

An aerial photograph of Lake Erie, showing a significant portion of the water covered in a bright green cyanobacteria bloom. The bloom is most concentrated in the western and central parts of the lake, extending towards the shorelines. The surrounding land is a patchwork of agricultural fields and urban areas. A semi-transparent dark blue horizontal band is overlaid across the middle of the image, containing the title text.

# Lake Erie Volunteer Science Network Summative Evaluation Report 2022-2023

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## Executive Summary

The Lake Erie Volunteer Science Network (LEVSN) is a program of the Gelfand STEM Center at Case Western Reserve University. LEVSN (formerly Smart Citizen Science) aimed to build a connection to, and sense of stewardship for, the Lake Erie watershed among students and teachers.

Using a combination of professional development for teachers, curricular modules related to Lake Erie environmental challenges, watershed experiences for teachers and students, and student project dissemination, LEVSN sought to impact the following outcomes:

1. Increase teacher knowledge of local freshwater resources.
2. Increase teacher efficacy in teaching on local freshwater resources.
3. Develop student knowledge, attitudes, and behaviors towards freshwater resources, including Lake Erie.
4. Encourage students to act as environmental stewards.
5. Improve student communication skills and interdisciplinary learning.
6. Increase motivation and engagement of students in utilizing science and technology to address water issues.

In the 2022-2023 school year, the program served 36 teachers across the Lake Erie watershed, plus their students (ranging 5th grade through high school) across five regions. The included regions were Buffalo, New York; Cleveland, Ohio; Fredonia, New York; Toledo, Ohio; and Southeast Michigan.

Data were collected in spring 2023 from 10 teachers and three students between a post-program teacher survey and a post-program student focus group. Data were also collected via a document review of program materials produced by the program director as well as by participating students and teachers.

Results indicate that LEVSN was successful in impacting teacher knowledge of critical environmental challenges facing the Lake Erie watershed, teacher efficacy in utilizing student-centered strategies in their teaching, and student attitudes toward critical environmental challenges facing freshwater resources. The program may also have impacted student action as environmental stewards and student 21st Century Skill development (pertaining to freshwater resources), to a lesser degree.

Recommendations for future programs include:

- Continue to offer local, relevant environmental education to make authentic connections with students.
- Provide students with information on how to take action as environmental stewards, post-program.
- Implement the program consistently across regions to improve student and teacher outcomes.
- Collect more data from participating teachers and students.



## Introduction

### Background

The Lake Erie Volunteer Science Network (LEVSN) is a program of the Gelfand STEM Center at Case Western Reserve University. LEVSN (formerly Smart Citizen Science) aims to build a connection to, and sense of stewardship for, the Lake Erie watershed among students and teachers.

LEVSN sought to impact the following outcomes:

1. Increase teacher knowledge of local freshwater resources.
2. Increase teacher efficacy in teaching on local freshwater resources.
3. Develop student knowledge, attitudes, and behaviors towards freshwater resources, including Lake Erie.
4. Encourage students to act as environmental stewards.
5. Improve student communication skills and interdisciplinary learning.
6. Increase motivation and engagement of students in utilizing science and technology to address water issues.

Serving 36 teachers across the Lake Erie watershed, plus their students (ranging 5th grade through high school), LEVSN offered professional development, curricular modules, and additional resources to support meaningful watershed experiences for students in the 2022-2023 academic year. The program supported schools across five regions, including:

- Buffalo, New York
- Cleveland, Ohio
- Fredonia, New York
- Toledo, Ohio

- Southeast Michigan

The program relied on four main components:

*Professional development:* LEVSN offered summer training followed by professional support meetings over the academic year.

*Curricular modules:* Three curricular modules were given to participating teachers for them to implement or adapt for their classrooms. These modules, as described on the program Google Site, included:

- Unit 1: “The **Climate Change and Harmful Algal Blooms** module uncovers the root causes of climate change and harmful algal blooms, investigates the connections and interactions between the two phenomena, and explores potential solutions by citizen scientists.”
- Unit 2: “Assessing the health of ecosystems big and small, our relationship to them and what we portray is important. The **Ecosystem Assessment** module touches on students' environmental identities, the science of environmental protocols, and the art of modifying media to tell a story.”
- Unit 3: “The **Digital Fabrication** module exposes students to the idea of computers operating machines that were once manually operated to successfully produce a product. This consists of students learning about the machines and strategies used, their associated safety standards, and the scientific process of solving a real-world problem.”

*Watershed experiences:* Via resources and financial support, LEVSN offered teachers opportunities to provide meaningful watershed experiences for their students.

*Student project dissemination:* Alongside student experiences and research projects, students presented their results to their peers in an end-of-year symposium and on a showcase website:

- An **end-of-the-year symposium** was held in May 2023 to celebrate the completion of the program and share experiences among participating teachers and students. The symposium was virtual and hosted on Zoom by the program director. Nine teachers attended, three of whom attended with their students. Attending students ranged from 5th to 12th grade. Approximately 15 students attended (i.e., two groups of three students, and one group of approximately eight students). Attendees were thanked for their participation in the program and were encouraged to share action-research projects that they completed. All three student groups presented their work, highlighting projects like removing invasive species, raising and releasing native trout, and conducting water quality testing. Teachers without attending students also shared their experiences in the program and what projects they worked on with their students.
- The **digital repository of student-generated artifacts** resulting from participation in the LEVSN was hosted on a shared Google Site. Teachers were encouraged to upload digital copies of Lake Erie or Great Lakes-based artifacts their students developed, such as posters, reports, images, videos, songs,

poems, or any other artifact that showcased student understanding and attitudes about the challenges faced by people in the Lake Erie basin. Each region was offered a tab on the Google Site, under which each participating school was listed.

## Purpose of the Evaluation

The STEM education evaluation firm, Improved Insights, was contracted to conduct a summative evaluation of the LEVSN program to assess the outcomes of the program on its student and teacher audiences.

For participating teachers, the study aimed to understand potential changes to teacher knowledge of critical environmental challenges facing the Lake Erie watershed and teacher efficacy in utilizing student-centered strategies in teaching. Originally, the study also aimed to understand the change in teacher ability to build strong relationships with local community champions and positively affect teaching practices as a result. However, a mid-year change to the program design eliminated this third interest area.

For participating students, the study aimed to understand potential changes to student attitudes towards critical environmental challenges facing the Lake Erie watershed, student action in environmental stewardship, and 21st Century Skill development (i.e., communication, motivation, and interdisciplinary learning) as it pertains to the Lake Erie watershed.

## Methods

### Evaluation Questions

Five evaluation questions were developed to guide this study across the teacher and student audiences.

#### Teachers

1. To what extent do teachers participating in the LEVN program express increased knowledge about critical environmental challenges facing the Lake Erie watershed?
2. To what extent do teachers participating in the LEVN program express increased efficacy in utilizing student-centered strategies in their teaching?

#### Students

1. After participating in the LEVN program, do students express changes in their attitudes toward critical environmental challenges facing freshwater resources?
2. After participating in the LEVN program, how are students taking action as environmental stewards, if at all?
3. After participating in the LEVN program, in what ways do students express improvements in their 21st Century Skills (i.e., communication, motivation, and interdisciplinary learning) as they pertain to freshwater resources?

### Recruitment

#### *Teacher Survey*

Teachers were recruited into the evaluation process from a comprehensive list of all summer professional development attendees. A list of 36 teacher participants across five regions was provided by the program director at Gelfand STEM Center. All 36 teachers were contacted by the

evaluator, asking them to participate in a post-program survey. Two rounds of follow-up emails encouraging the teachers to participate were sent over the course of three weeks. Of the 36 teachers contacted to participate, 10 completed the survey.

#### *Student Focus Group*

Four participating teachers were nominated by the program director to coordinate with the evaluator for student focus groups. These teachers were chosen purposely as they were highly engaged teachers who had implemented the curricular units in interesting and varied ways with their students. Originally, one focus group per region was planned. However, as some regions were more engaged than others in the program (for various reasons relating to program implementation), it was decided that focus groups would not have to be from four different regions.

Of these four selected classes/teachers, only one focus group was able to be conducted. Two teachers were unable to schedule focus groups with their students due to end of school timeline not lining up with the data collection timeline. One teacher was unresponsive. The final teacher scheduled a focus group and coordinated with the evaluators to administer and collect student consent forms for participating students. Three students participated in the student focus group.

Across the data collection timeframes for both the student focus groups and the teacher survey, the end of the school year was a major impediment to recruitment. Since the LEVSN worked with so many different schools, with their last days of school ranging from the end of May to mid-June, it was challenging for the program

director to schedule a final event (the symposium) that avoided testing dates and was still within the regular schedule of the school year for all participants. It was also challenging for the evaluation to connect with teachers after the final symposium on May 25, 2023, and before the end of the school year. It is likely that many teachers were already on their summer break when the recruitment emails were sent for the teacher survey. Also, with the end of the year being so busy for students and teachers, it was difficult to schedule the student focus groups.

A mixed-methods approach was implemented between July 2022 and June 2023 to answer the evaluation questions. Evaluation methods included a post-program survey to gauge teacher development and learning, a post-program student focus group to assess psychosocial effects (i.e., attitudes and behaviors) and skill gains, and a document review of program materials (e.g., curricula, student project dissemination website, etc.) to contextualize the evaluation and explore student and teacher outcomes.

## Teacher Survey

### Instrument

The teacher survey (Appendix A) focused on the program's potential effects on teacher knowledge regarding critical environmental challenges facing the Lake Erie watershed, and teacher efficacy in utilizing student-centered teaching strategies.

The survey collected data regarding teacher involvement in the program, such as which unit they used in their classroom, if they implemented that unit in in-school or out-of-

school contexts, and which program training or meetings they attended. Basic demographic data were also collected. To understand the potential effects on teacher knowledge regarding critical environmental challenges facing the Lake Erie watershed and teacher use of student-centered teaching strategies, a five-point Likert-type scale of agreement (from strongly disagree to strongly agree) was employed. Questions covered the potential effects of the program's training, meetings, and resources about critical environmental challenges as well as student-centered teaching. Teachers were also asked to reflect on the program's effects on their students, regarding their students' knowledge, attitudes, and behaviors toward freshwater resources.

### Data collection and analysis

Teacher survey data were collected between May 2023 and June 2023 via Google Forms. Ten responses were collected (N=36, 28% response rate). Analysis was done in Microsoft Excel for basic proportions and key qualitative themes.

## Student Focus Group

### Instrument

The student focus group collected data on the student experience in the LEVSN program, including student attitudes on critical environmental challenges facing freshwater resources, student behaviors (or intended behaviors) as environmental stewards, and 21st Century Skill development (i.e., communication, motivation, and interdisciplinary learning).

A student focus group consent form (Appendix B) and focus group guide

(Appendix C) were developed to use with the student population.

#### Data collection and analysis

Student focus group data were collected in June 2023 in a single virtual focus group hosted over Zoom. Three students participated in the focus group from one school. Responses were analyzed for key qualitative themes.

*Note: The participating class completed the first unit; Climate Change and Harmful Algal Blooms.*

#### Document Review

##### Instrument

A document review was conducted on program materials at the end of the program. Documents collected over the course of the program were reviewed for themes relating to the evaluation questions, as well as for contextual information on the program and how it was implemented. Notes collected by the evaluator were included, as well as program materials produced by the program director and program participants.

##### Data collection and analysis

Program materials were collected and reviewed for program contextualization, to understand program changes, and to better understand program effects on teachers and students.

Materials included in the review were:

- Program proposal
- Curricular units
- Program logic model and amended logic model
- Summer teacher training schedule

- Digital repository of student projects (Appendix D)
- Evaluator meeting notes (including meetings with the program director as well as a professional development meeting with teachers)
- Evaluator notes from the symposium



## Findings

### Teacher Outcomes

#### *Knowledge about critical environmental challenges impacting the Lake Erie watershed*

Ten teachers responded to the post-program survey on their experiences in the LEVSN program. Of the ten respondents who replied to the scale of agreement question about the program's effect on their knowledge of critical environmental challenges, nine (90%) agreed or strongly agreed that the program increased their

knowledge of critical environmental challenges facing freshwater resources, as evidenced in Figure 1. Teachers also largely agreed (though to a lesser extent) that the program increased their knowledge of instructional strategies for teaching students about environmental challenges facing freshwater resources.

When asked to detail major successes that they've experienced as a result of participating in the LEVSN, five teachers responded. Their responses were coded and three themes emerged, as detailed in Table 1.

Figure 1. Teacher agreement regarding knowledge and teaching efficacy about critical environmental challenges facing the Lake Erie watershed.

Most respondents agreed to some extent that the program **increased their knowledge of, and ability to teach about, freshwater resource challenges.**

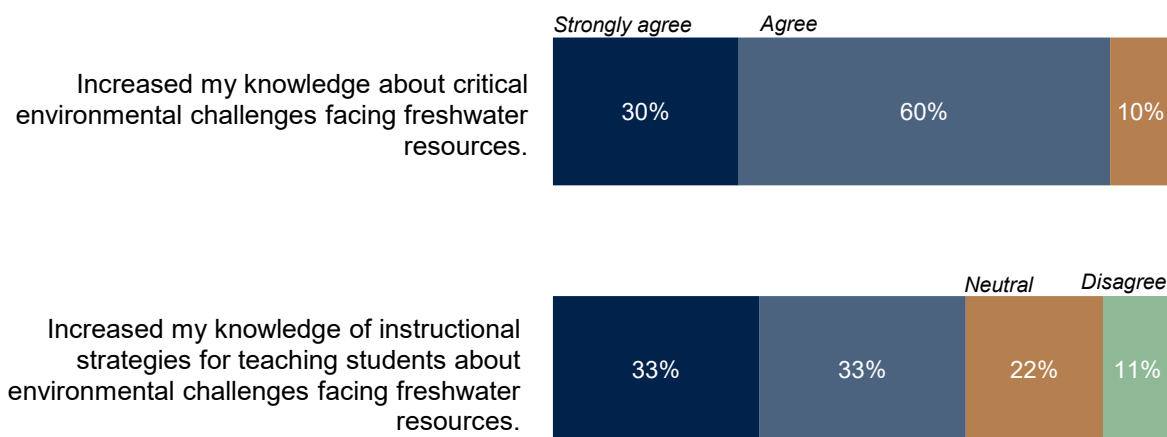


Table 1. Themes in teacher successes as a result of LEVSN (n=5).

Theme	Number of Respondents	Percentage of Respondents	Example
Access to resources	3	60%	“Access to water quality testing locations and connections to Case Western Reserve.”
Positive attitudes (i.e., relevance and connection)	3	40%	“The students also considered the unit to be relevant and important to our community.”
Knowledge gain and use	2	60%	“I was able to use the information to teach students [...]”

Access to resources and positive perceptions (from teachers themselves as well as their students) were the major success themes most often shared by the respondents. In the responses detailing access to resources, teachers spoke about access to water quality testing locations, connections to Case Western Reserve University, citizen science resources, water quality testing supplies, and a professional development course. Said one teacher, *“The resources provided were valuable. I have been exposed to best practices and insightful planning and implementation.”*

Respondents who mentioned positive attitudes about the LEVSN program cited feeling a deeper connection to freshwater resources, and that the content and resources were relevant to them and their students. Said one teacher, *“I was able to participate in a professional development course that is relevant to the content area I*

*teach, and to the real world.”* Said another, *“The students were most certainly engaged and enthusiastic about the unit. By providing a variety of options I was able to observe the creativity and strengths of my students.”*

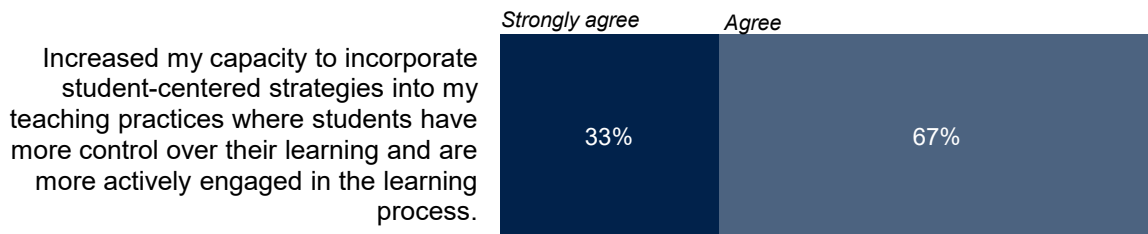
Two teachers mentioned a major success being their improved knowledge gain and use about freshwater resources. Said one, *“Overall, I feel confident when I talk with my students and I feel more connected to the Great Lakes, especially my Lake Erie. More importantly, I am excited and less afraid to talk about it and engage in meaningful conversations.”*

#### *Teacher efficacy in using student-centered strategies in their teaching*

All ten teachers agreed or strongly agreed that LEVSN increased their capacity to incorporate student-centered teaching practices into their classrooms, as detailed in Figure 2.

Figure 2. Teacher agreement regarding student-centered strategies.

All teachers agreed that LEVSN **increased their capacity to incorporate student-centered teaching strategies.**



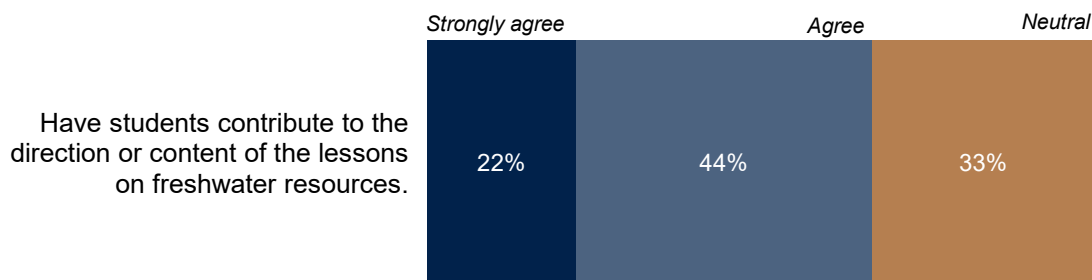
To a lesser extent, teachers agreed or strongly agreed that the program impacted their ability to involve students in lesson design and development. As represented in

Figure 3., of the nine responding teachers, seven (66%) agreed to some extent, while the remaining two teachers neither agreed nor disagreed with the statement.

Figure 3. Teacher agreement regarding student involvement in lesson direction and content development.

The majority of teachers agreed to some extent that LEVSN **improved their ability to involve students in lesson direction or content development.**

*The LEVSN's training, meetings, and resources have improved my ability to...*



## Student Outcomes

### *Learning and skill development*

Three students participated in a focus group to discuss their experiences in the program. They expressed learning and skill development; a change in their attitudes and beliefs about, and interest in, Lake Erie and freshwater resources; interest in taking action as environmental stewards; and other effects of the LEVSN program.

Student self-reported learning and skill development centered around developing research skills (through activities like water quality testing) and content knowledge about watersheds, the health of Lake Erie, algal blooms, invasive species, and other related topics. One student reflected on the impact of conducting water quality testing, *“I didn’t think Lake Erie was that polluted because when you see the pictures online it looks very clean and stuff like that. But then when we did the actual water quality testing, I saw that, wow, this was really bad water quality and I couldn’t believe that people weren’t doing more to help it.”*

Teachers were also asked to reflect upon the potential effects of the program on their students in the post-program survey. Nine of the ten teachers (90%) agreed or strongly agreed that the program helped them positively impact their students’ knowledge of freshwater resources (Figure 5.).

On the Google Site, one student reflected on her learning in the program, stating: *“I was able to learn a lot about the development of trout, which helped me appreciate the value and beauty of aquatic organisms. I loved seeing the trout swimming in our fish tank as soon as I got*

*to class every morning. Raising rainbow trout is very important since they are keystone species, meaning that they are essential to our local ecosystem. This project helped me learn more about the aquatic ecosystem in the Rocky River and Lake Erie, which helped me feel more connected to my local watershed. By testing water quality from local sources in the Metroparks, I started to make connections between what a watershed is and how human activities affect it. Overall, this experience has made me aware of watersheds and the issues that they face.”*

Students were asked to reflect on their 21st Century Skill development in the focus group, particularly in the areas of communication, motivation, and interdisciplinary learning. All three students expressed having shared information about Lake Erie and its health challenges with their families, indicating that they practiced communication skills (specifically science communication skills), but none identified a change in their own personal skillsets as a result of the program. One student identified a cross-curricular connection she made when learning about the history of Lake Erie, but no student made a connection to interdisciplinary learning skill development in their reflections. However, all three students expressed increased motivation to learn about Lake Erie and watershed health, as well as to take personal action to steward these freshwater resources. One student said the program motivated them to learn more about the lake as *“Lake Erie [is] such a very important part of where I live [...] I personally believe that everywhere our environment should be very clean and stuff like that. So, it has definitely motivated me more to research what I can do and research what other people are doing so*



*maybe I could help support them in a way.”*

This motivation to learn more about the environmental challenges Lake Erie is facing and to take personal action is detailed further in the environmental stewardship section of this report.

In the post-program survey, teachers were asked to reflect on how the program’s

training, meetings, and resources may have impacted their ability to facilitate student learning, skill development, and other outcomes. The heatmap detailed in Figure 4. shows the varying proportions of agreement and disagreement across several related statements.

Figure 4. Teacher agreement regarding improvement in their teaching practices and strategies.

<b>The LEVSN’s training, meetings, and resources have improved my ability (in my teaching practices or strategies) to...</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neither Agree nor Disagree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
Encourage students to connect what they learned in the classroom to what’s happening in the real world regarding freshwater resources.	40%	60%	0%	0%	0%
Allow students to participate in field trips or outdoor activities to foster their learning further and deepen their understanding of freshwater resources’ challenges.	40%	10%	50%	0%	0%
Facilitate classroom discussions where students actively engage in presenting ideas, giving/receiving feedback, and discussing what they learned about freshwater resources.	33%	67%	0%	0%	0%
Engage students in exploring, investigating, and helping solve challenges facing freshwater resources.	30%	60%	10%	0%	0%
Have students collaborate with one another while learning about freshwater resources.	40%	50%	0%	10%	0%
Engage students in critical thinking, asking questions, and assessing the challenges facing freshwater resources.	33%	44%	22%	0%	0%

In general, teachers agreed or strongly agreed that the program improved their

students’ ability to engage in various skills (including critical thinking, questioning,

assessing challenges, and investigating issues). It also helped them give students opportunities to participate in engaging classroom discussions, collaborate with other students, and connect what they learned in the classroom to the real world.

Half of the teachers agreed that the program allowed their students to participate in field trips or outdoor activities to foster learning and deepen their understanding of freshwater challenges. The remaining half neither agreed nor disagreed with this statement.

The end-of-year symposium took place on May 25, 2023 with nine teachers and three groups of students in attendance. All attending teachers and students presented on action research projects they completed while in LEVSN. Projects undertaken by students included many opportunities for students to practice both 21st Century Skills and research skills. In their descriptions of their projects, students identified participating in various activities like water quality testing, raising and releasing native trout, removal of invasive species, creating public education videos, identifying macroinvertebrates in local water, and writing scientific blog posts.

#### *Attitudes about Lake Erie and freshwater resources*

Students in the focus group expressed new attitudes and changed beliefs about Lake Erie and freshwater resources as a result of the LEVSN program. Among them, the importance of freshwater resources, the importance of helping ecosystems and local communities, and the importance of personal action like picking up trash on the beach. Said one student, *“I think that I*

*realized the importance of trying to help the ecosystem and community.”*

Reflecting on the program also encouraged these students to express their personal beliefs about what they learned, with sentiments like ‘our environment should be clean,’ ‘it is important to voice opinions about bad water quality in Lake Erie,’ and surprise that people aren’t doing more to help the water quality in Lake Erie.

As reflected in the heatmap in Figure 5., 90% of responding teachers also agreed or strongly agreed in the post-program survey that the program helped them impact their students’ attitudes regarding freshwater resources.

All three students in the focus group expressed increased interest in Lake Erie and freshwater resources as a result of the program. Comments included a desire to increase their awareness of environmental issues and personal action opportunities, a desire to pay more attention to environmental issues, and satisfaction in learning about Lake Erie and its ecosystems. One student expressed that this project showed her that learning interesting things in school (such as about Lake Erie) can happen, indicating perhaps that the personal relevance and place-based learning effectively engaged her during the program.

#### *Environmental stewardship*

Personal action was a common theme in the focus group, with students reflecting both on pro-environmental behaviors they currently partake in (e.g., picking up trash), and expressing a desire to be more involved in environmental stewardship regarding Lake Erie. All three students expressed

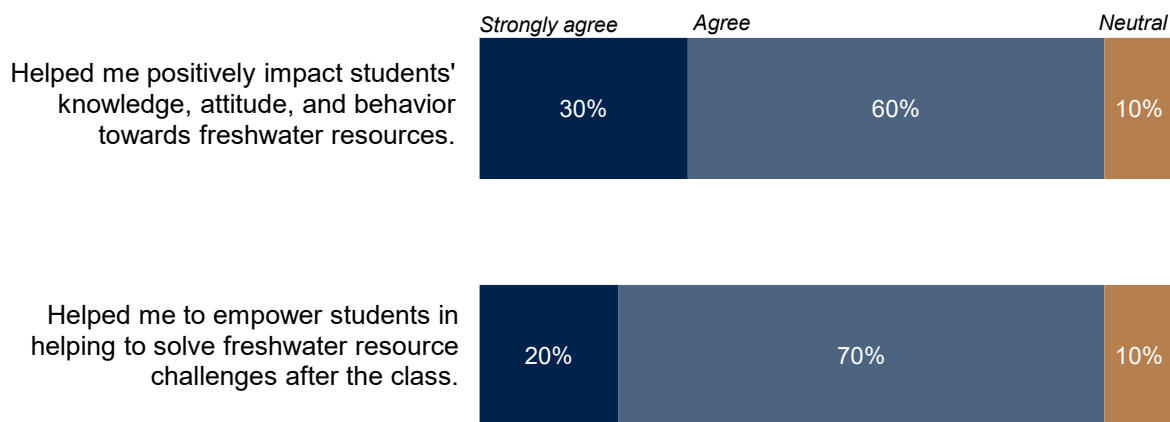
having shared what they were learning with their families during the program, which can also be considered personal action. Interestingly, students expressed some frustration over not feeling as though they could take many actions (as young people) and that they did not know ways that they could help. Said one student, *“Well I can’t do anything right now, but I do want to be more aware of the issues, and I definitely want to research more into the issues and what me, a student, can do in reality. Because obviously I can’t go out to Lake Erie every day and help because that’s just not realistic.”* All three students stated they

would want to help out more in the future, and one expressed having researched how they can take action as environmental stewards.

Nine of ten teachers (90%) agreed or strongly agreed in the post-program survey that the program helped them positively impact students’ behaviors towards freshwater resources and helped them empower their students to take an active role in helping to solve freshwater resource challenges. In each case, one teacher remained neutral, as detailed in Figure 5.

Figure 5. Teacher agreement regarding student outcomes.

**Respondents largely strongly agreed or agreed that the program helped them empower and impact their students.**



Some students were able to take stewardship action during the program, as part of hands-on research and stewardship activities. Said one student on the Google Site, *“Our class has not only participated in the Lake Erie Journey but also worked to remove invasive species local to our community. For a few days, the AP Environmental Science class worked with our sophomore biology class to remove*

*Narrowleaf Cattail, a rhizomatous perennial, Common Reed Grass, an aggressive wetland invader, and Reed Canary Grass. Learning how these invasive species can impact the local biodiversity and natural resources available to humans allowed me to expand my knowledge of my community and our local watershed.”*

Said another, *“Our ‘Trout in the Classroom Project’ really opened my eyes to the beauty of aquatic organisms. From the start of our project, I would look forward, every day, to walking into the classroom and checking in on our little fish friends. Throughout the process of taking care of them, my classmates and I were vigilant in testing the water quality, replacing the water, and ensuring the filtration systems were up to date. My favorite part of the project was seeing them excitedly swim up to the surface of the water as we fed them. The three months of taking care of the trout made me more aware of the importance of water quality, and it was a small step in bringing me closer to my own watershed of Lake Erie.”*

#### *Other effects*

Students also mentioned other effects of the program, including a broader understanding of the interconnectedness of ecosystems and seeing Lake Erie in a new way. Said one student, *“Every time I see something at Lake Erie, you think about this project. How Lake Erie is not clean.”* A second student agreed, *“When I go to my grandma’s house and I see the lake I think about the project and how Lake Erie’s health is.”*

#### Program Reflection

##### *Curricula implementation*

Teachers implemented the curricular units in a variety of ways. Of the three curricular units (i.e., Climate Change and Harmful Algal Blooms, Ecosystem Assessment, and Digital Fabrication), two-thirds of respondents (six, 67%) implemented Climate Change and Harmful Algal Blooms, the remaining implemented Ecosystem Assessment (four, 44%) and Digital Fabrication (one, 11%). *Note: respondents*

*could choose more than one unit, therefore responses total more than 100%.*

The majority of respondents (eight, 89%) implemented only one unit, while the remaining respondent implemented three.

Of the nine respondents, eight of them implemented the curricular modules during the regular school day (89%) while one implemented the modules during out-of-school time (11%). When asked to describe how they implemented the learning modules, six of the eight teachers expanded upon their implementation in an in-school setting and one described their implementation in an out-of-school setting.

The qualitative responses were coded to identify recurring themes in the data. Among the in-school implementers, the most common themes were teachers describing their instructional practices (e.g., what materials they used in their teaching, descriptions of lesson plans, specific technology used, etc.) (five teachers, 63%) and describing how students conducted research (four teachers, 50%). A few teachers also mentioned using the curricular modules in specific classes (two teachers, 25%) and student dissemination as a component of the learning (such as via gallery walks or the shared project Google Site) (two teachers, 25%). One teacher also mentioned a field trip to a local watershed.

One teacher shared their implementation of the unit in great detail: *“I used many of the instructional materials and resources provided to us to create a Google Slide instructional with images and links that introduced the topic of HABs [Harmful Algal Blooms]. Using the data (graphs) provided and a few that I researched, students*



*worked in small groups to analyze and extrapolate the trends shown. We used the Lake Erie HAB model diagram to evaluate the sources of HABs. We found that the majority of us had little knowledge of HABs and the combination of factors leading to their more regular return. I then challenged the students to create a message that was focused on improving public awareness of HABs and how the general population could be asked to help mitigate the problem. Students were given the option to create a pamphlet, poster, or video sharing the information and dangers of HABs. They could also choose to write a legislative bill that would propose to change laws related to activities related to HABs. A final option would be related to engineering and designing a form of technology that could aid in the reduction of HAB-producing factors. We finished with a gallery walk of the student projects. There were examples of all of the options provided which added to the variety of the projects to view.”*

#### *Professional development*

Only half of the responding teachers reported attending the summer professional development training (five, 50%), and only six (60%) attended at least one of the Professional Learning Community Meetings (PLCMs) during the academic year.

#### *Barriers to implementing LEVSN curricula and materials*

When asked to detail major challenges that they've faced as a result of participating in the LEVSN, five teachers responded. Responses were more varied in this question and included time constraints, a personal health issue, resources that were not age-appropriate, receiving the curriculum late, and a concern about standards.

Two respondents cited time constraints, one very general and the other citing a desire for more outside time with their students in early fall and late spring.

One teacher cited a personal health issue and how they addressed this challenge to keep being involved with the program. *“I ended up getting COVID this school year, and it really impacted my pacing in catching up with lessons necessary for my students to learn for their BIOLOGY OSTs; thus, the stress associated with this also affected my overall mental health.”* To address this, the respondent said *“I modified a few of the activities to capture the essence of the lessons and the primary objective of the learning modules.”*

Another teacher mentioned adapting the curriculum in order to overcome a challenge (in this case, resources that were not age-appropriate): *“By no fault other than my own, I tend to remake or redesign the materials provided in order to meet the instructional level of my students. Several of the resources were geared more toward high school level student learning strategies.”*

A final respondent detailed that they received the curriculum documents only a few weeks before the end of the program and so were unable to implement it this year. However, they stated, they will be adding it to their syllabus for the next school year; *“I don't think that I used this curriculum per se. I have used resources and networks provided by this partnership this school year. I have also kept water quality and Lake Erie as a common theme in my classroom.”* The same teacher noted that adherence to state standards is a big

concern for them, although it is unclear if this is a standalone challenge or simply more context for them wanting to implement the curriculum in the following year.

#### *Areas for program improvement*

Teachers were asked to reflect upon their experience in the summer training and Professional Learning Community Meetings. Three respondents offered areas of improvement for these components. Their feedback fell into two categories: (1) general reflection on the summer training and (2) suggestions for curriculum improvement.

Respondents provided conflicting feedback on the summer training, with one stating *“we really didn’t do too much at the training session. It wasn’t the best,”* and another stating *“the summer learning experience was great.”* A third respondent offered a suggestion on curriculum improvement that could occur during the professional development, stating, *“include an activity that highlights work they could possibly do during seasons where it is not possible to go outside or do outdoor activities.”*

When asked to provide additional comments or feedback, five teachers chose to reply. Three themes emerged from the data: (1) feedback regarding materials, curriculum, and resources, (2) general praise, and (3) suggested partnerships and connections.

Three teachers expressed feedback regarding materials, curriculum, and resources which ranged from small-scale criticisms on the materials (i.e., *“make sure links work in the materials”*) to an appreciation for the materials (i.e., *“I really liked that the topic and resources supported place-based citizen science”*) to student benefit (i.e., *“the students also benefited from the supplies that I was able to purchase”*).

General praise was given by two of the teachers as follows: *“this was one of the best PDs I have participated in!”* and *“this program is absolutely valuable to teachers and the community.”*

Finally, two teachers provided suggestions for partnerships and connections for future years of the program. One teacher cited the United Nations Sustainable Goals as a potential connection and another cited wanting to strengthen the partnership with people and organizations on Kelley’s Island.

A review of the LEVSN Google Site, a digital repository of student-generated artifacts resulting from the program, also brought up some areas of improvement. The participation from various regions was varied, as detailed in Table 2.

While some regions (like Cleveland, Ohio) were strong participants in the end-of-year activities, others were less engaged.

Table 2. Regional participation in Symposium and Google Site.

<b>Region</b>	<b>Number of Participating Schools at Symposium</b>	<b>Number of Participating Schools in Google Site</b>
Buffalo, New York	0	0
Cleveland, Ohio	5	5
Fredonia, New York	1	1
Toledo, Ohio	1	1
Southeast Michigan	2	1
Total	9	8

## Discussion and Recommendations

### Discussion

*Teacher knowledge about critical environmental challenges facing the Lake Erie watershed.*

LEVSN increased teachers' knowledge about critical environmental challenges facing the Lake Erie watershed. In the post-program survey, teachers largely agreed that the program improved their knowledge of critical environmental challenges facing freshwater resources. Two teachers (of five responding) also mentioned their knowledge gain and use as being a major success they've experienced as a result of participating in LEVSN.

*Teacher efficacy in utilizing student-centered strategies in their teaching.*

LEVSN increased teachers' knowledge of student-centered strategies. In the post-program survey, the majority of teachers expressed that LEVSN increased their knowledge of instructional strategies for teaching students about these environmental challenges. All ten teachers agreed that the program increased their capacity to incorporate student-centered teaching strategies. In other scale-based survey questions, teachers largely agreed that LEVSN approved their ability to incorporate students into lesson direction and content development.

*Student attitudes toward critical environmental challenges facing freshwater resources.*

LEVSN impacted student attitudes toward critical environmental challenges facing freshwater resources. Students in the focus group expressed new attitudes and

changed beliefs about Lake Erie and freshwater resources as a result of the LEVSN program. They also expressed a desire to take pro-environmental action as a result of the program.

Teachers responded to the survey that believe they positively impacted students' attitudes regarding freshwater resources through the program.

*Student action as environmental stewards.*

LEVSN had some impact on students acting as environmental stewards. Students had the opportunity to act as environmental stewards during LEVSN through action projects like invasive species removal. In the focus group, students expressed a desire to take action as environmental stewards after participating in the program. However, these same students also expressed a lack of understanding of *how* to take action, as well as a lack of self-efficacy in acting as environmental stewards. One student did express having already taken action to learn how to become more involved in environmental stewardship.

In the post-program survey, teachers largely thought they empowered the students to take action for the environment.

*Student 21st Century Skill development as they pertain to freshwater resources.*

LEVSN may have had an impact on students' 21st Century Skill Development. While teachers in the survey were largely in agreement that the program helped them foster skill development in their students, students themselves did not identify 21st Century Skill gains as readily in the focus group. This may be because they were too young (developmentally) to identify this type of development in themselves or that the



program simply did not develop students' 21st Century Skills as much as expected. In both the focus group and student project dissemination components (i.e., end-of-year symposium and Google Site), students did express practicing the skills in question (i.e., communication, motivation, and interdisciplinary learning) though they did not identify their own personal growth in those skills.

### Recommendations

**Continue to offer local, relevant environmental education to make authentic connections with students.**

LEVSN succeeded in connecting with students due to its focus on local, relevant environmental issues. Future iterations of this program could continue this focus in order to develop pro-environmental beliefs, attitudes, and interests among students.

**Provide students with information on how to take action as environmental stewards post-program.** While students in the focus group expressed a desire to take action as environmental stewards, they also expressed a lack of self-efficacy to actually take action and a lack of understanding of

*how* to take action. In future iterations of LEVSN, more attention could be paid to building the knowledge and self-efficacy of students to allow them to take action as environmental stewards, after their involvement in the program.

**Implement the program consistently across regions to improve student and teacher outcomes.** This implementation of LEVSN changed across regions due to various programmatic reasons. Because of this, certain regions had more highly-involved teachers than others. This likely impacted the program evaluation as well as the reception of the program by teachers and students. A future iteration of this program would benefit from more consistent implementation across regions.

**Collect more data from participating teachers and students.** Due in large part to scheduling difficulties at the end of the school year, this evaluation presented a small sample of participating students. While the teacher survey response rate was better, a future evaluation of this program would benefit from larger sample sizes among both audiences.

## Appendices

### Appendix A: Teacher Survey

#### Lake Erie Volunteer Science Network (LEVSN) Teacher Year-End Survey

Improved Insights, an external evaluation firm, is working with Case Western Reserve University to better understand the teacher experience in the LEVSN program.

This survey is designed to collect your feedback on the LEVSN program. It will ask questions about you, your experiences in LEVSN, potential effects of the program on your teaching and content knowledge, and your application of the LEVSN curricula and resources in your classroom. Your feedback will help us better understand the LEVSN program and improve it for the future.

Participating in the survey will take approximately 10 minutes and is optional. You may skip any questions you do not want to answer, though we really appreciate your feedback. Your responses will be kept strictly confidential and will only be used for the purposes of the evaluation.

Thank you for your time and feedback. If you have any questions about this survey, please contact Sarah Dunifon ([sarah@improvedinsights.com](mailto:sarah@improvedinsights.com)).

#### Demographics

Name: \_\_\_\_\_

School: \_\_\_\_\_

1. Approximately how long have you worked in the education field?
  - a. Less than a year
  - b. 1-3 years
  - c. 4-6 years
  - d. 7-10 years
  - e. 11-15 years
  - f. 16-20 years
  - g. More than 20 years
  
2. Which grade level do you teach? Check all that apply.
  - a. Intermediate School (3-5 grade)
  - b. Middle School (6-7 grade)
  - c. High School (9-12 grade)
  
3. What is your gender?
  - a. Female
  - b. Male
  - c. Prefer not to answer
  - d. Other (please specify)

4. What is your race/ethnicity?
  - a. White or Caucasian
  - b. Black or African American
  - c. Hispanic or Latino
  - d. Asian or Asian American
  - e. American Indian or Alaskan Native
  - f. Native Hawaiian or other Pacific Islander
  - g. Biracial/Multiracial
  - h. Prefer not to answer
  - i. Other (please specify)
  
5. Which of the three LEVSN's curriculum learning module(s) did you implement in your classroom during this past academic year (2022-23)? Please click all that apply.
  - a. Climate Change and Harmful Algal Bloom
  - b. Ecosystem Assessment
  - c. Digital Fabrication
  
6. In which setting did you implement the LEVSN curriculum learning module?
  - a. During the regular school day
  - b. During out-of-school time (e.g., before- or after-school, weekend)
    - a. Please describe how you implemented the LEVSN learning module in your classroom.
    - b. Please describe how you implemented the LEVSN learning module in an out-of-school setting.
  
7. Did you attend the LEVSN 2022 Summer Training?
  - a. Yes
  - b. No
  
8. Did you attend the virtual LEVSN Professional Learning Community meetings during the school year (2022-2023)?
  - a. Yes
  - b. No
    - a. If you attended LEVSN's virtual Professional Learning Community meetings, approximately how many did you attend during this past school year?

**Impact on Knowledge & Student-Centered Teaching Strategies**

The following sections will ask you about the extent to which you agree or disagree with the following statements.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The LEVSN's training, meetings, and resources have ...					

Increased my knowledge about critical environmental challenges facing freshwater resources.					
Increased my knowledge of instructional strategies for teaching students about environmental challenges facing freshwater resources.					
Increased my capacity to incorporate student-centered strategies into my teaching practices where students have more control over their learning and are more actively engaged in the learning process.					

<b>The LEVSN's training, meetings, and resources have improved my ability (<i>in my teaching practices or strategies</i>) to ...</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neither Agree nor Disagree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
Engage students in critical thinking, asking questions, and assessing the challenges facing freshwater resources.					
Engage students in exploring, investigating, and helping solve challenges facing freshwater resources.					
Facilitate classroom discussions where students actively engage in presenting ideas, giving/receiving feedback, and discussing what they learned about freshwater resources.					
Have students contribute to the direction or content of the lessons learned on freshwater resources (e.g., students having input on the design or goals of the classroom learning, students voting on classroom projects or topics).					
Have students collaborate with one another while learning about freshwater resources.					
Encourage students to connect what they learned in the classroom to what's happening in the real world regarding freshwater resources.					
Allow students to participate in field trips or outdoor activities to foster their learning further and deepen their understanding of freshwater resources' challenges.					

<b>The LEVSN's training, meetings, and resources have ...</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neither Agree nor Disagree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>

Helped me positively impact students' knowledge, attitude, and behavior toward freshwater resources.					
Helped me to empower students to take an active role in continuing to help solve the challenges facing freshwater resources after they completed the class (e.g., beach clean-ups, not littering, educating friends and family).					

**Conclusion**

9. What major successes have you experienced as a result of participating in LEVSN's 2022 Summer Training/Professional Learning Community monthly meetings?
10. Did you have any major challenges implementing and carrying out the LEVSN-designed curriculum? If so, what were those challenges, and how you addressed them?
11. How would you improve the Summer Training and/or Professional Learning Community meetings?
12. Are there any other comments or feedback you would like to provide?

## Appendix B: Student Consent Form

### Evaluation Consent Form

Protocol Director: Sarah Dunifon, Improved Insights

Dear Students and Parents/Guardians,

You (students) are invited to participate in a program evaluation regarding the Lake Erie Volunteer Science Network (LEVSN) program conducted through Improved Insights, Case Western Reserve University, and your school. Please read this form carefully and ask any questions you may have before agreeing to be in the study. You will receive a copy of this form for your records.

**Purpose:** The purpose of this study is to understand the effects of the NOAA-funded B-WET program, LEVSN, on participating students and teachers. The implementation of the LEVSN program varied widely. At your school, this program may have been a simple unit in your classroom or an after-school student research experience. We seek to explore student experiences, any changes in attitudes or behaviors they may have observed, and the skills they have gained as a result of their participation in this program via a student focus group. Findings will be used for program improvement only.

**Procedures:** If you agree to be in this study, you will be asked to participate in a 45–60-minute focus group regarding your experiences in the LEVSN program. The focus group will be conducted over Zoom and will be recorded for transcription. You will participate in the focus group alongside other students, and answer questions about your perceptions of the program, your experiences, and other self-reported attitudes and behaviors. There are no right or wrong answers.

**Risks and Benefits:** We do not anticipate any specific risks resulting from this study. The study will not have any direct benefits for you, but your participation will help us learn more about the LEVSN program and its effects. This information you share will inform future programs that will impact other students.

**Voluntary Nature of Participation:** Your decision whether or not to participate will not affect your current or future relationship with your school or Case Western Reserve University. If you decide to participate, you are free to withdraw at any time without affecting those relationships. You may decline to answer any questions that you do not feel comfortable answering. Before beginning the focus group, the evaluator will review this consent form with participants and obtain verbal assent from students.

**Confidentiality:** This study will not include any information that will make it possible to identify you. All data collected from the focus group will be kept digitally in folders only accessible to the evaluation team (i.e., Improved Insights). This consent form will be stored digitally and separately from the data. Your teacher will not be present during the focus group.



**Contacts and Questions:** The evaluator conducting the focus group is Dr. Oseela Thomas, and the protocol director is Sarah Dunifon. If you have questions about this study, you may contact Sarah Dunifon (sarah@improvedinsights.com).

**Statement of Consent:** I have been given information about this study and its risks and benefits and have had the opportunity to ask questions and have them answered to my satisfaction.

*I consent to participate in this study (students age 18 or older).*

**Student Name:** \_\_\_\_\_

I am 18 years of age or older.

Yes \_\_\_ No \_\_\_

**Student Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

*I consent to my child participating in this study (students under age 18).*

**Parent/Guardian Name:** \_\_\_\_\_

**Parent/Guardian Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

## Appendix C: Student Focus Group Guide

### Lake Erie Volunteer Science Network (LEVSN)

#### Student Focus Group Protocol

##### Introduction of Moderator and Focus Group Guidelines [1]

Hello everybody, (*Greet and ask for each student's name*)

My name is \_\_\_\_\_, and I am an evaluator studying the Lake Erie Volunteer Science Network B-WET program, which is what you just completed. Now the implementation of this program may look different depending on the school. And your teacher may have called it by a different name. Could you share with me the name of your particular project or unit that you studied? \_\_\_\_\_.

Great, so we will talk about your experience on that particular project/unit as we are interested in understanding how the class/project went for you from your perspective. That is why we have invited you to participate in this group. We will spend around 40 minutes to an hour to get your feedback and opinions.

But first, I'm going to go over some guidelines to follow. The purpose of following the guidelines is to create a safe space so that everyone feels comfortable discussing their opinions and to give each of you (student) a chance (an opportunity) to speak and participate. They are as follows:

- One person should speak at a time.
- There are no "right" or "wrong" answers to any of the questions. We are only interested in hearing your perspectives as students.
- We value confidentiality, so everything you say in this focus group will be kept confidential. That means we will not associate feedback from this focus group with a particular individual.
- Everyone will have a chance to speak. If you have not had an opportunity to provide your perspective, I may call on you.
- I ask that you turn off or silence your cell phones at this time.
- Are there additional guidelines that you (the group) would like to add?

I'd like to record the interview so that I can transcribe it. Would that be alright with everyone?

This interview is voluntary, and there is no requirement for you to participate. If you'd like to stop participating at any point during our focus group discussion, you may do so. You may also skip any question you do not wish to answer.

Do you have any questions for me before I start?

[Once you receive everyone's response] - Great, now do you all agree to participate?

### **Curriculum Impact on Student Awareness and Attitude**

1. Different teachers and students have engaged with the freshwater resource project in different ways. What did it look like at your school (e.g., a field trip, a unit, a project, etc.)? What did you call it (e.g., LEVSN, the Lake Erie unit, etc.)?
  - a. What projects did you do? *(Could you summarize what you did or what you learned during the project\_\_\_\_\_? What activities did you engage in? What did the project\_\_\_\_\_ entail?)*
    - i. Did you engage in outdoor activities or go on field fieldtrips to deepen your understanding of freshwater resources? Did you do any group projects? Or did you learn about it in class only?
    - ii. (The three curriculum modules) Did you participate in any of the following activities?
      1. Did you participate in any activities or projects that dealt with Climate change and harmful Algal bloom?
      2. What about assessing the health of a freshwater resource to conserve the limited natural resources? This could be on or by your local school grounds or elsewhere.
      3. How about being exposed to digital fabrication technology (e.g., 3D printing, robotics, and other activities you might find in a makerspace or FabLab)?
  - b. What did you learn?
2. Since participating in the project \_\_\_\_\_, did your attitude change regarding the challenges facing freshwater resources? If so, how has it changed?
  - a. Prior to (before) your involvement in the project\_\_\_\_\_, what was your level of awareness or knowledge about the challenges faced by your freshwater resources? What did you know before your involvement in the project\_\_\_\_\_? What was your attitude like before?
  - b. Now that you have completed the project\_\_\_\_\_, how has your attitude changed, if it did?

### **Curriculum Impact on Student Behavior**

3. After participating in the project \_\_\_\_\_, are you taking any action to preserve the health of your local freshwater resources? If so, could you explain in what ways you are taking action?
  - a. Has the project\_\_\_\_\_ motivated/empowered you to get more involved in preserving the health of freshwater resources? If so, how?

- b. Do you plan to get more involved in preserving the health of freshwater resources locally or elsewhere? How will you get involved? (e.g., joined a new club focused on environmentalism, listened to a podcast, talked to their family members about freshwater resources, picked up trash in a nearby stream, etc.)

### **Improvement in 21st-Century Skills: Communication, Motivation, and Interdisciplinary Learning**

4. Has your involvement in the current project\_\_\_\_\_ improved your communication skills in any way?

- a. Could you give an example of how the project improved your communication skills?
  - i. Has it impacted how you express yourself, share your ideas, give your opinions, argue your point, or provide feedback to your peers, such as family members, teachers, etc.? If so, how?

5. Also, has your involvement motivated you to learn more in school or life in general? If so, in what ways has the project motivated you?

- a. Could you provide an example or tell me a story of how the project motivated you further?
  - i. What are you thinking or doing now that you either had not thought of before or done since the completion of the project?

6. Lastly, has your involvement in the project\_\_\_\_\_ allowed you to connect what you have learned during the unit/project/class to other subjects in school that you are studying?

- a. Has it allowed you to connect what you have learned in the unit/project/class to situations in life? If so, how? Could you provide an example to help me understand?

# Appendix D: Student Project Dissemination Google Site Example

