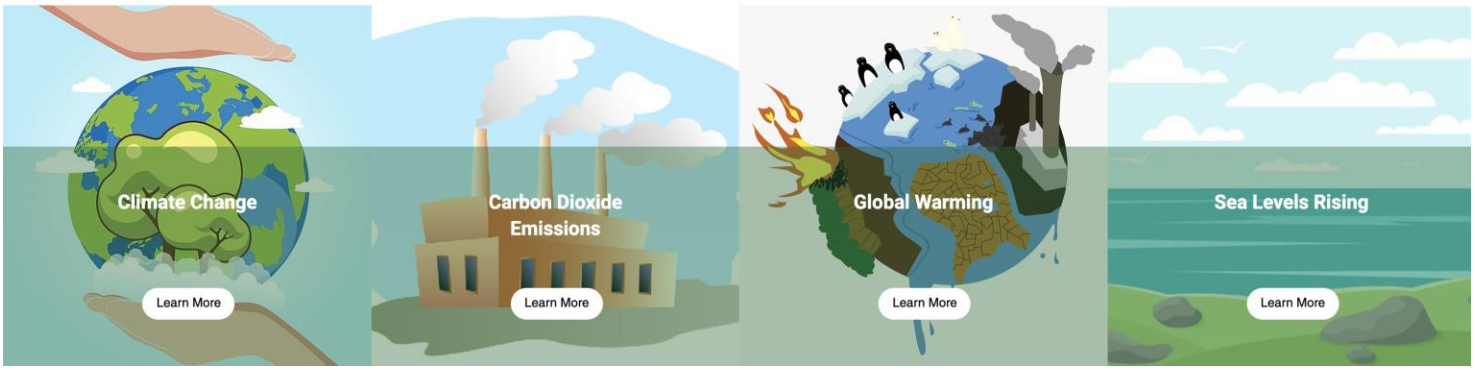
*(Research Releases, 2017)*

# CO-CREATED CURRICULUM

We worked with middle school teachers in Worcester county to co-create a climate change curriculum and an online platform for delivery. The two central goals of this curriculum were to teach about the science of climate change and motivate behavior change. We engaged the students with this interactive website so they could learn about the causes and consequences of climate change and ways to get involved in climate action.

We chose four main topics for the students to focus on: Climate Change, Carbon Dioxide Emissions, Global Warming, and Sea Levels Rising along with a "What Can You Do?" page.

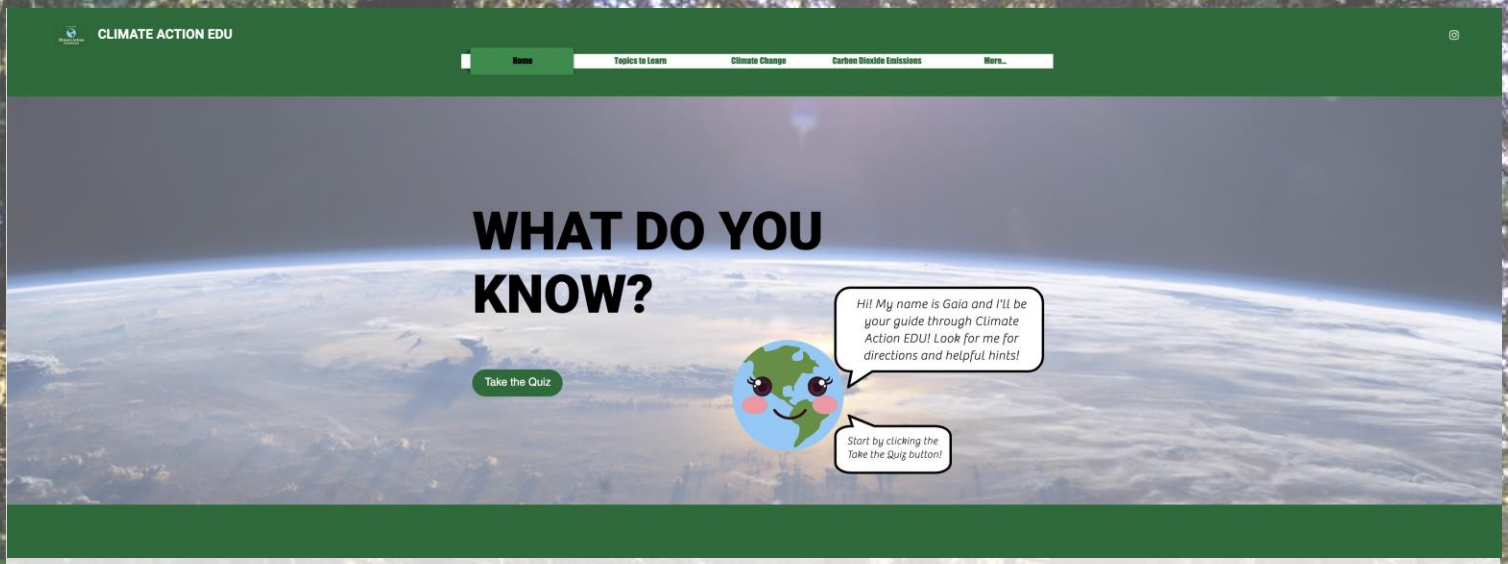
Those four topics were presented via multimedia such as videos, infographics, and games. We believed interactive features were the best way to retain the student's attention and improve their learning experience on the website.




*The Topics to Learn page on the website*


*"What Can You Do?" page on the website*

# WEBSITE DEVELOPMENT




*The image above displays the website's homepage*

Each page of the website consists of short introductions explaining the topic, along with images and other text. We designed a climate change board game and an interactive simulation for the students to visualize the buildup of carbon dioxide in the air over time. The "What Can You Do?" page was used to inform the students about some possible ways they could make a difference to improve the climate crisis. This page included infographics, fun facts, climate change stories, and other links so they could get more involved in climate action.

We set up the website with a natural flow through the content. Students began with an overview of climate change, then they learned the ways carbon dioxide affects climate change. After that, they moved to global warming which is caused by the greenhouse gases. Then they saw some consequences of global warming on the sea levels rising page. Finally, the students learned about actions they could take to make a difference in the climate change crisis.

# WEBSITE DEVELOPMENT

The website needed to be developmentally appropriate for the middle school audience. The amount of content on the site was discussed with middle school teachers. Images, infographics, games and videos were also reviewed to ensure they were age appropriate for the students.

This website was deployed to students currently completing their school year in a remote learning environment due to the COVID-19 pandemic. In discussions with the middle school teachers, it became clear that getting students to follow directions would be difficult on an online platform. It was essential we considered that the website provided clear directions to guide students through the interactive experience.

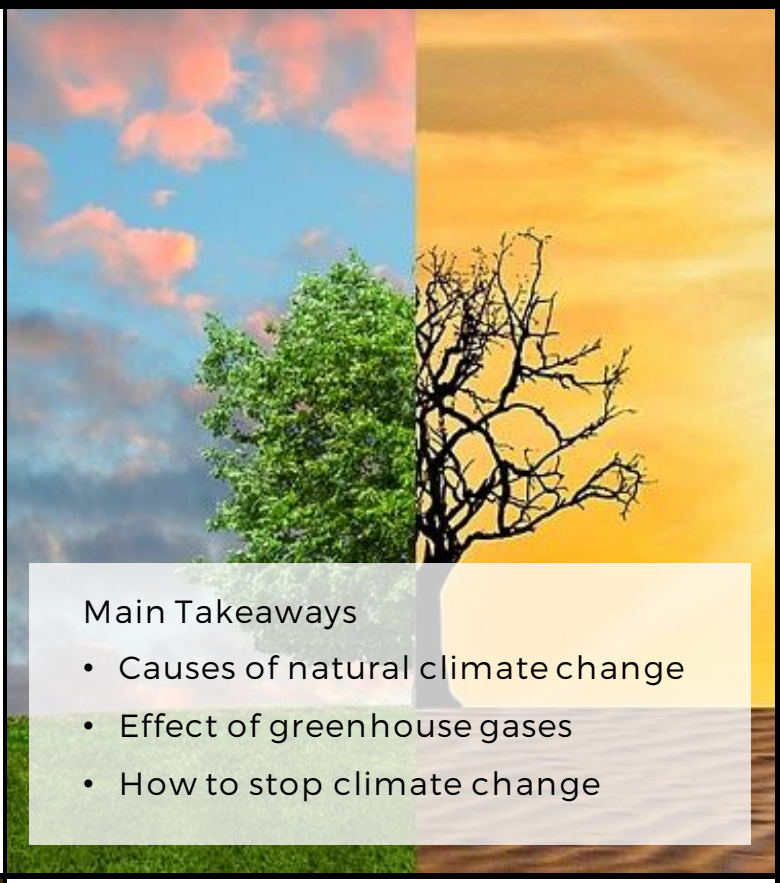
We decided to create a website character, Gaia (seen in Figure 3). The website character acts as a guide directing students through the pages and pointing out important facts for students to know. Gaia allows the website to feel more like a directed lesson in contrast to other websites that allow students to explore anywhere within the site.


*Figure 3: Gaia website character*

# WEBSITE CONTENT

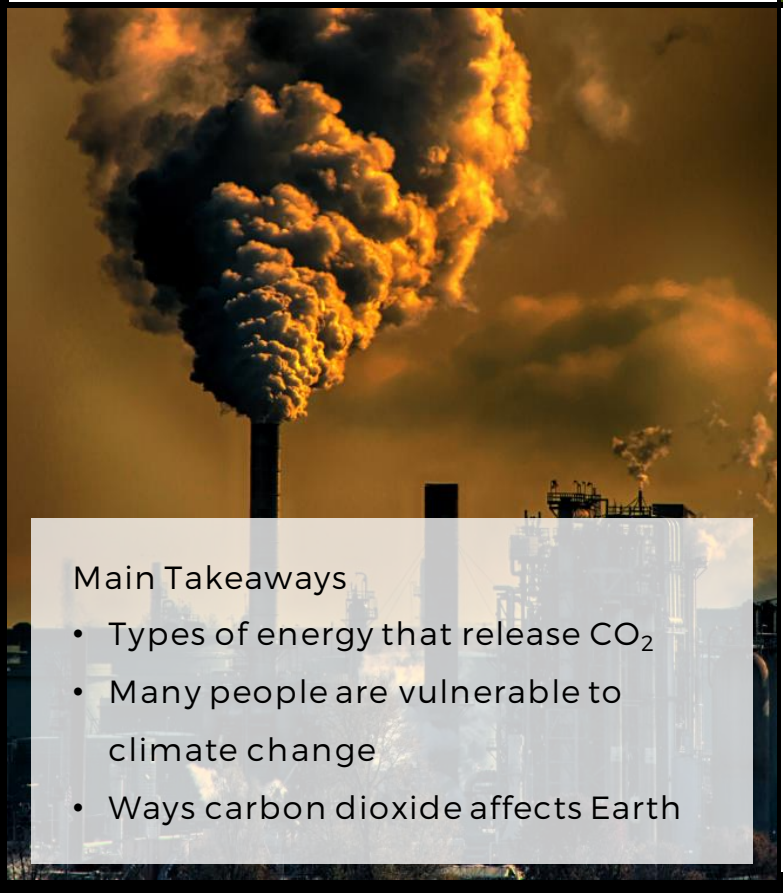
## CLIMATE CHANGE

The Climate Change page included an educational video that described climate change at a middle school level. The site also featured 12 facts that were compiled in an infographic with Gaia pointing out a few key facts to keep the students engaged as they read. It featured climate change effects on animals, and the ways climate change affects food.



Main Takeaways

- Causes of natural climate change
- Effect of greenhouse gases
- How to stop climate change



Main Takeaways

- Types of energy that release $CO_2$
- Many people are vulnerable to climate change
- Ways carbon dioxide affects Earth

## CARBON DIOXIDE EMISSIONS

The Carbon Dioxide page featured an informational introduction and some Tik Toks (social media videos popular with this age). There was also a section about the ways $CO_2$ affects the ocean. We created a simulation for students to visualize $CO_2$ in the air. A pie chart showed sources of emissions and a carbon cycle game allowed students to see the ways carbon changes form and moves throughout the Earth.

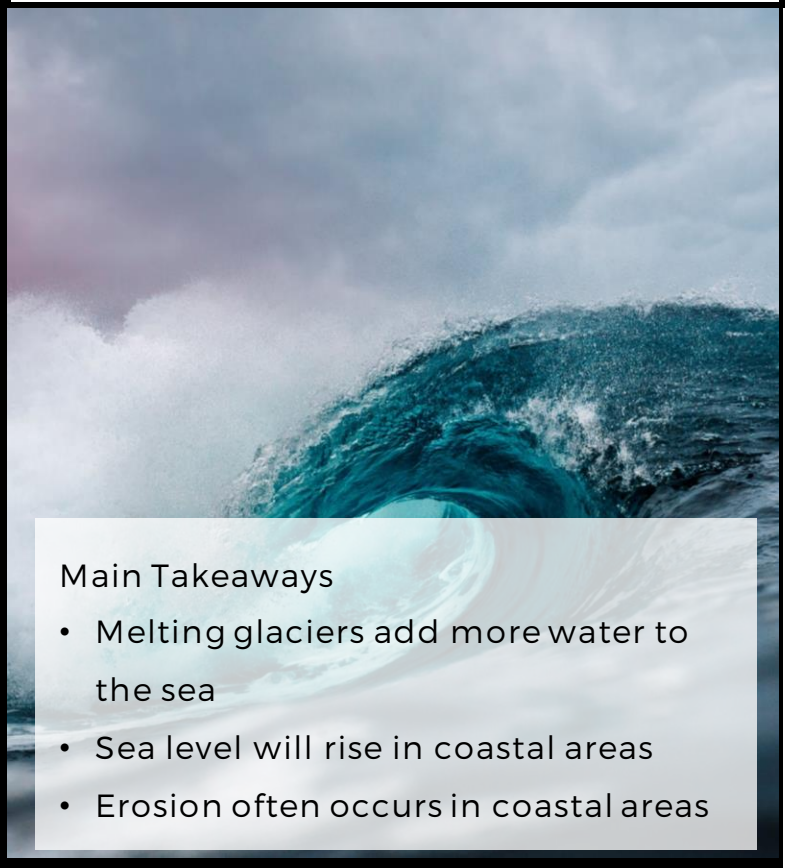
# WEBSITE CONTENT

## GLOBAL WARMING

The Global Warming page featured an informational introduction and a map for students to see the temperature changes throughout the world in recent years. GIFs were included to describe the difference between climate change and global warming. There was also a section on the changing seasons in New England. Another section showed changes to the coasts, animals, and weather patterns.

Main Takeaways

- Events caused by global warming
- Global Warming was caused mostly due to human activities
- Changing seasons & weather



Main Takeaways

- Melting glaciers add more water to the sea
- Sea level will rise in coastal areas
- Erosion often occurs in coastal areas

## SEA LEVELS RISING

The Sea Levels Rising page included a short introduction. An interactive map was shown so students could search any city and see the ocean level rise. There also was an immersive GIF of Boston under water. This page featured the Environmental Protection Agency's embedded website with sea level rise information. Finally, a story with images was shown of a beach in Cape Cod affected by erosion.

# WEBSITE CONTENT

## WHAT CAN YOU DO?

The What Can You Do page featured an infographic of ways students could prevent climate change and possible career paths that may have an impact on the environment. Also included was information for students to join or create a club, positive stories, quick facts, a carbon footprint calculator, project ideas, and games.


*(Meehan, 2018)*

Main Takeaways

- Ways middle school students can help prevent climate change
- Careers, clubs, changing behaviors

# WEBSITE SURVEYS

We developed a series of surveys to determine the effectiveness of the delivery of climate change content. These surveys were designed to collect student's thoughts, behaviors and knowledge surrounding climate change. The pre-survey featured questions that focused on student's original thoughts and behaviors as well as some pre-benchmarking questions.

After each lesson, the students answered 2-3 technical benchmarking questions. These were compared with the pre-survey benchmarking questions to determine if students had gained more knowledge. The benchmarking questions were also used as formative feedback that the students could use to understand any limitations in their learning and ways for possible improvement. The benchmarking questions are also a way for the teachers to know what the students are not understanding, and how they can address the issue.

# WEBSITE SURVEYS

Once all the lessons were completed, the Post Lesson Survey assessed if any of their thoughts and behaviors about climate change had changed. The full surveys can be seen in Appendix A.

## Prior Knowledge Questions

This survey is to collect data on what you know and how you feel about the climate change crisis. Please answer each one to the best of your ability. If you do not know the answer, type "I don't know"

Click Next

## Climate Change

* Required

Question 1

What causes NATURAL climate change? [select all that apply] * 1 point

- [ ] Volcanic eruptions
- [ ] Changes in the Sun's energy
- [ ] Changes in the Earth's orbit
- [ ] Human produced emissions

## CO2 Emissions Questions

* Required

Question 1

What types of energy emits carbon dioxide? * 1 point

- ( ) Hydropower
- ( ) Fossil fuels: coal, oil, natural gas
- ( ) Trees through photosynthesis
- ( ) Solar power

## Global Warming Questions

Question 1

Which of the following is NOT caused by global warming? 1 point

- ( ) Extreme Weather Drought
- ( ) Displacement of animals
- ( ) Drought
- ( ) Freezing ice sheets

## Sea Levels Rising Questions

* Required

Question 1

By the year 2100, how many feet will the sea level rise in Boston? * 1 point

- ( ) 3 feet and 2 inches
- ( ) 7 feet and 4 inches
- ( ) 1 foot and 5 inches
- ( ) 20 feet and 8 inches

## Post Lesson Questions

* Required

Question 1

After viewing the website, I understand the consequences of climate change. *

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|
| Much Less | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) | Much More |

# SURVEY RESULTS

While responses varied, many students learned new ways to prevent climate change and many gained a better understanding of climate change in general. To determine if students learned anything new, we asked them to list all the ways they could think of to prevent climate change on both the pre- and post-survey. Some of the post-survey responses included producing renewable energy, recycling, or riding a bike as opposed to driving a car.

**80%**

of students learned new ways to prevent climate change

Many of the post survey responses included information from the site when asked about new ways they could help climate change. Answers included taking shorter showers or shutting off the light when they are not needed. After learning about the climate change crisis and ways to prevent it, students were asked how likely they are to help reduce climate change in their own lives.

**83%**

of students are willing to help prevent climate change

In the post survey, students were also asked to rank their understanding of climate change topics using a Likert scale of 1 – 7. Many students recorded responses between 5 and 7, indicating improved learning in the areas of consequences of climate change, the effects of global warming, and the effects of $CO_2$ on the Earth's temperature and environment.

**88%**

of students gained a better understanding of climate change

# SURVEY RESULTS

55% of the students improved or maintained their test results between the pre-survey and benchmarking quizzes. However, some that did not improve their scores reported gains in understanding of climate change. The questions that students struggled with the most were specific facts or statistics. Most students correctly answered general questions about climate change, but once it came to recalling the statistics or facts from the page above, they answered incorrectly. This means that while students may not have remembered certain facts from the website, they still understood the general knowledge of the page. This is supported by Figure 4, which shows most students reported a much greater understanding of the consequences of climate change after viewing the website.

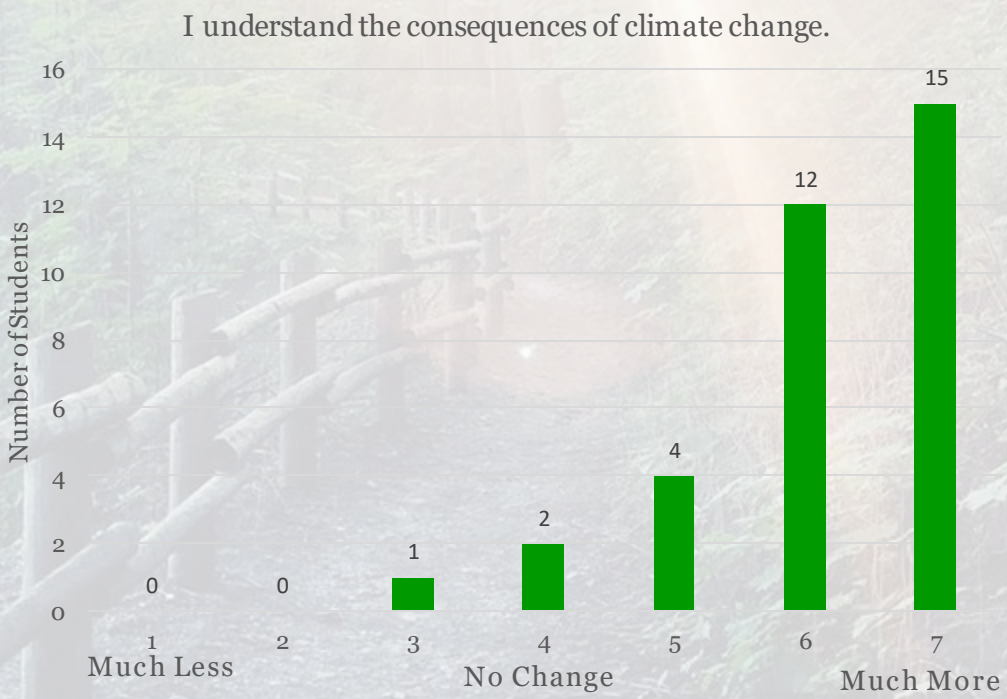



*Figure 4: Graph of responses to the post-survey statement "I understand the consequences of climate change" on a 1-7 scale*

# SURVEY RESULTS

While most students understood how $CO_2$ affects the Earth's climate as seen in Figure 5, they struggled to understand how $CO_2$ increased the temperature of the Earth as seen in Figure 6. Many students recorded a 1 on the 1-7 scale meaning they understood less of how $CO_2$ increases the temperature of the Earth. The differences in student responces between these two questions is not fully understood. The teachers were surprised by this result and did not know the cause. One possible issue could have been that the question was not written in a useful way for this audience.

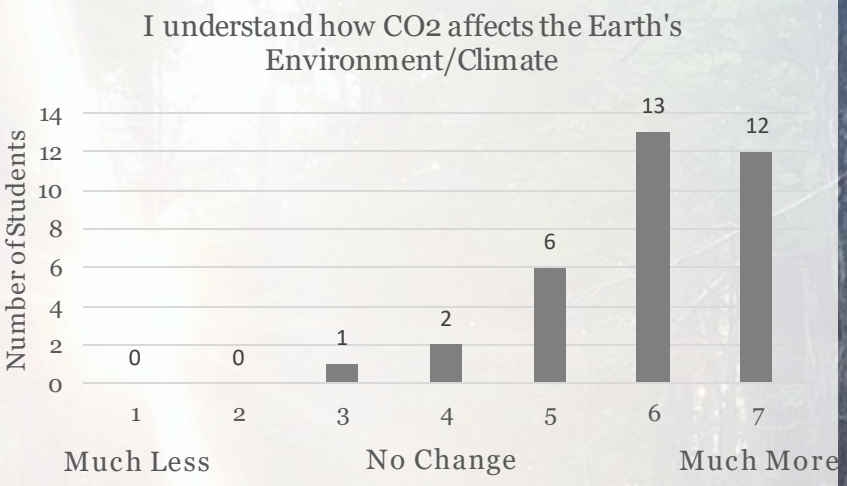



*Figure 5: Graph of responses to the post-survey statement "I understand how $CO_2$ affects the Earth's environment/climate" on a 1-7 scale*

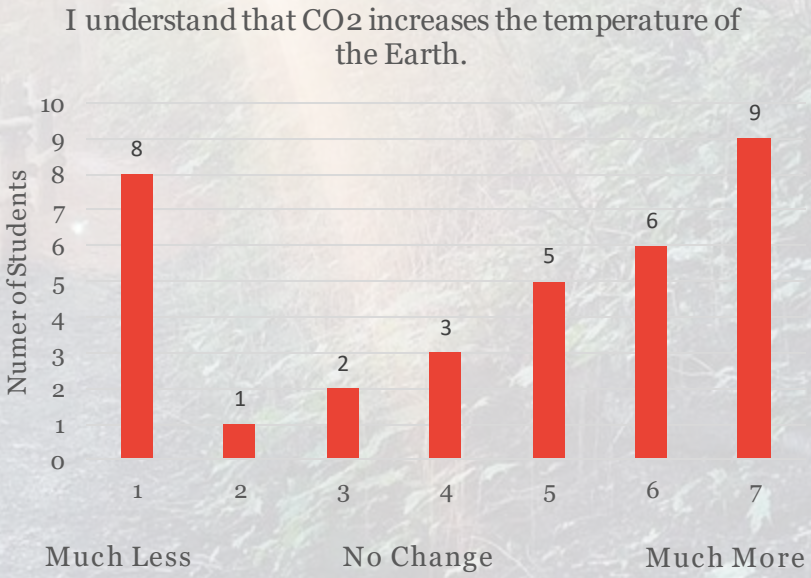



*Figure 6: Graph of responses to the post-survey statement "I understand that $CO_2$ increases the temperature of the earth" on a 1-7 scale*

# STUDENT WEBSITE EXPERIENCE

We received data from 34 students that successfully completed the site. Based on those responses, Figure 7 shows the sections that students enjoyed learning about the most. In a post survey question, students were asked which aspects of climate change they were interested in learning about in greater detail. Based on those responses, many students were intrigued with climate change and would like to learn more about certain topics. Common responses included impacts to animals and sea level rise.

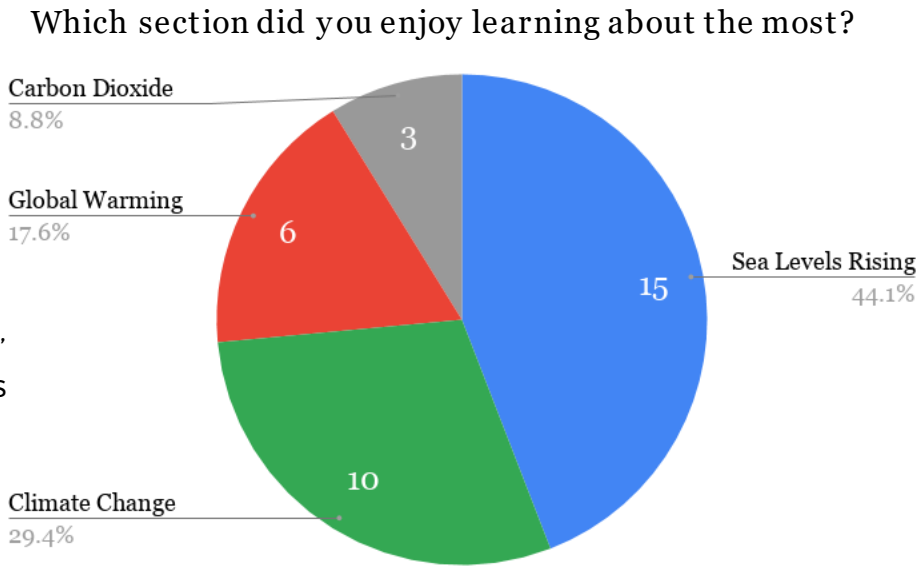



*Figure 7: Pie chart of the number of students that enjoyed each section the most.*

The website provided information about several ways for students to participate in preventing climate change. While some students initially had very few thoughts on the climate change crisis, many more came out of the experience with ideas of ways they could help reverse the crisis and prevent further damage. Upon learning about new ways to prevent climate change, 16 students responded that they are more likely to help, as indicated in Figure 8.

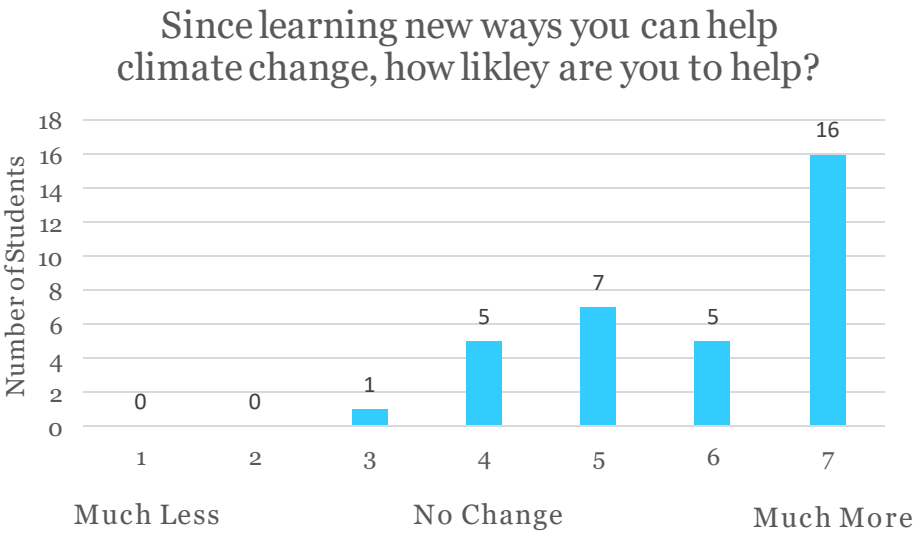



*Figure 8: Bar graph showing the number of students that are likely to help combat the climate change crisis.*

# STUDENTS MAKING A DIFFERENCE

> "I want to see how Earth could get better and go back to normal!"

> "Save the animals that might not live through climate change."

> "I want to [know] more about climate change activists."

> "People can be affected from their own actions!"

After learning about the severity of climate change, many students were moved by the way it is affecting the world and were interested in participating to prevent climate change. By appealing to their personal behaviors and climate change effects on their own daily lives, we were able to convey the importance of climate change and actions to prevent further damage. We wanted to make it clear that the crisis is important, and it *will* affect their lives if little is done to prevent climate change.

# STUDENTS MAKING A DIFFERENCE

After completing all the modules on the website, students reported some of the new ways they learned to help prevent climate change. Figure 9 shows certain ways students learned to make a difference and the corresponding number of students that reported. In the post survey, most students responded with new ways that they learned to make a difference in the climate change crisis.

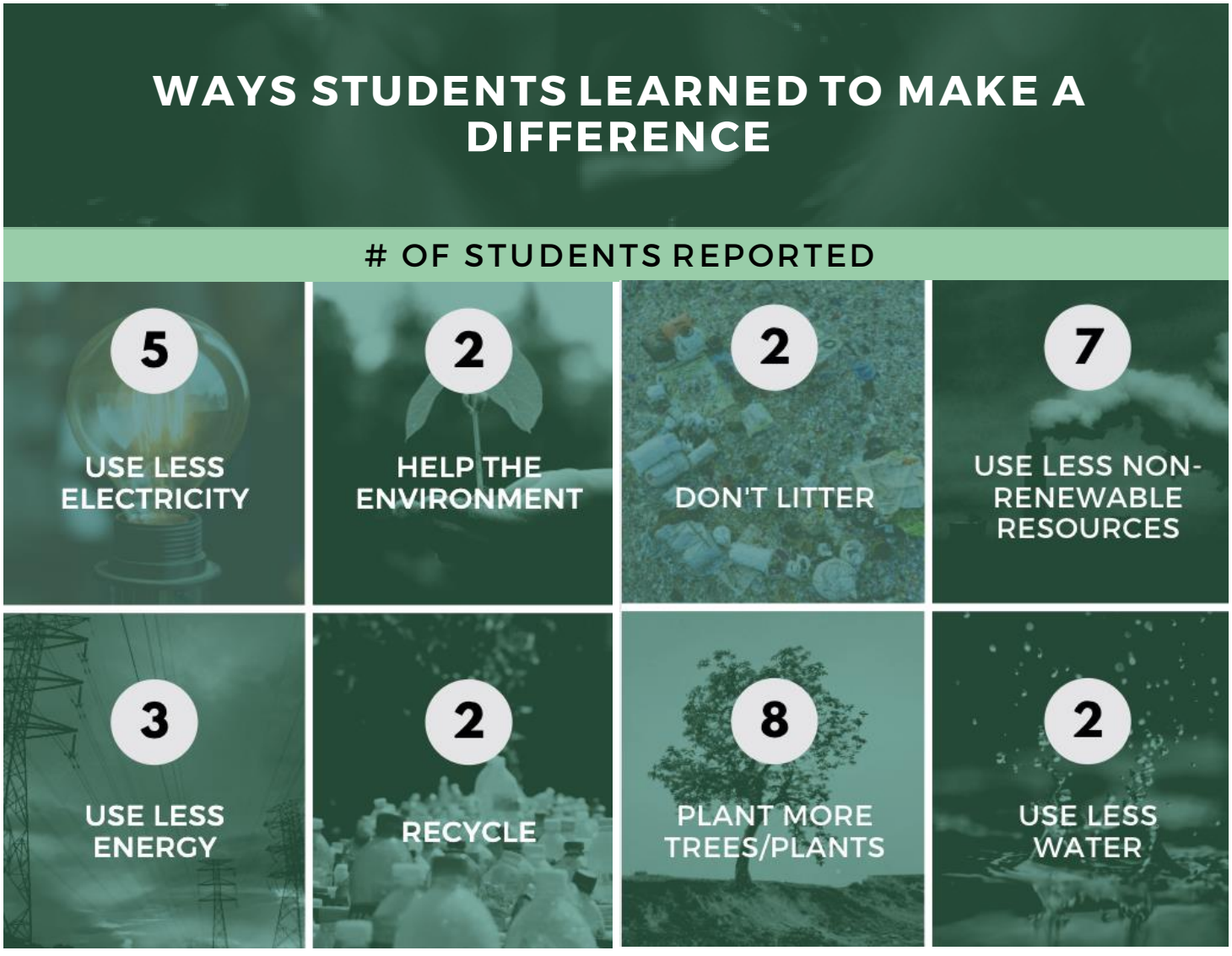



*Figure 9: Infographic of the Ways Students Learned to Make a Difference*

# TEACHER EXPERIENCE

The site was setup so that student responses went directly to teachers using google classroom, the classroom management software already used at their schools. Our website laid out clear instructions for the students allowing the teachers to direct their students to complete the assignments without additional directions. The teachers enjoyed working with the platform and loved the creativity of the content. The teachers believed that the platform was easy to navigate and smoothly transitioned between topics. Overall they stated that we did an "Awesome Job!". The content on the site fit the teachers' style because it was co-created. In order to analyze our website we asked the teachers about the strengths, weaknesses, opportunities, and possibilities of the website. By doing so we learned improvements we can make to the website for future projects.


# THE IMPACT OF A SWOP ANALYSIS

## STRENGTHS

Some of the strengths of the website were the **embedded video clips, games, and websites** that the students could engage with. It also covered **relevant material** that students had learned from the school year. The teachers thought it was well **organized** to allow for easy navigation, and the language used was age appropriate. Aesthetically, they thought the website was **bright and colorful.**

## WEAKNESSES

One of the weaknesses was that the large **amount of information** on each page made it hard for students to learn. It was not as effective for students who were **less invested** in the material. Additionally, the website did not work well on **phones** since it was designed for a tablet or computer.

## OPPORTUNITIES

The teachers were interested in using this curriculum **next year** and would possibly create a **classroom experience** to use alongside the website. They also wanted the website to focus more on the material they were covering such as the **carbon cycle**. Additionally, they believed that they would use the site as an aid to **topics covered earlier** in the year.

## POSSIBILITIES

The teachers wanted to expand this website to the **high school** and possibly the **environmental science classes**. They thought it would be useful to get feedback from older and **more advanced students**. They also saw it as a great way to support **community outreach** and great way to get students interested in other projects such as the **science fair**.

The full Strengths, Weaknesses, Opportunities, and Possibilities Analysis can be found in Appendix B.

# CONTINUOUS IMPROVEMENT

As a team, we had numerous successes building and delivering our co-created curriculum to the middle school students. Our tool aided the teachers and proved to be effective. Although we perceived an overall great experience from students and teachers, we learned a few things that we would have changed to improve our project. It is important to test our platform with numerous different middle schools in the future. It would have been interesting to find out if varied demographics would result in varied results. We saw that students had trouble retaining specific factual information on how $CO_2$ increases the Earth's temperature. The trend of students retaining larger concepts but not facts and figures was observed across the student experience. It would be interesting to study if transitioning any specific data into generalizations, would have resulted in better retention of the concept when quizzed. In addition, this age group has not yet been exposed to complex concepts of chemistry which may have made it challenging to grasp the idea of $CO_2$ heating up the Earth's atmosphere.

# CONCLUSION

The goal of this project was to work with middle school teachers to co-create a climate change curriculum to appear on an interactive website in an effort to educate and motivate their students. We successfully designed an interactive website that covered topics such as general climate change, carbon emissions, global warming, and sea level rise. We incorporated different forms of media to keep students engaged and then tested the website with middle schoolers in Worcester county. We found that students learned more about climate change and were motivated to participate in climate action after viewing the website. We also found ways to improve this site to increase its effectiveness and to expand it to larger audiences in the future.

# OUR EXPERIENCES

MATTHEW KIREJCZYK

Aerospace Engineering

As a team, we overcame situations and scenarios that I would have never predicted. After the news that our abroad IQP had been cancelled, we chose to make the most of an otherwise emotional experience. Starting from the ground up, we worked hard to find a new project, new sponsors, and conduct new research. I learned how versatile the internet is by communicating with the team via videoconference, and finding software that allowed collaborative efforts. I am thrilled with the work we have accomplished over the past fourteen weeks and I believe that we planted a seed of change for the next decade. I am so thankful for this group of friends and the countless memories we made together. I can't wait to see the impact we have on the world.

CARTER LEWIS

Biology / Biotechnology

I have learned a lot during the course of this project, not just about climate change, but how to adapt and overcome unexpected challenges and difficulties. From transitioning to a completely online platform, to all the different changes to our project and hurtles we faced, I learned how to make the most out every situation and find solutions to tough problems. I really enjoyed our project and designing a website where middle schoolers could learn more about climate change, because I am passionate about climate change myself. This was my first big team project and I improved my communication and collaboration skills throughout the weeks we worked together. Along the way our team became closer, and not only did we end up with a successful project, but I ended up with some great friends.

# OUR EXPERIENCES

TINA LY

Architectural Engineering

The year 2020 has washed in a whirlwind of emotions. While expecting to travel abroad to transitioning to a remote IQP environment was difficult news to swallow, I believe my team and I handled it very well. Going into D-Term, we had little knowledge of what our project was going to turn into. After going through several possible project iterations, we were able to produce, what I believe to be, a very impactful project. This experience not only taught me that it is important to be able to adapt to any given situation, but to never underestimate how well four intellectuals can work together. I am grateful to have been able to work with my teammates and produce a product that will affect the younger generations for many years to come. I cannot wait to see what the future holds – both for my team members, now friends, and the many middle school children whom we, hopefully, impacted.

ALYSSA WEBB

Biomedical Engineering

The transition to a remote project certainly had its challenges, but I feel that we were able to have an impactful project. The beginning of the term was frustrating as other students on IQP completed their proposed projects remotely and we had to start from scratch and create a new project. We went through many different project ideas and eventually found our way to designing this website for middle schoolers. It was very interesting to see what the students had to think about climate change before and after our website. It was a great opportunity to work with teachers in the area and I'm glad we had the chance to inspire some students of the future generation. I enjoyed completing this project and making new friends along the way. This certainly was not the experience I had expected, but I am proud of what we have accomplished.

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# REFERENCES


1. CAST. (2018). Universal design for learning guidelines version 2.2. Retrieved from http://udlguidelines.cast.org
2. Christensen, J. (2019). Middle schoolers may be the secret weapon in fight against climate change. Retrieved from https://www.cnn.com/2019/05/10/health/climate-change-middle-schoolers-study/index.html
3. Hillemann, D. (2019). How greta thunberg might fail just by a lack of respect and humility. Retrieved from https://medium.com/@DHillemann/how-greta-thunberg-might-fail-just-by-a-lack-of-respect-and-humility-e7ae3cddb81b
4. Lorain, P. Brain development in young adolescents. National Education Association, Retrieved from http://www.nea.org/tools/16653.htm
5. Meehan, J. (2018). School strike for climate Melbourne. Retrieved from https://flic.kr/p/RerNFo
6. Morin, A. (2019). Developmental milestones for middle-schoolers. . Retrieved from https://www.understood.org/en/learning-thinking-differences/signs-symptoms/developmental-milestones/developmental-milestones-for-typical-middle-schoolers
7. NASA. (2019). Overview: Weather, global warming and climate change. . Retrieved from https://climate.nasa.gov/resources/global-warming-vs-climate-change/
8. NYP HOLDINGS, I. (2020). Majority of young americans say climate change affects their major life decisions. Retrieved from https://nypost.com/2020/04/20/majority-of-young-american-adults-say-climate-change-affects-their-major-life-decisions/
9. Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. American Journal of Health Promotion, 12(1), 38-48. doi:10.4278/0890-1171-12.1.38
10. Research Releases. (2017). Exposing newborn mice to general anesthetic disrupts brain development. Retrieved from https://fourthventricle.com/anesthetic-disrupts-development/
11. Schulze, B. (2013). Hiking in the scapegoat wilderness photograph. Retrieved from https://flic.kr/p/f8jazW
12. Sharp, T. (2018). What is earth's average temperature? Retrieved from https://www.space.com/17816-earth-temperature.html
13. Sloan, F. A. (1961). Developmental characteristics of young adolescents and the school program. The High School Journal, 44(7), 257-262.
14. TNN. (2019). 9, 11, 13: New face of climate activism is vocal, young and in school - times of india. Retrieved from https://timesofindia.indiatimes.com/india/9-11-13-new-face-of-climate-activism-is-vocal-young-and-in-school/articleshow/71627991.cms
15. Welch, C. (2015). Five reasons we need to act now on climate change. Retrieved from https://www.nationalgeographic.com/news/2015/12/151204-climate-paris-disease-antarctic-arctic-ice-melt-acidification-fish-co2/

# APPENDIX A

Below are the survey questions that are asked to the middle school students before, during, and after the website experience.

**Pre-lesson survey questions:**
Below are questions given to students to test their prior knowledge of climate change.

1. Code:

2. List some thoughts you have about the climate change crisis.

3. How do you feel about the climate change crisis?

4. List as many things you **CAN** do to prevent the climate change crisis (open answer)

5. What are some things **YOU** are **currently** doing to prevent/fix the climate change crisis?

6. Which of the following causes the climate change crisis?
   a. The way the planets move
   b. The shape of the clouds
   **c. Pollution in the atmosphere**
   d. The time animals sleep

7. Which of the following releases the most carbon dioxide into the atmosphere?
   a. Hydropower electricity generation
   **b. Burning coal, oil, and natural gas**
   c. Trees through photosynthesis
   d. Solar power electricity generation

8. Which of the following does carbon dioxide **NOT** have a big effect on?
   **a. The ground**
   b. The air
   c. The oceans
   d. Global temperature

9. Which of the following is NOT caused by global warming?
   a. Drought
   **b. Freezing ice sheets**
   c. Extreme Weather
   d. Displacement of animals

**Benchmark survey questions:**
These questions were given upon completion of each section.

<u>Climate Change</u>
1. What causes natural climate change? [select all that apply]
   **a. Volcanic eruptions**
   **b. Changes in the Sun's energy**
   **c. Changes in the Earth's orbit**
   d. Human produced emissions

2. What is the effect of greenhouse gases?
   a. They make houses turn green
   **b. They cause the Earth's atmosphere to heat up**
   c. Green gas comes out of houses
   d. They increase the Sun's temperature

3. How do you stop the climate from changing?
   a. By moving the furniture in the house around
   b. By cutting down trees
   **c. By decreasing how much greenhouse gas is released**
   d. By creating more plastic waste

<u>Carbon Dioxide Emissions</u>
1. What types of energy emits carbon dioxide?
   a. Hydropower
   **b. Fossil fuels: coal, oil, natural gas**
   c. Trees through photosynthesis
   d. Solar power

2. How many people in the world are currently vulnerable to climate change from drought, floods, heatwaves and sea level rise?
   a. 300 Million
   b. 500 Million
   **c. 800 Million**
   d. 1 Billion

3. True or False: Carbon dioxide only affects the earth when it is in the atmosphere
   a. True
   **b. False**

# APPENDIX A

**Benchmark survey questions cont.**

Global Warming

1. Which of the following is **NOT** caused by global warming?
   a. Extreme Weather
   b. Displacement of animals
   c. Drought
   **d. Freezing ice sheets**

2. True or False: Recent global warming is mostly due to human activities
   **a. True**
   b. False

Sea Levels Rising

1. By the year 2100, how many feet will the sea level rise in Boston?
   a. 3 feet and 2 inches
   **b. 7 feet and 4 inches**
   c. 1 foot and 5 inches
   d. 20 feet and 8 inches

2. What major event took place due to coastal erosion at Herring Cove?
   a. All of the rocks and seashells were collected by beachgoers
   **b. The bike trails and parking lots fell into the ocean**
   c. The color of the ocean turned orange
   d. The waves in the ocean were gone

**Post-lesson survey questions:** Given after reviewing all materials on the website

After viewing the website, I understand the consequences of climate change.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Much Less | | | No change | | | Much More |

After viewing the website, I am aware of the effects global warming has on sea levels.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Much Less | | | No change | | | Much More |

After viewing the website, I understand how $CO_2$ affects the Earth's environment/climate.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Much Less | | | No change | | | Much More |

After viewing the website, I understand that $CO_2$ increases the temperature of the Earth.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Much Less | | | No change | | | Much More |

After viewing the website, what are all the new ways you learned to make a difference in the climate change crisis?

What are you interested in learning more about regarding the climate change crisis?

Which section did you enjoy learning about the most?
- Climate Change (in general)
- Carbon Dioxide Emissions
- Sea Levels Rising
- Global Warming

Since learning more ways you can help climate change... How likely are you to help?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Very unlikely | | | No change | | | Much More likely |

# APPENDIX B

## SWOP ANALYSIS

Strengths

- Video clips & embedded websites & games
- Reflected material from earlier in the year
- Arrows/organization easy to navigate through
- Bright cheery colorful
- Language was simplistic enough and encompassed some information from earlier in the year

Weaknesses

- A lot of information
- Good for those who were invested in the topic
    - Tough to hit less advanced kids,
- Took an hour and 20 minutes to get through the website
- Viewing test results prevented them from moving on
    - Had to go back to the beginning
    - Had difficulty finding the next button
- 80/20 split, 80% of students had no trouble, 20% had trouble and needed email help
    - 10% didn't pay attention (to directions, etc)
- Not iPhone friendly
- Could have gone through the topics better in the classroom
    - It was harder to make sure they understood everything
- If they could do something with the information that would be better.

Opportunities

- The teachers want to use it next year!
- May use the carbon platform earlier in the year
    - More focus on the carbon module
- Teachers will have access to the website and are able to switch the survey questions if they feel
- Teachers believe that they would love to spread the material out a little bit more and if this was an in-class experience

Possibilities

- Possibly expand to Auburn High School
    - Environmental science classes?
- Getting more info on a higher level
    - Feedback from older students
- Support community outreach
    - Science fair topics
    - Other projects: "How would you have designed a website content like this"
    - Getting inside their brains