

Our Climate, Our Communities: Science, Systems, and Solutions

Zoom Transforms Hybrid to Online.

The screenshot shows a web browser window displaying the 'Massachusetts Wildlife Climate Action Tool' for Blanding's Turtle. The page includes a search bar, navigation links, and a map of Massachusetts with a layer for 'Current (GAP) - Blanding's Turtle'. A sidebar on the left features a photo of the turtle and text: 'Photo credit: Bill Byrne, MassWildlife', 'Scientific name: Emydoidea blandingii', and 'Species stressors: Aquatic connectivity loss (roads and dams)'. The browser's address bar shows 'climateactiontool.org/species/blandingsturtle?extents='.

Massachusetts Wildlife Climate Action Tool - screenshot

By **Jane Heinze-Fry**

"We say that in times of great environmental change, all species are faced with the challenge: adapt, migrate, or perish. When COVID-19 spread throughout the globe, stretching across the United States and resulting in massive school closures, we adapted our professional learning institute by substituting virtual sessions for the on-site sessions."

Flashback Foundation

I WAS SO EXCITED to be doing exactly what I had been dreaming about for years. During the Fall, with the staff of the Wade Institute for Science Education (formerly the Museum Institute for Teaching Science), I developed a 10-week course to offer middle and high school teachers. Our Climate, Our Communities: Science, Systems, and Solutions was built on the foundations of Wade's commitment to hands-on, minds-on inquiry-based education and research into the best practices for climate change education. Research by Munroe et al. had suggested that "two themes were common to most environmental education: (1)

focusing on personally relevant and meaningful information and (2) using active and engaging teaching methods. Four themes specific to issues such as climate change were also generated: (1) engaging in deliberative discussions, (2) interacting with scientists, (3) addressing misconceptions, and (4) implementing school or community projects."

Hybrid design

Having offered many hybrid institutes over the years, we returned to this model that offers "the best of both worlds." We developed a mix of online assignments, which teachers could address as their schedules allowed. Read-and-respond inquiry-based pedagogy and climate science articles offered preparation for speakers. Toolbox assignments directed participants to review the Climate Literacy and Energy Awareness Network (CLEAN) Collection of Educational Resources and other websites to build their own personal toolboxes and to share their findings collaboratively. Discussions encouraged teachers to apply their learning to their classrooms and to share experiences, perspectives, and resources. At-home investigations engaged teachers with science practices that would be built on during the on-site sessions.



getting their classrooms. The next week, there were rumors of COVID-19 reaching Massachusetts. And the following week, the Mass Audubon sanctuary where we met was closed. The schools closed, not to reopen this school year. We had one week to pivot to a virtual meeting. Could we transform quickly enough?

Springboard

A number of supports were already in place. The teachers displayed some cohesiveness. We had interacted with the participants at the first, on-site session. By working on the Schoology platform, the teachers demonstrated some tech savvy. Engaging at-home investigations were already built in to the online part of the course. In addition, Wade Institute had a Zoom contract to run meetings with staff and partners.

We planned four on-site 6.5-hour Saturday sessions to showcase the expertise of speakers and to engage in question-and-answer sessions with participants. In addition, we designed small-group investigations to observe climate phenomena and engage in science and engineering practices. These experiences were meant to model ways to approach inquiry-based instruction in the classroom, including investigations that might be adapted for use in the classroom. By December, the syllabus was finalized. We were ready to offer the course.

Implementation

In the New Year, our excitement grew as the online Schoology platform developed. Twenty-five teachers, some from the same districts, registered and sailed through the introductory assignments. With this full class size, Wade Institute Executive Director Sandi Ryack-Bell joined the course as co-instructor.

First (and only) on-site session

Our jam-packed introductory on-site session kicked off on February 29. Teachers met in small groups, based on geography, grade level, and subject matter. They moved on to engage in a soil investigation at different levels of the inquiry continuum: confirmation, structured, guided, open. Switching focus to science content, teachers participated in the Incredible Carbon Journey. Acting as carbon atoms, participants experienced how carbon shifted its presence in the four earth systems from pre-industrial revolution times to the present.

At lunch, participants sought out those they had met in the introductory online activities. In the afternoon, teachers listened to Dr. Bob Chen explain ‘systems thinking,’ particularly within the climate system context. Teachers then examined a K–12 Science, Technology, and Engineering strand map to identify the weather/climate standards for their grade. Finally, using internet resources, they found municipal vulnerability plans (MVP) to identify how climate change was affecting their communities.

Within this collaborative learning culture, teachers were primed to develop meaningful units and investigations tar-

However, none of us had used Zoom for instruction. The on-site plans for interacting with speakers, investigations, and pedagogy activities required adaptation to the virtual meeting venue. Because schedules were set, we could not change meeting times.

The pivot: fear to fun

While teachers were engaged with Feederwatch in Module 1, instructors began a crash course on Zoom. Sandi anchored the Zoom application, while I integrated the components of the course delivery. An invitation to the first Zoom practice session appeared in my email.

Anxiety rippled down my spine. Would the invitation work? Would I need a password? Click. Hm. Click again. “Ah, I see you!” “What?” We kept talking on our cell phones as I learned to hit the unmute button. We were in Zoom’s main room. “What does this button do?” We explored. We found ways of viewing Zoom participants: active speaker and gallery views; the chat box; the screen share. We discovered how confusing it can be to screen-share when there are too many documents open on a messy desktop. Click. We shared a PowerPoint slide. “Very cool.” Hitting ‘stop screen share,’ we found ourselves blinking at each other back in the safety of the main meeting room. “Not bad. Pretty intuitive.”

“Ok, let’s see if I can send you into a breakout room,” ventured Sandi. “Fine. I’m ready.” Pssshhhhhh! This moment felt like “Beam me up, Scotty” for those of a certain Treky generation or like ‘disapparating’ for those of a different generation. “Oh, look, let’s screen-share here, too. Look at this whiteboard. Ah, we can play with the font and color and stamps.” But all too soon, it was time to return to the main room. For one terrifying moment, I was lost in cyberspace. Fortunately, there is more than one way to return home again. There are ‘return to main room’ messages to click. And the controller can also bring participants back to the main room. I noted that the first trip can be a “wild ride.” Moving on, I learned how to generate Zoom invites.

Then it was my turn to work with our Mass Audubon co-instructor and other speakers to assure that we could all operate together in this new ‘sandbox.’ With varying



degrees of Zoom experience, we shared discoveries as we learned. We handled each other with care and stayed tethered. No one wanted to lose a colleague to the black holes of cyberspace. We took chances and pressed buttons together.

The first virtual session

Sandi and I met on Zoom at 8:30am on March 11. Participants had received Zoom invitations, directions, and a worksheet. By 8:40, teachers started popping up in the gallery. Twenty-four teachers arrived to participate in this marathon session. We welcomed everyone, thanked them for coming, and introduced our speaker. Would it work?

Mass Audubon's Joan Walsh shared recent research on how Massachusetts bird populations are responding to climate change. Because her home did not have enough bandwidth, her colleague, ecologist Dr. Martha Gach, showed Joan's PowerPoint slides as she spoke and moderated participants' questions typed in the chat box. I followed up with a brief discussion of Feederwatch and the phenomena of the spring sounds of bird and frog calls. We gave our participants a first experience with the breakout rooms to share the whiteboard and discuss: "What might students ask about these spring calls? What evidence could they collect? What science practices could they use?" For this experience, instructors reported back to the main room with our group's discussion. We had varying degrees of success with sharing the whiteboard. After a short break, Martha presented "Investigating a Climate-Sensitive Ecosystem." She showed slides of vernal pools and their organisms as well as methods to collect data. We returned to the breakout rooms, this time to examine data collected from two vernal pools. Teachers were asked: "What questions could be answered with this data? What would it take for this data to address

climate change connections?" Teachers reported their results using the whiteboard, a Word document, or simply a verbal description.

After lunch, teachers viewed websites that displayed community-based climate data: the Massachusetts Wildlife Climate Action Tool, Lyme disease, and equine encephalitis. With PowerPoint slides, Martha shared how Mass Audubon's rain garden addressed the area's increased precipitation. As the afternoon waned, Sandi noticed the faces of our participants and sent me a personal chat message. The worksheet could be completed at home. We were exhausted. But we had met our mission as best we could under the circumstances. As it turned out, we would need to continue these adaptation patterns for the remaining two virtual sessions.

Adaptation: the main room

Presentations by speakers in Zoom's main room went smoothly. Typically, the speaker shared a PowerPoint presentation and stopped for questions during the session or held questions for the end. The questions and answers were controlled by a moderator or by the speaker who was comfortable following the chat.

Kicking off the second virtual session, resource economist Gene Fry dug into the importance of albedo and feedback loops with "Why Carbon Neutral is Way Not Enough." Gene stopped at carefully chosen points in this dense presentation, and I moderated questions from the chat box. Later, engineer Rick Rys shared a vision in which Massachusetts could shift to renewable energy sources to provide the state's electricity. He took questions directly from the teachers, and only then followed up with a musical PowerPoint to showcase construction of his net-zero home.

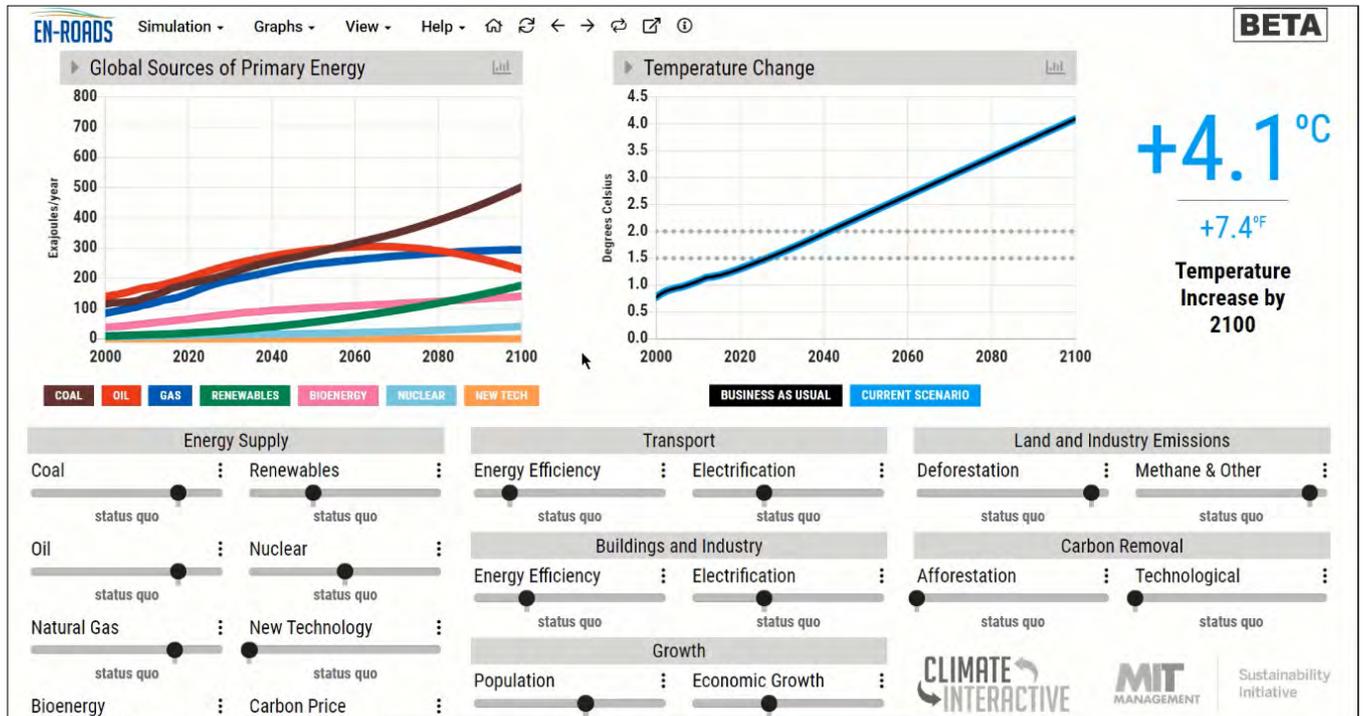
At our last virtual session, the founder of the Bionutrient Food Association, Dan Kittredge, catalyzed a conversation targeting soil, health, and climate. The path of discussion wound its way from the significance of the soil biome, to soil health, to the Real Food Campaign, to how soils can sequester carbon to address climate change.

Adaptation: breakout and mail rooms

Investigations

In the second virtual session, we challenged the teachers with the investigation: "What actions can we take to meet the Paris Agreement's 2°C target?" Training to become En-ROADS ambassadors, Jim Lagomarsino and Meg Haight introduced the development of the En-ROADS Climate Solutions Simulator in the main room. Adjourning to breakout rooms, teachers shared their reasoning for their top picks from the 18 sliders listed on the En-ROADS Control Panel Guide they had received at home. Testing each choice individually, no "silver bullet" was to be found. However, the target could be successfully approached or surpassed by simultaneously using multiple sliders. Returning to the main room, we even peeked "under the hood" and saw how to adjust the simulation's assumptions. Additional classroom investigations on these topics were provided on Schoology.

Meanwhile, I received at my home materials for the last investigation: "How do mycorrhizae affect the growth of roots and stems of winter wheat?" After COVID, we redesigned this investigation in order to mail supplies and instructions to the participants. Teachers searched for some materials at home. At our last virtual session, I presented



En-ROADS Climate Solutions Simulator - screenshot

an overview of the investigation. We turned to the breakout rooms to combine the teachers' individual results into class data from which we drew our consensus conclusions.

Pedagogy activities

For a pedagogical activity, Sandi shared a PowerPoint presentation describing phenomena-based inquiry. In advance, she had selected photos of climate-related events and identified teachers who would screen share a photo during the virtual session. Within the breakout rooms, teachers discussed the photo and asked, "What is happening?" From their group's discussion, they generated a news story, which they shared with the whole group back in the main room. This activity segued to the online module's emphasis on interdisciplinary instruction.

In our last session, Dr. Bob Chen led a revisit to a selection of the teachers' climate system representations. In breakout rooms, each group selected one connection on one climate representation. They brainstormed how this connection could inspire questioning and data collection in the classroom. The group's discussion was summarized and shared in the main room.

Successes and highlights

Instructors' perspectives

Teamwork by instructors, speakers, and Wade staff was imperative. We each brought different strengths to the effort. We shared the complexities and urgent challenges of climate change, while providing hope through a variety of solutions. We were able to provide experience with some investigations to the participants.

The participants stepped up to the challenge of the course. They carried on rich discussions through the online component. Most of the teachers completed the course successfully. Twenty-four out of 25 completed the instruction. Twenty-two submitted varied and rich unit and investigation plans: storm water capture, tracking mosquitos, human

impacts on the water cycle, health impacts linked to climate change, extreme weather, sea level rise, and more.

We developed our minds, thinking about the whole climate system and deepening different components of it. We addressed a number of misconceptions about climate change, and teachers investigated a few of the misconceptions of their students. We began a discussion comparing COVID and climate change.

A comparison of the participants' pre-post assessments demonstrated statistically significant increases in teachers' understanding of science content and inquiry-based pedagogy. In addition, teachers demonstrated increased 1) confidence in their knowledge of climate change and climate change education and 2) awareness of potential climate change collaborators in their communities.

Participants' perspectives

For teachers, the most frequently-mentioned highlights of the course were the investigations and inquiry methods; the variety of speakers; the resources provided; and the knowledge gained about the climate system. Also mentioned were the collaborative context of the course; addressing common climate change misconceptions; and the pivot from hybrid to online. From the teachers:

"Doing the experiments, particularly getting experience with structured, guided, and open inquiry [was a highlight]."

"The resources we were exposed to were great. There was enough variety that I could find resources to deepen my own knowledge on the topic, as well as resources that were appropriate to use with middle schoolers."

"The highlight of this course was hearing from so many experts who have devoted their careers to understanding climate change and working toward meaningful solutions to the problem."



“The highlights of the course include modeling of a seamless transition to remote learning... The second “in-person” class was my first ever Zoom, and now I feel like I live on it!”

“When we started the virtual sessions, I was quite surprised [by] how interesting they were and how organized they were... I thought the breakout groups were nice... It was definitely not the same as being there in person, but the interaction in the breakout room was useful to bounce ideas off of each other.”

“We did not need to spend so much time in transportation, and we did reduce our carbon footprint!”

Challenges

Instructors’ perspectives

Instructors missed the warmth and speed of personal communication. Sometimes it felt like we were “moving through Jell-O.” We missed the “voice of inquiry,” when teachers put their heads together in an investigation. We practiced patience and persistence to simultaneously work together to adapt the course, continue to run the course, and prepare the speakers for a different venue from the original plans. The virtual sessions were too long, even with guest speakers. Technological incompatibilities were annoying, but manageable.

Participants’ perspectives

Teachers were hugely challenged by many simultaneous changes: the pivot of the course, their own work schedules, and shifting family commitments. The length of the virtual sessions was too long, even with breaks from sitting and screen time. Participants missed doing hands-on investigations in small groups, as well as informal conversations and networking. Interpersonal connection is simply better face-to-face. Also mentioned were slower clarification of lessons and assignments (compared to face-to-face interactions) and some technical difficulties with the breakout rooms or other areas.

Key take-aways

Change and online solutions

With COVID-19, we are walking into a new world with more uncertainty. This is a wake-up call. We need to have

tools to continue educational instruction when crises hit. Zoom, Schoology, and other online tools can help us meet those needs. We cannot be too proactive about increasing our skills with these tools.

Time management

Time management is a priority. We need to be aware of attention spans. We can plan meetings for the whole group at the same time and meetings for small groups at flexible times. We can design activities that support skills for independent or small-group learning without the teachers’ collective presence.

Personal, please

We should make the virtual environment as personal as possible. Putting pictures (or an avatar) in the online profiles is helpful. A casual chat place where students can socialize is recommended.

Investigations and more

We need to design investigations in which students can share science practices together, even while at home. Students need to have access to investigative supplies at home and/or teachers need to develop student “resource packets.” We need to explore multiple forms of instruction (such as systems thinking and concept mapping) that lend themselves to online learning.

Teamwork

Scientists and community members support our work. We need to collaborate to enrich instruction and to provide smooth logistics. Through working in teams, our students can learn effective leadership and followership skills.

Reflection

As I complete the pivot, I wonder, “What was lost and what was gained?” At the end of the day, I can say, “I have a new tool that prepares me for the day when someone says, I’m declaring a state of emergency. You need to shelter in place.” These times call for the inquiring intrepid spirit of Ms. Frizzle from the Magic School Bus series: “Take chances, make mistakes, get messy!” That’s how we’ll create toolboxes for new challenges. Let’s Zoom into the future together!

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Additional References

Martha C. Monroe, Richard R. Plate, Annie Oxarart, Alison Bowers & Willandia A. Chaves (2019) Identifying effective climate change education strategies: a systematic review of the research, *Environmental Education Research*, 25:6, 791-812, <https://www.tandfonline.com/doi/full/10.1080/13504622.2017.1360842>

CLEAN Collection of Educational Resources
https://cleanet.org/clean/educational_resources/index.html

Wade Institute for Science Education Homepage
<https://www.wadeinstitutema.org/>