



Abstract

Through generous NOAA Planet Stewards funding, schools in the Northern Illinois area had the unique opportunity to participate in a one-day design challenge that focused on local and state environmental issues. Student teams, which ranged from fifth grade through high school, engaged in research and design thinking to create innovative responses and solutions to address their selected water challenge. Subject matter experts were available, both virtually and in person, for questions, conversations, and insights as teams worked. Simultaneously team sponsors engaged in their own professional development related to the NOAA Planet Stewards Program. Students showcased their work at the end of the day to experts and educator mentors.

The Illinois Mathematics and Science Academy (IMSA, imsa.edu) is located roughly 40 miles west of Lake Michigan. When NOAA Planet Stewards contacted IMSA regarding developing and hosting a Planet Stewards workshop, we immediately thought of the Lake and named the event after Michigan, which means large or great lake, thus the name, The Great Water Challenge.

Planning the event was a team effort between NOAA Planet Stewards and IMSA’s Statewide Educator Initiative Team (SEI). SEI’s mission is to impact mathematics and science education by supporting educators with relevant professional development in areas such as technology, problem-based learning, the Next Generation Science Standards (NGSS, 2013), and a micro-credentialing program. SEI and NOAA Planet Stewards engage with formal and informal educators as well as students to increase scientific literacy. NOAA’s focus on climate literacy (NOAA, 2006) and water-related issues closely aligns with IMSA’s focus on the United Nations Sustainable Development Goals (UN, 2015), particularly goals 13-15. Earth and human activity, as well as engineering and design performance expectations from the Next Generation Science Standards, of which Illinois has adopted, are also interrelated.

Table 1. Event Goals

Source	Goal
United Nations Sustainable Development Goals https://sdgs.un.org/goals	Goal 13: Climate Action Goal 14: Life Below Water Goal 15: Life on Land
Essential Principles of Climate Literacy https://www.climate.gov/teaching/essential-principles-climate-literacy/essential-principles-climate-literacy	Essential Principle 6: Human activities are impacting the climate system. Essential Principle 7: Climate change will have consequences for the Earth system and human lives.
Next Generation Science Standards https://www.nextgenscience.org/	Middle School Earth and Human Activity: MS-ESS3-2, MS-ESS3-3, MS-ESS3-5 Engineering and Design: MS-ETS1-1, MS-ETS1-1, MS-ETS1-4
	High School Earth and Human Activity: HS-ESS3-1, HS-ESS3-4 Engineering and Design: HS-ETS1-1, HS-ETS1-2, HS-ETS1-3

Allowing student choice, using local issues, and connecting learners with experts in the field were the best pedagogical practices used as criteria for the project development. These led us to employ a modified design sprint. The function of a design sprint is to identify a problem and solve it within a short amount of time, usually five days, through research, discussion, ideation, and prototyping. As this was a one-day event, teams were not expected to complete a significant portion of the design sprint process. Teams would identify a local environmental problem they wanted to mitigate, research the issue, and develop a plan of action or solution. In order to narrow the field of issues for the students and the teachers, a focused list of locally relevant topics was developed. Categories were selected based on local environmental issues, recent events, appropriate resources, and availability of subject matter experts. Research questions were then developed for each of the categories. Below is the list of topics and questions.

Algal Blooms, Pet Illnesses

- How does the Midwest contribute to harmful algal blooms in the Gulf of Mexico and how can we lessen the impact?
- How do harmful algal blooms affect plants, animals (including pets), and humans?
- What are potential solutions to reducing harmful algal bloom events?

Algae

- Why are algae necessary for the biosphere?
- How can uses of algae positively impact climate change or sustainability?

Biodiversity/Invasive Animal Species

- How is climate change affecting the spread of invasive species (such as zebra mussels)?
- What are the impacts of invasive species (such as zebra mussels)?
- What actions can be taken to control invasive species (such as zebra mussels)?

Biodiversity/Invasive Plant Species

- How is climate change affecting the spread of invasive plant species (such as purple loosestrife)?
- What are the impacts of invasive species (such as purple loosestrife)?
- What actions can be taken to control invasive species (such as purple loosestrife)?

Marine Debris, Microplastics, Plastics

- What are the trends in the use of microplastics and what actions can be taken to reduce what ends up in the ocean?
- Document the presence of marine debris in the Great Lakes and what communities can do to reduce the input.

Human Health Issues, Vector-borne Disease

- How is climate change affecting the incidence of vector-borne diseases?
- What actions can be taken to reduce the incidences of vector-borne diseases?

Nuisance Flooding, Weather Incidents, Shoreline Changes

- What are the impacts of flooding events in Illinois and what strategies are communities using to protect citizens and property?
- Document how climate change may affect the incidences of severe weather. What actions should citizens take to prepare for the new climate future?

During registration for the project, student teams selected the question they wanted to investigate, subject matter experts they wished to hear, and submitted questions they wanted to ask each of the subject matter experts at the event.

Teams were provided with resources to use for preliminary research prior to the event. Many student teams came prepared with extensive background knowledge about their chosen issue. This allowed them to focus on having final questions answered from the experts and to develop solutions and evidence to support their choice.

Planning for a one-day event that provides an immersive experience for students requires an attention to detail. Scheduling for the day included general sessions and customized sessions for each school to meet with their subject matter experts of choice. Identification of and communication with subject matter experts was critical. Presentation materials, topics and questions from teams, schedules, and technical platforms needed to be developed and shared. School and student permissions, schedules, and other logistics for the day also needed to be sent in advance. Some of the responsibilities for the hosting SEI team included facility reservations for large and small group work, food, check in, moderating sessions, obtaining and providing materials for teams, and supervising students. We also wanted to provide the sponsoring teachers with their own professional development. NOAA Planet Stewards Program, NOAA resources, implementation ideas, and other related topics were presented at an educator-only session during the event while the students worked with the subject matter experts.

The day of the Great Water Challenge began with all participants gathered in the auditorium. Subject matter experts introduced themselves, briefly spoke about their jobs, and shared their areas of expertise. From there teams moved following their individual schedules as they met with the subject matter experts either in-person or virtually, who presented additional background information regarding their topics and answered student questions.

Each team then began developing ideas to mitigate their selected issue, as well as a presentation and materials for the poster session in the afternoon. For the final session, student teams were divided into groups A and B. This allowed group A teams to present and group B teams to move about and listen to group A team presentations. Roles were reversed so group B teams presented for group A teams. The day wrapped up with awards that recognized creative efforts, scientific accuracy, and clarity of solutions. Teams were also presented with *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* by Paul Hawken, water bottles, and metal straws.

Table 2. Sample of Student Developed Questions

- How do you think AI can help solve the issue of invasive species?
- Do invasive species cause long term human health issues? If so, what kind and what have we done in the past to prevent / stop them?
- What does marine debris encompass? Please provide categories or examples.
- Is it possible to introduce catalysts that will re-polymerize microplastics so they can be combined into larger molecules that are easier to extract?
- Are there any projects where algae or bacteria are being used to breakdown plastics or marine debris?
- In what ways do algae benefit the ecosystem compared to what they take away?
- How do algae compare to other marine/aquatic plant life?
- Could there be blooms of any other plant species that cause as much harm as algal blooms?
- What is the main cause of algal blooms? Where is it most prevalent?
- If algae is helpful to ecosystems, how does it also cause harm?
- Could the impact of algae blooms extend as far as the Midwest and affect our drinking water supply?
- Once an aquatic system is thrown off-balance, can it fully recover, and how?
- What types of laws or regulations have been put in place to regulate the use of fertilizers?



Figure 1. Dennis Liu talks with a student about biodiversity and invasive species.

Photo credit: Angela Rowley



Figure 2. Students engage with a virtual expert to learn more about their chosen topic.

Photo credit: Angela Rowley

Impact

The impact of the Great Water Challenge is largely anecdotal in nature. Participant numbers included 25 educators, 87 students, 6 subject matter experts, and 10 IMSA SEI Team members. Comments during the day were very positive from the students, the participating educators, and the subject matter experts.

Participant comments included

- “Our students thoroughly enjoyed the day. They have been talking about their idea to all of their teachers.” – *Educator*
- “I didn’t know that what we do here bothers the ocean.” – *Student*
- “Why aren’t there laws to stop that?” – *Student*
- “This is the best day of my life!” – *Student*
- “I met real scientists.” – *Student*
- “Students were well prepared. They asked really good questions and had great ideas.” – *Subject Matter Expert*
- “They are persistent.” – *Subject Matter Expert*
- “It was refreshing – their perspective.” – *Subject Matter Expert*

As a pilot project, the design challenge may provide a spring board for more opportunities so that students may interact with subject matter experts regarding a wide range of environmental issues.

References

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About the Author

Liz Martinez is a curriculum and professional development specialist for The Center for Teaching and Learning at the Illinois Mathematics and Science Academy (IMSA) in Aurora, IL. Before she joined IMSA she was a middle school science teacher for 29 years. Liz is a past president and current secretary of the National Middle Level Science Teachers Association. She has been a NOAA Climate/Planet Steward for many years and is appreciative of the support provided by the project. She can be reached at emartinez@imsa.edu.