

# The Astounding Adventures of Marco the Water Molecule

Water Cycle/Extreme Weather/Climate Action Video Game with Educator Support

Supported by the CO2 Foundation



Program description prepared by  
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in collaboration with partners

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## SUMMARY

This engaging video game with hands-on/outdoor activities motivates students to join Marco's journey of discovery: water's impacts on Earth, how extreme weather events are

challenging him, and actions we can take for a stable climate. Training, lesson plans, and other resources enable educators to meet NGSS and Common Core standards.

## PROJECT DESCRIPTION

### Water Cycle & Climate Science Education

Changes in the water cycle have brought the most devastating impacts of the climate crisis. More intense hurricanes, floods, droughts, heat waves, and megafires are primarily the result of more trapped energy impacting the water cycle. Students need to understand that and related phenomena like ocean acidification, as well as ways to slow and reverse them.

### Engaging Students & Meeting Standards

An enjoyable, interactive video game, combined with educator training, resources, and support, will inspire large numbers of students, families,

and educators. The game will target grade 3–8 students and be designed for all ages to enjoy. Scientists and curriculum specialists will ensure content is accurate and meets standards.

The [2D action-adventure game](#) will be developed for iOS (Apple App Store), Android (Google Play), Windows, and Mac. The code/[Unity](#) project (premier software free for student/non-profit use) will be distributed through a [Creative Commons/non-commercial](#) license, so students and others can create new chapters or other games.

## Educator Training & Supporting Resources

Free online and in-person workshops will be offered by the [Bay Area E-STEM Institute \(BAESI\)](#), [Green Ninja](#), and other partners to prepare educators to engage students with the game and related activities. We will also provide educator stipends to increase inclusiveness, retention, and equity.

## Compelling Story & Game Play

A game with the character Marco the Molecule from [this enjoyable story/activity book](#) has been requested for years. Linda McNamara, Director of the [Connect Program](#) that serves disadvantaged youth, recently said “We are seriously excited . . . about Marco becoming a video game!” It will follow Marco as he flows around the global ocean in currents, evaporates, grabs onto water molecule friends to form droplets, gets pulled back to the surface as precipitation, allows ecosystems to flourish, and more. As the climate warms, changing the water cycle and related systems, students will

## RATIONALE

[Research supports the efficacy of games](#), [phenomena-based learning](#), and hands-on learning. Providing free tools that employ these strategies will empower educators and students from all backgrounds to have a voice in the program and its evolution over time.

Observed changes in the water cycle include more rapid evaporation and more powerful storms. Climate change is part of NGSS standards, but there are no enjoyable video games that teach the concepts in standards-aligned ways. In the process of game play and hands-on experiments, students will develop deeper understanding of the phenomena, how they can be modeled, and ways to take action to reverse current trends.

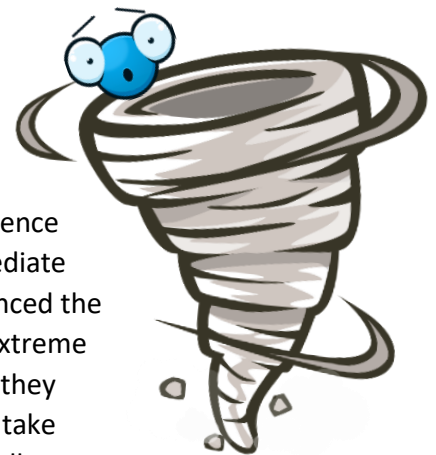


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experience how extreme weather events such as intense lightning storms, tornadoes, floods, droughts, and megafires increase. Then they take steps to increase resilience and create a stable climate.

We will save time/expense by adapting art/animation/code from our new game “[Fight the Bites!](#)”, which teaches how to stay safe from mosquitoes and vector-borne disease. It has been well-received by students and educators, including the artistic design.

Educators, students, and partners who participate in our program will become ambassadors of the science and the need for immediate action. Having experienced the calamitous effects of extreme weather through play, they will gain motivation to take action in real life, as well.



Extension activities will include possible action projects like tree planting and inquiry projects to help students delve deeper into the science and share what they learn. Our experience and [research](#) have shown that youth are impactful spokespeople.

## SCALE & SIGNIFICANCE



Focusing on educator outreach, curriculum, training, and partnerships will dramatically increase our impact. Middle school teachers engage about 150 students per year and elementary teachers engage about 25 students per year, for an average of 88 students per year. We plan to train 100 teachers in the year following game completion, with \$100 stipends contingent on reporting student outcomes. Nearly 9,000 students can be impacted, with tens of thousands engaged in subsequent years.

Students empowered with understanding of the crisis and how it impacts people differently (climate justice) can help catalyze the scale of action needed. As the youth climate movement has shown, informed students can inspire their families, communities, and leaders to act, potentially leading to exponential growth.

BAESI, Green Ninja, Engaging Every Student, and other partners have educator networks that can be invited to participate. The program will integrate well with their other initiatives.

Options for next steps can include presentations/writing to school and government officials about the need to reduce pollution and increase energy efficiency and renewable sources.

Careers in environmental and engineering STEM fields and personal choices that reduce carbon footprints, like walking, biking, or using public transit instead of driving will also be explored.



## TEAM

- [Rick Reynolds, M.S.Ed.](#) and [Krista Reynolds, MLIS, M.Ed.](#) of [Engaging Every Student](#) will lead game design/research. Rick has been an educator and developer of educational resources for about 30 years. He has taught nearly every grade and subject, K-12, including meteorology and hands-on science. Krista joined EES last year after 15 years as a research librarian/educator. They work with organizations such as those listed below on curricula, multimedia content, and games/simulations.
- [Eugene Cordero, Ph.D.](#) is Professor of Meteorology & Climate Science at San José State University (SJSU) and Director of the [Green Ninja Project](#), which will advise and integrate our program. Their middle school materials were adopted by the California Department of Education and elementary programs are planned. They are currently expanding to become a nationwide program.
- [Ellen Metzger, Ph.D.](#), Professor of Geology & Science Education at SJSU and co-director of [Bay Area Environmental-STEM Institute \(BAESI\)](#), will lead curriculum/professional development in collaboration with Rick Reynolds and other partners.



- Andy Dunau will manage financials as executive director of the [Foundation for Water & Energy Education \(FWEE\)](#). He also serves as leads [Spokane River Forum](#). Both organizations will assist with outreach.
- [Arko Chakraborty, M.Des.](#) will lead software development.
- Robert Brooks, creator of [Game Developer Studio](#), will be lead animator, supported by Rick Reynolds and Arko Chakraborty.
- The [CO2 Foundation](#) has provided funding for the game and training program. They are led by William Calvin, Ph.D., Katherine Graubard, Ph.D., and Karen Wolfgang, MA.



- Other key partners include:
  - [American Meteorological Association](#)
  - [CLEAN](#) (Climate Literacy + Energy Awareness Network)
  - [Oregon Science Teachers Association \(OSTA\)](#)
  - [Washington Science Teachers Association \(WSTA\)](#)
  - [IdaH<sub>2</sub>O/Project Wet](#)
  - [National Oceanic & Atmospheric Administration \(NOAA\)](#)
  - [North American Association of Environmental Educators \(NAAEE\)](#)
  - [STEM Oregon](#)
  - [Portland Public Schools](#)
  - [Portland Metro STEM Partnership](#)
  - [Eco-School Network](#)
  - [EEAO](#)
  - [The River Mile network/NPS](#)
  - [National Wildlife Federation](#)
  - [Partners for Sustainable Schools](#)
  - [Connect Program/Neighborhood House](#),
  - [Shape of Life](#),
  - [Oregon Climate Action Hub](#), and
  - Educators/students.

## Program Assessment



We will assess the program through online surveys and other communications. Informal assessments of our approach have been taking place as we plan the program, by asking for input from partner organizations and educators. All participants have offered enthusiastic support, and many have provided helpful ideas. Once we receive funding we will arrange a more formal meeting of educators and partners to discuss the program. Participants will be asked to complete a short online survey and share feedback about the plan, including ideas for improvements.

We will use online surveys again at the following stages of the project to help us

“The Astounding Adventures of Marco the Water Molecule” – Video Game + Educator Support Program

collect feedback about the game from a diverse range of educators, students, and other partners:

- After Chapter 1 is complete
- After Chapter 2 is complete
- After Chapters 3 and 4 are complete
- After educator training is offered in collaboration with partners
- 6 months after training

Data collected will include:

- Grade level of educators
- School/district/organization name

- Number of students impacted
- Economic need of student body (Title 1, rural high-need school, etc.)
- Ideas for improvements to game, hands-on lessons, and training, including ideas to help meet education standards and promote justice, equity, diversity, and inclusion (JEDI).

We can also explore the idea of doing more robust assessments of educator and student participants. For instance, our partner Eugene Cordero, Ph.D. and his colleagues from San Jose State University [found a powerful link between climate change education and reducing emissions](#) among college students, and we could do similar research with our K–12 participants. This would be a good next step in the program that would help us quantify the direct benefits of our program to the climate if that is determined to be a priority goal of CO2F and partners.

Dozens of partners will continue to share the resources for many years after the two-year grant period. We will continue to track data through [CLEAN](#) website analytics and other partners to help us determine how many tens of thousands of additional students are reached.



Scientists and curriculum specialists from the American Meteorology Society, BAESI, Green Ninja, and other partners will review content to ensure it is accurate and meets standards.

We will share the latest scientific understanding with the widest possible audience. Students and others who participate in our program will become ambassadors of the science and the need for immediate action. Having experienced the calamitous effects of extreme weather through play, they will gain motivation to take action in real life, as well.



Extension activities will include possible action projects like tree planting and inquiry projects to help students delve deeper into the science, share what they learn, and build more resilient communities. [Research](#) and our experience have shown that youth are impactful spokespeople. We will keep in touch with educators and other partners to track community projects and provide support by facilitating connections and sharing inspiring stories.

The game code/[Unity](#) project (premier software free for student/non-profit use) will be distributed through a [Creative Commons/non-commercial](#) license, so students and others can create new chapters or other games. We will track additional game projects that are developed and share them with our networks. Allowing new game development will provide another way to engage students, particularly those in middle school and high school, in climate action, as well as provide a free, accessible way for them to learn coding and other STEAM skills through project-based learning. Long-term success on climate action and resilience requires that the next generation is adept with a wide-range of STEAM skills, including those related to technology and communication.



## Timeline with Goals, Objectives, Milestones, and Engagement

1. We will share news of the program with a broader range of educators and other potential partners. We will provide a link to the [detailed game development plan](#) (in progress) and host a meeting to solicit feedback about our plan for the game, curriculum, and training. In our communications and meeting we will also share existing resources and networks that educators can tap into right away, such as those with [CLEAN](#), [ClimeTime](#), and [BAESI](#), for immediate positive impacts on students and to address the climate crisis.
2. Once partners reach consensus, we will complete/revise the plan for the game and create new animations.
3. We will create a prototype of Chapter 1 of the game within 5 months of funding. An online survey will be used to collect feedback about the game from educators, students, and other partners.
4. Chapters 1 and 2 will be completed within 7 months of funding. During that time, we will also begin creating/curating hands-on lessons and training resources. We will then share the prototype and curriculum outline with partners.
5. We plan to have the complete prototype of Chapters 1-3 of the game ready 10–11 months after we receive funding. Versions for iOS, Android, Windows, and Mac will be shared, making it accessible to nearly everyone with a computer, smartphone, or tablet.
6. We will have a bug-free game endorsed by partners 12 months after funding. We will then begin widespread promotion of it and workshop offerings. We anticipate we will offer a hybrid educator workshop in Portland and online within 16 months of funding. We will also create short training videos for flexible, on-demand training.
7. We will conduct a survey at the end of training to assess impacts and areas for improvement for the game, educational resources, and training.
8. We will conduct a follow-up survey 6 months after participants have been trained to help determine the effectiveness of the program, how it has impacted students, and ways it can be improved.
9. We plan to train 100 teachers in the year following game completion.
10. If we receive additional funding we will create Chapter 4 of the game, which will allow students to take actions in the game to implement solutions to address the challenges. These include ecosystem restoration, technological innovation to increase the efficiency of renewable energy sources including solar, wind, and hydropower, and other ways to take action to reduce greenhouse gases in the atmosphere, mitigate the impacts of extreme weather, and help their communities adapt to our changing climate.

# Answers to Questions from Matching Donors Carl Haefling & Pam Johnson

## Answered by Rick Reynolds

### 1. How complex and how long will the game be?

The goal is for the game to be played by an average 3<sup>rd</sup>–6<sup>th</sup> grade student in 30 minutes or less, partly so it can be completed in one class period (leading to more widespread adoption and completion). The game will be divided into 4 main sections if partners agree:

- **Chapter 1:** 4–5 minutes traveling around the world’s global ocean through the critical thermohaline circulation system, helping every fascinating living thing to thrive. Students will also explore the structure of water molecules.
- **Chapter 2:** 8–10 minutes exploring the water cycle and other natural systems, like ways water makes life on Earth possible, the importance of glaciers, and how groundwater can travel very slowly back to the ocean.
- **Chapter 3:** 5–8 minutes exploring the impacts of more intense extreme weather events due to increasing temperatures, as well other negative impacts of the climate crisis, like species loss, more powerful hurricanes and tornadoes, ocean acidification, melting ice caps, and changes in ocean currents.
- **Chapter 4:** 9–10 minutes working on climate mitigation strategies to help save the world. Tasks will include trying to increase natural habitats and protect biodiversity, restoring wetlands, improving agricultural practices, shifting to renewable energy sources, walking, biking, and taking public transit instead of driving, better insulating homes/schools, and growing gardens.



The plan is for an ambitious 2D adventure/problem solving game. It will be more robust than most educational games, which are generally very simple and not very good, and it will cover a lot of science/action items. Most importantly, it will leave students feeling hopeful about the future and inspired for critical actions that must be done NOW and for the rest of their lives if a sustainable future for them is to be achieved.

### 2. Has any part of the game been created yet? I noticed you have a book using Marco; is the character copyrighted?

Yes, [game design is in progress](#) and some art/animation/code is created. I will donate Marco the Molecule, other characters, and the story for the project. I copyrighted them when they were created, but everything will be donated to the Creative Commons.

### 3. Once the game is created, who pays for its distribution? It appears you are connected to a few orgs that might help, but it seems like a daunting task.

Distribution/marketing are monumental tasks...at least as big as creating a great game, other curricular materials, and training. By focusing on our networks of educators, we dramatically increase distribution to students and their families. That is why such a large percentage of the initial budget will be spent on educator training and materials.

Over time, funds we raise for the project will be used to grow the number of educators, students, and partners using the game and other resources. We will attend conferences like NSTA, CSTA, NAAEE, OSTA, WSTA, E3 Washington, and others across the country, online, and potentially around the world. I already participate in a lot of conferences and enjoy working with partners, so Engaging Every Student has a database of about 1,000 educators and partner organizations. In addition, we work with partners with much larger distribution lists. Through the power of partnerships—and passion for the critical work—we can do it.

Offering the game and supporting resources for free will make it much easier to get widespread adoption—and be more equitable. Teachers and students in poorer schools and countries will have similar access to the resources as those in richer areas. Offering online training workshops to teachers and training videos for all online through YouTube will also help meet our equity goals.

In the long-term, we want to help empower students around the world to continue development of the game and other impactful games. In middle school I created an elaborate video game that was one of my most enjoyable educational experiences. By providing the Unity project and open-source code, we can work with teachers and students to help them program new adventures in the game and other games. This will be another way to engage students, especially middle school and older students, and potentially result in other great educational games that folks around the world will want to play.

#### **4. It appears to be a one-time only game designed to teach a student a specific set of learnings. Or will the game have different levels of learning more complex concepts about water?**

Playing it one time will allow students to explore critical concepts, but it is being designed to be enjoyable enough that students will want to play it over and over again. That is what we have found with “Fight the Bites!” and this game will be magnitudes better if we can raise the funds needed. In addition, inquiry-based projects and other activities will be shared with educators to help students develop a deeper understanding of water and become proficient with the [3 Dimensions of NGSS](#).



Playing and creating well-designed educational games is a joyful, empowering process. All kids can be equally engaged in STEM when we consider their needs for learning to be fun and meaningful. By offering these experiences to students at an age when the concepts and skills can best prepare them to successfully overcome the climate crisis, we will also present them with exciting opportunities to pursue fulfilling careers in STEM fields. Investing in engaging educational tools and training for K–12 students and educators now will create ripples that will travel out for years and generations to come.