Gaylen Moore Program Evaluation Services
304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

Report of the Evaluation of the BOP CCRES STEM+C Project Year 3 2020-2021

Submitted by

Gaylen Moore
and
Cara-Lynne Thomas

August 2021

Contents

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

Report of the Evaluation of the
BOP CCRES STEM + C Project
Year 3
2020-2021

I. INTRODUCTION – ACCOMPLISHMENTS

MAJOR ACTIVITIES

The STEM+C Billion Oyster Project (BOP) was designed to carry forward the work of the BOP CCRES Phase I grant conducted from 2014 to 2018 and, in addition, integrate computer and data science into oyster restoration research in the New York Harbor. The STEM+C project is comprised of four pillars of activities for teachers and students in the New York City public schools: PILLAR 1*: scientific STEM professional development activities for teachers;* PILLAR 2: *development and piloting of middle school curriculum units that integrate computer science and data* science into exploration of oyster restoration research, and describe pathways to restoration-based STEM+C careers; PILLAR 3: *a Summer STEM Institute facilitated by Pace University faculty and mentors to develop computer science and computing at the high school level*; and PILLAR 4: *the expansion and development of restoration STEM Hubs* that support field research experiences for students.

The BOP-CCRES digital platform was not operative in 2020-21. Staff worked with Morgan Stanley pro bono consultants to re-work the digital platform and it is projected to be up and running in September 2021. Data collected and posted in CCRES Phase I, the first version of the digital platform, was used consistently throughout the project in Year 2 to facilitate teacher and student learning about oyster restoration in the New York Harbor

MAJOR GOALS

The major goals of the STEM+C project are:

- sustain and augment the success of the BOP-CCRES Phase I project
- provide support to teachers and students in learning statistical and computational concepts
- expand the primary programmatic offerings to increase student understanding and interest in restoration-based STEM+C careers
- further develop the BOP-CCERS Digital Platform

In Year 2, the lockdown of New York City schools during the covid-19 pandemic had an impact on the implementation of STEM+C activities in all four pillars. The following report summarizes

the strengths, challenges, and modifications in adapting implementation to the remote learning environment to achieve the project's objectives.

II. EVALUATION METHODOLOGY

Specific Objectives

To gather data to evaluate the extent to which the STEM+C program achieved its goals, four key questions framed the evaluation.

Evaluation Question 1. How well was the STEM+C program implemented?

Evaluation Question 2. How well did STEM+C work in supporting teachers and STEM +C professionals/scientists to develop students' content knowledge, knowledge and skills in computer and data science, positive perceptions of STEM +C, and interest in pursuing a STEM +C career?

Evaluation Question 3. How well did the project work in supporting students in building their content knowledge and skills, instilling positive perceptions of STEM +C, and developing career awareness and interest in pursuing future education and a career in STEM +C?

Evaluation Question 4. To what extent was the research effective in gathering evidence in answering the research questions and identifying the impacts of the program.

Evaluation Activities

Evaluators conducted the following evaluation activities from January to June 2021 to evaluate the effectiveness and impact of the BOP STEM+C grant:

- observations of 11 teacher professional learning sessions (ongoing)
- observation of 12 student/teacher sessions (ongoing)
- *Year-End Retrospective Teacher Survey* (June)
- *Professional Learning Survey* (ongoing)
- *Teacher Symposium Survey* (June)
- observations of Symposium Project presentations (June)
- Student Survey evaluation questions

Data collection has been a challenge for the STEM+C Billion Oyster Project. In Spring 2021 collection of student data by the research team, The Mark, improved but evaluators encountered new challenges in collecting teacher survey data. Several factors for collecting teacher evaluation data were identified: 1) teachers were exhausted by the efforts of virtual teaching for the entire school year due to covid19, and had no bandwidth left to fill out surveys, several of which came at the end of the year when they were working with students to complete Symposium projects; 2) the master list of teacher participants has not been curated sufficiently to weed out citizen scientists who participate in BOP activities but whose responses are not included in the grant's data analysis; and 3) there is a small, very dedicated and committed cadre of teachers who

participated enthusiastically in all BOP activities and completed surveys. These teachers were very satisfied and excited about the project's offerings, both for them and their students as will be demonstrated in the findings presented below. Findings from the evaluation activities are summarized below under *Significant Results* and *Key Outcomes*.

III. EVALUATION FINDINGS

What was accomplished to address these evaluation questions is presented below. The evaluation of the BOP-CCRES STEM+C Project included assessment of the impact of the activities on students. Several evaluation questions were added to the Student Survey for students participating in Pillar 3 of the project: Computer and Data Science and Pillar 4: STEM Hubs. The items focused on students' perceptions of their STEM skills in scientific investigation and STEM career awareness, two of the project's major goals:

- provide support to teachers and students in learning statistical and computational concepts.
- increase student understanding and interest in restoration-based STEM+C careers

SIGNIFICANT RESULTS

PILLAR 3: DATA AND COMPUTER SCIENCE

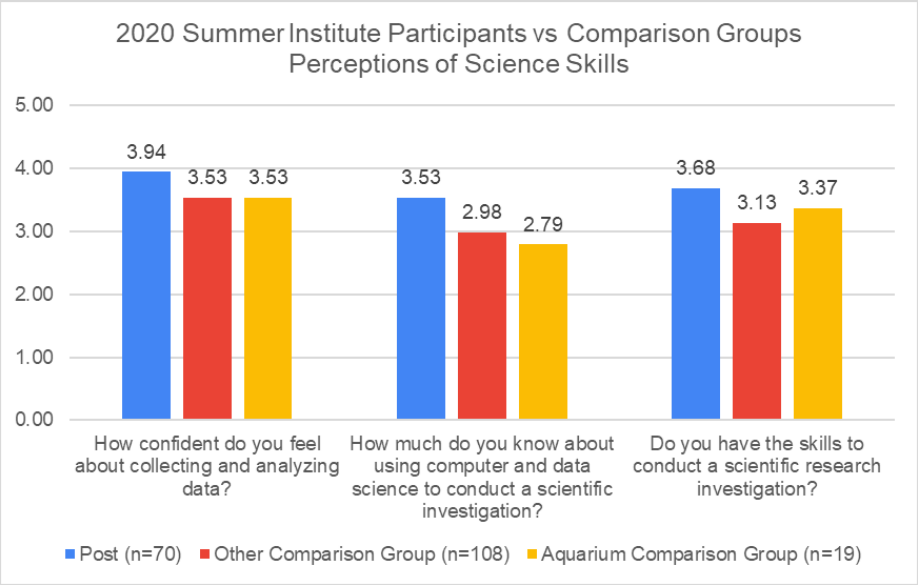
Below are the statistically significant student findings for the activities in Pillar 3.
The student findings are presented in more detail in the section Key Outcomes or Other Achievements under Evaluation Question 3.

Student Surveys were administered online by The Mark before and after events throughout the year in which students participated in Pace University STEM Institute and Hackathon data science and computing activities. In PILLAR 3, a total of 14 pre-surveys and 70 post-surveys from these activities were analyzed for statistical significance . Pre and post surveys were compared to surveys completed by two control groups: 1) students with no involvement in BOP or other marine science programs (the 'Other' comparison group); and 2) students who were involved in New York Aquarium programming (the Aquarium comparison group).

PACE UNIVERSITY STEM INSTITUTE, Summer 2020

Results of Comparison Groups: Student Perceptions of Science Skills

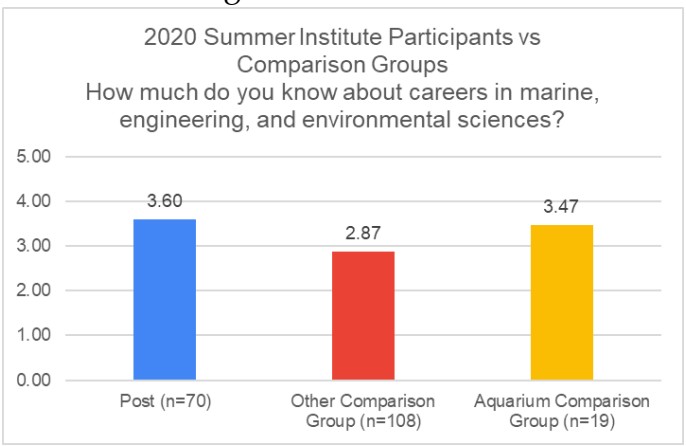
Findings show:



- STEM Institute participants reported more positive perceptions of their scientific skills than those in either comparison group.
- Unpaired t-tests were conducted to establish statistical significance of the results between these groups. The following results were statistically significant:
    - STEM Institute participants responded more positively to confidence in collecting and analyzing data than the other student comparison group.
    - STEM Institute participants responded more positively to knowledge about using computer and data science to conduct a scientific investigation than both the other student comparison group and the NY Aquarium comparison group.
    - STEM Institute participants responded more positively to having skills to conduct scientific research than the other student comparison group.

Results of Comparison Group: Student STEM Awareness

Students in both the experimental and two control groups also responded to questions about their awareness of STEM careers. Findings show:

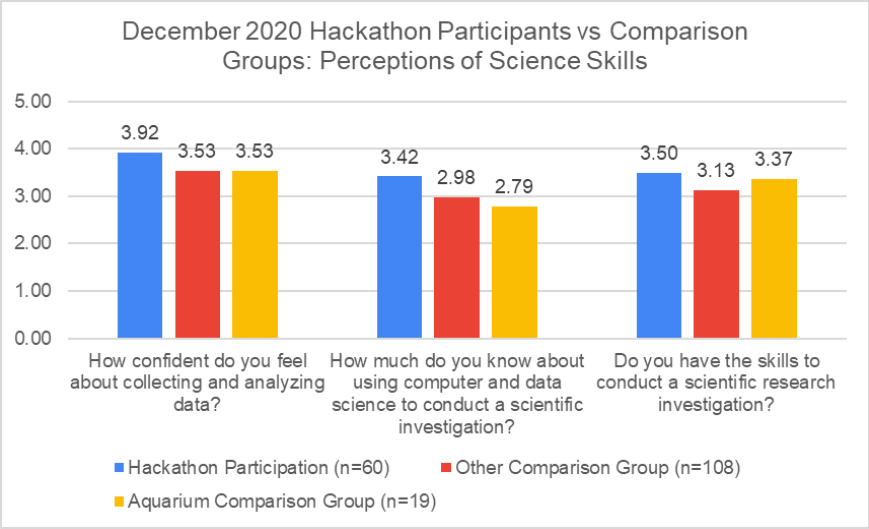


- STEM Institute participants reported knowing more about careers in marine, engineering, and environmental sciences than students in the comparison groups.
- STEM Institute participants responded 0.73 points more positively than the other student comparison group. In an unpaired t-test between the groups, the results were statistically significant.

PACE UNIVERSITY HACKATHON, December 2020

Results of Comparison Group: Perceptions of Science Skills

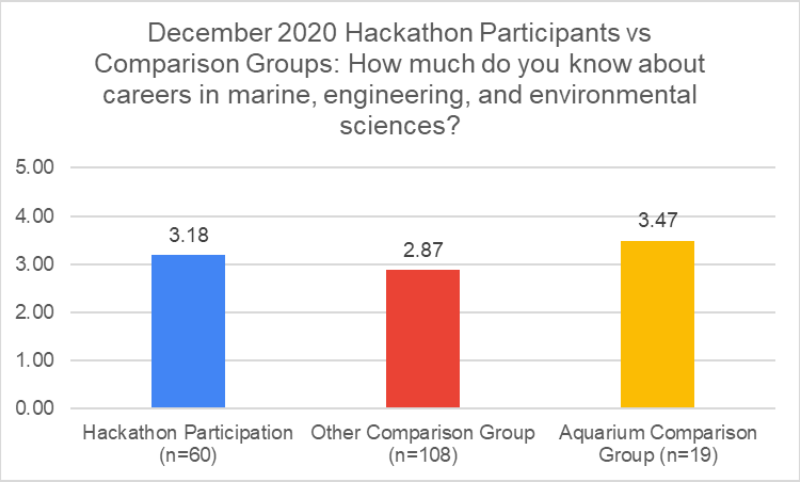
Evaluators also collected student survey data from the Pace Hackathon participants' to assess their skills in scientific research before and after participation in the Hackathon. Survey results were compared to two other groups of students: 1) students with no involvement in BOP or other marine science programs (the 'Other' comparison group); and 2) students who were involved in New York Aquarium programming (the Aquarium comparison group). Findings show:



- Participants in the December 2020 Hackathon felt more positively about their scientific skills that students in either comparison group.
- Unpaired t-tests were conducted to establish statistical significance of the results between these groups. The following results were statistically significant:
    - Hackathon participants responded more positively to confidence in collecting and analyzing data than the other student comparison group.
    - Hackathon participants responded more positively to knowledge about using computer and data science to conduct a scientific investigation than both the other student comparison group and the NY Aquarium comparison group.
    - Hackathon participants responded more positively to having skills to conduct scientific research than the other student comparison group.

Comparison Group: Student Career Awareness

In questions about awareness of STEM careers, findings indicate:



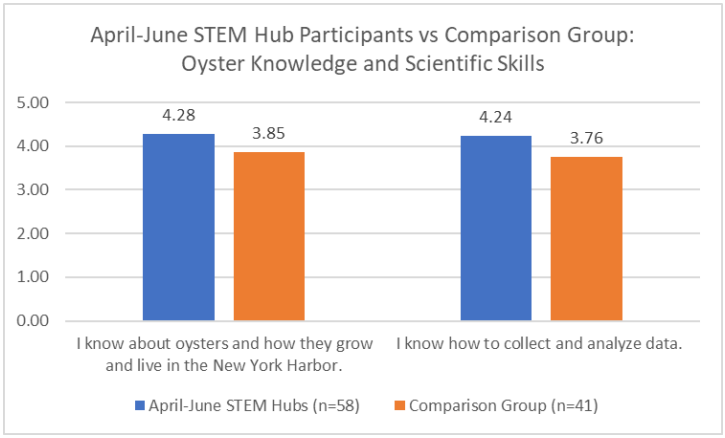
- Hackathon participants reported knowing more about careers in marine, engineering, and environmental sciences than students in the 'other' student comparison group. This result is statistically significant.

NOTE: No significant results were found in the February 2021 iteration of the Hackathon.

PILLAR 4: STEM HUBS

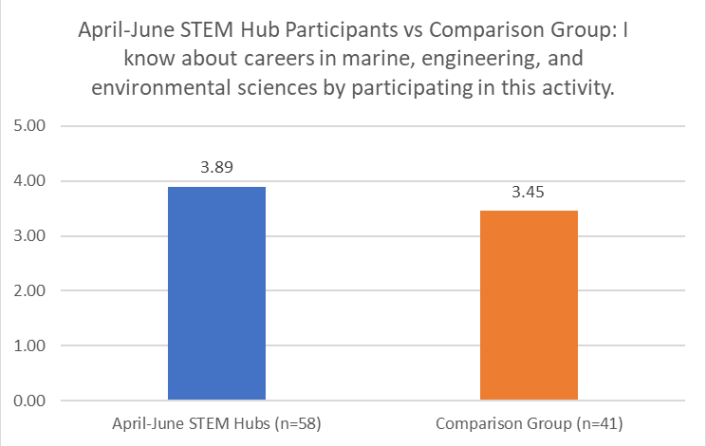
Results of Comparison Group: Student Perceptions of Science Skills

In STEM Hub activities, students participated in virtual visits and explorations of oyster restoration stations to collect and analyze data about water quality and oyster mortality. Evaluators compared STEM Hub participant responses to responses from students who completed the survey from April to July but these responses could not definitively be connected to their participation in a BOP activity. Findings show:



- STEM Hub participants reported knowing more about oysters than the comparison group. The average response was 0.43 higher.
- STEM Hub participants' average response to the statement *I know how to collect and analyze data* was more positive than the comparison group by 0.48 points.
- Unpaired t-tests were performed. These results were statistically significant.

Results of Comparison Group: Student Career Awareness
Findings show:



- STEM Hub participants reported more marine, engineering, and environmental science career knowledge than the comparison group. The average response was 0.44 points higher.
- Unpaired t-test were conducted on the results for the STEM Hub participants and the control group. The results were statistically significant.

KEY OUTCOMES OR OTHER ACHIEVEMENTS, By Evaluation Question

In this section, the report presents key outcomes for each evaluation question (specific objective).
NOTE: All evaluation results can be found in full reports in the Appendix.

EVALUATION QUESTION 1: Implementation

How well was the STEM+C program implemented?

The evaluator found that the implementation of STEM+C in Year 2 was effective in all four pillars. The evaluator's observations of 15 teacher and 5 teacher/student activities provided evidence that project staff adapted professional development activities to the remote learning environment that were effective in preparing teachers to engage students in exploring and learning content related to oyster restoration research in the New York Harbor; developed and piloted a computer science-based curriculum with a cadre of teachers who tried out lessons with

their students and came back together to discuss their questions and challenges; designed and facilitated a data and computer science-oriented 2020 STEM Summer Institute and two mid-winter Hackathons with Pace University which included international students (made possible by zoom technology); and created STEM Hub activities for the classroom when covid-19 prevented students from going out to the Hubs to monitor their oyster restoration stations.

Professional Learning activities for teachers focused on collecting and using data by modelling best practices of inquiry instruction at home in a series of workshops called "Inquiry from Anywhere;" installing and monitoring Oyster Research Stations (ORS) and Classroom Oyster Tanks in real and virtual activities; modeling use of oyster data collected by students in BOP Phase I and the use of other data sources included the curriculum piloting activities. Aspects of these activities provided opportunities for raising students' awareness about careers in STEM marine sciences, and encouraging them to see themselves as scientists in collecting and analyzing data. The Symposium Research Project prep sessions provided in April and May helped teachers guide students in being scientists as they did their own research projects for presentation at the BOP Annual Research Symposium in June.

The use of technology enabled staff who were facilitating activities in all four pillars to develop and use pre-prepared videos, create live on-site video connections to oyster restoration station monitoring sites for teachers and students facilitated by project staff; teach "classroom" lessons on zoom; create webinars and zoom professional development for teachers with activities created specifically for remote teaching and learning experiences; develop lessons and curriculum with toolkits and activities for students to do at home, all of which contributed to building student engagement, student learning, and interest in STEM careers. The project also created a *virtual* BOP Annual Student Research Project Symposium for the second year in a row in June 2021 which elicited 124 student project presentations guided by 16 teachers – a much greater number than in previous years with live presentations.

The evaluators' observations of a sample of 20 STEM+C activities suggested that the virtual environment provided greater opportunities for project staff to interact individually with both teachers and students, which appeared to encourage the building of a continuing community of teachers who participated consistently in the computer and data science teaching and learning opportunities offered by the STEM+C project. The virtual approach accomplished what several project staff had recommended as the way forward in the post covid-19 future – finding ways to provide more individual hand-holding and follow-up that will build teachers' confidence, as well as their capacity and skills to use data and computer science to do oyster restoration research with students. It also encouraged greater and more consistent teacher participation in BOP activities which had the potential to develop and promote teachers' capacity to increase STEM student engagement, student learning, and interest in STEM careers.

Key outcomes from the STEM+C project's activities and practices are discussed in the following sections of the report.

EVALUATION QUESTION 2: Teacher Impact

How well did STEM+C work in supporting teachers and STEM +C professionals/scientists to develop students' content knowledge, knowledge and skills in computer and data science, positive perceptions of STEM +C, and interest in pursuing a STEM +C career?

What opportunities for training and professional development has the project provided?

The STEM+C project achieved its professional development objectives to:

- provide support to teachers and students in learning statistical and computational concepts.
- expand the Phase I primary programmatic offerings to increase student understanding and interest in restoration-based STEM+C careers

PILLARS 1, 2, and 3 provided a range of high quality professional development opportunities for teachers in 2020-21 to facilitate integration of the STEM+C computer and data science-specific activities and expand Phase I BOP activities for the purpose of developing student engagement, interest, as well as STEM career awareness in fields related to oyster restoration. Results are presented below, by pillar.

PILLAR 1: STEM PROFESSIONAL DEVELOPMENT FOR TEACHERS

RESULTS OF PROFESSIONAL DEVELOPMENT SURVEY

Background

The Billion Oyster Project (BOP) offered a variety of professional learning activities for teachers from September 2020 to June 2021 to build their content knowledge and scientific research instructional practices related to BOP oyster restoration research. Using programs modified during the previous year due to the ongoing COVID-19 pandemic, BOP facilitated a combination of remote and in-person professional learning sessions, as changing COVID-19 conditions allowed, from January through July 2021.

At the conclusion of each event, teachers responded to a survey following each session, rating their experiences on a scale of 1(Strongly Disagree) to 6 (Strongly Agree). In total, evaluators received 27 responses from teachers or educators. Fifty-two percent of respondents were high school teachers. This was the most frequent response. From these teachers, at least 700 students may engage in BOP activities in their classes based on these workshops.

Student Engagement and Learning

Potential student engagement and learning is considered through several factors: whether teachers plan to use professional learning activities with students, whether they think the session they attended will increase student STEM career knowledge, and whether they plan to bring student projects to the annual BOP Symposium. Further factors in student engagement and learning are discussed in the individual session sections below.

- Ninety-three percent of teacher respondents plan to use their professional learning activity with their students. This finding suggests that BOP is providing lessons, materials, and activities that are useful for teachers and that teachers think will engage their students.
- Ninety-three percent of teachers thought that their BOP activity would increase student knowledge of STEM careers.

This report discusses results from the Spring 2021 professional development activities. It corroborates findings from the Fall 2020 professional development. The Fall 2020 report is included in the Appendix.

Results of Fall 2020 Professional Development Activities , by Activity

(See Appendix)

Results of Spring 2021 Professional Development Activities, by Activity

The sessions delivered from February to June 2021 were organized in the following five categories: *Oyster Research Station (ORS) Basic Training*, *Introduction to the Oyster Research Tank*, the *Inquiry from Anywhere* professional learning series, and *Symposium Prep Sessions*. Evaluators reviewed results from these sessions in the following categories: teacher engagement and learning, continuing teacher participation, teacher feedback, and student engagement and learning. A summary of findings is presented below.

Oyster Research Station (ORS) Basic Training

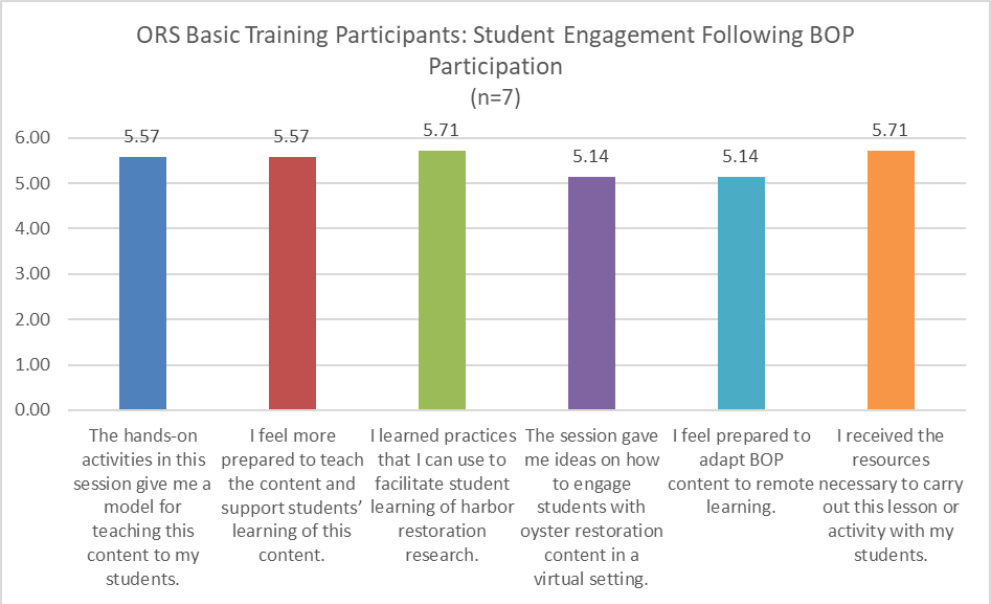
Evaluators received seven surveys from three sessions of Oyster Research Station (ORS) basic training workshops and Oyster Tank Training. ORS basic training is an entry-level training to familiarize participants with BOP, oyster restoration, and collecting data through monitoring an ORS unit stationed in the New York Harbor. Oyster Tank Training prepares teachers to set up oyster tanks in their classroom. There were three sessions, two held virtually and one in-person. For 57 percent of respondents, the ORS training was their first time participating in BOP programming.

Student Engagement and Learning

The level of student engagement and learning that resulted from BOP professional development activities was evaluated through teacher participants' intention to use activities from their BOP professional learning session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how they engage students in BOP activities and lessons.

Teachers responded to a series of statements about how they will engage with students based on what they learned from the sessions they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). All respondents from ORS basic training plan to use their training with their students. Teachers plan to use the activities to give students hands-on

scientific experience, and help them advocate for and learn about the environment of the New York Harbor.



- Teachers' average responses to all student engagement statements were positive and fell between 5 (agree) and 6 (Strongly Agree).
- Two statements had the highest average response at 5.71 (standard deviation=0.49):
    - *I learned practices that I can use to facilitate student learning of harbor restoration research.*
    - *I received the resources necessary to carry out this lesson or activity with my students.*

Teacher Engagement and Learning

Teachers responded to a series of statements about what they learned from the oyster research station session they attended. They rated these statements on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

- The highest average response was to the statement *I increased my knowledge of STEM concepts and content related to restoration science and BOP* with an average of 5.71(standard deviation=0.49).

Symposium Preparation and Student Project Review Sessions

Symposium Prep Sessions for Teachers

Evaluators received eight responses from three dates of BOP Symposium prep sessions, 53 percent of the participants. The sessions focused on different aspects of preparing students to present research projects in a virtual environment at the annual BOP Research Symposium held in June 2021. One was a group session, others were "office hours" for 1:1 consultation with BOP educators. For 13 percent of survey respondents, symposium preparation was their first time participating in BOP programming.

Teachers responded to a series of statements about the new knowledge or learning they took away from the Symposium Prep sessions. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: Respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

Student Engagement and Learning

Teachers responded to a series of statements about how they will engage with students based on what they learned from the Symposium Prep session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

All respondents from the Symposium Prep sessions plan to use the activities to work with students to develop symposium projects. Teachers reported they got ideas from BOP staff educators, as well as their colleagues to aid in student research and project design. They also received feedback on symposium projects in progress.

- Average responses from teachers at the Symposium Prep sessions related to student engagement where highly positive and between 5 (Agree) and 6 (Strongly Agree). These sessions may be particularly effective at engaging students. The teachers attending these sessions were also motivated toward learning about how to engage students in research.
- The highest average response was to the statement *The hands-on activities in this session give me a model for teaching this content to my students* with an average of 6.00; however, three respondents felt this statement was not applicable to their session

High average responses to the survey and clear plans for ways to use Symposium Prep materials with students suggests high potential for student engagement and learning.

Teacher Engagement and Learning

- Average responses about teacher learning from the Symposium Prep sessions were positive and were between 5 (Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *I increased my knowledge of data science concepts and content* with an average of 5.67 (standard deviation=0.52).

Symposium Student Presentations

At the virtual Symposium, an external group of scientists and educators not participating in the STEM+C project, provided feedback as students' presented their projects over a period of a week. Each presentation and review session was 30 minutes long. A total of 16 teachers and 213 students participated in the Symposium. Two teachers completed an evaluation survey following the 2021 BOP Research Symposium in June 2021. Teachers reported that the review

sessions were a positive experience for their students. They agreed that student participation in the symposium enabled students to learn about scientific research and STEM careers. They also reported that students were able to choose the type of project they did, on their own, and were able to collect field data for their projects, as well as using data provided by BOP. Both teachers agreed that students' research projects also increased their knowledge about oyster restoration.

When asked about the sessions with reviewers this teacher commented, "I think they were awesome. Being able to talk to the reviewers from different backgrounds was helpful for the students. It also helped the students broaden their perspective of STEM careers." When asked about how BOP could support student project development, both teachers had comments:

- *Easier access to data. It was hard to navigate and find data about Oyster growth from one particular website*
- *I appreciate the time taken by all the reviewers to talk to the students and give them feedback. Some are already thinking of what they can do next year. The information session was helpful in planning and implementation. Hearing how other educators integrated it into their curriculum was also helpful.*

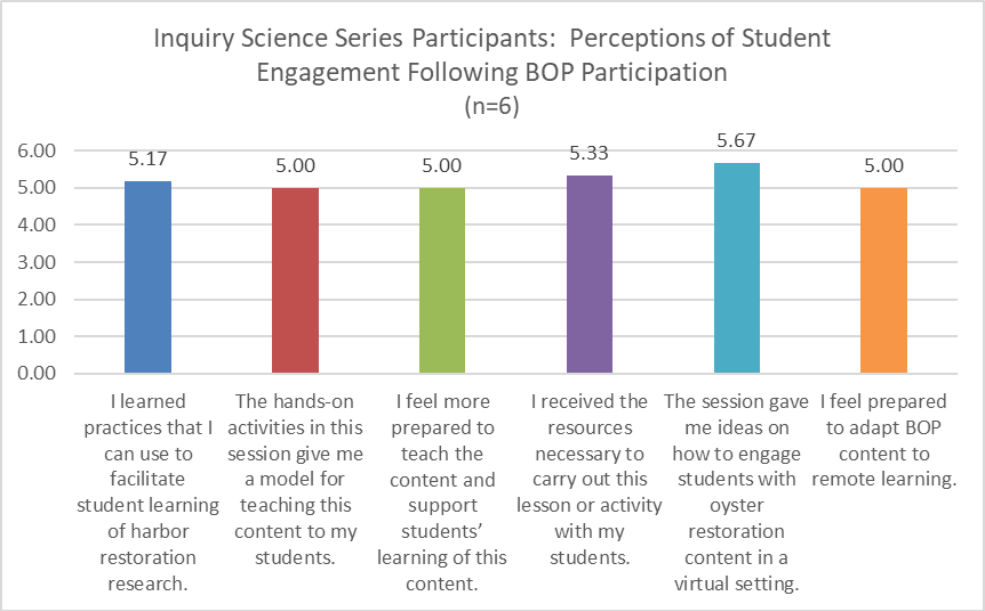
Teachers gave suggestions about aspects of the virtual symposium that they would like to see continue once the symposium returns to an in-person event. One teacher commented, "The timing of the BOP Symposium is usually during the end of the year when there are many events at school so sometimes in the past it coincides with a school event. This year since it is virtual, we don't have to worry about logistics." This has been a concern in previous years as well. While it would be impossible to fit with every school's schedule, BOP staff could consider moving the symposium to May, before the end of the year rush of activities. However, it was a positive experience for teachers and their students which supported students learning and engagement in STEM projects and careers.

***"Inquiry from Anywhere"* Workshop Series**

The *Inquiry from Anywhere* workshop series was designed specifically for the remote learning environment to enable teachers and students to conduct scientific research investigations at home or outside the home. There were three sessions in the series, one in the fall, two during Spring 2021. The sessions focused on: biodiversity data analysis; data collection; and species identification. Evaluators received 6 survey responses from these sessions. This is 100 percent of the teachers who attended. For 83 percent of survey respondents, a session in the *Inquiry from Anywhere* series was their first time participating in BOP programming.

Student Engagement and Learning

- Eighty-three percent of respondents plan to use activities from these sessions with their students. Teachers plan to use the activities because they want to engage students in more data collection and data analysis and are seeking opportunities for students to become involved in environmental work.

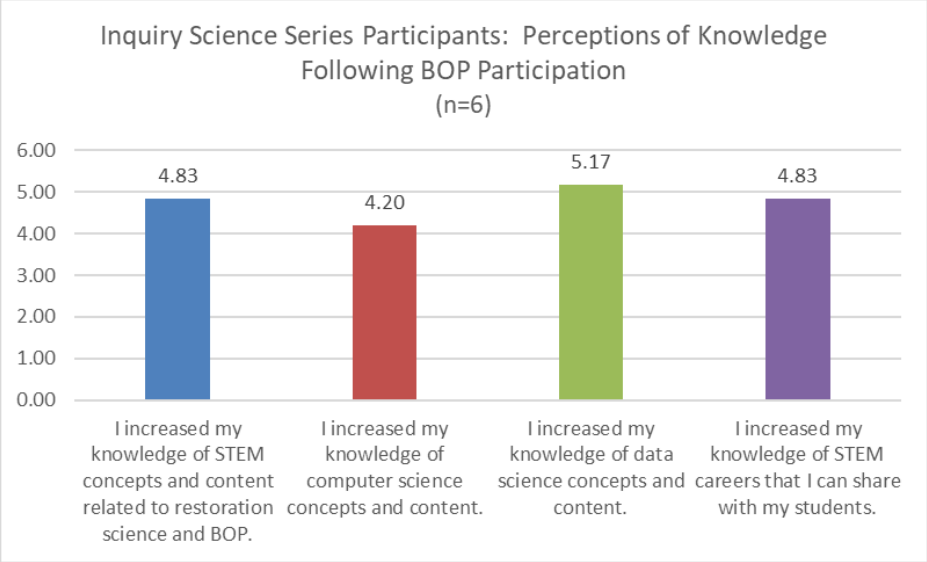


- Average participant responses to perceptions of student engagement were positive with average responses between 5 (Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *The session gave me ideas on how to engage students with oyster restoration content in a virtual setting* with an average of 5.67 (standard deviation=0.52).

Some, but not all participants had clear goals to use data collection and environmental stewardship as a way to engage students with the *Inquiry Science* activities and materials. The findings suggest that teachers will be able to translate their professional learning experience to their students.

Teacher Engagement and Learning

Teachers rated their knowledge of STEM+C content and concepts as a result of participating in the *Inquiry from Anywhere* workshops



- Most average responses in this category were between 4 (Somewhat Agree) and 5 (Agree). One response was higher than 5 (Agree).
- The highest average response was to the statement *I increased my knowledge of data science concepts and content* with an average of 5.17 (standard deviation=0.75)

SUMMARY OF PROFESSIONAL DEVELOPMENT SURVEY FINDINGS

Overall, data collected from a survey of teachers following their participation in a sample of BOP professional learning activities in Pillar 1 in Year 2, provides evidence that these sessions were successful and met the project's goals to provide support and resources for teachers to increase student engagement and learning in oyster restoration research, and interest in STEM careers. Teachers reported consistently positive experiences throughout all BOP professional learning sessions. Ongoing participation in these activities gives teachers more resources for engaging their students and building STEM engagement and interest. Most sessions gave teachers clear ideas for how to get students involved in data science and research processes. Teachers also thought that students would increase their awareness of STEM careers as a result of participating in the BOP activities.

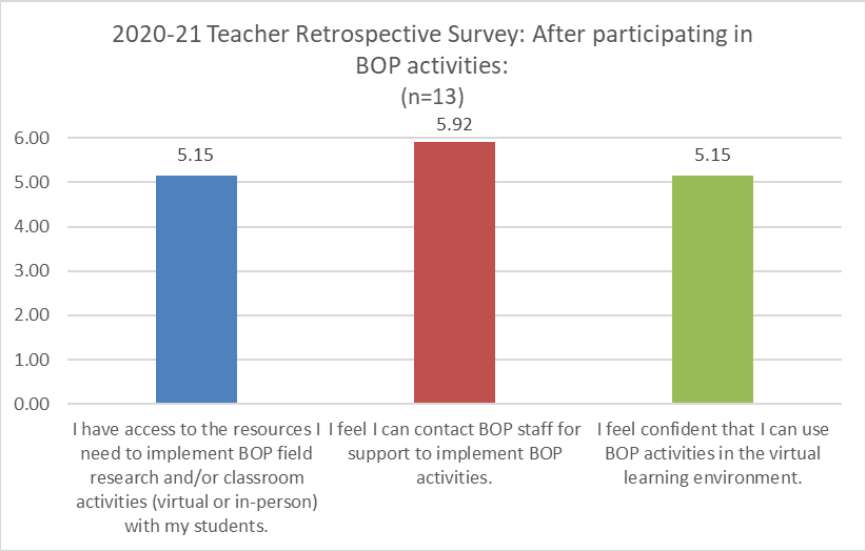
RESULTS FROM TEACHER RETROSPECTIVE SURVEY

Supporting Teachers in Oyster Restoration Research

The Teacher Retrospective Survey administered at the end of the school year to all BOP participants in 2020-2021 was designed to give teachers the opportunity to look back on the entirety of their BOP experiences to assess the value and impact of the STEM+C project activities in supporting them and their students over the school year in developing data analysis and computing skills to conduct oyster restoration research.

Analysis of the year-end *Retrospective Teacher Survey* data shows that

- following participation in BOP activities (all virtual), respondents felt positively about the support they received from BOP throughout the year. Participants' average responses to these statements fell between 5 (Agree) and 6 (Strongly Agree) on a Likert scale of 1 to 6.



- The highest average response was to the statement *I feel I can contact BOP staff for support to implement BOP activities* with an average of 5.92 (standard deviation=0.28).
- Two statements received an average of 5.15:
  - *I have access to the resources I need to implement BOP field research and/or classroom activities (virtual and/or in-person) with my students* (standard deviation=1.14).
  - *I feel confident that I can use BOP activities in the virtual learning environment* (standard deviation=1.41).

High average responses in this category suggests that BOP staff has been successful in providing teachers with the resources and support they need to use BOP activities with their students and in pivoting workshops from an in-person model to virtual programming for both teachers and students.

Teacher Engagement and Learning

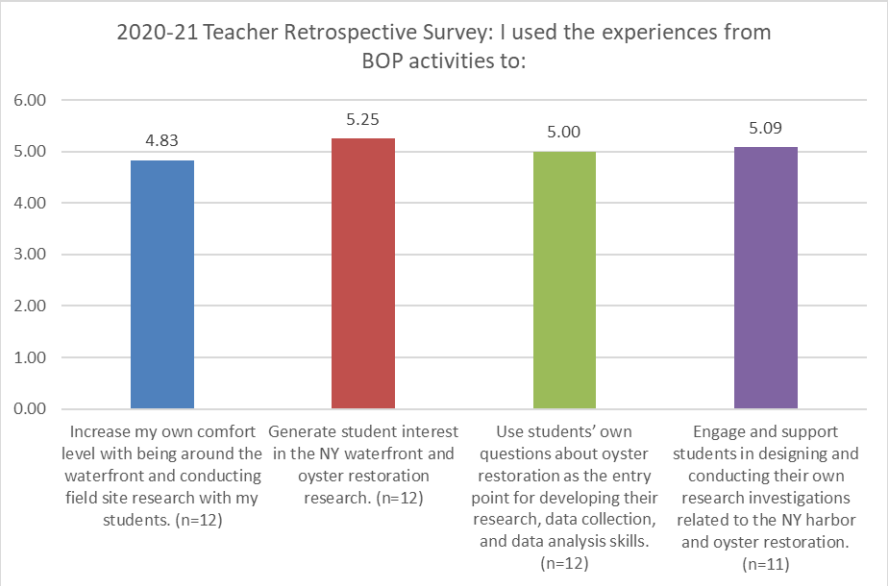
Teachers also responded positively to the impact of BOP in their understanding of oyster restoration research, with average responses between 5 (Agree) and 6 (Strongly Agree).

- The statement *My experience in BOP has increased my awareness of what is happening with oyster restoration in the New York Harbor* received an average response of 5.77 (standard deviation=0.44).
- The statement *My experience in BOP had exposed me to ways to engage my students in virtual or in-person field site or classroom oyster restoration research* received an average response of 5.46 (standard deviation=1.13).

These responses suggest that the STEM+C project provided teachers with a range of ways to involve students and achieved one of their goals to raise awareness of oyster restoration in the New York Harbor.

Student Engagement and Learning

A third category of questions focused on using BOP experiences to conduct research with students. Responses to these statements, while still positive, were lower than others. Average responses to these statements mostly were close to 5 (Agree).



- The statement with the highest average response was *I used the experiences from BOP activities to generate student interest in the New York waterfront and oyster restoration research* with an average of 5.25 (standard deviation=1.14).

Teachers were also asked what could improve their experience in BOP activities. Feedback included:

- *Great to visit BOP HQ and all there is present on the [Governor's] island!*
- *I'm interested in a couple print/digital tools to go along with identifying organisms at an ORS. We used the ecosystem engineers curriculum, but I couldn't find animal "cards" to go with the food web lessons, and today I saw a bingo organism game on the dock. Are these available somewhere?*
- *Continue PD Workshops for educators and integration of STEAM in curriculum.*
- *BOP in person again!*

Annual Symposium of Student Research Projects

The Annual BOP Symposium in June is an opportunity for students to present research projects related to oyster restoration. Among the BOP professional development offerings in Spring 2021 were workshops designed to support teachers in guiding students to conduct their own research

in groups or as individuals. Teachers were asked to what extent they and their students participated in these activities.

- Thirty-eight percent of respondents reported that their students did their own oyster restoration research projects. Among those who reported doing research projects, one teacher had elementary age students, one had middle school grades, and three had high school grade students.
- Sixty-two percent did not engage students in their own oyster restoration research projects.
- Among those who did their own research projects, 40 percent (2 out of 5 teachers) reported that they presented at the virtual BOP symposium.

Those who reported students doing their own oyster research projects were asked how BOP materials and data were used in that research. Teachers could select multiple sources of information.

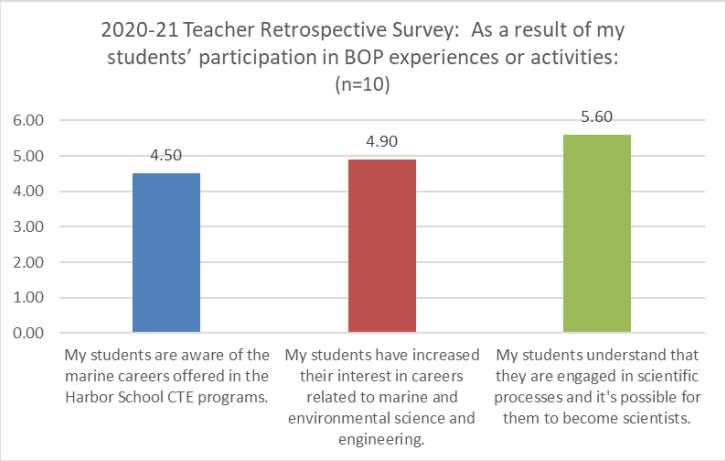
- Four teachers reported using data provided by BOP in their students' research.
- Two teachers used other sources of data and research for their students:
    - *Eel Mop installation in JC, Morris Canal*
    - *previous year's BOP professional development including engineering and design and the ROV with John Paul, also the plankton studies with the River Project*

STEM Career Knowledge and Interest

A key objective of BOP activities is for teachers to raise student awareness and interest in a range of marine STEM careers and build interest in those careers.

- Eighty-five percent of respondents reported they attended activities where they learned how to develop students' awareness of STEM careers.
- The average response to the statement *BOP activities modeled practices and instructional activities that I can use to motivate students to follow careers in STEM fields* was positive at 5.33 (standard deviation=0.65).

Teachers were also asked what impact those career awareness activities had on their students.



- Responses to STEM career awareness and interest were mixed, but still positive overall.
- The highest average response was to the statement *As a result of my students' participation in BOP experiences or activities, my students understand that they are engaged in scientific processes and it's possible for them to become scientists* with an average of 5.60 (standard deviation=0.70).
- The lowest average response was to the statement *As a result of my students' participation in BOP experiences or activities, my students are aware of the marine careers offered in the Harbor School CTE programs* with an average of 4.50 (standard deviation=1.43).

While marine science careers may be mentioned in a wide range of BOP activities, the Harbor School CTE programs may not be mentioned by name.

SUMMARY OF TEACHER RETROSPECTIVE SURVEY FINDINGS

Teachers who participated in the 2020-21 Retrospective survey attended a range of BOP STEM+C activities during the school year. Participants reported positive experiences both in professional learning sessions and in using BOP lessons and activities in their classrooms. All respondents used their participation as a way to teach students about harbor restoration and some used it as an entry to students own scientific research. The majority of respondents thought that BOP activities facilitated teachers' abilities to develop students' interest in STEM careers, although what that means varied by grade level and teacher experience. All around teachers had a positive and impactful experience with Billion Oyster Project.

PILLAR 2: PILOT OF DATA SCIENCE CURRICULUM

RESULTS FROM PILOT CURRICULUM SURVEY

Background

Developing a curriculum based on BOP oyster restoration research activities constituted Pillar 2 of the STEM+C project. The curriculum was designed by BOP educators to integrate data science and the practices of scientific research for middle and high school students, utilizing water quality and oyster mortality data collected in the Phase 1 CCRES grant and the ITEST CCRES grant. The ideal audience, observed BOP staff, was high school students. BOP educators developed two chapters of the curriculum in 2020-21 with a total of 16 lessons; the lessons are listed below. The lessons were designed to promote students' skills and processes of scientific investigation and to use BOP data to answer student-generated questions related to oyster restoration.

Chapter 1: Build a culture of inquiry in oyster research

- Lesson 1: Observe your class oyster clumps
- Lesson 2: Make and refine predictions about your oyster research site
- Lesson 3: Explore your oyster research site and your harbor oysters
- Lesson 4: Ask the internet about oysters and your oyster research site
- Lesson 5: What makes a great question?
- Lesson 6: What kind of data do you need to investigate your questions?

Chapter 2: How are the oysters doing in New York Harbor?

- Lesson 1: Field questions about oysters
- Lesson 2: Choose a question for data analysis
- Lesson 3: Choose your data
- Lesson 4: Make and test your predictions
- Lesson 5: Feedback, reflection, and revision
- Lesson 6: Oyster ecology background reading
- Lesson 7: Correlation and causation
- Lesson 8: Select variables to test for relationships
- Lesson 9: Predict and test relationships between variables
- Lesson 10: What do you want to tell BOP?

The thirteen participants in the STEM+C Pillar 2 were middle and high school teachers who were paid for their participation. They were expected to read and provide written comment on all 16 chapters, and to choose six to eight lessons to teach their students over a six-month period. From January through June 2021, teachers met monthly to share their experiences, brainstorm, offer feedback, and suggest ideas for improving the lessons. Teachers took turns facilitating these sessions.

The survey data presented below suggests that the project achieved its goal to support teachers in developing students' content knowledge, data science skills, and instilling positive

perceptions of STEM +C. It was less effective in developing awareness of STEM careers, both with teachers and students.

Reasons for Teacher Participation

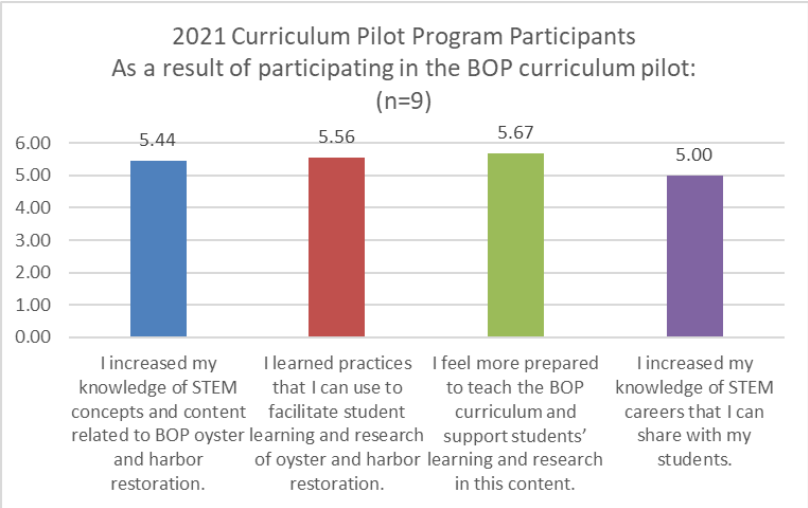
Findings show that teachers chose to participate in the STEM+C curriculum pilot project for several reasons:

- The most frequent reason for program participation was *general interest in the topic* (89 percent).
- *Increase my content knowledge for teaching oyster restoration lessons* was also frequently cited (78 percent).
- Other reasons teachers cited for program participation were:
  - *build teaching skills in relation to data and its analysis*
  - *was provided payment*

Perceptions of Professional Development for Curriculum Pilot

In June 2021, 13 teachers took a survey to assess their experience in the workshop sessions and in using the curriculum with students. Nine participants responded to the survey (69 percent of program participants). Teachers rated the pilot sessions on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree) on the effectiveness of the activities in engaging students in BOP oyster restoration research.

Teachers responded to a series of statements about what they gained from their participation in the pilot program. Each statement was evaluated on a scale from 1 (Strongly Disagree) to 6 (Strongly Agree).



- Teachers' responses to all statements were positive with all average responses between 5.00 (Agree) and 6.00 (Strongly Agree).

- The highest average response was to the statement *I feel more prepared to teach the BOP curriculum and support students' learning and research in this content* with an average of 5.67 (standard deviation=0.71).

Student Career Awareness

Participants rated the professional development sessions slightly less positively in addressing STEM career awareness.

- The lowest average response was to the *statement I increased my knowledge of STEM careers that I can share with my students* with an average of 5.00 (standard deviation=0.71)

When asked if students' participation in the lessons increased their interest in STEM careers:

- 33 percent of respondents responded 'Yes.'
- 67 percent responded 'Don't Know'

This response is in line with teachers' responses in other surveys related to building students' interest in STEM careers. Teachers reported less student interest in career content and less awareness of careers overall.

Teacher Feedback on Curriculum Pilot Sessions.

Teachers also provided detailed feedback on the sessions. Teachers particularly liked being able to discuss different parts of the lessons with other teachers and having access to "real" data. Specific feedback on helpful aspects of the program included:

- *Having real data that was collected by students and community members!*
- *I really appreciated hearing how other teachers modified the curriculum for students with disabilities. I also liked meeting before the Symposium to get feedback on my students' work.*
- *reviewing the curriculum and sharing our work - it forced a deep dive into the lessons.*
- *Getting kids using google sheets for data analysis because it helped them navigate data sets and figure out ways of analyze and graphically representing trends they found in the data. This feel more like "real science" compared to more cookbook lab type curriculums*
- *As the semester went on, the teacher presentations became more interesting and focused. I would ask that BOP provide more guidance for teachers when presenting.*

Teachers identified what they thought was missing from the sessions that would make them more helpful. Feedback included:

- *Ideas of how to scaffold some of the activities for students. Although teachers came up with various ideas, it might be useful to have some suggestions built into the curriculum.*
- *A little more help with making the data digestible*
- *Maybe we could demo. Maybe some direct instruction about the material to help us be experts*
- *Maybe some lessons on stats - the second half of the data analysis chapter is dense and it's been a long time since I've used that level of analysis myself. It would be a challenge to implement without a renewed understanding myself.*
- *It would be nice to have more background info on the science of oysters*
- *I would love more ways to weave into environmental and living environment curriculum*

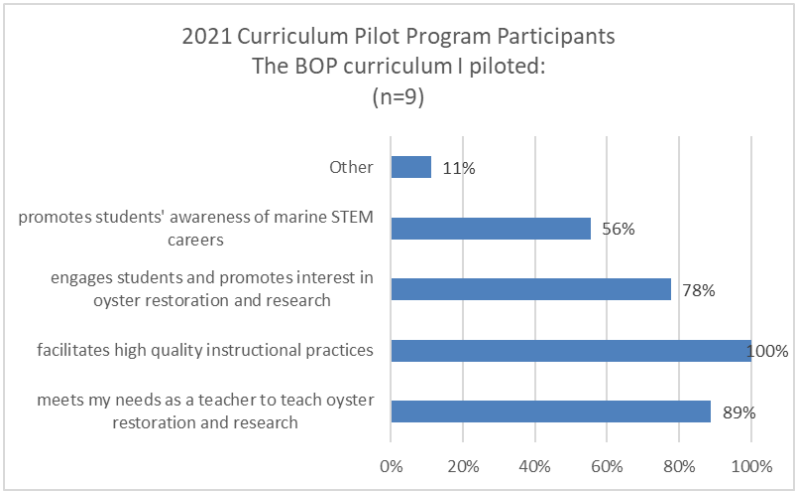
BOP STEM+C Curriculum

Teacher Perceptions of the Curriculum

Teachers rated their perceptions of the overall BOP curriculum on a scale of 1(Useless) to (5 (Excellent) on four parameters. The curriculum:

I. meets my needs to teach Oyster restoration
II. generates student engagement and interest
III. facilitates high quality instructional practices
IV. facilitates awareness of STEM careers

Teachers identified the following strengths and limitations of the curriculum.



- All respondents thought that the BOP curriculum *facilitates high quality instructional practices.*
- Eighty-nine percent said the curriculum *meets needs as a teacher to teach oyster restoration and research*.
- The lowest response was to *The BOP curriculum I piloted promotes students' awareness of marine STEM careers* with 56 percent responding.
- Other responses included:
    - *required a lot of custom modification based on the time and space I was given to teach it, since I could not teach the entire lesson sequences in their original form*

Teacher Perceptions of Curriculum Lessons

After teaching a sample of lessons in the curriculum, teachers responded to questions that specific to the lessons. Teachers rated the BOP them on a scale of 1 (Useless) to 5 (Excellent).

- The average rating of the lessons in the curriculum pilot was 4.33 (standard deviation=0.50). This falls between 4 (Good) and 5 (Excellent).

Teacher Feedback on Lessons

Teachers also provided feedback for any other suggestions for improving the curriculum workshops or the curriculum itself. Responses included:

- *Make the lessons more interactive, with more images, etc. It's a bit dense and text heavy*
- *Perhaps break up the lessons into smaller chunks; go through a lesson as writers of the curriculum to explain your rationale*
- *Create stand alone lessons instead of a progressive unit plan*
- *Maybe have a master list of resources that are embedded in the lessons*

Observations of Curriculum Pilot Sessions.

The evaluator observed two curriculum pilot sessions in zoom format in which teachers presented and discussed their experiences in piloting lessons of their choice. Evaluators used the *Observation Checklist Protocol* (See Appendix) to identify the presence or absence of best practices in these sessions. Both sessions demonstrated a high level of professional development practice in which participants were the key players, discussing their experiences. Participants were given the opportunity to present the lesson, discuss the student work, and facilitate discussion and reflection among their colleagues, but in practice teachers "presented" the lesson and the student work, forgoing the intended interactive elements of the facilitation. In fact, one of the participants' feedback included a request that BOP educators prepare them to present the lessons. A mini lesson in which facilitators modeled a lesson presentation could be added to future iterations of the curriculum pilot sessions.

SUMMARY OF PILOT CURRICULUM SURVEY FINDINGS

Overall, participants rated the curriculum and associated workshops highly and had a positive experience in the program. Two areas in need of improvement stand out:

- Making the curriculum more flexible to meet a range of needs for teachers
    - While no curriculum can meet all needs, making it easier for teachers to adapt the activities for their classrooms could lead to more extensive use of the curriculum.
- Placing greater emphasis on STEM marine careers
    - Designing a video series of BOP and BOP partner scientists could be a simple resource for teachers to integrate more information about careers in their classes.

Even with recommended areas of improvement, teachers' perceptions of the program and curriculum support indicated that PILLAR 2 was a high-quality component of the STEM+C program.

PILLAR 3: DATA SCIENCE ACTIVITIES

RESULTS OF FACILITATOR/MENTOR SURVEY

Background

In Pillar 3, the BOP STEM+C project developed a series of computing and data science activities for students at the high school level that were facilitated by Pace University Seidenberg School of Computer Science and Information Science faculty, mentors, and staff coordinators for national and international students, an unexpected benefit of the Zoom format that was dictated by the covid-19 shutdown. The events were held virtually for the first time. The activities included a two-week STEM Institute in Summer 2020, and two four-day Hackathons in December 2020 and January 2021 which incorporated the Billion Oyster Project's work on oyster restoration in the New York Harbor. The Hackathons were designed to teach students the python programing language, the skills of design thinking, and then students were asked to use python to pose and answer a research question related to water quality and oyster mortality data collected by BOP participants from the New York Harbor since CCRES Phase I of the program began in 2014-15. Students worked in small groups and presented their projects at the conclusion of these events.

In preparation for these events, the Pace University facilitators and mentors received training and briefings on the Billion Oyster Project content and water quality and oyster mortality data. They responded to a *Facilitator/Mentor Survey* at the conclusion of each event for the purpose of assessing the nature and quality of their preparation for incorporating the Billion Oyster Project content and data into the computer science activities and to evaluate student engagement and learning about oyster restoration. It was also a goal of these activities to introduce and expand the idea of pursuing a STEM career in computing and computer science, or in marine-related careers. For this purpose, activities included virtual guest appearances from professionals in fields of computer science and technology. Survey data collected for each of these events is analyzed separately below.

RESULTS OF PACE FACILITATOR/MENTOR SURVEY, by Activity

PACE University STEM Institute

In summer 2020, faculty and graduate students from the Pace University Seidenberg School of Computer Science and Information Systems and BOP scientists and educators designed a two-week STEM Institute for high school students to create a research project using the skills of python programming to analyze data collected by the Billion Oyster Project students in other iterations of Pace University's CCRES grants, Phase I, II, and III.

Following completion of the STEM Institute, 14 faculty, mentors, and other staff took a post survey about their preparation for their roles as facilitators, as well as their perceptions of the impact of their preparation on student participants' learning and engagement during the Institute. The survey utilized a scale of 1 (Strongly Disagree) to (6 Strongly Agree). Respondents were comprised of: 21 percent Pace faculty facilitators who organized the program and led sessions; 71 percent mentors who helped student teams with their research projects; and 7 percent staff coordinators.

Changes in Implementation Due to COVID-19 Pandemic

For the first time, the STEM Summer Institute was held virtually due to the COVID-19 pandemic. This change allowed more students and students from all over the United States to participate than in previous years; 24 students came from New York, 30 came from 7 other states: Virginia, California, Texas, Illinois, New Jersey, Connecticut, and Massachusetts). This change in population led to changes in both curriculum and instructional practice.

Facilitators' Responses. Facilitators identified changes they made in curriculum and instructional practice to adapt to the virtual learning format.
Curricular changes included:

- *Some exercises [changed] so the students could do them remotely rather than in person*
- *More hands-on sessions*
- *Talks from companies instead of visits*
- *More defined sessions [with a] start and end*
- *Use of tools online*
- *Creating more friendly environment*
- *We used Google classroom and other open platforms that students can interact on virtually.*

Instructional practices included:

- *Office hours for mentors and instructors*
- *Challenges for team members to know each other - team picture, team video*
- *Student-produced videos and presentations*
- *Adapting to online meant shortening instructional time in "consumable" portions, and not overloading the student or have them get "Zoom fatigue" from being in front of the computer for long periods of time. We broke it up so that more interactive activities made it less repetitive and lecture heavy.*

Mentor's Responses. Mentors also made changes in curriculum and instructional practice due to the virtual learning environment

Curricular changes included:

- *It was quite smooth, can keep a single zoom session and then use breakout rooms wherever necessary. This will help avoid jumping between multiple zoom sessions*
- *Using Google Colab. Adapting with break out rooms in zoom meetings to promote collaboration and teamwork. Working with Mural to help and improvise ideas for a good story telling experience.*
- *The Professors guided all the mentors in such a way that mentors could make it easy for the curriculum to adapt to the online zoom teaching and learning.*
- *The Instructors of the course modified the curriculum to adapt to online teaching by introducing google colab for teaching python and to do the project, google drive to collaborate as a team, and work.*
- *Distributing the workload, revising the lecture, creating presentation and sharing it*
- *I had to be more engaged and share documents for easier understanding*

Instructional Practices included:

- *I made sure my group always had our personal zoom link and was always on slack to answer any questions they may have.*
- *Motivating students to take optional quiz as a challenge they were expecting. Giving them scope to think out of the box to come up with creative solutions to a problem. Rest is all perfect.*
- *I went flexible as per the students understanding and availability where me and student could go on same page. It was is really learning experience for both mentors and students.*
- *I followed the instructions as they were perfect and did not need any changes to continue the course successfully.*
- *To let them work on exercises and practices*
- *I tried keeping them engaged, delegated tasks amongst each team members so that every can contribute to their project. Because it was virtual this time, I took an approach of asking one person to share their screen and others should be collaboratively work and provide their inputs making every individual understand that what is a team and even if it is virtual, goals can be achieved. This really helped in getting things done.*
- *Creating zoom meetings, creating breakout room to help students talk to each other and know more*

Facilitator Preparation/Support

The staff were very positive in their ratings of the training and support they received from Pace faculty and BOP staff to prepare them for the 2020 STEM Summer Institute.

- Facilitators and staff responded highly positively to all statements about their preparation to train them in using Python, lead students in oyster-related research, and motivate their interest in STEM activities, with average responses to all statements above 5 (Agree).

- With an average response of 5.25, items related to facilitators' preparation in knowledge of the New York Harbor and oyster restoration had the lowest average responses, indicating a need for greater focus in future Pace facilitator training on the Billion Oyster Project and data.

Mentor Preparation/Support

Ten respondents had the role of mentoring a team of students. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

- Mentor perceptions of their preparation to work with students were positive, with all statements receiving an average response above 5 (Agree).
- The highest average response was to the statement *I was able to develop students' ability to use Python to research a problem related to new York Harbor restoration*, with an average response of 5.70 (standard deviation=0.67).

- The lowest average response was to the statement *I felt knowledgeable enough about oyster restoration and the New York Harbor to support students' research and projects* with an average response of 5.20 (standard deviation=0.79). This statement was also rated less positively by program facilitators and staff.

Perceptions of Student Engagement and Learning

- Facilitators and mentors responded positively to students' ability to engage in harbor research using design thinking and programming skills, with average responses to these statements above 5 (Agree).

- The statement *I feel students were prepared effectively to use design thinking to help solve a problem related to the New York Harbor* had a lower average response at 5.10 (standard deviation=0.57). This finding is in line with facilitators' confidence in their own knowledge of oyster restoration.

Facilitator and Mentor Feedback

Facilitators and mentors shared feedback for improving the Pace STEM Institute in the future. Comments included:

- *Better understanding of the BOP data*
- *Familiarizing students with tools online, it is necessary to set a baseline coming in. Starting from nothing takes a while for the students to get used to before they are absolutely comfortable.*
- *If there were more ice breaker activities, then they would help students towards strong team building and promote teamwork for better outcomes.*
- *For mentors, the training was given by the instructors and enough material was provided. It was very well designed and carried out.*
- *To add more activities which let them know the people of other teams.*
- *About the ice breaker, if we can have more during first week for eg: more movie nights, tiktok challenges, or online games.*
- *More preparation for the mentors before starting the program*
- *Of course making the switch to virtual took away the face-to-face and in-person trips and lunches, but given the parameters we had to conform to, I believe we made it interactive and immersive. Perhaps next year, we can do a mix of in-person and virtual.*

Recommendations for STEM Institute

While mentors and facilitators had positive feedback on both their preparation and students' learning, there are areas for improvement as well.

- More opportunities to learn about Billion Oyster Project, oyster restoration, and the BOP data. This is especially important as students are unable to visit Governor's Island and BOP due to the virtual nature of the STEM Institute this year. An opportunity to meet with BOP staff once students have started their projects could also allow them to ask questions as they arise throughout the process, instead of relying on Pace University mentors and facilitators for both oyster and computer science content.
- More opportunities for students to get to know each other, even virtually as identified by several mentors in their feedback

---

Pace University Hackathon Sessions

December 2020 Hackathon

In December 2020, Pace University hosted a hackathon, which focused on developing an app or game related to Billion Oyster Project's harbor restoration work, for high school student participants that was designed and facilitated by Pace faculty and mentored by Pace graduate students. Students came from 9 states and three countries (USA, Senegal, Cameroon) At the end of the four-day session, 16 mentors and program facilitators took a post-survey to assess their preparation for their roles, and to evaluate the impact of their facilitation on student learning and engagement in the program.

Changes in Implementation Due to COVID-19 Pandemic

Due to covid-19, the Hackathon was held virtually through platforms like Zoom and Slack. The inability to meet in-person led to changes in curriculum and the role of facilitator and mentor.

Facilitators' Responses

Curricular changes included:

- *Curriculum was delivered fully online with different tools to create engagement and participation with teammates. I assisted in coordinating the online community to ensure students had access to resources and shared knowledge to participate in the hack-a-thon.*
- *Using virtual whiteboard to replace in class activities.*

Instructional practices changes included:

- *Utilizing different technologies was crucial in the delivery of this opportunity so students could participate at any time and had access to proper resources.*
- *This was the heaviest use of slack (in a good way) that I have ever had for a course.*
- *Collaborative and interactive learning*

Mentors' Responses

Curricular changes included:

- *I basically led with the direction the students needed to go in based on their behaviors and input based on where they were in the process. We took it from there.*

- *Open times, since not everyone could work at once. I adjusted availability*
- *Strict scheduling and reinforced open communication between members.*
- *Meeting separately, chatting the entire time we developed so that questions were open and always welcome.*
- *It's harder to make them engage in a zoom meeting*

Changes to instruction included:

- *I altered visional aides and the way I explained concepts.*
- *I was listening, and listening skills are mandatory for instructional practices.*
- *By sharing my screen and giving controls to the students every time we had to work on the app*
- *I encouraged participation and made sure all students contributed to the completion to the app.*
- *I gave demonstrations like I would in a physical setting and was able to help them with any issue by seeing the screen or remote controlling it to point things out easier then describing locations*
- *Slow reiteration to the students and making it clear and concise.*
- *utilize sharing screen and sharing of many links and articles. using chat, video and audio features as much as possible. suggesting to students to "share screen" often.*
- *I watched youtube tutorials that were provided by Pace professors*
- *Sharing screens, not copying code but assisting the student in developing a solution. I had made the game in its entirety before and it allowed me to always be of assistance.*
- *I encourage them to have their cameras on, and with the limited time, I had them work on different things*

RESULTS FROM DECEMBER HACKATHON FACILITATOR SURVEY

Following completion of the December 2020 Hackathon, 16 mentors and program facilitators completed a *Facilitator/Mentor Survey* about their preparation for their roles, as well as their students' learning and engagement in the program.

Facilitator Preparation/Support

Three respondents had a role as a facilitator in the Hackathon. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

- Average responses to all statements were positive with averages above 5 (Agree).
- Three statements received the same average response of 5.67 (standard deviation=0.58). Those statements are:
    - *I feel I was able to motivate and engage student' interest in STEM activities.*
    - *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project.*

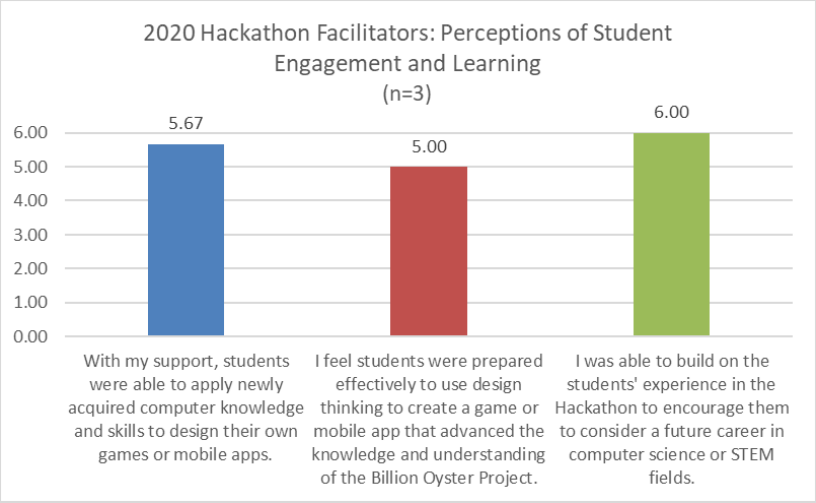
- *I was able to develop students' ability to use new technologies in creating games or mobile apps.*

- One statement received a lower average response at 5.33: *I felt knowledgeable enough about oyster restoration and the Billion Oyster Project to support students' work* (standard deviation=1.15).

Mentor Preparation/Support

- While mentor average responses were generally lower than facilitator responses, they are still positive with average responses above 5 (Agree).
- The highest average response was to the statement *I felt knowledgeable enough about oyster restoration and the Billion Oyster Project to support students' work* with an average of 5.46 (standard deviation=0.78)
- The lowest average response was to the statement *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project* with an average of 5.23 (standard deviation=0.73).

Facilitators' Perceptions of Student Engagement and Learning



- Average responses to all three statements were positive and at or above 5 (Agree).
- The highest average response was to the *statement I was able to build on the students' experiences in the Hackathon to encourage them to consider a future career in computer science or STEM fields* at 6.00.
- The lowest average response was to the statement *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project* with an average of 5.00 (standard deviation=1.00).

Mentors' Perceptions of Student Engagement and Learning

- Mentor perceptions of student engagement and learning were also lower than facilitators' perspectives. They were still positive overall with average responses on all statements above 5 (Agree).
- Two statements had the same average response of 5.54:
    - *With my support, students were able to apply newly acquired computer knowledge and skills to design their own games or mobile apps* (standard deviation=0.66).
    - *I was able to build on students' experience in the Hackathon to encourage them to consider a future career in computer science or STEM fields* (standard deviation=0.52).
- One statement had a lower average response, *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project*, at 5.38 (standard deviation=0.77).

Facilitator and Mentor Feedback

Facilitators and mentors also shared feedback for improving the program in the future. Comments included:

- *I think the opportunity was great! Finding a platform that allows for in program video-conferencing would be great (discord) to eliminate confusion with students moving from zoom room to zoom room.*
- *I think this Hackathon was the best prep for the next Hackathon.*
- *Mentors would have benefited greatly from advanced meeting and planning to receive direction and explanation concerning the project concerning the event and subject.*
- *Participants often felt they were in the wrong rooms because of wait times regarding adherence to the schedule.*
- *Some more time to work with the students on the app would have been great. Besides, I think everything was good.*
- *A better team building activity that won't crash a server.*
- *felt well prepared and supported for the requirements of the Hackathon. Although some coding questions/bugs were a challenge to find solutions to at times with just google. suggested resources or docs might be helpful and allotted time to troubleshoot. although without this, things were still a success. and QA was available albeit more impromptu.*
- *If there will be a more centralized means of communication and share point the program will benefit greatly. It felt that students had to follow too many platforms of communication and at times it was confusing.*
- *Encouraging more development time/getting more talent for more apps/games*

February 2021 Hackathon

In February 2021, Pace University hosted a second hackathon focused on developing an app or game related to Billion Oyster Project's harbor restoration work. Due to the ongoing COVID-19 pandemic, the program was held virtually and included students from the United States and Senegal. Some changes were made to the program's design based on the feedback of mentors and facilitators from the December hackathon.

Following the program completion, 16 mentors and program facilitators took a post-survey about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were selected on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

- 4 respondents worked with students as a facilitator/professor.
- 12 respondents worked with students in the role of mentor.

Changes in Implementation Due to COVID-19 Pandemic

Although it was their second online Hackathon, Pace University facilitators and mentors made changes in how they worked with students.

Curricular changes included:

- *We held logs of who was doing what task at what time and had open communication as the mentors stayed on Zoom for hours available to talk to at any time.*
- *I made sure that my camera was on so that the understanding is simple.*
- *My group utilized zoom and discord to discuss app development. When problems arose, we worked together and used online resources to solve them.*
- *screen sharing and being patient*
- *I applied my experience of Game Jams with people with different skills completely online to point everyone in their own direction of self-learning.*
- *Maintaining a strong structure and important building block of a successful project.*
- *We used collaboration for unity for all to work at once and used zoom remote when I needed to show them something important.*
- *Being able to use breakout rooms was crucial as it eliminated the need for 20 different zoom rooms.*

Changes to instruction included:

- *We involved the sharing screen feature a bit more than usual for a better understanding*
- *As my students were from Senegal language was the barrier so I made sure that they understand the instructions properly by converting English to French.*
- *My group had open discussions about our goals. We would all come up with ideas that helped reach the goals we set.*
- *I tried to let the members of the team think about the solution, before providing them with an answer. Basically if they asked the right questions, I would provide them with an explanation.*
- *Stayed in a zoom while doing any development in case anyone had questions.*
- *I had an amazing opportunity and experience in mentoring students from Senegal. The Hackathon was well organized and was divided into parts, which made it helpful for me to mentor the*

students. It was scheduled on time which made it competitive and fun for the students. I made sure the right deliverables were submitted on time. I motivated the students from start to end.
- *We had the students controlling their screen, and screen sharing it to us so that we [could] guide them throughout the process.*

Facilitator Perceptions of Preparation

Survey respondents were asked if they were adequately prepared for their role.
- Facilitators agreed that they were prepared for their roles in the Hackathon, with average responses to all statements at 5.00 (Agree) or above.
- The highest average response was to the statement *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project* with an average of 6.00.
- The lowest average response was to the statement *I feel I was able to motivate and engage students' interest in STEM activities* with an average of 5.00 (standard deviation=0.82).

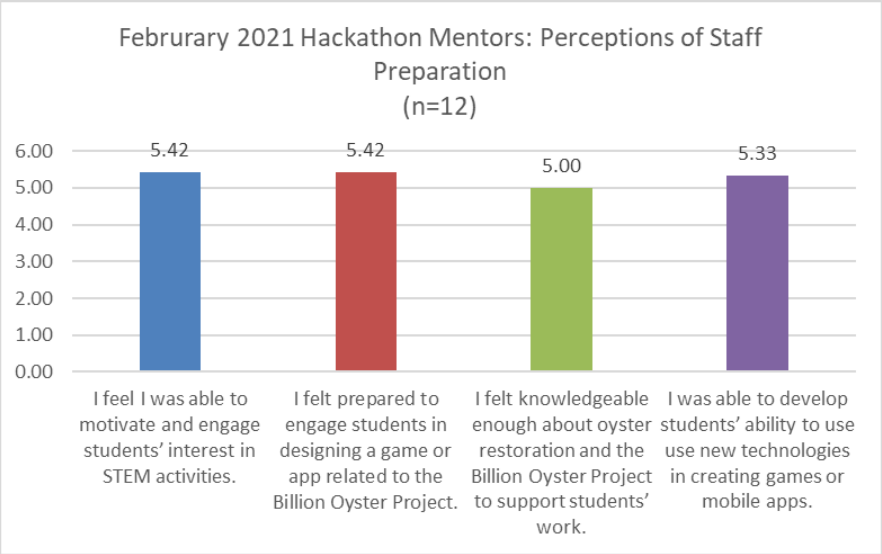
Facilitators Perceptions of Student Engagement and Learning

Respondents were asked what the impact of the session was on students.
- Facilitator perceptions of student engagement and learning were positive overall.
- The statement with the highest average response was *With my support, students were able to apply newly acquired computer knowledge and skills to design their own games or mobile apps* with an average of 5.67 (standard deviation=0.58)
- The statement with the lowest average response was *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project* with an average of 4.50 (standard deviation=1.00).

Based on these survey responses, facilitators felt that they were well-prepared to guide students in developing apps or games about BOP content, but saw a gap in how the students were able to carry out their goal. The Hackathon time is short by nature, so there is limited time for instruction and work, thus limited time for students to work through aspects they may not understand. Additionally, as mentors mentioned in their feedback below, there were some students for whom there may have been an additional challenge in language and fully understanding the English instruction they were given.

Mentors' Perceptions of Preparation

Twelve respondents had the role of mentoring a team of students. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).



- Mentor perceptions of preparation for their role in the February 2021 Hackathon was positive.
- Two statements had an average response of 5.42:
    - *I feel I was able to motivate and engage students' interest in STEM activities* (standard deviation=0.67).
    - *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project* (standard deviation=0.79).

These two aspects are integral to the role mentors play in the Hackathon so receiving high quality preparation is important to the success of the program.

- The statement with the lowest average response was *I felt knowledgeable enough about oyster restoration and the Billion Oyster Project to support students' work* with an average of 5.00 (standard deviation=0.95).

This is one area where the Hackathon program could improve. Additional time for mentors to learn about oyster content or more involvement from BOP could lead to not only mentors having more knowledge but for students to learn more as well.

Mentors' Perceptions of Student Engagement and Learning

Mentors were asked to assess the impact of the session on students.

- Average responses from mentors about their perceptions of student engagement and learning were positive, with all average responses between 5.00 (Agree) and 6.00 (Strongly Agree).
- The statement with the highest average response was *With my support, students were able to apply newly acquired computer knowledge and skills to design their own games or mobile apps* with an average of 5.58 (standard deviation=0.51).
- Two statements had an average response of 5.17:

- *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project* (standard deviation=0.72).
- *I was able to build on the students' experience in the Hackathon to encourage them to consider a future career in computer science or STEM fields* (standard deviation=0.72).

Facilitator and Mentor Feedback

Facilitators and mentors also shared feedback for improving the program in the future. Comments included:

- *I think we should run the schedule a bit differently*
- *I genuinely think that the hackathon was a success and hope for wider reach with advertising for more students to attend.*
- *My experience was really great as a mentor. It's a great opportunity to learn something new and a chance to show your leadership qualities.*
- *More preparation with mentors on the actual material. MIT App Inventor was as new to me as the mentees and I felt I couldn't help them to my full potential.*
- *I think the tutorials and the lessons were a good first step in terms of instruction, however a lot of the students would have benefited if there was literature prepared by pace with documentation on C# and Unity*
- *I feel every mentor should be given 1-day training prior to the event. Overall, the event was amazing and was well organized.*

RESULTS OF OBSERVATIONS OF SAMPLE PROFESSIONAL LEARNING ACTIVITIES

Observations of a sample of 20 STEM+C teacher professional development and student learning activities facilitated by the Billion Oyster Project STEM+C educators and staff from September to December 2020 and from January to June 2021 provided evidence to support the survey results. These sessions were evaluated using the *Observation Checklist for High-Quality Professional Development Training* developed by Noonan et al. (2016 - updated 2017) and adapted by evaluators for use in BOP professional learning sessions. (See Appendix.) According to Gaumer Erickson et al. (2016), "this checklist was designed specifically to: 1) evaluate training on the inclusion of research-based adult learning components that have been shown to increase the knowledge and skills to implement practices; and 2) provide guidance for training providers to help them improve their practices."

The evaluator observed 6 professional learning sessions for teachers facilitated by BOP staff from September to December 2020, and 9 teacher professional development activities and 5 student activities, such as STEM Hub zoom activities; Pace University STEM Institute and Hackathons:

and Symposium student project review sessions from January to June 2021. The observation protocol was used in all 20 observations.

Each of the 17 items on the *Checklist for High-Quality Professional Development Training* represents a high-quality professional development practice. The instrument uses a 'yes' or 'no' rating system, indicating the presence or lack of presence of each of the desired practices assessed by the protocol. For this report, results are presented in three categories: *organization practices, facilitator practices, and participant practices*.

Organization Practices

Evaluators looked for four practices as indicators of organization during each session. Organization items relate to preparation for the session and managing time within the session. These practices and the outcomes are listed below.

Item	Percent of Sessions Item Observed
Provides a description of the training with learning objectives prior to training	100%
Provides readings, activities, and/or questions in accessible formats to think about prior to the training	15%
Provides an agenda before or at the beginning of the training/activity	85%
Adheres to agenda and time constraints	100%
Average of Organization Practices Observed	**75%**

Two practices in this category were observed at all sessions: *provides a description of the training and learning objectives* and *adheres to agenda and time constraints*. BOP facilitators provided a description and learning objective for each session on the BOP Eventbrite webpage when teachers registered for the event. In other sessions, facilitators verbally provided an agenda and explained the activity and purpose. Facilitators provided readings or other activities prior to the session in only 15 percent of the sessions. During all observed sessions, facilitators stayed on time.

Facilitator Practices

Evaluators looked for nine practices from the facilitator to indicate high-quality facilitation. These items are actions that connect participants (teachers or students) to the topic of the session, emphasize the importance of the content and practices in the session, and provide resources during and following the session. These items are listed below.

Item	Percent of Sessions Item Observed
Establishes rapport with participants from beginning of the session	100%
Connects topic to participants' context	100%
Content builds on or relates to participants' previous sessions – where applicable (not applicable to all sessions)*	100%
Aligns with organizational standards or goals	100%
Emphasizes impact of content	70%
Builds and reiterates shared vocabulary required to implement and sustain the session	100%
Provides examples of the content/practice in use	100%
Illustrates the benefits of the session to the participants' context	50%
Offers opportunities for continued learning through technical assistance and/or resources.	100%
Average of Facilitator Practices Observed	**80.2 %**

BOP facilitators were highly successful in this category. Best practices in the '*Facilitator Actions* 'category were observed in an average of 80.2 percent of the sessions. Most of the sessions followed the practice of inquiry in which participants interacted with the facilitator and participants and participants with each other in practicing and reflecting on the activities.

*Note: The item "*Facilitators connected to or built on prior training*" was not applicable to all activities observed as some were stand-alone or entry level sessions. While not all participants attended a previous session in a series, or they were first-time BOP participants, facilitators created a context and connections for the participants to other BOP STEM+C activities.

Participant Practices

Evaluators looked for four items connecting to opportunities for participants to be actively involved in the activities. These items relate to using the skills and content in the session; giving perspectives and working with other session participants; and allocating time for reflection on the session and learning. These items are listed below:

Item	Percent of Sessions Practice Observed

Includes opportunities for participants to apply content and/or practice skills during training	90%
Includes opportunities for participants to express personal perspectives	90%
Facilitates opportunities for participants to interact with each other related to training content	85%
Includes opportunities for participants to reflect on learning	85%
Average of Participants' Actions Observed	**87.5%**
OVERALL AVERAGE	**86.5%**

These findings provide additional evidence of the extensive use of inquiry practices that were observed in 86.5 percent of the sessions. There were some sessions that were not designed as participant interactive experiences, such as the *Introduction to the Oyster Restoration Station* (ORS), for example, but the *curriculum pilot* workshops adhered strictly to inquiry practice with participants tasked with presenting lessons they had implemented with their students. The *ORS Basic Training sessions, Pace Summer Institute and Hackathon sessions* were entirely oriented toward participants (students or teachers) working together in small groups to practice the skills and reflect on what they were learning.

Sample Observation of Professional Development Activities

In an observation during the February Hackathon which was characteristic of the Pace PILLAR 4 events, evaluators observed an example of best practices of inquiry professional development:

- The facilitator was organized and spent time reviewing instructions in multiple ways to ensure that all students understood the goals. Break-out sessions happened in small, focused chunks which encouraged teams to stay on task. The facilitator was able to check in on teams in the break out rooms to troubleshoot issues and encourage them to work together. During student presentations, the facilitator provided clear feedback to the teams and reminded students that there are always ways an app can be improved.
- In breakout sessions with mentors, mentors had different styles of engaging students.
    - One mentor let students take the lead on discussing how they were going to do the project. This created space for the students to show each other how to do things and allowed the students' voices and thoughts on their app to be strong. However, it also led to students working in silence without clear individual roles in the project. Ultimately, students worked individually without realizing that their progress was not being saved to the group project. After encouragement from the facilitator to share screens, the group was able to collaborate more efficiently.
    - Another mentor took on a leadership role within their group. Each student had chosen a specific aspect of the project to be their responsibility. The mentor guided

the students with feedback and gave them next step on which to focus. As the mentor asked questions, holes in the project became apparent. Students discussed who would take on those responsibilities, and the mentor offered encouragement for carrying out different tasks.

SUMMARY OF OBSERVATION RESULTS

The data collected from observations of a sample of STEM+C professional development activities contribute to answering Evaluation Question 2 and achieving one of the project's major goals: providing support to teachers and students in learning statistical and computational concepts. The majority of practices identified as characteristics of high-quality facilitation were observed in an average of 86.5 percent of sessions. An integral element of the STEM+C activities was the interactive component. Providing opportunities for participants (teachers or students) to have an active role is important for high-quality professional learning sessions as these practices can carry over to the classroom. Teachers report in their participant survey that these qualities are what makes STEM+C sessions successful for them. Responses also reflect that teachers plan to attend more Billion Oyster Project professional learning sessions in the future.

EVALUATION QUESTION 3: STUDENTS

How well did the project work in supporting students in building their content knowledge and skills, instilling positive perceptions of STEM +C, and developing career awareness and interest in pursuing future STEM education and career?

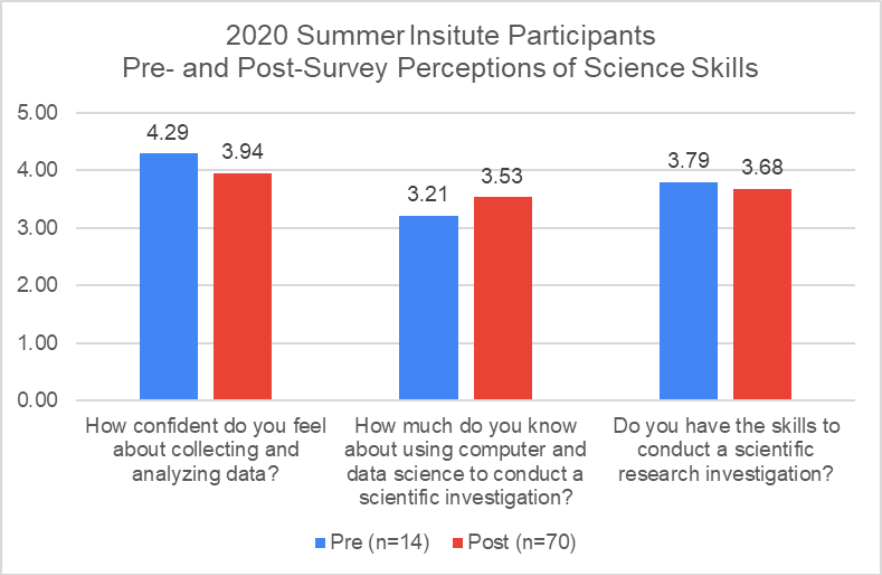
STEM+C PILLAR 3: DATA SCIENCE AND COMPUTER SKILLS

RESULTS OF PACE STEM INSTITUTE

To assess the extent to which the project achieved its goals to support students in developing oyster restoration knowledge and scientific research skills, and becoming aware and interested in STEM careers, the Mark administered a survey to students before and after participating in the STEM Institute in July 2020. The Institute was facilitated by the Seidenberg School of Computer Science and Information Systems at Pace University. Fourteen students completed pre-surveys, and 70 completed post-surveys. One challenge in comparing pre- and post-surveys is the large difference in the number of surveys.

Student Perceptions of Science Skills

Students responded to three questions on the survey about their perceptions of their abilities and skills to conduct scientific research and investigation. All questions were rated on a scale of 1 to 5, with 1 being the most negative response and 5 being the most positive.



- Average responses to each question on the post-survey were between 3 (a neutral response) and 4 (a positive response).
- Average responses to one question increased from the pre-survey to the post-survey: *How much do you know about using computer and data science to conduct a scientific investigation?*
    - Average scores increased by 0.32 points on the post-survey.

The STEM Institute focused heavily on these topics, and these results suggest this activity in Pillar 4 was successful in teaching students' computer and data science skills. However, there is another result that brings into question these findings.

- Average responses to two other questions decreased from the pre- to the post-survey:
    - *How confident do you feel about collecting and analyzing data?*
    - *Do you have the skills to conduct a scientific research investigation?*

It seems unlikely that participation in the STEM Institute would lead to a decline in students' skills in this area. These results may reflect a discrepancy between students who filled out both the pre- and post-survey and those who only filled out the post-survey, or it may reflect respondents' more realistic picture of what using data in conducting a research investigation using data involves after doing it.

Student STEM Career Knowledge and Interest

On both the pre- and post-survey, students responded to one question about their knowledge of marine, engineering, and environmental sciences careers. Students responded to this question on a scale of 1 (Almost Nothing) to 5 (A lot).

- Average responses about students' knowledge about careers in marine, engineering, and environmental science did not change from pre- to post-surveys.
- On post-surveys, the average response was 3.6.

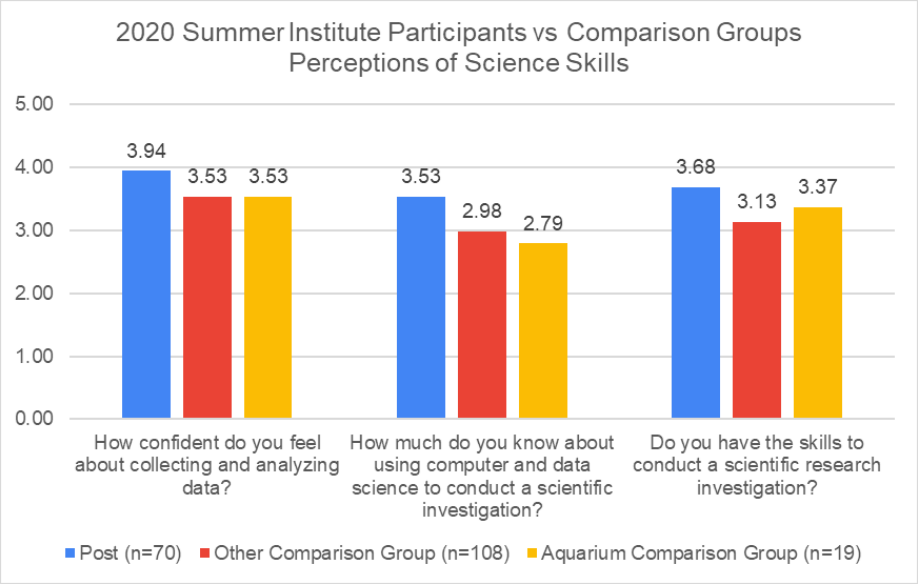
This finding suggests that students know some about these careers but could learn more.

Following participation in the STEM Institute, students also responded to a statement on how well prepared they felt they were to carry out their oyster restoration research projects in the second week of the institute.

- Students felt positively that they did *receive adequate knowledge about oyster restoration and data science skills to conduct an investigation using BOP data* with an average of 4.24 (standard deviation=0.69) to this statement.

Comparison Group: Student Perceptions of Science Skills

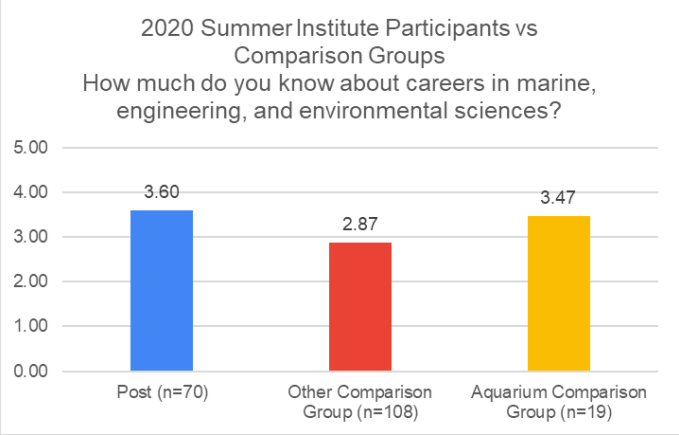
STEM Institute participants' post-survey results were compared to two other groups of students: 1) students with no involvement in BOP or other marine science programs (the 'Other' comparison group), and 2) students who were involved in New York Aquarium programming (the Aquarium comparison group).



- STEM Institute participants reported more positive perceptions of their scientific skills than those in either comparison group.
- Unpaired t-tests were conducted to establish statistical significance of the results between these groups. The following results were statistically significant:
  - STEM Institute participants responded more positively to confidence in collecting and analyzing data than the other student comparison group.
  - STEM Institute participants responded more positively to knowledge about using computer and data science to conduct a scientific investigation than both the other student comparison group and the NY Aquarium comparison group.

- STEM Institute participants responded more positively to having skills to conduct scientific research than the other student comparison group.

Comparison Group: Student STEM Career Knowledge and Interest



- STEM Institute participants reported knowing more about careers in marine, engineering, and environmental sciences than students in the comparison groups.
- STEM Institute participants responded 0.73 points more positively than the other student comparison group. In an unpaired t-test between the groups, the results were statistically significant.

This finding suggests that the STEM Institute may attract students who already know much more than the average student about STEM careers

RESULTS FROM PACE HACKATHON ACTIVITIES

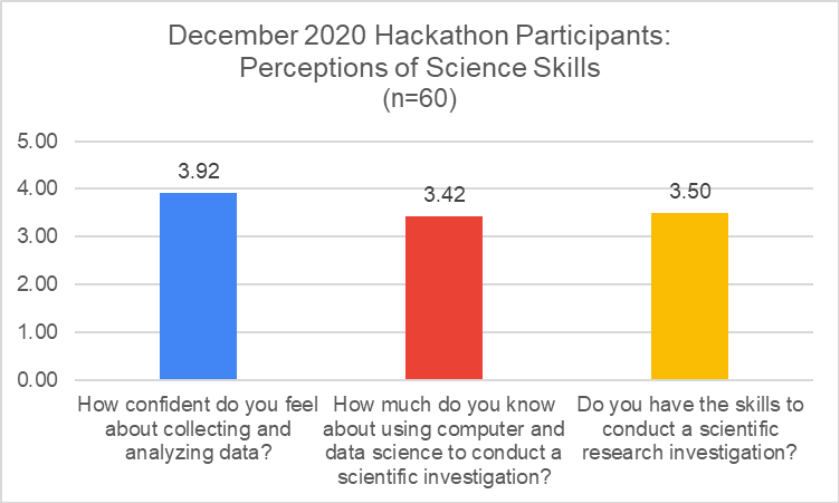
Two iterations of a four-day virtual Hackathon took place online from Pace University in December 2020 and February 2021 in which the focus was the development of a game or app that integrated students' python programming. The evaluation data collected for these events will be analyzed for each iteration. Computer science was more of the focus for the Hackathons than it was in the STEM Institute.

December 2020 Hackathon

Following their participation in December 2020, 60 students responded to surveys about their engagement and learning during the program. Surveys included a series of questions about students' perceptions of their skills in science investigation skills, in app or game development, and their knowledge of STEM marine careers demonstrated in the Billion Oyster Project.

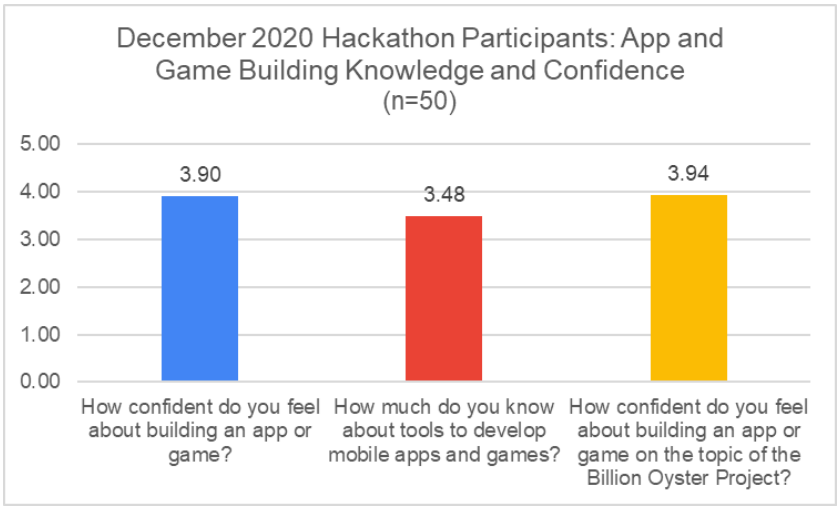
Student Perceptions of Science Skills

Students responded to three questions about their perceptions of their scientific skills on a scale of 1 to 5, with 1 being the most negative response and 5 being the most positive.



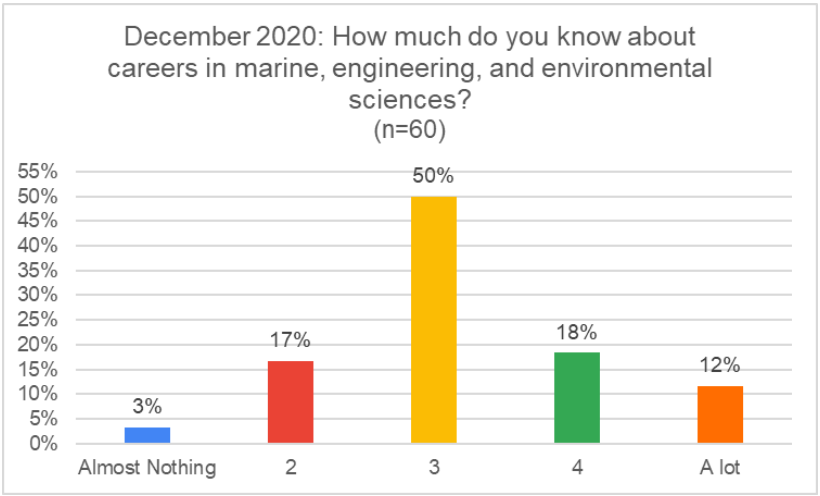
- Average responses to questions about students' perceptions of their scientific skills were between a neutral to positive response.
- The highest average response was to the question *How confident do you feel about collecting and analyzing data?* (on a scale of 1 (Not at all confident) to 5 (Very Confident) with an average of 3.92 (standard deviation=0.81).
- The lowest average response was to the statement *How much do you know about using computer and data science to conduct a scientific investigation?* (on a scale of 1(Almost nothing) to 5 (A lot)) with an average of 3.42 (standard deviation=0.87). This finding reflects the variation in duration and content focus of the STEM Institute and Hackathons.

Participants also responded to survey items about their knowledge and confidence about their skills in game and app development, which was the focus of the Hackathon.



- Average responses in this skill-specific category were higher than responses about general science skills.
- The highest average response was to *How confident do you feel about building an app or game on the topic of the Billion Oyster Project?* (on a scale of 1 (Not at all confident) to 5 (Very confident) with an average of 3.94 (standard deviation=0.74).
- The lowest average response was to *How much do you know about tools to develop mobile app and games?* (on a scale of 1 (Almost Nothing) to 5 (A lot) with an average of 3.48 (standard deviation=0.93).

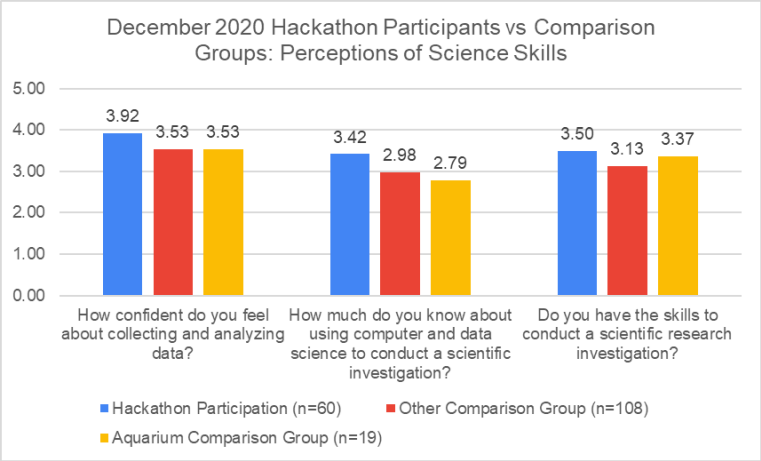
Student STEM Career Knowledge and Interest



- The most frequent response to how much students knew about careers in marine, engineering, and environmental sciences was in the middle of the scale, suggesting students know some, but not a lot about these careers following Hackathon participation.
- The average response was 3.18.

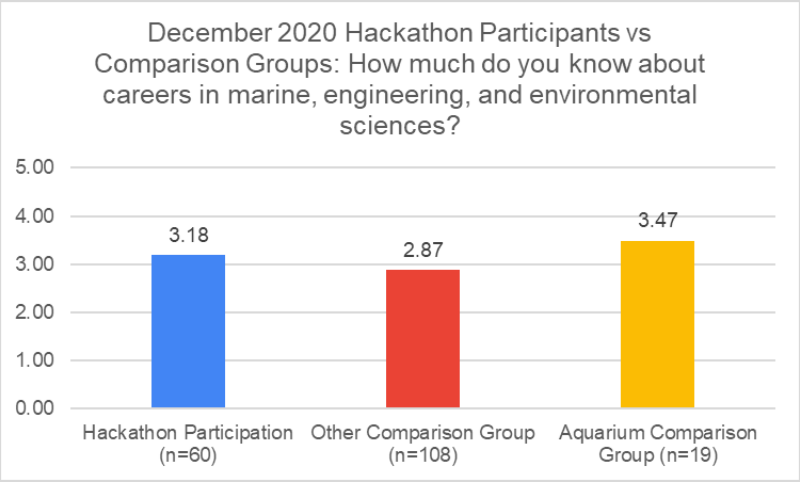
Comparison Group: Student Perceptions of Science Skills

Hackathon participants' survey results were compared to two other groups of students: 1) students with no involvement in BOP or other marine science programs (the 'Other' comparison group); and 2) students who were involved in New York Aquarium programming (the Aquarium comparison group).



- Participants in the December 2020 Hackathon felt more positively about their scientific skills that students in either comparison group.
- Unpaired t-tests were conducted to establish statistical significance of the results between these groups. The following results were statistically significant:
  - Hackathon participants responded more positively to confidence in collecting and analyzing data than the other student comparison group.
  - Hackathon participants responded more positively to knowledge about using computer and data science to conduct a scientific investigation than both the other student comparison group and the NY Aquarium comparison group.
  - Hackathon participants responded more positively to having skills to conduct scientific research than the other student comparison group.

Comparison Group: Student STEM Career Knowledge and Interest



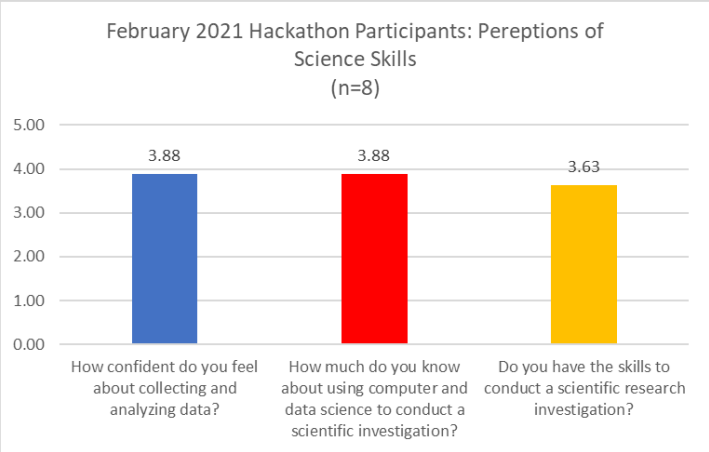
- Hackathon participants reported knowing more about careers in marine, engineering, and environmental sciences than students in the 'other' student comparison group. This result is statistically significant.
- Students from the NY Aquarium comparison group reported more career knowledge than those who participated in the Hackathon.

February 2021 Hackathon

Pace University hosted a second online hackathon focused on developing apps and games connected to Billion Oyster Project and oyster restoration. Following their participation in the four-day Hackathon, 8 students responded to evaluation questions about their engagement and learning during the program. Participants responded to a series of questions about their perceptions of scientific skills, and their knowledge of STEM careers related to Billion Oyster Project.

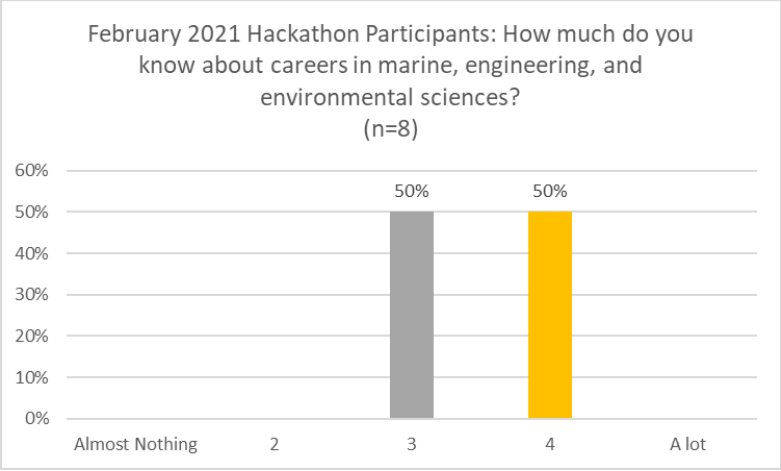
Student Perceptions of Science Skills

Students responded to three questions about their perceptions of their scientific skills on a scale of 1 to 5, with 1 being the most negative response and 5 being the most positive.



- Students in the February hackathon also responded between neutral and positive on their confidence in their scientific skills.
- Two questions received an average response of 3.88 (standard deviation=0.64):
    - *How confident do you feel about collecting and analyzing data?*
    - *How much do you know about using computer and data science to conduct a scientific investigation?*
- *Do you have the skills to conduct a scientific research investigation?* received a lower average response at 3.63 (standard deviation=1.06).

Student STEM Career Knowledge and Interest

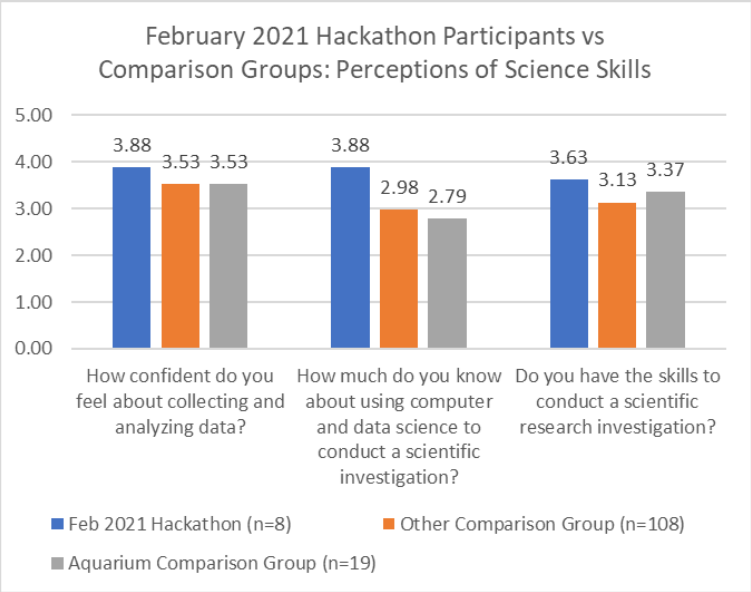


- The average response to STEM career knowledge was 3.50 (standard deviation=0.53).
- All respondents reported having at least some knowledge of STEM careers. No participant reported having a lot of knowledge.

Comparison Group: Student Perceptions of Science Skills

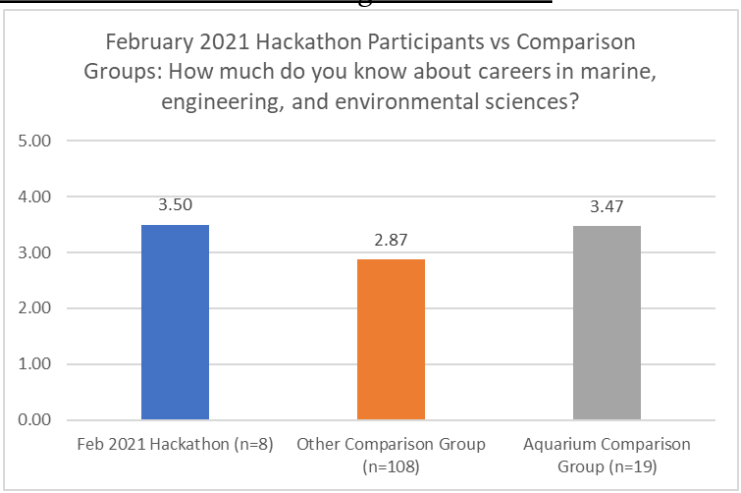
February 2021 Hackathon participants' survey outcomes were compared to the same two other groups of students as the December participants: students with no involvement in BOP or other

marine science programs (the 'Other' comparison group), and students who were involved in New York Aquarium programming (the Aquarium comparison group). Due to the lower percentage of February Hackathon students who completed the post-survey following their participation, these comparisons are more challenging. It is difficult to say whether differences shown between the groups relates to their program experience or something about these eight students who completed the survey.



- Participants in the February Hackathon felt more confidence in their scientific skills than students in either comparison group.

Comparison Group: Student STEM Career Knowledge and Interest



- February Hackathon participants reported knowing more about careers in marine, engineering, and environmental sciences than students in either comparison group.

PILLAR 4: STEM HUBS

STEM Hubs are sites in the New York Harbor that include Coney Island, Brooklyn Bridge Par, Bush Terminal Park, Canarsie, and other sites where the Billion Oyster Project maintains oyster reefs and/or oyster research stations to monitor oyster restoration. Teachers and students visit these sites to collect water quality and oyster mortality data. These experiences were conducted virtually in the classroom 20-21 during the covid-19 pandemic.

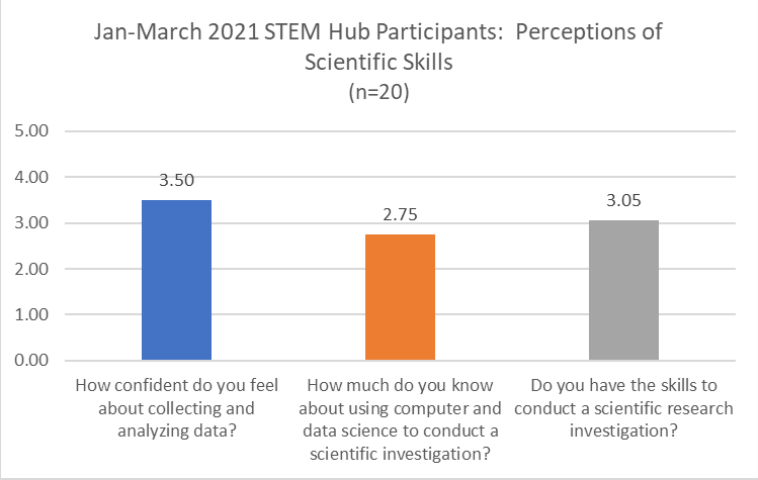
Following virtual Billion Oyster Project STEM Hub activities, students had the opportunity to answer several evaluation questions about perceptions of their scientific skills and STEM career knowledge; this survey was part of a larger research survey administered by The Mark. Results are presented in two sections: January-March and April-July. In April 2021, the survey was briefly taken offline and revamped to streamline the experience for students and make it easier for them to complete the survey. While the goals of the questions remained the same, the wording and answer choice changed. Participation in BOP programming was established by correlating the date of Billion Oyster Project student events to the date when surveys were started. Surveys started within a week of an event were considered participant surveys.

RESULTS FROM STUDENT STEM HUB ACTIVITIES – January to March 2021

Evaluators identified 20 students who had attended STEM Hub events from January-March 2021.

Student Perceptions of Science Skills

Survey questions were answered on a scale of 1 to 5, which 1 being the most negative and 5 being the most positive.



- The most positive response was to the question *How confident do you feel about collecting and analyzing data?* with an average response was 3.50 (standard deviation=0.89). On average, students report having some confidence in collecting and analyzing data.
- The least positive response was to the question *How much do you know about using computer and data science to conduct a scientific investigation* with an average of 2.75 (standard deviation=1.07).

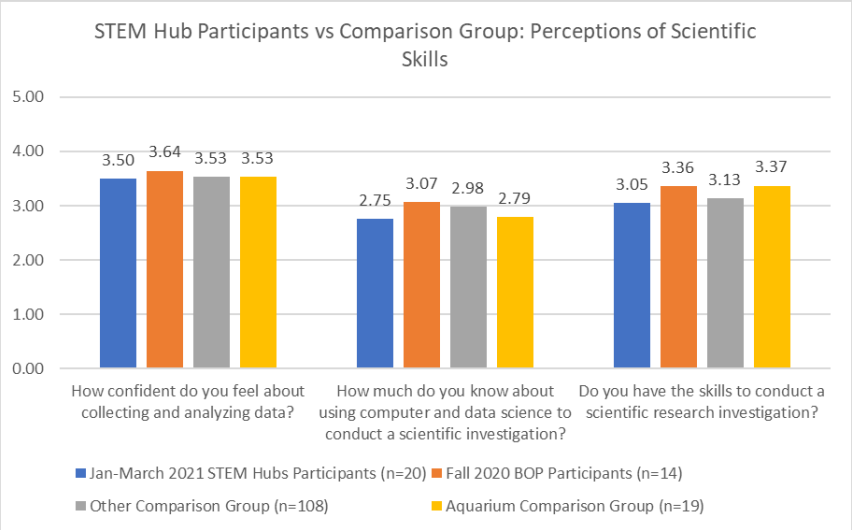
Student STEM Career Knowledge and Interest

Students also responded to a question about their knowledge of STEM careers connected to harbor restoration and environmental science. Students responded on a scale of 1 (Almost Nothing) to 5 (A lot)

- The average response to STEM career awareness was 3.15.
- Sixty-five percent of students responded in the middle of the scale that they know some about these careers.

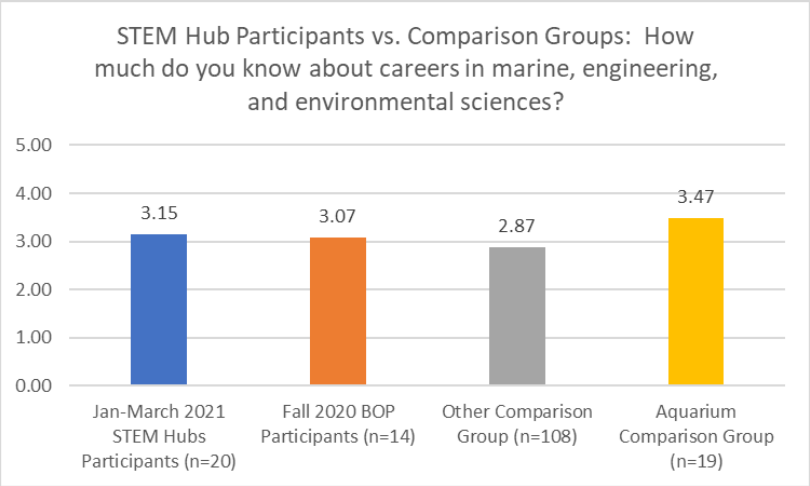
Comparison Groups: Perceptions of Science Skills

January-March STEM Hub participants' responses were compared to three groups of students: STEM Hub participants from the Fall 2020 semester, students from Fall 2020 who completed a survey but had no experience with BOP or another science organization, and a group of students who participated in New York Aquarium programming.



- January-March STEM Hub participants had lower average responses to all scientific skills questions than the participants from Fall 2020.
- Participants' responses were similar to or slightly lower than students who had not participated in the STEM Hub activities.

Comparison Groups: Perceptions of STEM Career Knowledge and Interest



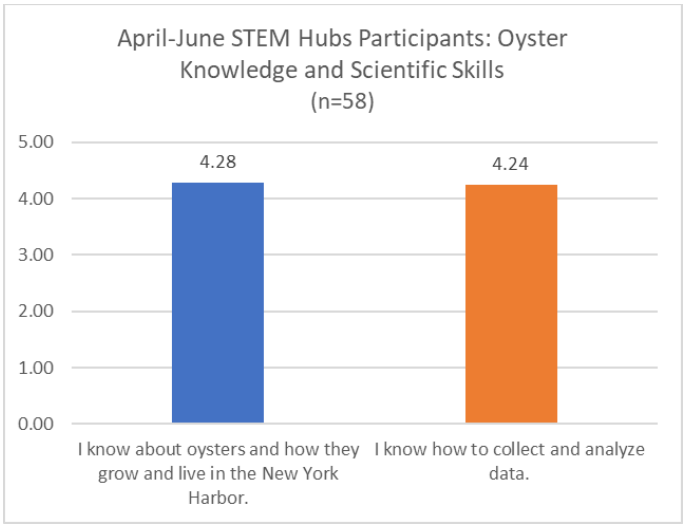
- January-March STEM Hub participants felt more positively about their STEM career knowledge than the Fall 2020 participants and the general comparison group. They responded less positively than the New York Aquarium students.

FINDINGS FROM STEM HUB ACTIVITIES – April to June 2021

In April 2021, BOP staff and evaluators worked together to revise the student evaluation survey. Questions were changed to more closely align to BOP events in which students were participating and to make the survey process easier. Evaluators identified 58 students who participated in STEM Hub activities from April-June and completed the student evaluation survey.

Student Perceptions of Science Skills

In the new iteration of the survey, student responded to statements about oyster knowledge and scientific skills. All statements were rated on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).



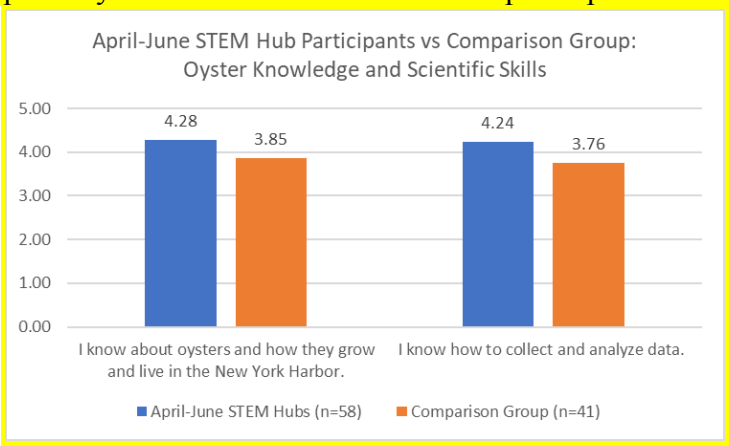
- STEM Hub participants' average responses to both statements were positive and were between 4 (Agree) and 5 (Strongly Agree).
- *I know about oysters and how they grow and live in the New York Harbor* had an average response of 4.28 (standard deviation=0.67)
- *I know how to collect and analyze data* had an average response of 4.24 (standard deviation=0.68).
    - For students taking the Jan-March version of the survey, the statement about collecting and analyzing data received the most positive response.

Student STEM Career Knowledge and Interest

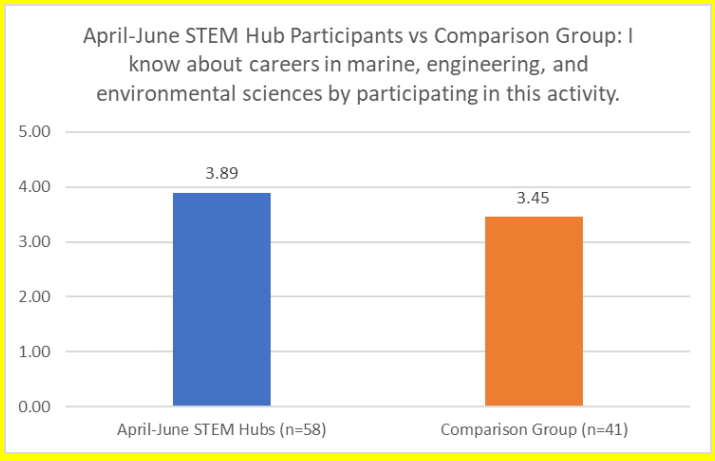
- The average response to STEM career knowledge for April-June STEM Hub participants was 3.89.
- Seventy-two percent of respondents agreed to some extent with the statement *I know about careers in marine, engineering, and environmental sciences by participating in this activity.*
    - This statement was changed to make it more specific to the activity which students attended before taking the survey in order to make responses clearer.

STEM Hub Activities and Comparison Groups

Evaluators compared STEM Hub participant surveys to surveys from students who took the student evaluation survey from April-July but could not be connected to participation in a BOP activity.



- STEM Hub participants reported knowing more about oysters than the comparison group. The average response was 0.43 higher.
- STEM Hub participants' average response to the *statement I know how to collect and analyze data* was more positive than the comparison group by 0.48 points.
- Unpaired t-tests were performed. These results were statistically significant.



- STEM Hub participants reported more marine, engineering, and environmental science career knowledge than the comparison group. The average response was 0.44 points higher.
- Unpaired t-test were conducted on the results for the STEM Hub participants and the control group. The results were statistically significant.

EVALUATION QUESTION 4. To what extent was the research effective in gathering evidence in answering the research questions and identifying the impacts of the program.

EFFECTIVENESS OF RESEARCH IN ANSWERING RESEARCH QUESTIONS

Challenges in Data Collection

The effectiveness of the research in answering the research questions and identifying the impact of the STEM+C project was circumscribed by challenges in data collection. In Year 2, the challenge of the covid-19 pandemic was not only in implementing the project, but also adapting the research activities to the virtual environment. Throughout Year 2, researchers at The Mark encountered many obstacles in collecting viable responses to the student survey. The process, as designed by The Mark, of administering surveys and getting a fully completed survey and parental consent from each respondent was cumbersome, especially during the pandemic which limited access to students. Additions such as inserting color pictures into the survey in earlier iterations to make it more user friendly had not produced the expected results, nor had offering certificates for survey completion.

In regular, biweekly discussions from January to June 2021, BOP staff, researchers from The Mark, and evaluators from Gaylen Moore Program Evaluation Services explored solutions such as shortening and updating the survey, which by Year 2 included items that were no longer relevant, and providing IRB allowable incentives for completion. By mid-semester, the research group had shortened the survey, and streamlined the survey logic to make it easier to do the survey and obtain parent consent, as well as follow up with respondents to get parental consent.

In addition, the entire BOP staff was enlisted to push harder to exhort students participating in the activities that proliferated in the spring semester to complete the survey.

The process of revising the student survey was slowed and complicated by an ongoing turnover of assistant and senior researchers at The Mark throughout Year 2. It took time for new researchers to learn about the project and get up to speed with the instrument. The evaluator recommended the new research staff attend one of the BOP informational sessions to learn about the Billion Oyster Project. BOP educators facilitated a session specifically for The Mark researchers. By April, researchers had finalized a much shorter and more simplified version of the survey, substantially increasing the number of completed student surveys in this semester. More detailed changes to the survey were discussed above.

Evaluators also encountered challenges in collecting teacher survey data in the Spring 2021 semester. Several factors were identified: 1) teachers were exhausted by the efforts of virtual teaching for the entire school year due to covid19, and had no bandwidth left to fill out surveys, two of which came at the end of the year when they were working with students to complete Symposium projects; 2) the master list of teacher participants has not been curated sufficiently to weed out citizen scientists who participate in BOP activities but whose responses are not included in the grant's data analysis; and 3) there is a small, very dedicated and committed cadre of teachers who participated enthusiastically in all BOP activities and completed surveys. These teachers were very satisfied and excited about the project's offerings, both for them and their students, as the data discussed earlier has shown. Plans to increase teacher survey response include teacher visits to the BOP headquarters and oyster nursey at Governors Island, and opportunities to meet other teachers in person in social events such as the BOP Mingle event at Governors Island held in July 2021.

RESULTS OF RESEARCH TO ASSESS ACHIEVEMENT OF STEM+C GOALS

Analyzing the data that was collected, evaluators and researchers were able to present findings that provided evidence presented in this report that the STEM+C project has met its goal to:

- sustain and augment the success of the BOP-CCRES Phase I project

The research protocols and survey instruments established in Phase I were expanded and enriched by the integration of data science curriculum and use of data collected in Phase I in monitoring oyster restoration to build teachers' and students' skills in research and scientific investigation.

The project has accomplished that by achieving the goals of :

- providing high quality preparation and support to teachers and students in learning data and computational concepts.
- Expanding programmatic content to increase student understanding and interest in STEM+C careers

The data does show a positive impact on teachers and students in statistically significant outcomes on these parameters. Teacher survey data has identified the strengths of the

professional development activities in preparing and supporting teachers to engage students in the Billion Oyster Project and to guide students in their own oyster restoration research, even instilling an interest in being stewards of the environment.

The student data enabled evaluators to identify statistically significant benefits for students as a result of the high quality professional development provided by the project which contributed to promoting student engagement and learning related to research skills and data science.

Teachers also learned practices, created their own experiences in BOP of 'being a scientist,' and acquired ideas about how to motivate students to pursue STEM careers, but the project's impact on both teacher and student participants in building STEM career awareness and interest was less successful.

One goal was not assessed by evaluators:

- further development of the BOP digital platform

BOP staff informed evaluators and researchers in quarterly meetings of the progress on developing the digital platform in collaboration with Morgan Stanley consultants who were working pro bono for the STEM+C project. However, data collected and posted in CCRES Phase I on the first version of the digital platform was used consistently throughout the project in Year 2 to facilitate teacher and student learning and research activities about oyster restoration in the New York Harbor

---

How have the results been disseminated to communities of interest?

To date, the results have not been disseminated.

IV. PRODUCTS

The evaluator has produced annual and interim reports for the BOP-CCRES Projects in Phases I, II, and III.

V. PARTICIPANTS

What individuals have worked on the project?

Gaylen Moore	Senior Evaluator	August 2021
Sole Proprietor of Gaylen Moore Program Evaluation Services		
Cara-Lynne Thomas	Assistant Researcher	August 2021

What other organizations have been involved as partners?

None.

Have other collaborators or contacts been involved?
No

VI. IMPACTS

What is the impact on the development of the principal disciplines of the project?
Nothing to report.

What is the impact on other disciplines?
Nothing to Report.

What is the impact on the development of human resources?
The evaluation knowledge and skills of my Assistant Researcher have grown considerably over the five years she has been working with me on the evaluations of the Billion Oyster Project CCRES Phases I, II, and III. She is more than ready to assume a Senior Researcher role in any evaluation.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology
Nothing to report.

VII. CHANGES / PROBLEMS

Changes in approach and reasons for change
Nothing to report

Actual or anticipated problems or delays and actions or plans to resolve them.

Nothing to report

Changes that have a significant impact on expenditures

Nothing to report

Significant changes in use or care of human subjects

Nothing to report

Significant changes in use or care of biohazards

N/A

APPENDIX: STEM + C Evaluation Reports
2020-21

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

Billion Oyster Project
STEM+C Professional Development Survey Results Fall 2020

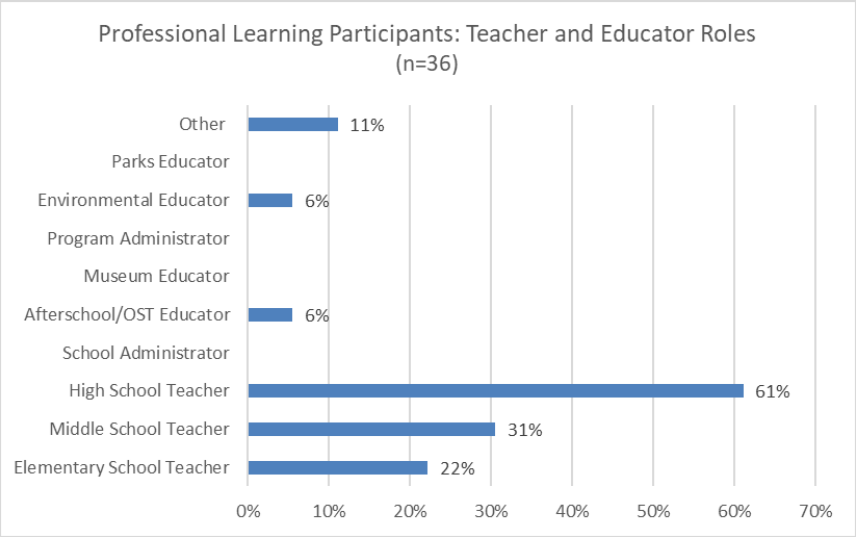
The Billion Oyster Project (BOP) offered professional learning activities for teachers and community scientists throughout 2020, but with the onset of COVID-19 and closure of schools in March, the delivery of Spring 2020 activities was limited. Project staff worked effectively over the summer months to modify and adapt their menu of professional learning activities to the virtual learning environment. From October to December 2020, BOP facilitated 12 remote and 1 onsite professional learning sessions. Participants responded to a survey following each session. In total, evaluators received 98 responses. Out of these responses, 70 came from teachers or educators, and 28 were from community scientists.
The survey solicited teachers' evaluation of BOP professional learning experiences in two areas: their own content learning and practice, and perceptions of the use and impact of their learning on students' interest and engagement with STEM and student awareness and interest in pursuing a STEM career.

TEACHER AND EDUCATOR PROFESSIONAL LEARNING SURVEY RESULTS

Below are the responses from the 70 program participants who identified themselves as teachers or educators. Many of these participants attended multiple sessions indicating that project staff's efforts to develop a cohort of teachers to encourage ongoing teacher participation and build a community of BOP educators was succeeding. The sessions were organized in the following four categories: *Oyster Research Station (ORS) Basic Training*, *Oyster Tank Training*, the *Inquiry from Anywhere* professional learning series, and others, including *Living Breakwaters* activities. Evaluators reviewed results from these sessions in the following categories of teacher and student engagement: teacher engagement and learning, continuing teacher participation, teacher feedback, student engagement and learning, and student interest in STEM careers.

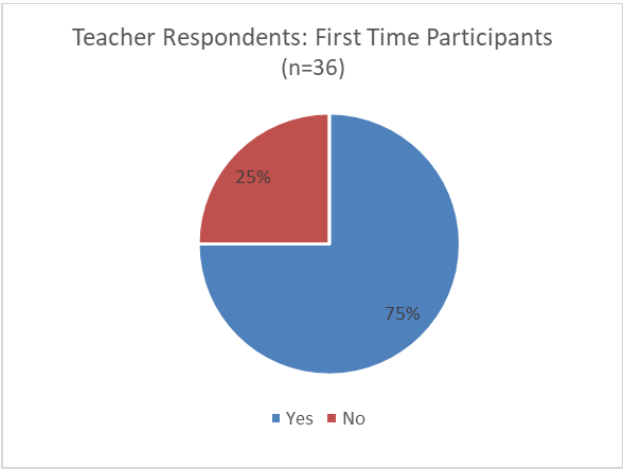
Overview of Respondents

Thirty-six individual teachers responded to the survey. For teachers who completed the survey following multiple workshops, results in the following tables reporting the nature of teacher participation are based on respondents' first survey only. From these 36 teachers, at least 1500 students may engage in BOP activities in their classes based on these workshops.

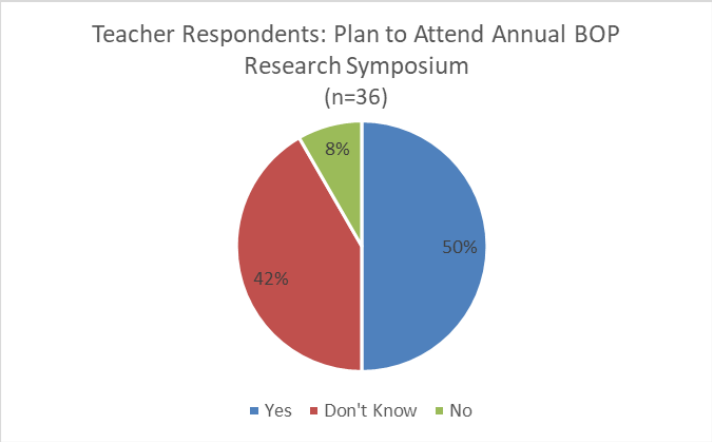


Note: respondents could select more than one response.

- The majority of respondents teach in a school setting. Sixty-one percent of respondents teach high school. Thirty-one percent teach middle school, and twenty-two percent teach elementary school.
- Eleven percent reported that they have 'Other' roles. Those roles include:
    - Science Department Chair
    - Afterschool Program Manager
    - Universal Literacy Coach

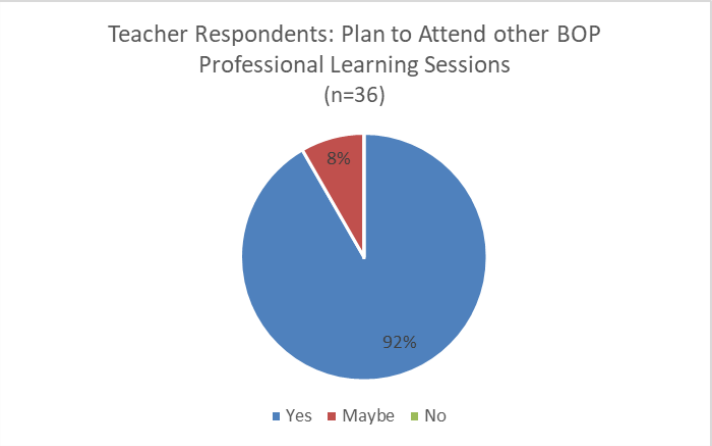


- Seventy-five percent of respondents said they were new to BOP. This fall (during COVID-19) was the first time they participated in Billion Oyster Project professional learning opportunities.
- Twenty-five percent of respondents had participated in BOP programming prior to this year.



- Half of survey respondents plan to attend the annual BOP Student Research Symposium with their students.
- Forty-two percent do not know if they will attend with their students.

The Symposium provides a connection from teacher professional learning sessions to student learning and potential STEM career interest. While teachers are attending the professional learning sessions, they can utilize the activities and lessons from these sessions to engage students in their own research projects. At the Symposium, students present their projects and have the opportunity to discuss them with the scientists and other STEM professionals on the judging panel and to learn from them directly about STEM careers.



- Ninety-two percent of respondents plan to attend future BOP professional learning workshops. As seen from the repeated survey takers from various events, some respondents already attended several more workshops since their initial BOP activity.

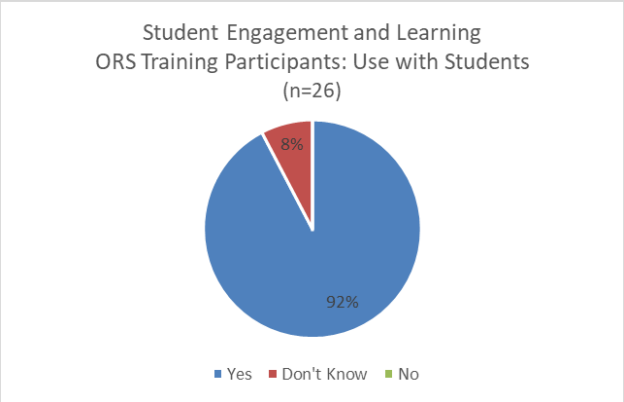
OYSTER RESEARCH STATION (ORS) BASIC TRAINING

Evaluators received twenty-six surveys from four sessions of Oyster Research Station (ORS) basic training workshops. ORS basic training is an entry-level training to familiarize participants with BOP, harbor

restoration, and collecting data through monitoring an ORS unit. ORS basic training consisted of three sessions held virtually and in-person. Some participants completed surveys after both of their virtual sessions; these surveys are included in the responses below. ORS training dates included in these results are: Oct. 1, 2020, Oct. 6, 2020, Nov. 6, 2020, and Nov. 11, 2020. For 46 percent of respondents, the first session of their ORS training was their first time participating in BOP programming.

Student Engagement and Learning

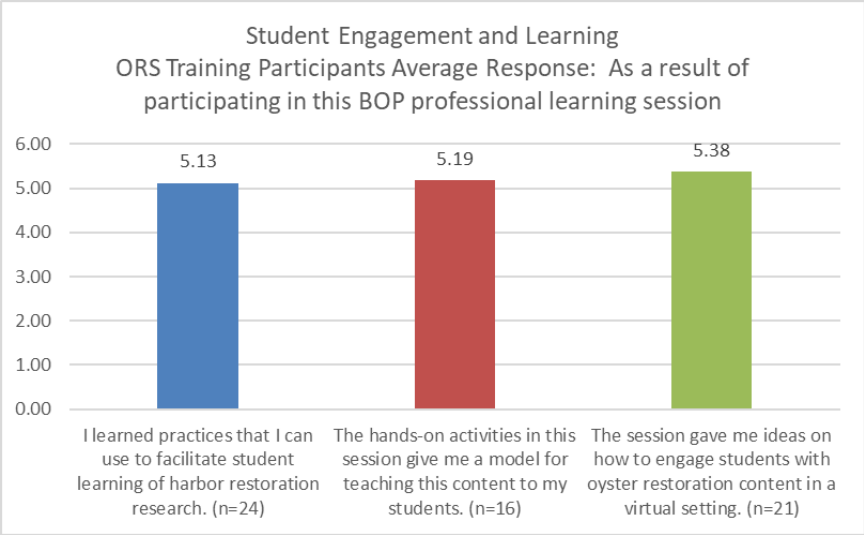
Student engagement and learning was evaluated through teacher participants' intention to use activities from their BOP professional learning session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how they engage students with BOP activities and lessons.



- Ninety-two percent of respondents plan to use activities from ORS training with their students.
- Teachers plan to use the training with students for research projects, data collection, curriculum about oyster restoration, in extracurricular groups, and other ways. Specific thoughts about how or why they will use ORS activities include:
    - *Teach students how to record the data*
    - *Many of my research students are interested in the environment and this is a great way to get them involved in their community.*
    - *Great opportunity for students to appreciate local ecology and practice science skills*
    - *I think this would be a great ongoing project for the Science Dept at the high school. We are starting with Honor Society but could grow from there.*
    - *I hope to enter data with some students in Urban Barcode*
    - *We are hoping to adopt an ORS and get a new one installed so that students can participate in measurements*
    - *Many of my research students have an interest in the environment and this would be a perfect way to get them involved in it.*
    - *We have a marine biology club. This will definitely help them to take care of the oysters*
    - *Our students are very excited to monitor oysters in our tanks and at field stations.*
    - *A student actually reached out to me who had worked with UBP. This could be a great continuation to use with Science Honor Society students.*
    - *I will use the video of the oyster anatomy and the ORS before taking the students out in the field.*

- *I plan to co-mentor one team that I believe will be doing a BOP related project.*
- *Oyster anatomy will be key to introduce to my kids and then learning how to survey the ORS.*
- *I believe that this activity will not only fascinate my students but will also build community relations.*

Teachers also responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

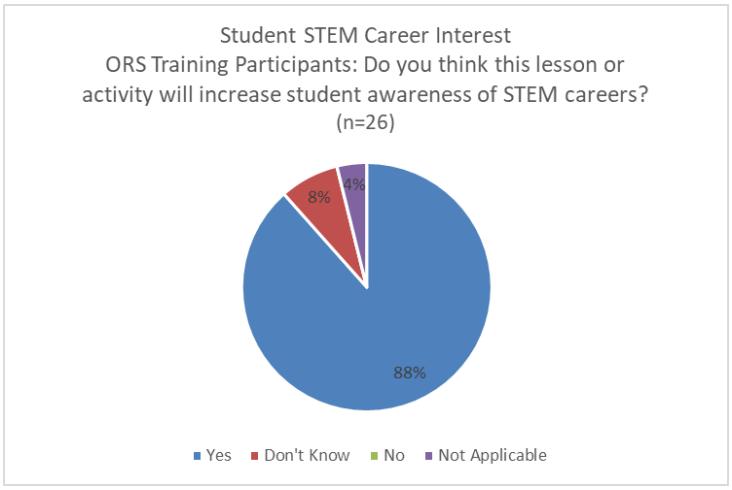


- Average responses from teachers to three statements pertaining to student engagement and learning all ranged from 5 (Agree) and 6 (Strongly Agree).
- The statement with the highest average response was *The session gave me ideas on how to engage students with oyster restoration content in a virtual setting*, with an average of 5.38 (standard deviation=1.16). Five respondents selected 'not addressed in this session.'

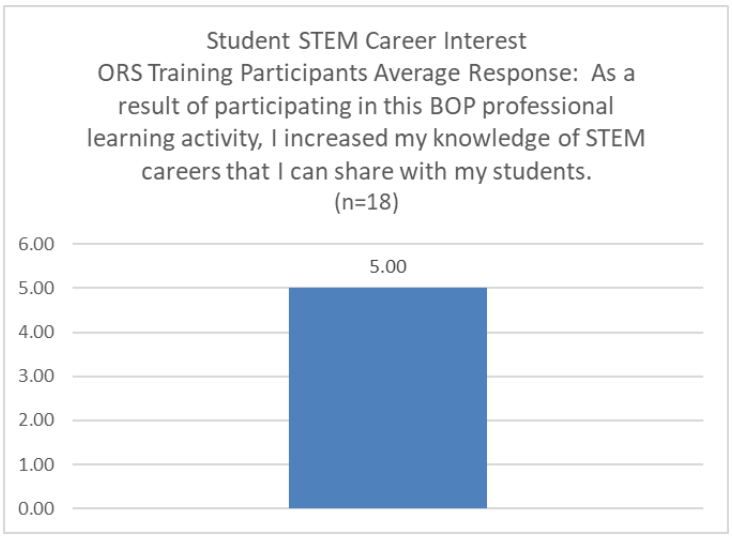
High average responses to these statements suggest that teachers feel prepared to engage students in learning about harbor restoration content and research following ORS basic training activities.

Student Interest in STEM Careers

Student interest in STEM careers was evaluated through teacher participants' perceptions of BOP activities and the extent to which they could contribute to increasing student awareness of STEM careers, as well as their own learning about STEM careers.

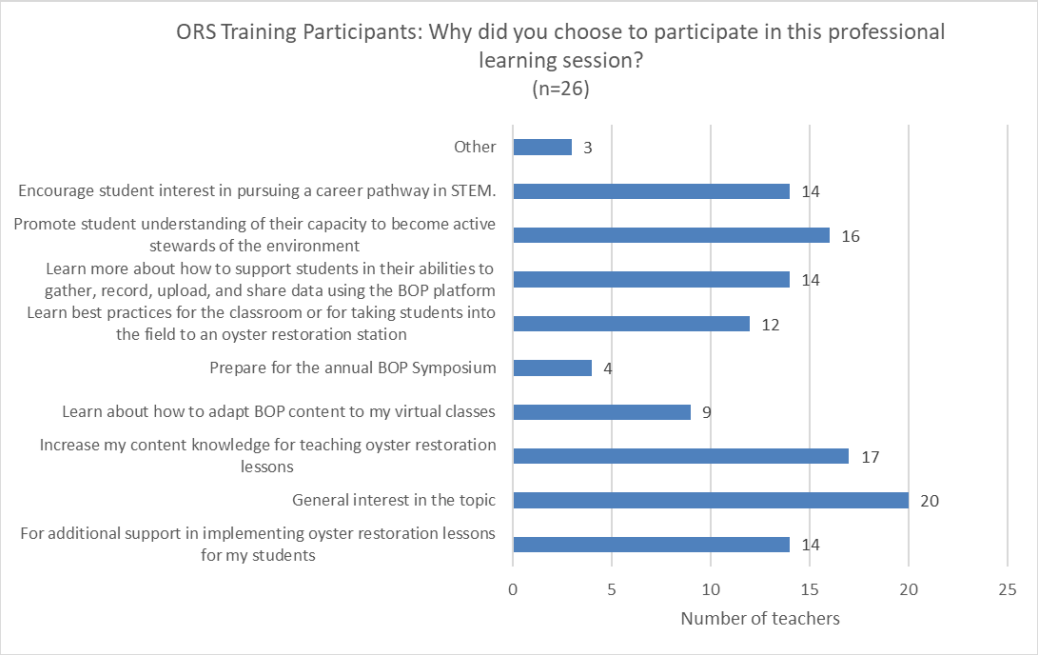


- Eighty-eight percent of respondents thought that using the ORS training lessons and activities would increase their students' awareness of STEM careers.

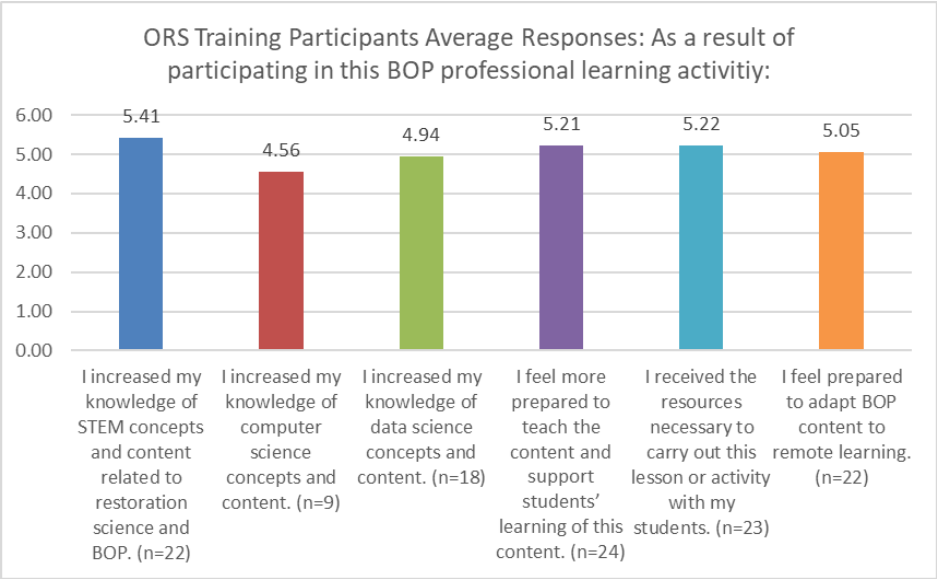


- On average, teachers 'agreed' they increased their knowledge of STEM careers through their participation that they can share with students. Eight participants responded that this was 'not addressed in this session.'

Teacher Engagement and Learning



- More than 50 percent of respondents chose to participate in ORS training for the following reasons:
  - General interest in the topic (77% of respondents)
  - Increase content knowledge for teaching oyster restoration lessons (65%)
  - Promote student understanding of their capacity to become active stewards of the environment (62%)
  - Encourage student interest in pursuing a career pathway in STEM (54%)
  - Learn more about how to support students in their abilities to gather, record, upload, and share data using the BOP platform (54%)
  - For additional support in implementing oyster restoration lessons for my students (54%)
- The reasons highlighted in yellow connect to student engagement and student interest in STEM careers. As teachers seek out professional learning to meet these goals, they bring this information back to their students and can actively promote career awareness and engagement as environmental stewards. Teachers responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: or these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

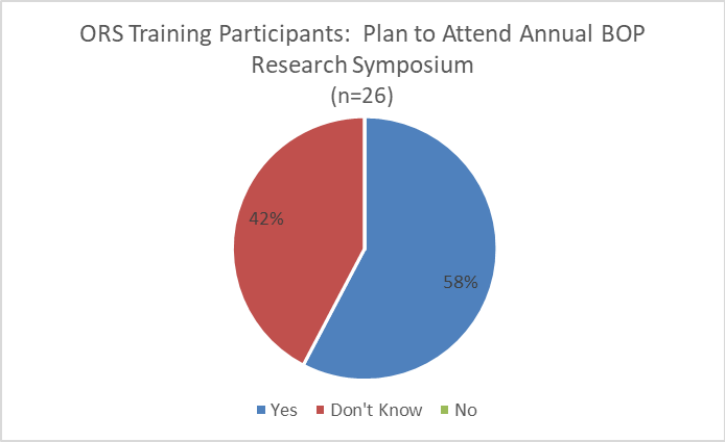


- Average responses to all statements were above 4 (Somewhat Agree), representing an overall positive experience with the ORS training.
- The highest average response was to the statement *I increased my knowledge of STEM concepts and content related to restoration science and BOP* with an average of 5.41 (standard deviation=1.18). These training sessions focused on the oyster research station and harbor restoration; this high rating suggest that teachers think BOP is meeting their primary goal in these trainings.
- The lowest average response was to the *statement I increased my knowledge of computer science concepts and content* with an average of 4.56 (standard deviation=1.59). Seventeen respondents said that this was 'not addressed in this session.' Computer science is not a focus of these training sessions and lower ratings are not surprising.
- Teachers were asked what could be changed about the training to better prepare teachers to use this material with their students. Answers are from after the first and the last session of the multi-session ORS training and included the following:
    - *More info on how to start oyster project.*
    - *Access to the model data sheet*
    - *I think this session served its purpose well.*
    - *I think that this session could have been a little longer, so that we had time to share teaching ideas, ask questions, and sort out any tech problems. I am very interested in accessing BOP data and online teaching resources.*
    - *It was great. Maybe add extension lessons for the classroom but we may be getting that.*
    - *How to implement resources for this topic for virtual learning.*
    - *Resources to share with the students.*
    - *It was repetitive from the last session*
    - *Nothing was missed. I am prepared for tomorrow when we do the hands-on portion.*
    - *More info about data sharing across ORS sites.*

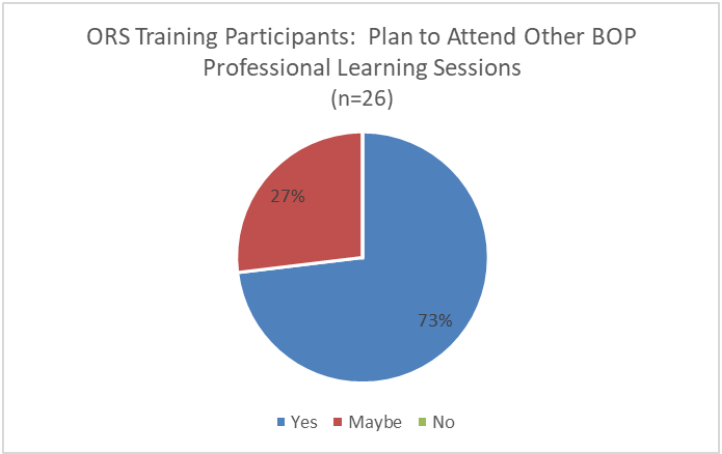
- *This session was pretty teacher-focused so it doesn't translate directly to students, I learned a lot. I would have liked a little more information about how BOP/ORS has been integrated into classrooms around the city, modifications for online learning, etc.*
- *Nothing was missing in this session. The presenter did an exceptional job informing the audience.*
- *Insight on how to use this in a virtual setting.*

Continuing Teacher Participation

Teachers' interest in continuing participation in BOP activities was evaluated by their plans to attend the annual BOP research symposium and to attend future BOP professional learning sessions, as well as whether they completed another survey from a different type of professional learning session.



- Fifty-eight percent of participants plan to attend the annual student research project symposium with their students in June 2021. As mentioned above, the symposium is an opportunity for students to engage with scientists and others' research as well as to present their own research. Sessions such as the ORS basic training provide an entry point for teachers to motivate and support their students to engage in their own research and attend events such as the symposium.

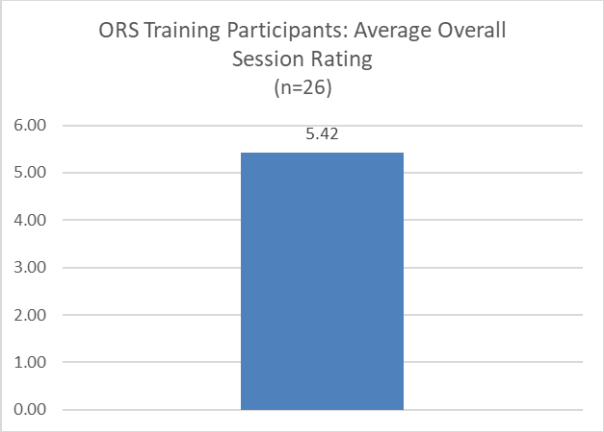


- Seventy-three percent of respondents plan to attend other BOP professional learning sessions.
- Among those who said they would 'maybe' attend, scheduling and availability were cited as factors for attending.

- Two teachers who cited ORS basic training as their first BOP participation completed surveys for additional professional learning sessions during fall 2020.

Teacher Comments and Feedback

Participants rated the session overall on a scale of 1 (Poor) to 6 (Excellent).

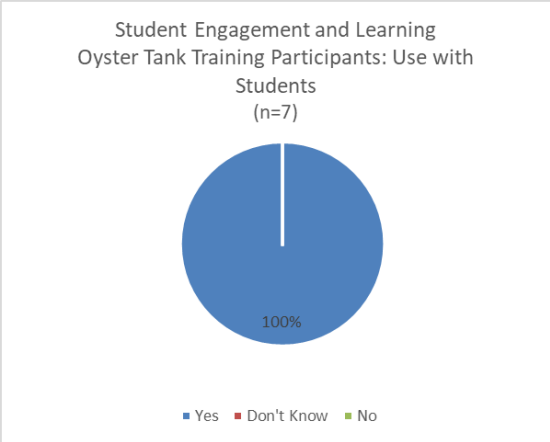


- The overall average rating for this session was highly positive at 5.42 (Standard deviation=0.81).
- Teachers provided additional feedback on how the sessions could be improved:
  - *It was perfect and a lot of fun.*
  - *Would like more info about sharing data and collaborating with other groups*
  - *Love the field research. More ideas for activities.*
  - *More hands-on activities.*
  - *It would be great if an activity involved watching BOP staff measuring and counting oysters through Zoom so that students can see firsthand what they will be expected to do when they collect data and if it is on Zoom, they can ask questions right there.*
  - *Have a classroom teacher present to share their experience with the program along with the BOP educator.*
  - *These learning opportunities have been a wonderful experience. There is nothing to improve on.*

OYSTER TANK TRAINING

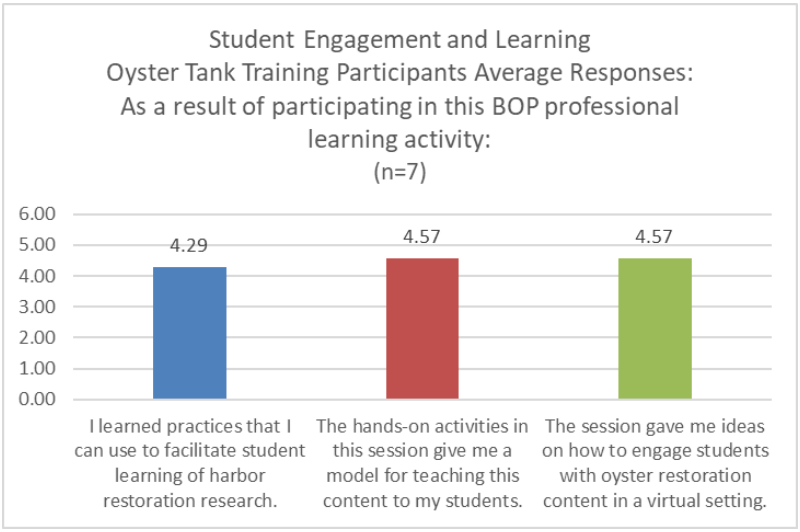
Evaluators received seven responses from two dates of oyster tank training workshops. Oyster tank training is a one-time session that walks participants through setting up and caring for their own oyster tank. Dates included in these results are: Oct. 23, 2020, and Oct. 24, 2020. For 57 percent of survey respondents, oyster tank training was their first time participating in BOP programming.

Student Engagement and Learning



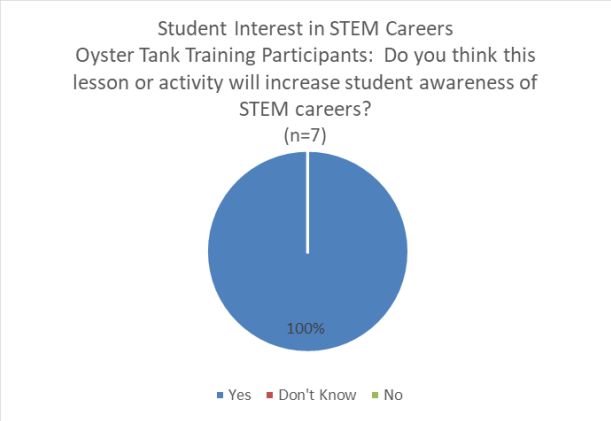
- One hundred percent of oyster tank training participants plan to use activities and lessons from their training with their students.
- Teachers plan to use oyster tank activities to engage students in research projects, math extensions, extracurricular clubs. Other thoughts about how to use the activities include:
    - *Just because we are remote, I don't want the kids to feel that we cannot get involved with the environment and do research.*
    - *My students will be in charge of my tanks and I will just be there to facilitate*
    - *We have a Marine Biology Society consisting of 57 students who are very interested in partaking in oyster research and presenting at the Symposium in June.*
    - *Especially during times of COVID, it is essential to provide students with experiences outside of their textbooks and bring the world into the classroom.*
    - *I want to expose my students in carrying out an authentic science experiment, as well as collecting and analyzing data.*

Teachers also responded to a series of statements about the extent to which the workshop modeled practices that they could use to engage students in oyster restoration research. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

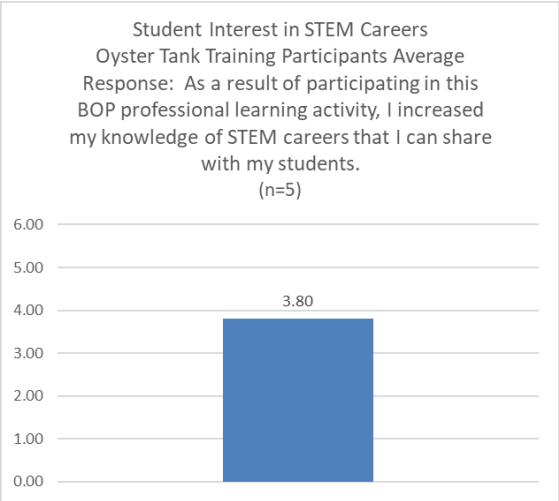


- Average responses to all three statements about student engagement and learning were between 4 (Somewhat Agree) and 5 (Agree), indicating that the oyster tank training was effective in providing the practices that would help teachers engage students in oyster restoration.[1]

Student Interest in STEM Careers



- All respondents thought that engaging students in the oyster tank activities could be utilized to increase their awareness of STEM careers.
-



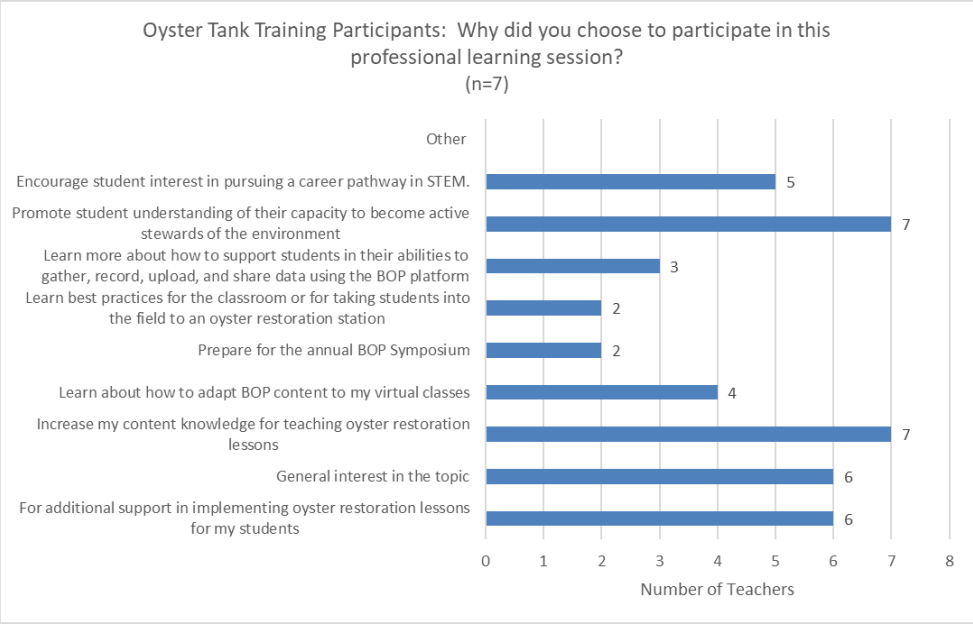
- Despite thinking that these activities would raise student awareness of STEM careers, the average response to *I increased my knowledge of STEM careers that I can share with my students* was between 3 (Somewhat Disagree) and 4 (Somewhat Agree) at 3.80 (standard deviation=2.59). Two respondents replied that this was 'not addressed in this session.'

Career awareness is one area where the training could be improved. The oyster tank training activities may be a less direct way to raise students' awareness of STEM careers, but still offer opportunities to do that. The majority of the training focuses on setting up the tank and how to use the tank with students to collect

[1] Positive comments combined with a positive overall rating of this session in sections below as well as high variance in responses suggests that one or more respondents may have misread the survey and checked boxes for 'highly disagree' instead of 'highly agree.' This may account for some of the lower averages across all statements.

data. Facilitators of these sessions could make explicit references to career opportunities in this type of research activity and model the practice of raising teachers' awareness of these careers, so that teachers can share that with their students when they use the tanks to gather data. In previous years, students have utilized oyster tanks in their research projects presented at the annual BOP symposium.

Teacher Engagement and Learning

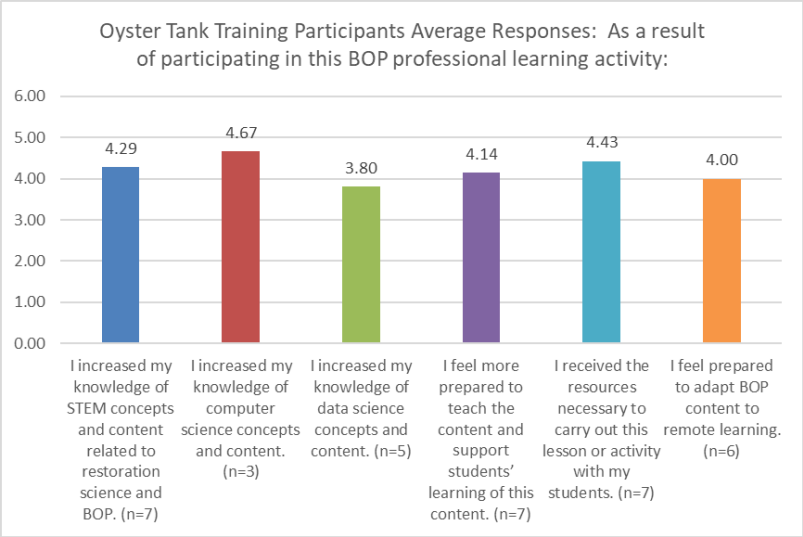


- More than 50 percent of respondents chose to participate in oyster tank training for the following reasons:
  - Encourage student interest in pursuing a career pathway in STEM (71%)
  - Promote student understanding of their capacity to become active stewards of the environment (100%)
  - Learn about how to adapt BOP content to my virtual classes (57%)
  - Increase my content knowledge for teaching oyster restoration lessons (100%)
  - General interest in the topic (86%)
  - For additional support in implementing oyster restoration lessons for my students (86%)
- The reasons highlighted in yellow connect to student engagement and student interest in STEM careers. Teachers in this training were highly interested in STEM career pathways and students as environmental stewards.

Teachers are actively seeking ways to incorporate information around these topics into their classroom. BOP activities can build on this interest and expand teachers' knowledge through the connections to various STEM careers that BOP already has. As activities change for virtual settings, providing videos or other media from people in various careers that connect to tank activities is one way that student knowledge of STEM careers could be expanded, particularly beyond ideas of being a scientist in a lab.

Teachers also responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly

Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."



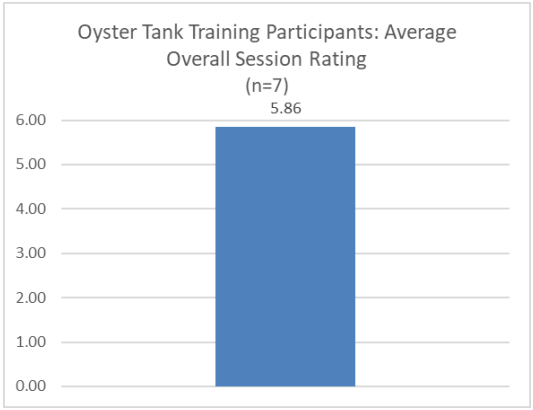
- The statement with the lowest average response was *I increased my knowledge of data science concepts and content* with an average of 3.80 (standard deviation=2.59). Two teachers responded that this was 'not addressed in this session.' As this training is a one-day introductory training, it is difficult to fit all potential topics and applications into one training. An advanced training could be added to address more of the ways an oyster tank can be utilized.
- Teachers responded most positively to the statement *I received the resources necessary to carry out this lesson or activity with my students* with an average response of 4.43 (standard deviation=2.37).[2]
- Teachers were asked what could be changed about the training to better prepare them to use this material with their students. Answers included the following:
    - *This session was informative and covered interesting topics.*
    - *Nothing - everything was extremely helpful in allowing us to utilize the Oyster Research Tanks in the classroom!*
    - *Being new to the oyster setup I think this was the best introductory lesson between the background of the program, oyster awareness and setting up the tank. I think I would like another training based on all the other testing supplies like the dissolved oxygen.*
    - *More time*

Continuing Teacher Participation

[2] See footnote on page 12.

- Eighty-six percent of participants plan to attend the annual BOP research symposium with students. As noted above, at previous symposia, many students presented research connected to oyster tanks. This training provides an entry point to getting students involved in research, particularly in the virtual learning environment, in which teachers maintain the tanks in their homes or classrooms in a blended learning environment.

- All respondents plan to attend another BOP professional learning session. Three teachers who reported that the oyster tank training was their first time participating in BOP attended other professional learning sessions later in the semester. *Teacher Comments and Feedback*
- Participants rated the quality of the session overall on a scale of 1 (Poor) to 6 (Excellent).



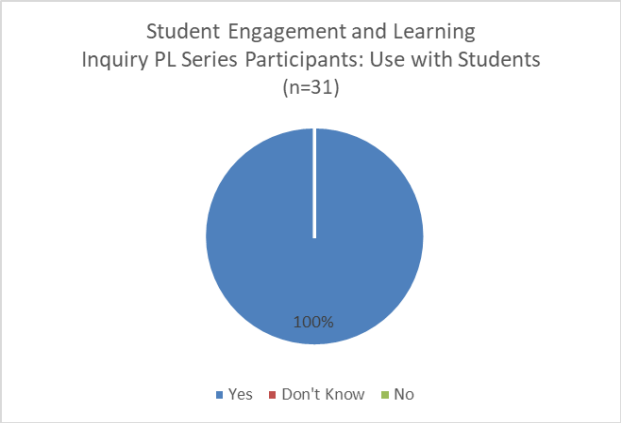
- Participants rated this training highly positively with an average response of 5.86 (standard deviation=0.38).
- Teachers provided additional feedback on how the sessions could be improved:
  - *Perfect as is!*
  - *Maybe make workshops geared to specific grade levels (elementary and secondary)? I really liked this professional development and I personally know I would love more!!!*
  - *Have more learning activities*

INQUIRY FROM ANYWHERE **PROFESSIONAL LEARNING SERIES**

The *Inquiry from Anywhere* series was designed specifically for the remote learning environment to enable teachers and students to conduct scientific research at home or outside the home. There were four sessions in the series. The second session was a repeat of the first session delivered because of popular demand.

Sessions one and two focused on data collection and observations from the natural world, session three focused on animal behavior, and session four focused on biodiversity. Evaluators received 31 responses from these sessions. Some participants attended one session and others attended more. These workshops were held on the following dates: Oct. 27, 2020, Nov. 12, 2020, Nov. 17, 2020, and Dec. 8, 2020. For 29 percent of survey respondents, a session in the *Inquiry from Anywhere* series was their first time participating in BOP programming. Some participants completed surveys for multiple sessions.

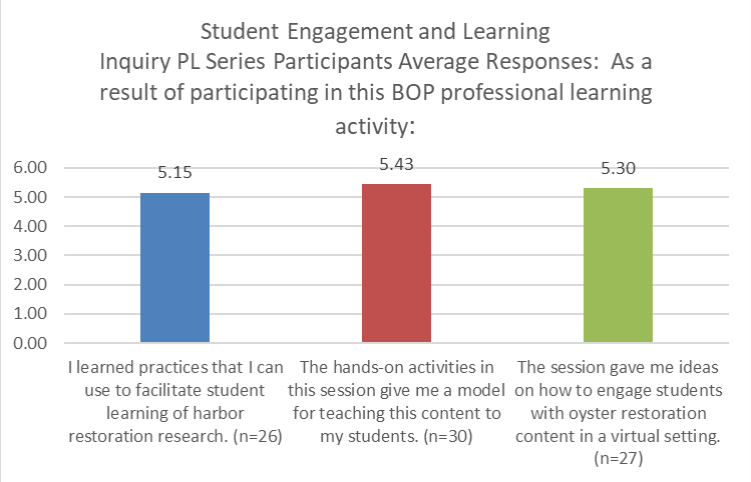
Student Engagement and Learning



- All respondents plan to use activities and lessons from the inquiry professional learning series with their students.
- Teachers plan to use activities and lessons from the inquiry series in a variety of ways including as research activities in larger curricular units, to generate questions for research and experimental design, for data collection and entry, with extracurricular clubs, as part of the Living Environment curriculum, and other ways. Specific ideas for use included:
    - *We have a field study class for the freshmen, and I am looking to expand the class for upper class men.*
    - *It is a way for students to learn how to manipulate data with Google Sheets that they or their peers might have collected themselves.*
    - *I will use this is an example of how students can begin to think about how to analyze data.*
    - *The data set is really good and will be a great way to introduce students to data collection and analysis using something that will be interesting to them.*
    - *I like that the data provided is for a local ecosystem and can be used for different levels of instruction.*
    - *It can help get them engaged in a virtual setting and is something they can do from home with technology.*
    - *Using videos to make observations is a very promising strategy during remote learning.*
    - *I think this is an excellent way to introduce students to creating authentic questions, making observations, and coming up with ways of collecting data in a remote setting.*
    - *While animal behavior is not a part of my curricula, it would be a good activity to help students develop their question-asking and data collection skills.*

- *I'd like to use it as an exercise to get students to think about what types of data can be collected from the spaces around us that we might not normally consider for data collection/study.*
- *This session helped me see how easy it can be to engage students in data collection and analysis in an unconventional setting.*
- *My club has been itching to "get outside" and these activities are a good reminder of what we'll need to be doing in the field!*
- *I would like my students to engage in science in their community, even if they are remote. My students need to interact in with their environment*
- *I see this as a good opportunity for students to experience hands-on science.*
- *I would like to promote my students' understanding of their capacity to become active stewards of the environment*
- *I will facilitate the use of this lesson because it is a new virtual lesson that will keep my students engaged and interested in learning science.*
- *I think it is a great way to engage students in inquiry based learning while open enough to help them pursue this work within their own personal interests.*
- *Even if I do not do the oysters, this PD gave me great ideas to implement life science into the second grade curriculum and promote interest, inquiry, and discussion.*
- *We're working on making and recording observations as a basis for inquiry, so this is very relevant for my class right now.*

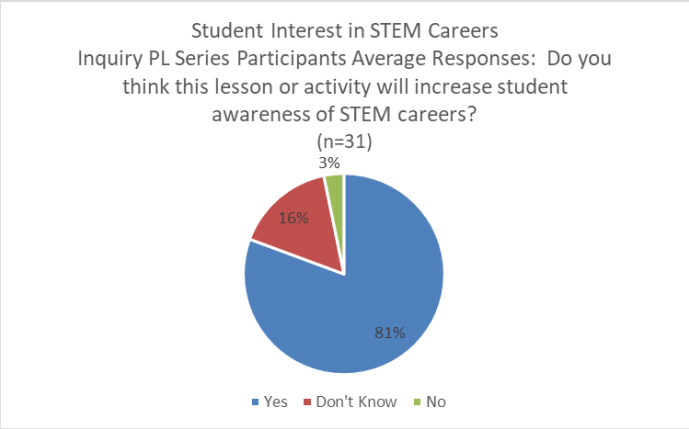
Teachers also responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."



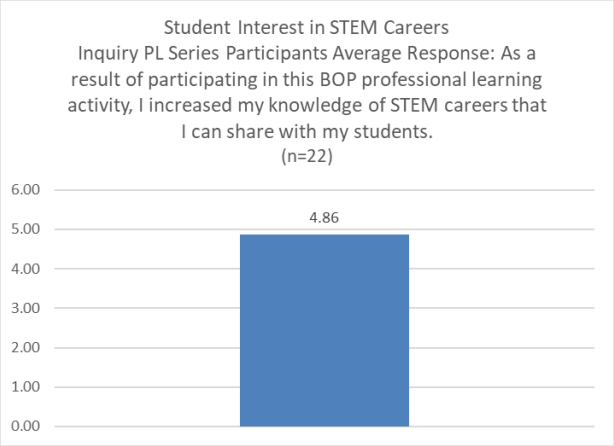
- On average, teachers rated all three statements positively with average responses between 5 (Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *The hands-on activities in this session give me a model for teaching this content to my students* with an average of 5.43 (standard deviation=1.01).

As teachers highlighted in their comments above, they thought that the activities in these sessions would be useful for introducing a range of topics and also had application beyond oyster restoration.

Student Interest in STEM Careers



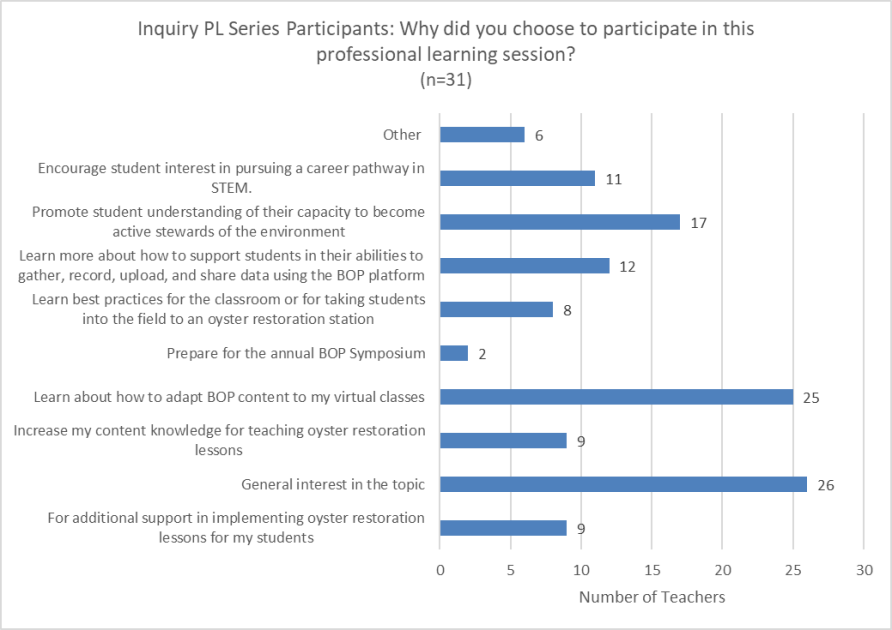
- Eighty-one percent of respondents thought that activities and lessons from the inquiry series would increase student awareness of STEM careers.



- The average response for *I increased my knowledge of STEM careers that I can share with my students* was 4.86 (standard deviation=1.01), with nine responding 'not addressed in this session.'

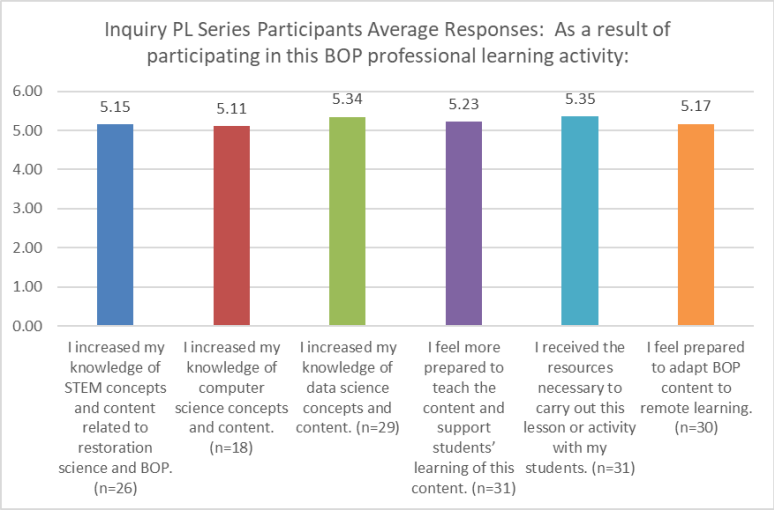
Teachers can use this *Inquiry* series to lay a foundation for many scientific ideas and ways of engaging students in the research process. To promote career awareness, facilitators could model strategies and be explicit in these sessions to introduce STEM careers to students in the context of these inquiry sessions.

Teacher Engagement and Learning



- A majority of respondents chose to participate in the *Inquiry from Anywhere* series for the following reasons:
    - *General interest in the topic* (84%)
    - *Learn about how to adapt BOP content to my virtual classes* (81%)
    - *Promote student understanding of their capacity to become active stewards of the environment* (55%)
- The reasons highlighted in yellow connect to teachers' interest in motivating student engagement in the content and student interest in STEM careers.

Teachers also responded to a series of statements about the nature and extent of their learning from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

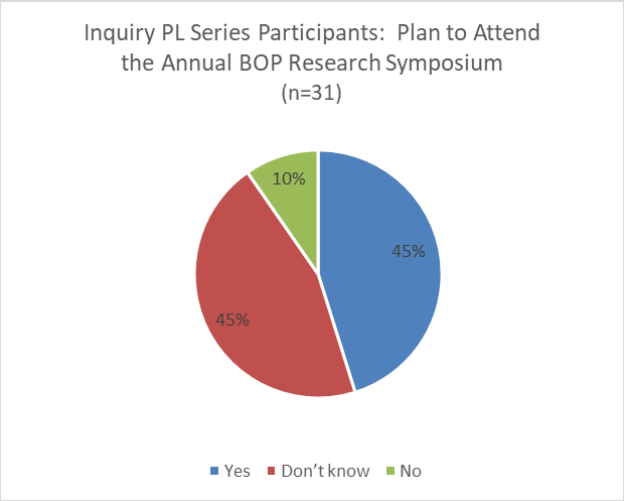


- Average responses to all statements were positive and between 5 (Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *I received the resources necessary to carry out this lesson or activity with my students* with an average of 5.35 (standard deviation=1.05).
- The lowest average response was to the *statement I increased my knowledge of computer science concepts and content* with an average of 5.11 (standard deviation=0.58). Thirteen respondents said that this was 'not addressed in this session.' Computer science was not a focus of these sessions and lower ratings are not surprising.

High rating on teacher engagement and learning suggests that teachers felt confident following the sessions to engage their students in these activities.
Teachers were asked what could be changed about the sessions to better prepare them to use this material with their students. Answers included the following:

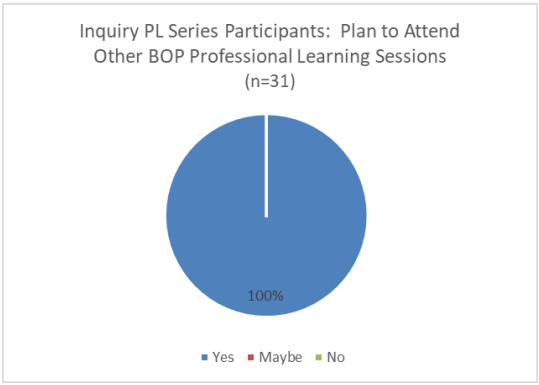
- *Nothing. It was great!*
- *It might have been interesting to hear about specific lesson plans or activities using the BOP biodiversity data and species guide to help brainstorm ideas about writing our own lessons.*
- *Nothing was missing from the session, but I think it would be helpful to have additional data such as size of the areas where the abundance was measured for statistics purposes.*
- *I liked the discussion between teachers about ideas for using the resources.*
- *maybe an introduction in how to create charts and graphs (like on google sheets)*
- *More time to discuss animal behavior videos students could use to make observations.*
- *Differentiation for lower grade levels.*
- *Everything was amazing*
- *I would like to listen to teachers who have done it.*
- *A scope and sequence on how to teach this unit/series of lessons on inquiry-based learning*
- *I would have appreciated a bit more time focused on how to integrate these activities within larger themes and how to assess some of these activities.*

Continuing Teacher Participation



- Forty-five percent of participants in this series of plan to attend the annual BOP research symposium with their students.
- Forty-five percent do not know if they will attend.
- Ten percent do not plan to attend.

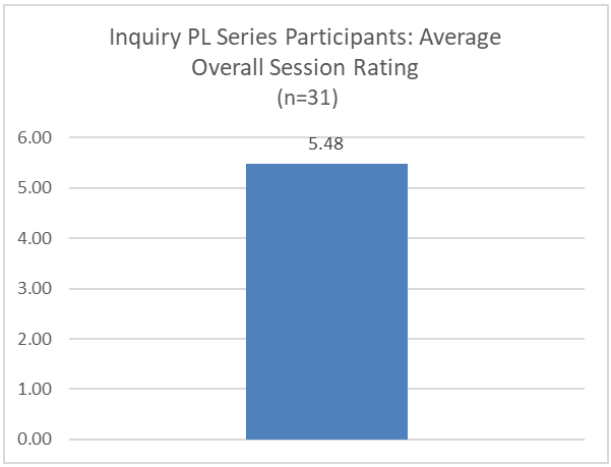
These findings suggest that the evaluator's observations of modelling of inquiry practices and discussions with participants about how to use them in the classroom gave teachers confidence to implement the same practices with their students in creating their own research projects, a key feature of the annual BOP Symposium. Session facilitators could include time in the workshops to discuss the symposium and how to use these sessions as resources for symposium projects, in particular because symposium participation is an opportunity for students to more directly engage with harbor restoration science, and to perceive themselves as someone who might be motivated to pursue a career in STEM.



- All participants from the inquiry professional learning series plan to attend more BOP PL sessions. These sessions were the last of the Fall 2020 school semester.

Teacher Comments and Feedback

Participants rated *Inquiry from Anywhere* sessions overall on a scale of 1 (Poor) to 6 (Excellent).



- Teachers rated this session positively with an average rating of 5.48 (standard deviation=0.81).
- Teachers provided additional feedback on how the sessions could be improved:
    - *Thanks for the resources*
    - *This has been a great series. Not sure how I would improve them.*
    - *Data that includes abiotic and biotic factors*
    - *Incorporate culturally responsive curriculum workshops/ antiracist curriculum workshops.*
    - *Incorporate next gen science standards*
    - *Keep on incorporating practical applications and incorporate considerations for equity.*
    - *I am interested to hear about experiences from teachers who have done it.*
    - *anchoring in NGSS would be helpful for educators*

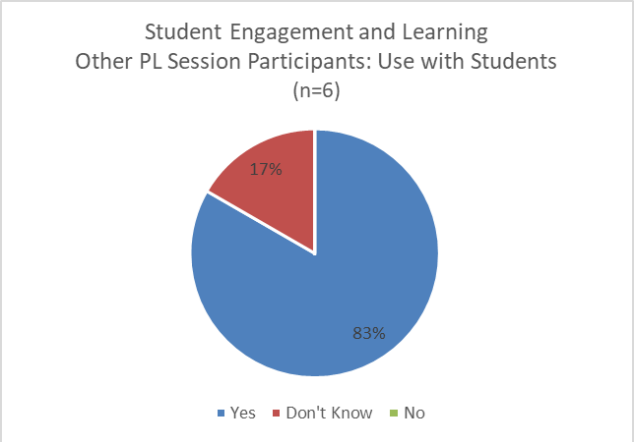
OTHER PROFESSIONAL LEARNING WORKSHOPS

Evaluators received six responses from two other stand-alone professional learning sessions. These sessions are the *Life Cycles of New York Harbor Critters* workshop on Nov. 10, 2020 and the *Living Breakwaters as a Habitat* workshop on Dec. 1, 2020. While these sessions were not a series, they both connected to BOP's Living Breakwater curriculum and highlighted specific activities for teachers to use with students. For 50 percent of survey respondents, one of these sessions was their first time participating in BOP programming.

As in discussions above about these survey findings, the impact of BOP professional learning sessions on student engagement and learning was evaluated through teacher participants' intention to use activities from their session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how to engage students with BOP activities and lessons.

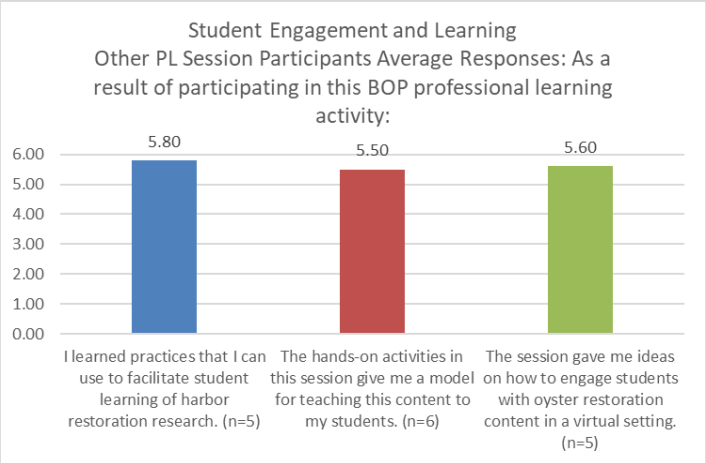
Student Engagement and Learning

As in discussions above about these survey findings, the impact of BOP professional learning sessions on student engagement and learning was evaluated through teacher participants' intention to use activities from their session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how to engage students with BOP activities and lessons.



- Eighty-three percent of participants plan to use the activities and lessons from these two sessions with their students.
- Teachers plan to use the activities within the Living Environment or life cycles curricular units. Specific thoughts about how to do that include:
    - *I'm not sure yet where this would fit in. I'm considering how I can introduce oysters in the first place. However, there are elements of the structural build that I think I can employ.*
    - *The hands-on experience is greatly needed during remote learning.*
    - *The google slide has a depth of knowledge of marine animals on the east coast. and it is ready to use in my classroom*
    - *Possibly an activity in which students construct a breakwater in an ecosystem so they can form hypotheses about how it would affect the ecosystem and its species.*
    - *I will ask the students to create their own models of the living breakwaters using materials from around their house. I even think using food or different shape/size pasta could be applicable. I would have them cut out the organisms from the slide deck and stick them in locations they believe the organisms would be found.*
    - *Adapt using engineering standards for students to construct their own breakwater models*
    - *I will share some of Google slide deck in Google classroom - having students do activities- such as sort the creatures and organize the development stages*

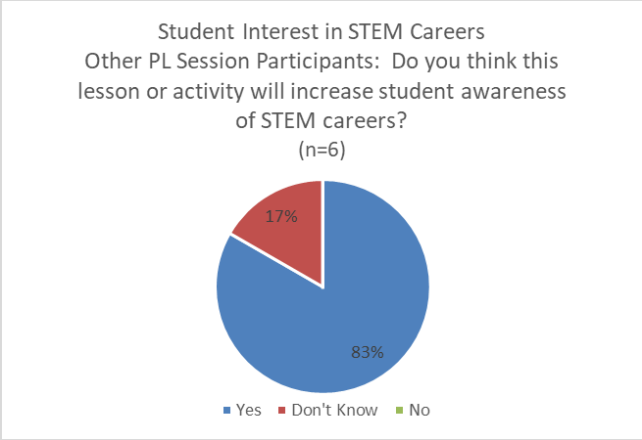
Teachers also responded to a series of statements about how the practices they learned from the professional learning session would facilitate student learning. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."



- On average, teachers responded positively to statements about student engagement and learning, with all three statements receiving ratings between 5 (Agree) and 6 (Strongly Agree).

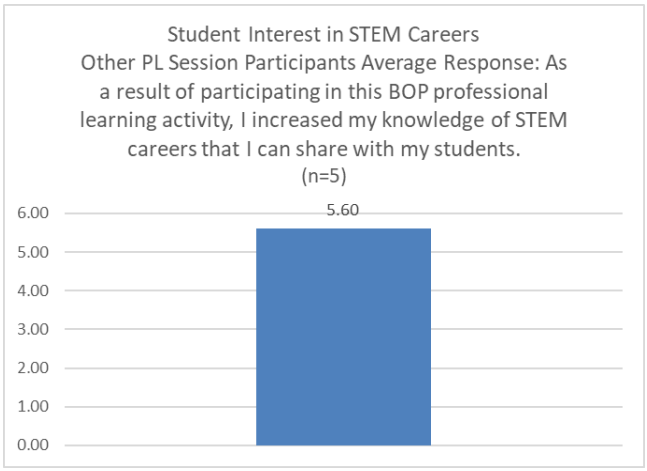
This finding suggests that one strength of these sessions was modeling ways to facilitate student learning and engage students virtually in oyster restoration content.

Student Interest in STEM Careers



- Eighty-three percent of participants thought that these lessons and activities would increase student awareness of STEM careers.

Because these sessions introduced BOP's Living Breakwater curriculum, the curriculum could provide lessons and extension activities that connect more specifically to developing student STEM career interests. As presented in the graph below, teachers sought out these sessions for ideas about how to teach BOP material in the virtual setting. The virtual setting provides a unique opportunity to give teachers more resources about careers through activities such as "virtual fieldtrips" than they otherwise might be able to do, and could enable students see how STEM professionals use concepts from the curriculum.



- Teachers responded positively to increasing their own knowledge of STEM careers through this session, with an average response of 5.60 (standard deviation=0.55). One participant responded 'not addressed in this session.

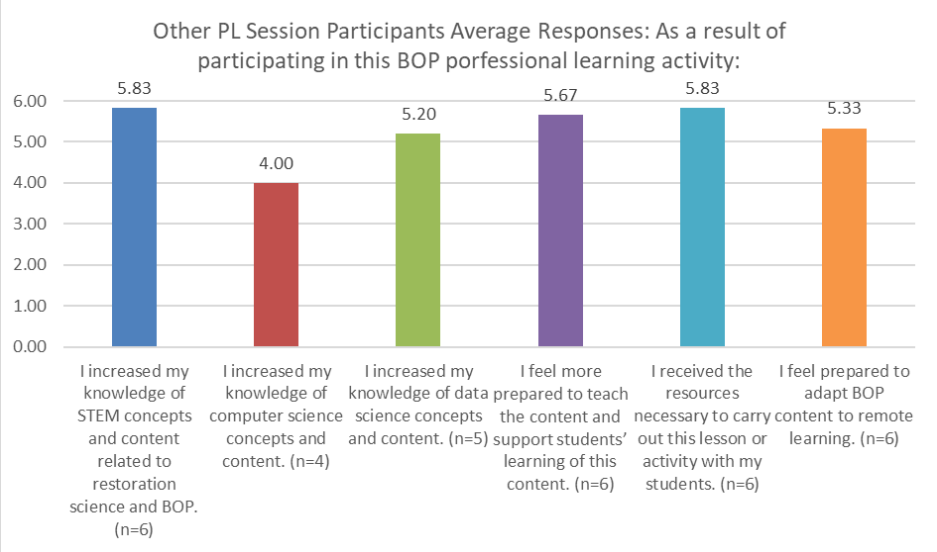
Teacher Engagement and Learning

- Fifty percent or more of respondents chose to participate in these other professional learning sessions for the following reasons:
    - Learn about how to adapt BOP content to my virtual classes (100%)
    - General interest in the topic (100%)

- Promote student understanding of their capacity to become active stewards of the environment (83%)
- Increase my content knowledge for teaching oyster restoration lessons (83%)
- Encourage student interest in pursuing a career pathway in STEM (50%)
- For additional support in implementing oyster restoration lessons for my students (50%)

The reasons highlighted in yellow connect to teachers' interest in motivating student engagement in the content and student interest in STEM careers.

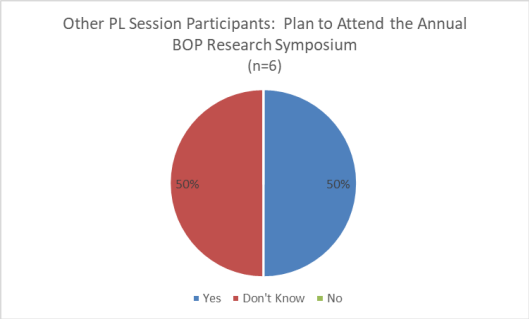
Teachers also responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."



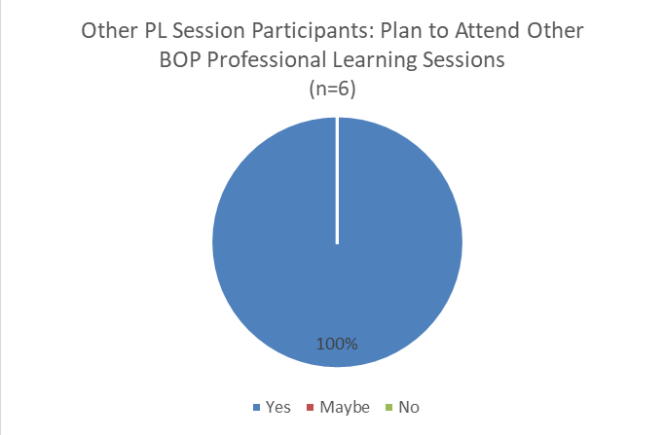
- The highest average response was on the following statements with an average of 5.83 (standard deviation=0.41):
  - *I increased my knowledge of STEM concepts and content related to restoration science and BOP.*
  - *I received the resources necessary to carry out this lesson or activity with my students.*
- The lowest average response was to the statement *I increased my knowledge of computer science concepts and content* with an average of 4.00 (standard deviation=1.41). Two participants responded that this was 'not addressed in this session.' Computer science was not a focus of these session, and this lower rating is not surprising.
- Teachers were asked what could be changed about the sessions to better prepare them to use this material with their students. Answers included the following:
  - *Perhaps a video showing an actual breakwater and how it effects ecosystems. Perhaps material connecting macroprocesses like global warming more directly to breakwaters.*

- *Nothing was missing. I think instead of just using recyclable materials, items such as paperclips, erasers, cotton balls, or even different sized food items could also be applied (pasta, pretzels, jellybeans, gummy bears, tic tacs etc.).*
- *I'm used to checklists or worksheets that can be used to guide students that are younger.*
- *My students generally come from Central America and the Caribbean; it might be useful to know where to find information about organisms native to those areas.*

Continuing Teacher Participation



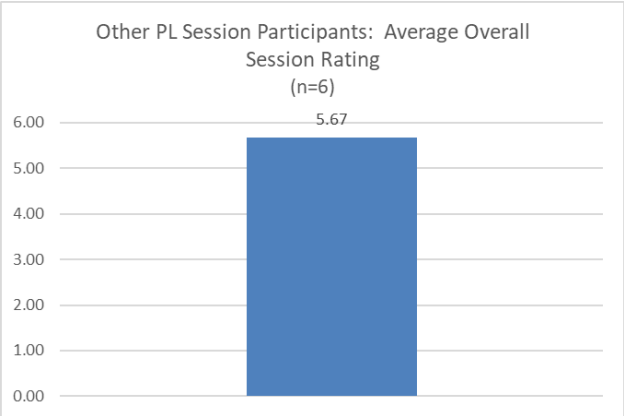
- Fifty percent of participants plan to attend the annual BOP symposium with their students.



- All participants plan to attend other BOP professional learning opportunities. These were the some of the last sessions of this semester.

These findings suggest that promoting ongoing participation in professional learning gives teachers more resources for engaging their students and new ways to build STEM career interest.

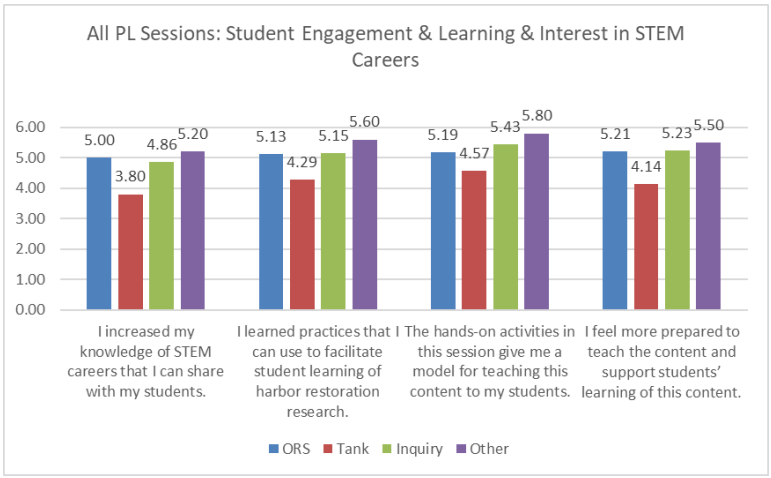
Teacher Comments and Feedback



- On average, teachers rated these sessions highly positively with an average of 5.67 (0.82).
- Teachers provided additional feedback for ways to improve sessions:
  - *I think all of the learning activities I have attended so far have been great and hope there are more to come!*
  - *I just keep thinking about AR or virtual simulations that probably exist...however, having an active build is great too.*

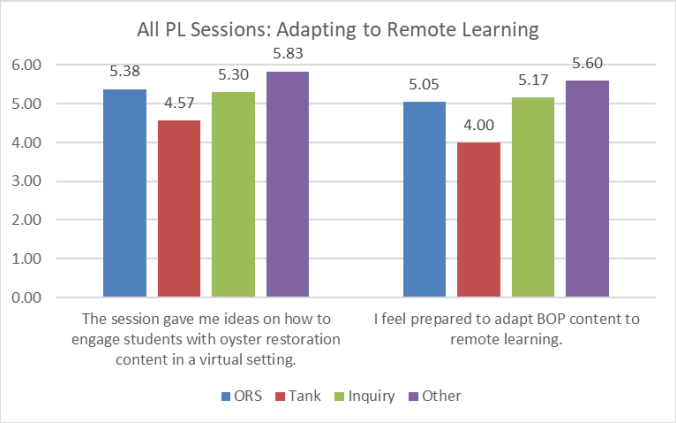
COMPARISON OF RESULTS ACROSS PROFESSIONAL LEARNING SESSIONS

Student Engagement and Learning and Interest in STEM Careers



- Connections to student engagement, learning, and interest in STEM careers were positive across all session categories.
- Teachers average responses were most positive to all statements in the single session other professional learning sessions connected to the Living Breakwater curriculum.

Adapting to Remote Learning



- Overall, teachers felt prepared following their professional learning sessions to utilize BOP lessons and activities in a virtual setting as remote learning is ongoing due to COVID-19.
- Two sets of sessions, the Inquiry from Anywhere and Other, were developed after the pandemic started and reflected a need for teachers to have access to more lessons for this environment. Applying some of the successful aspects of these sessions to some of the other sessions, in particular the oyster tank training, could lead to further teacher confidence in using BOP in remote learning.

SUMMARY OF EVALUATION SURVEY FINDINGS

Overall, data collected from a survey of teachers following their participation in BOP professional learning activities, provides evidence that these sessions were successful and met the project's goals to provide support and resources for teachers to engage students in oyster restoration research and learn to think of themselves as environmental stewards. Some sessions were more successful than others for helping teachers build student awareness and motivate interest in STEM careers.
Creating explicit content that connects students to careers, including those beyond lab scientists, is an area where BOP can expand by being more explicit in using the workshop activities to teach teachers how to raise student awareness of themselves as doing scientific work and to link students' research to the pursuit of a STEM career. The findings suggest that promoting ongoing participation in professional learning gives teachers more resources for engaging their students and new ways to build STEM career interest. Three new virtual sessions emerged this semester to address this issue, a series of career panels, which were designed specifically by and for students to address career awareness in maritime STEM fields. Student responses to those panels are addressed by The Mark project research staff.

Additionally, the annual BOP Student Research Symposium is a place where teachers can provide students with more direct engagement in BOP. Fifty percent of teacher respondents planned to bring students to the symposium following professional learning workshop participation. Having time to discuss next steps with teachers to continue or build on teachers' current engagement may encourage more teachers to plan to engage students in creating research projects for the symposium.

These findings suggest that BOP adapted well to the virtual learning environment that was dictated by the onset of COVID-19 in March. Project staff planning in spring and summer led to the successful

professional learning sessions delivered in the fall. To see how BOP project staff adapted professional learning offerings, see the staff and scientists interview data in *Interview Report.*

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

Billion Oyster Project
Professional Development Survey Results Spring 2021

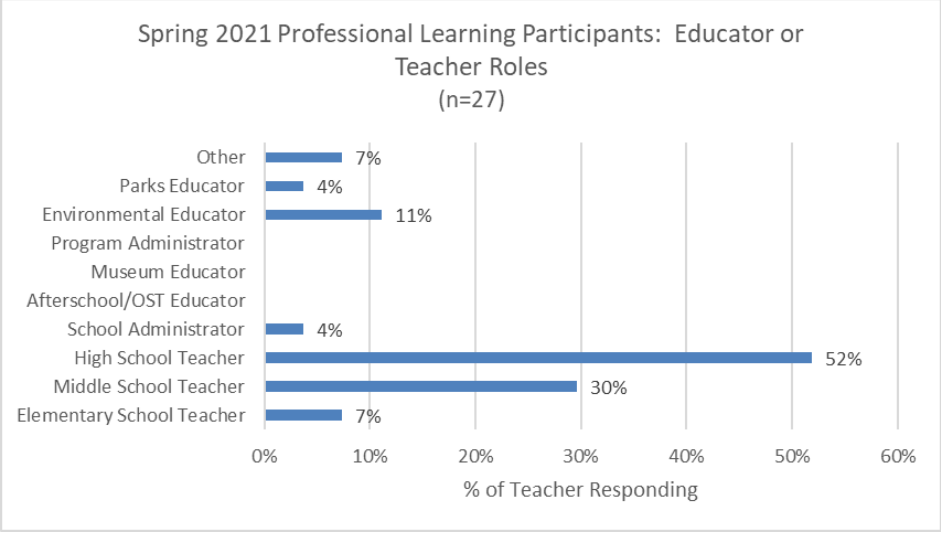
The Billion Oyster Project (BOP) offered professional learning activities for teachers and community scientists throughout the Spring 2021 school semester. Using programs modified during the previous year due to the ongoing COVID-19 pandemic, BOP facilitated a combination of remote and in-person professional learning sessions, as changing COVID-19 conditions allowed, from February through July 2021. Participants responded to a survey following each session. In total, evaluators received 49 responses. Out of these responses, 27 came from teachers or educators, and 22 were from community scientists.

TEACHER PROFESSIONAL LEARNING SURVEY RESULTS

Below are the responses from the 27 program participants who identified themselves as teachers or educators. The sessions were organized in the following five categories: *Oyster Research Station (ORS) Basic Training*, *Introduction to the Oyster Research Tank*, the *Inquiry from Anywhere* professional learning series, *Symposium Prep Sessions,* and *Lab Training for Teachers*. Evaluators reviewed results from these sessions in the following categories of teacher and student engagement: teacher engagement and learning, continuing teacher participation, teacher feedback, and student engagement and learning.

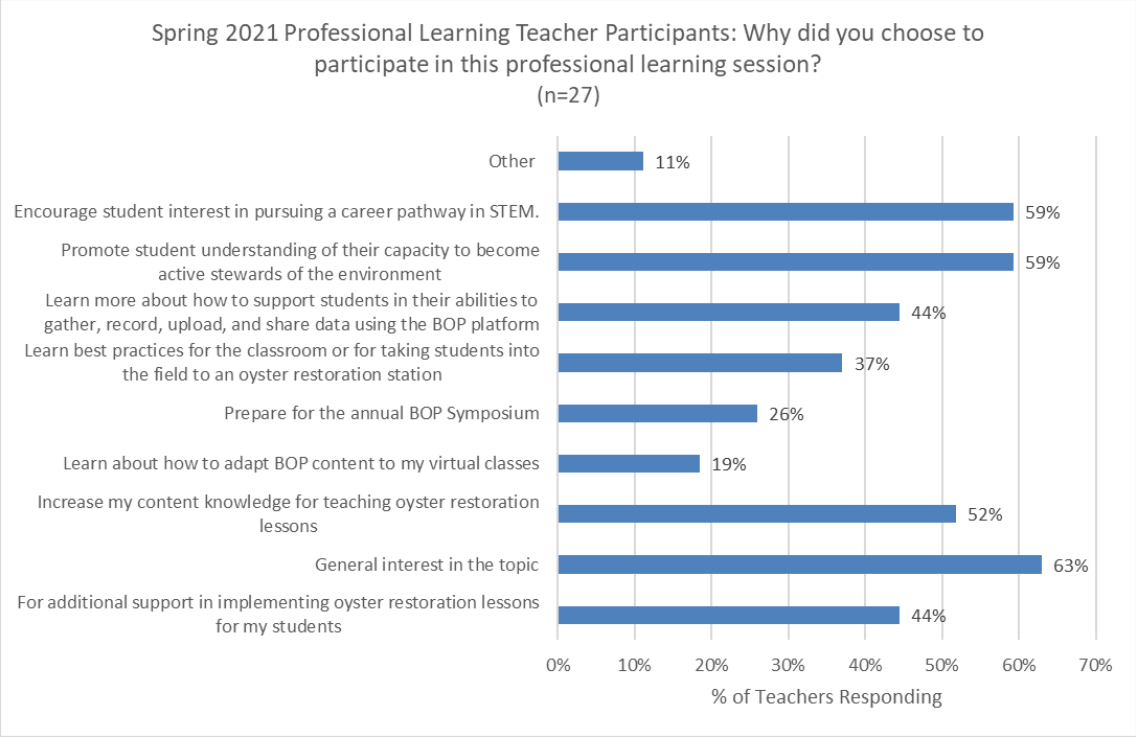
Overview of Respondents

Twenty-seven individual teachers responded to the survey. From these 27 teachers, at least 700 students may engage in BOP activities in their classes based on these workshops.



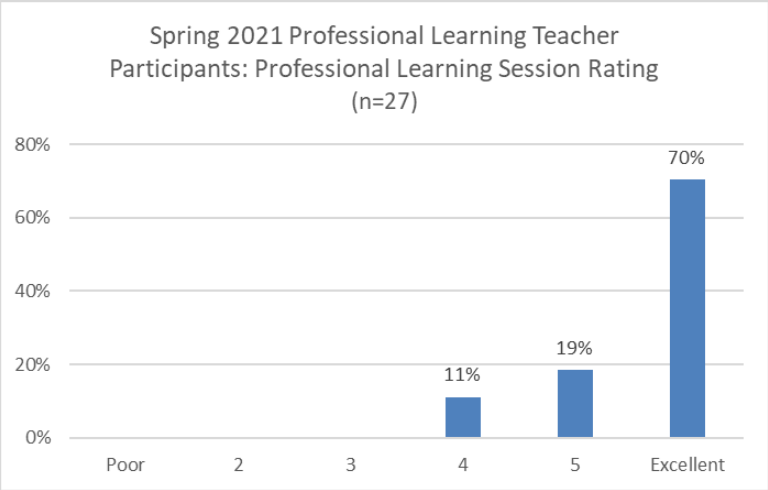
- Educator survey respondents held a range of roles during the 2020-21 school year.
- Fifty-two percent of respondents were high school teachers. This was the most frequent response.
- Eighty-nine percent of respondents reported being schoolteachers overall.

- Roles in the 'Other' category included:
  - Paraprofessional
  - College professor



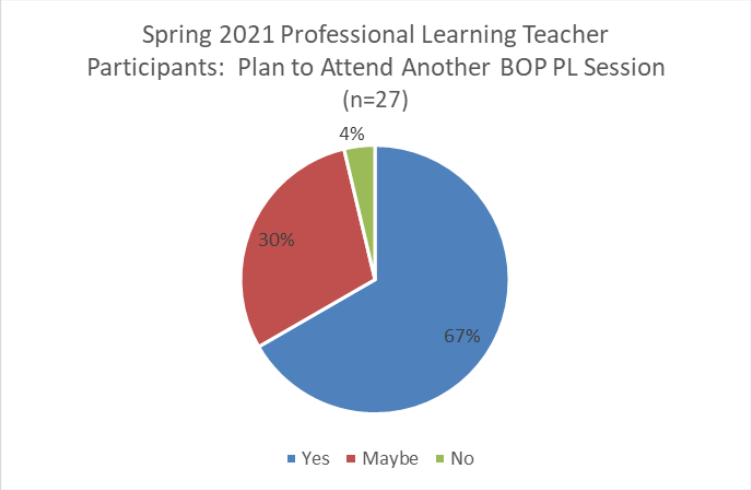
- Teachers shared reasons they chose to participate in BOP professional learning sessions. They could select more than one response to this question. Across the surveys, the three highest responses were:
  - *General interest in the topic* with 63 percent
  - *Encourage student interest in pursuing a career pathway in STEM* with 59 percent
  - *Promote student understanding of their capacity to become active stewards of the environment* with 59 percent
  - These second two responses suggest that teachers are actively looking for ways to engage students in environmental activities and to encourage STEM careers and that they see BOP as a source for this content.
  - Responses in the 'Other' category included:
    - Meet other educators
    - Incorporate DNA analysis into current science curriculum
    - Introducing oyster tank in the classroom

After each session, teachers rated the professional learning session overall from 1 (Poor) to 6 (Excellent).



- All teachers rated their sessions positively to some degree.
- Seventy percent of teachers rated their session as 'Excellent,' suggesting that BOP is meeting their goal of providing high-quality professional learning opportunities to teachers.
- The average rating for all the sessions was 5.50.
    - Two session categories had the highest average rating at 6.00:
        - Symposium Prep
        - Introduction to Oyster Tank Training
    - The session category with the lowest average rating was the Inquiry Science series with an average rating of 5.00 (standard deviation=0.89)

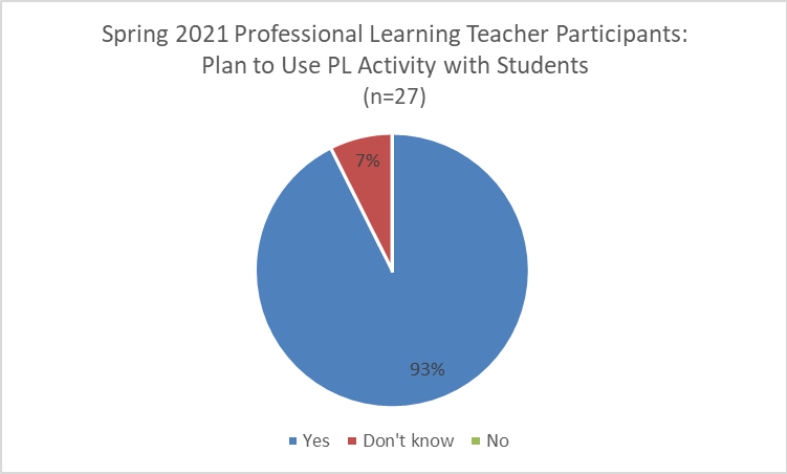
Teachers were also asked if they plan to attend additional BOP professional learning sessions.



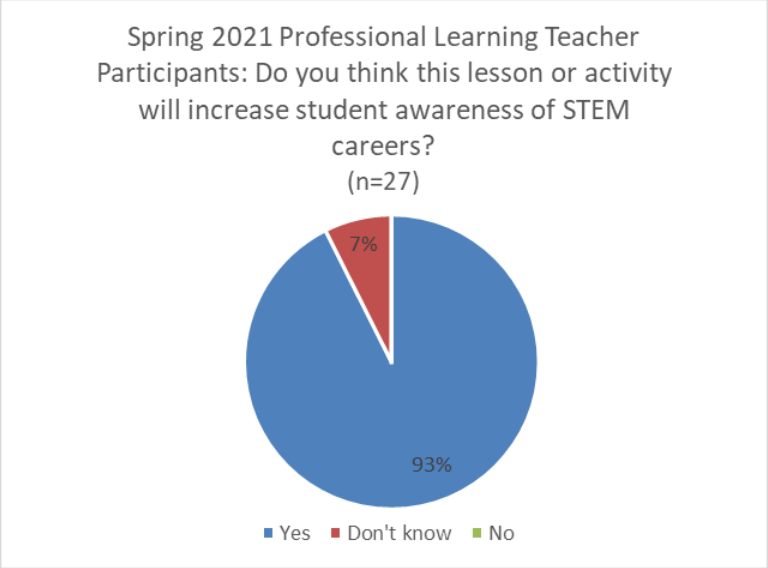
- Sixty-seven percent of respondents plan to attend another BOP professional learning event.
- Thirty percent said they 'maybe' would attend another.
- Four percent said they would not attend another BOP professional learning event.
- Factors in these responses are discussed in the sections on individual professional learning sessions.

Overall Student Engagement and Learning

Potential student engagement and learning is considered through several factors: whether teachers plan to use professional learning activities with students, whether they think the session they attended will increase student STEM career knowledge, and whether they plan to attend the annual BOP Symposium. Further factors in student engagement and learning are discussed in the individual session section below.



- Ninety-three percent of teacher respondents plan to use their professional learning activity with their students. This suggests that BOP is providing lessons, materials, and activities that are useful for teachers and that teachers think will engage their students.



- Ninety-three percent of teachers thought that their BOP lesson or activity would increase student knowledge of STEM careers.
- This positive outcome combined with a majority of participants seeking out BOP activities because they are interested in student STEM career and environmental stewardship awareness can reinforce BOP's role as a resource for this.

At the end of the school year, Billion Oyster Project hosts an annual research symposium for students, teachers, and community scientists to share their research and learn about other research happening in the

New York Harbor and beyond. Thus, the Symposium is an opportunity for students to go deeper into scientific work, both their own and others'.

- Fifty-two percent of participants planned to attend the Annual BOP Symposium.
- Forty-one percent said they maybe would attend.
- Factors in attendance from individual events is discussed below.

OYSTER RESEARCH STATION (ORS) BASIC TRAINING

Evaluators received seven surveys from three sessions of Oyster Research Station (ORS) basic training workshops. This is approximately 23 percent of ORS basic training teacher participants. ORS basic training is an entry-level training to familiarize participants with BOP, harbor restoration, and collecting data through monitoring an ORS unit. ORS basic training consisted of two sessions one held virtually and one in-person. ORS training dates included in these results are: April 8, 2021, June 24, 2021, and June 25, 2021. For 57 percent of respondents, their ORS training was their first time participating in BOP programming.

Student Engagement and Learning

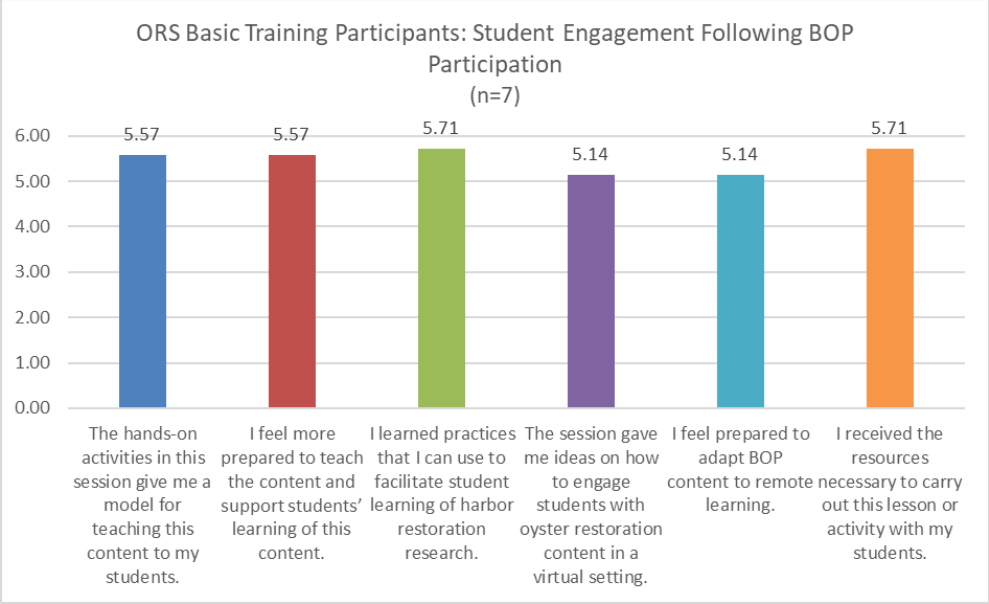
Student engagement and learning was evaluated through teacher participants' intention to use activities from their BOP professional learning session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how they engage students with BOP activities and lessons.

All the respondents from ORS basic training plan to use their training with their students. Teachers plan to use the activities because they will give students hands-on scientific experience, and help them advocate for and learn about the environment of the NY Harbor. Ways teachers plan to use the activities with their students include:

- *Bring them to the oyster stations, use oysters to explain keystone species and food webs*
- *Project-based learning and data collection*

- *I plan to teach using the "Ecosystem Engineers" curriculum developed by BOP with all my classes. I would like to take a smaller group of interested students out regularly to collect data. I hope to be able to have students present research or other art/activism works for the symposium.*

Teachers responded to a series of statements about how they will engage with students based on what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

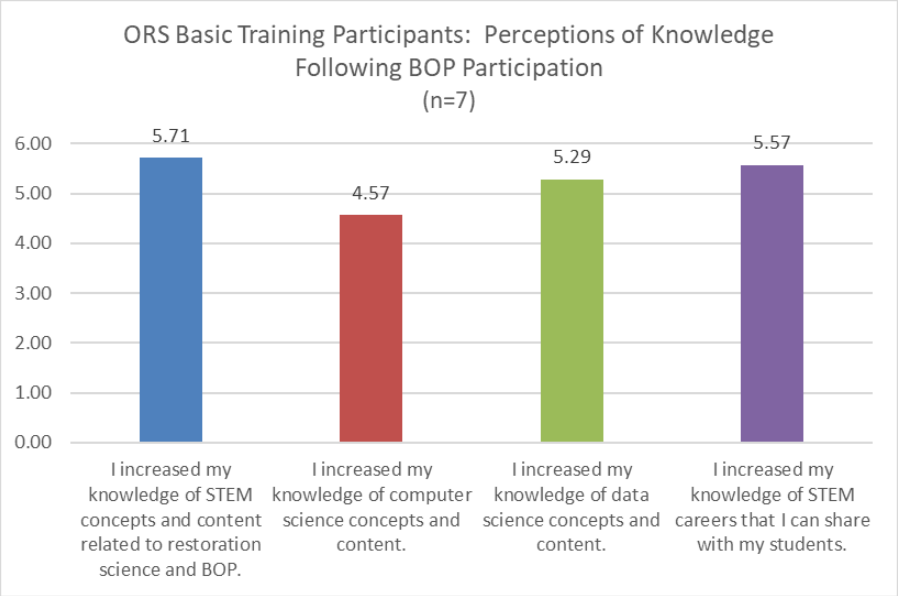


- Teachers' average responses to all student engagement statements were positive and fell between 5 (agree) and 6 (Strongly Agree).
- Two statements had the highest average response at 5.71 (standard deviation=0.49):
  - *I learned practices that I can use to facilitate student learning of harbor restoration research.*
  - *I received the resources necessary to carry out this lesson or activity with my students.*
- Two statements had the lowest average response at 5.14 (standard deviation=1.46):
  - *The session gave me ideas on how to engage students with oyster restoration content in a virtual setting.*
  - *I feel prepared to adapt BOP content to remote learning.*

High average responses to the survey and clear plans for ways to use ORS basic training materials with students suggests high potential for student engagement and learning.

Teacher Engagement and Learning

Teachers responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

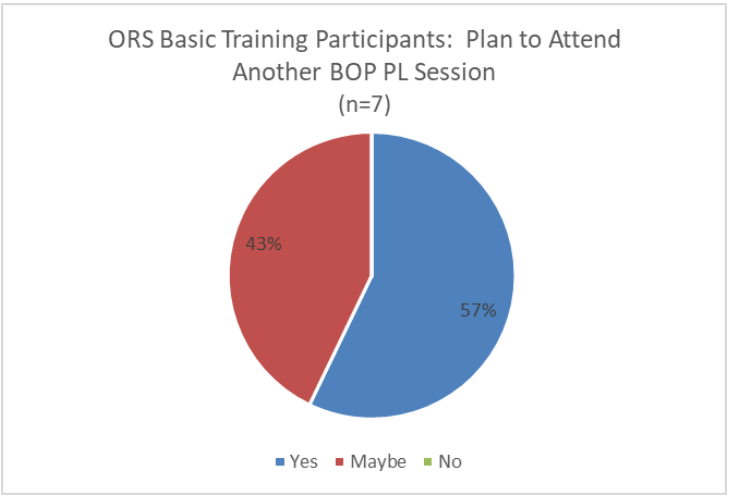


- The average responses to all statements were positive to some extent and were between 4 (Somewhat Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *I increased my knowledge of STEM concepts and content related to restoration science and BOP* with an average of 5.71(standard deviation=0.49).
- The lowest average response was to the statement *I increased my knowledge of computer science concepts and content* with an average of 4.57(standard deviation=1.62).
    - Computer science is not a focus of this professional learning workshop, so the lower average is not surprising.
- Teachers were asked what could be changed about the training to better prepare teachers to use this material with their students. Feedback included:
    - *I would have liked to have Agata tell us about common misconceptions or mistakes that students might make out on the field trip measuring oyster growth.*
    - *Access to the PowerPoint slides (if possible)*
    - *I wish that the session was more interactive. It was more a lecture, and the only engagement was at the beginning with the introductions.*

Continuing Teacher Participation

Teachers' interest in continuing participation in BOP activities was evaluated by their plans to attend the annual BOP research symposium and to attend future BOP professional learning sessions.

- Fifty-seven percent of ORS basic training respondents planned to attend the annual symposium.
- Some of the sessions were held after the 2021 Symposium, thus the next symposium is almost a year from the ORS session teachers attended. Additionally, over half of the ORS basic training respondents reported being first time participants and may not have had enough time to consider how the symposium fits into their plans for engaging their students.



- Fifty-seven percent of ORS basic training participants plan to attend another BOP professional learning sessions.
- Forty-three percent may attend another PL session.
- No one said they did not plan to attend another BOP professional learning session.
- When ask why they may or may not participate in the future, teachers gave the following feedback:
    - *I am not sure what other professional opportunities are available.*
    - *I am hoping to have students to participate in the symposium to share their research with a larger audience.*
    - *I hope to have interested students present work. It connects them to the community and real-world issues, and helps them take ownership of the work.*

Teacher Comments and Feedback

Teachers provided additional feedback on how the sessions could be improved:

- *It's hard to say without finishing the 2nd part of the session. There's a lot more I'm looking forward to doing with the hands-on part of the session. I appreciate that BOP shared the Ecosystem Engineers unit... it was very related to some of the things we briefly learned today (filtering, types of oyster habitats). I think it may be good to mention that unit resource in the session, in case other educators didn't know about it.*

SYMPOSIUM PREPARATION SESSIONS

Evaluators received eight responses from three dates of BOP Symposium prep sessions. This represents 53 percent of the teachers who participated in these sessions. The three sessions focused on different aspects of preparing students to present research at the annual BOP Research Symposium held in June 2021. Dates included in these results are: March 25, 2021, May 4, 2021, and May 11, 2021. For 13 percent of survey respondents, symposium preparation was their first time participating in BOP programming.

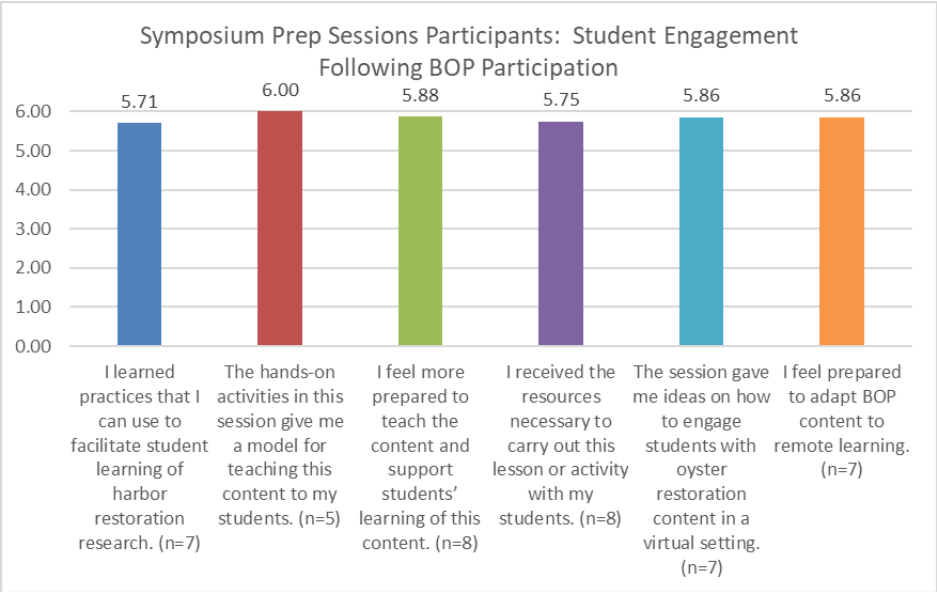
Student Engagement and Learning

Student engagement and learning was evaluated through teacher participants' intention to use activities from their BOP professional learning session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how they engage students with BOP activities and lessons.

All respondents from the Symposium Prep sessions plan to use the activities with their students. Teachers planned to use the activities with students because these sessions were specifically designed to help teachers who are working with students to develop symposium projects, and they received feedback on symposium projects and got ideas from BOP facilitators and peers to aid in student research and project design. More specific ways teachers plan to use the sessions include:

- *My students have analyzed the BOP oyster data using Google sheets, but the three students I focused on are stuck, and I needed help getting ideas on how to move them forward with their research. The other teachers / scientists at the event gave me feedback to have students work with each other, and to teach the data analysis in the framework of the scientific method. I will be using those two ideas and using the NYT's "What's Going On In This Graph" to move my students forward.*
- *We will look at data sets received and will look at different aspects of the data.*
- *Aim for next year's symposium and develop curriculum to scaffold up to that beginning fall 2021.*
- *Discuss with students about possible topics and other inspiration*

Teachers responded to a series of statements about how they will engage with students based on what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: for these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."

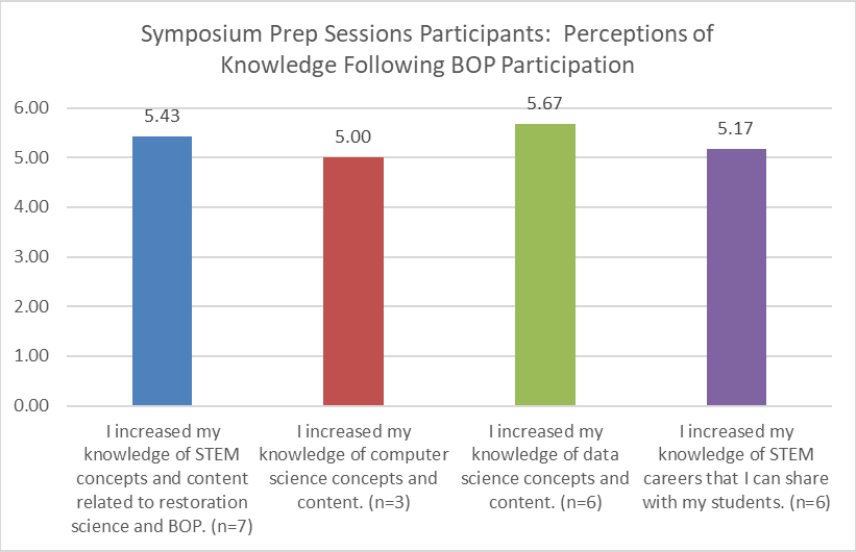


- Average responses from teachers at the Symposium Prep sessions related to student engagement where highly positive and between 5 (Agree) and 6 (Strongly Agree). These sessions may be particularly effective at engaging students. The teachers attending these sessions are also motivated toward learning about how to engage students in research.
- The highest average response was to the statement *The hands-on activities in this session give me a model for teaching this content to my students* with an average of 6.00; however, three respondents felt this statement was not applicable to their session.
- The lowest average was to the statement *I learned practices that I can use to facilitate student learning of harbor restoration research* with an average of 5.71 (standard deviation=0.49)

High average responses to the survey and clear plans for ways to use Symposium Prep materials with students suggests high potential for student engagement and learning.

Teacher Engagement and Learning

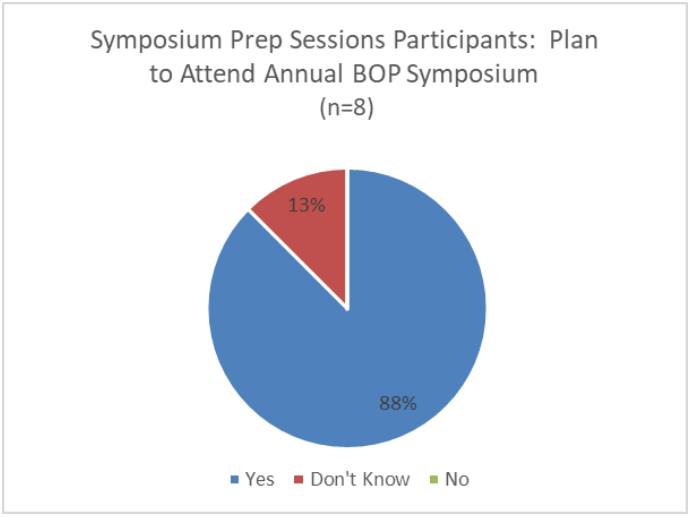
Teachers responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Note: or these statements, respondents also had the option "Not addressed in this session." Differences in n-values reflect those who selected "Not addressed."



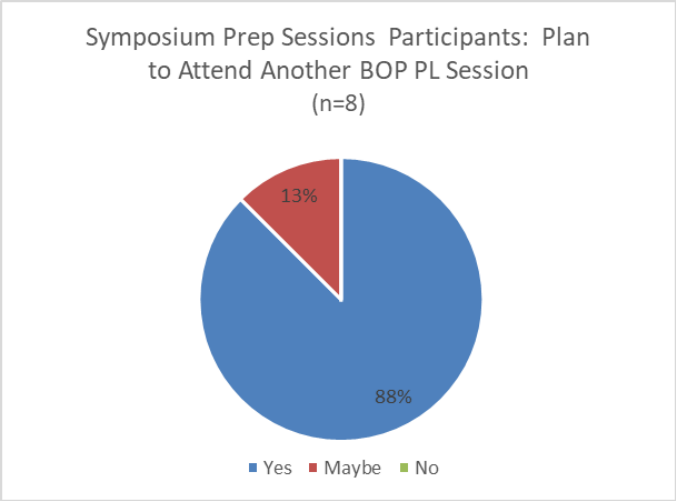
- Average responses about teacher learning from the Symposium Prep sessions were positive and were between 5 (Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *I increased my knowledge of data science concepts and content* with an average of 5.67 (standard deviation=0.52).
- The lowest average response was to the statement *I increased my knowledge of computer science concepts and content* with an average of 5.00 (standard deviation=1.00). This statement was marked 'Not Applicable' by five participants and was not an explicit focus of these sessions.
- Teachers were asked what could be changed about the training to better prepare teachers to use this material with their students. Only one response was received:
    - *We ran out of time at the end, but it would have been great to look at some former Symposium submissions for ideas. I haven't participated before so I will probably look at some stuff on my own time.*

Continuing Teacher Participation

Teachers' interest in continuing participation in BOP activities was evaluated by their plans to attend the annual BOP research symposium and to attend future BOP professional learning sessions.



- Eighty-eight percent of respondents planned to attend the annual BOP Symposium. This high participation rate is expected as preparing students to do research projects and present at the symposium is the goal of these sessions.



- Eighty-eight percent of respondents plan to attend another BOP professional learning session.
- Thirteen percent may participate in another session.
- Most of the participants in these sessions were previous BOP participants and were already engaged in BOP activities. When asked why they may or may not attend another BOP session responses included:
    - *It's been really helpful and has helped push my teaching career forward. I feel inspired to teach data analysis and ecology together, and to continue working with BOP in the future.*
    - *Time and sanity; it's been a long year*
    - *These sessions are always very effective and I learn a lot when attending.*
    - *I feel it's an important project and impacts our community and environment in wars that will positively effect change and strength in our students.*
    - *Learn more about how to inspire students towards research and how students can learn more about their surroundings*

Teacher Comments and Feedback

Teachers provided additional feedback on how the sessions could be improved. One response was received:

- *Consider adaptation for children with language-based disabilities (presenting could be a challenge)*

INQUIRY FROM ANYWHERE **PROFESSIONAL LEARNING SERIES**

The *Inquiry from Anywhere* series was designed specifically for the remote learning environment to enable teachers and students to conduct scientific research at home or outside the home. There were two sessions in the series during Spring 2021. One session focused on biodiversity data analysis. The second session focused on data collection. Evaluators received 6 responses from these sessions. This is 100 percent of the

teachers who attended. These workshops were held on the following dates: March 16, 2021, and April 13, 2021. For 83 percent of survey respondents, a session in the *Inquiry from Anywhere* series was their first time participating in BOP programming.

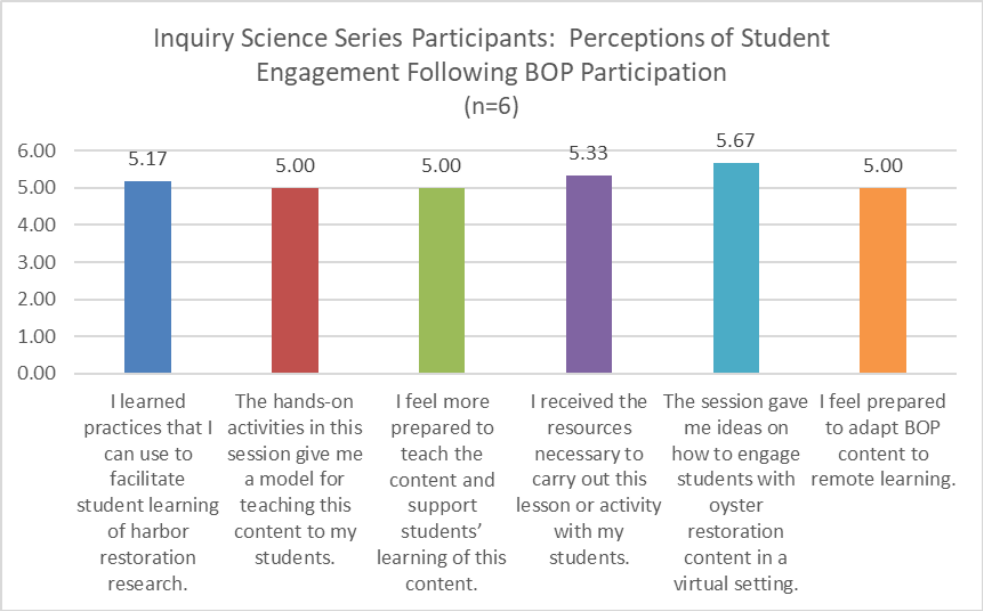
Student Engagement and Learning

Student engagement and learning was evaluated through teacher participants' intention to use activities from their BOP professional learning session(s) with their students, the ways they intend to use the activities, and what they learned from their session that can inform how they engage students with BOP activities and lessons.

Eighty-three percent of respondents plan to use activities from these sessions with their students. Teachers plan to use the activities because they want to engage students in more data collection and data analysis and are seeking opportunities for students to become involved in environmental work. One teacher said they didn't know if they would use the activities with students because *"I have to feel much more comfortable with using data sets. If there wasn't an analysis already to begin with I would be totally lost*." Other thoughts about how teachers would use the activities with students included:

- *We've done similar nature walks /observations, it was helpful to experience this workshop to learn new ways of framing content and working both independently and in group.*
- *I learned how to guide my students in creating their own inquiry-based questions.*
- *Use the data sheets and introduce the oyster project*

Teachers responded to a series of statements about how they will engage with students based on what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).



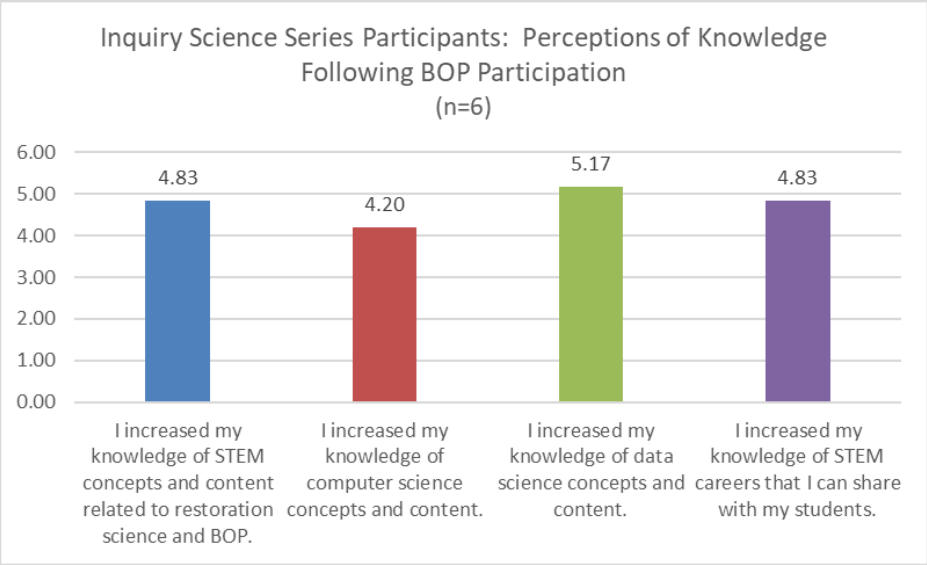
- Average participant responses to perceptions of student engagement were positive with average responses between 5 (Agree) and 6 (Strongly Agree).
- The highest average response was to the statement *The session gave me ideas on how to engage students with oyster restoration content in a virtual setting* with an average of 5.67 (standard deviation=0.52).

- Three statements had an average response of 5.00:
    - *The hands-on activities in this session give me a model for teaching this content to my students* (standard deviation=1.26)
    - *I feel more prepared to teach the content and support students' learning of this content* (standard deviation=0.89)
    - *I feel prepared to adapt BOP content to remote learning* (standard deviation=0.71).

Some, but not all participants had clear goals around data collection and environmental stewardship for engaging their students with the Inquiry Science materials. Outcomes were still positive on the survey and suggest that teachers will be able to translate their professional learning experience to their students.

Teacher Engagement and Learning

Teachers responded to a series of statements about what they learned from the professional learning session they attended. These statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

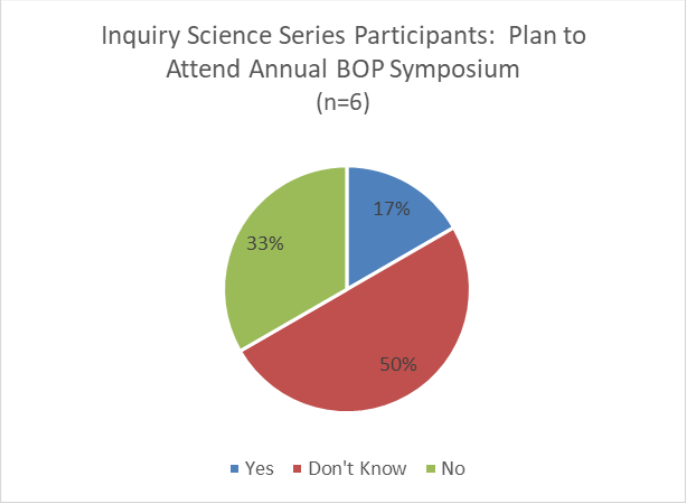


- Most average responses in this category were between 4 (Somewhat Agree) and 5 (Agree). One response was higher than 5 (Agree).
- The highest average response was to the statement *I increased my knowledge of data science concepts and content* with an average of 5.17 (standard deviation=0.75)
- The lowest average response was to the statement *I increased my knowledge of computer science concepts and content* with an average of 4.20 (standard deviation=1.48)
- Teachers were asked what could be changed about the training to better prepare teachers to use this material with their students. Responses included:
    - *It would have been nice to learn/ hear about specific measurement tools and equipment BOP uses.*
    - *I wish to learn more about Oysters projects.*
    - *More information about Oyster Project and accessibility*

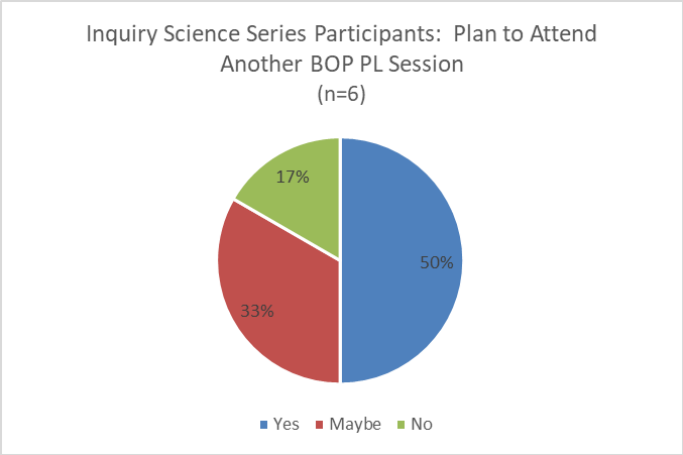
- *I would like more direction using the data, I was overwhelmed and am not familiar with spreadsheets. If some analysis wasn't already provided, I would have been really lost.*

Continuing Teacher Participation

Teachers' interest in continuing participation in BOP activities was evaluated by their plans to attend the annual BOP research symposium and to attend future BOP professional learning sessions.



- Seventeen percent of participants planned to attend the Annual BOP Symposium.
- Thirty-three percent did not plan to participate.



- Half of participants plan to attend another BOP professional learning session.
- Thirty-three percent said they may attend another session.
- Seventeen percent did not plan to attend another session.
- When asked why they would or would not attend more sessions, teacher responses included:
  - *I would like to learn how to get involved.*
  - *Not sure it would apply*

Teacher Comments and Feedback

Teachers provided additional feedback on how the sessions could be improved:

- *More information on the actual work at Oyster Project*

- *giving more direction to students when watching the video, something specific to look for, beginning the analysis of data with support and then having the students pick something to investigate.*

SUMMARY OF PROFESSIONAL DEVELOPMENT SURVEY FINDINGS

Teachers had positive experiences in BOP professional learning sessions. Most sessions gave teachers clear ideas for engaging their students in scientific content and processes. They also thought that engaging with the activities would increase awareness of STEM careers for their students. Teacher outcomes for their own engagement and learning were also positive. Sixty-seven percent of respondents plan to attend more BOP professional learning, and an additional 30 percent may attend more. Interest in continuing involvement also suggests that BOP is a high-quality resource for teachers.

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

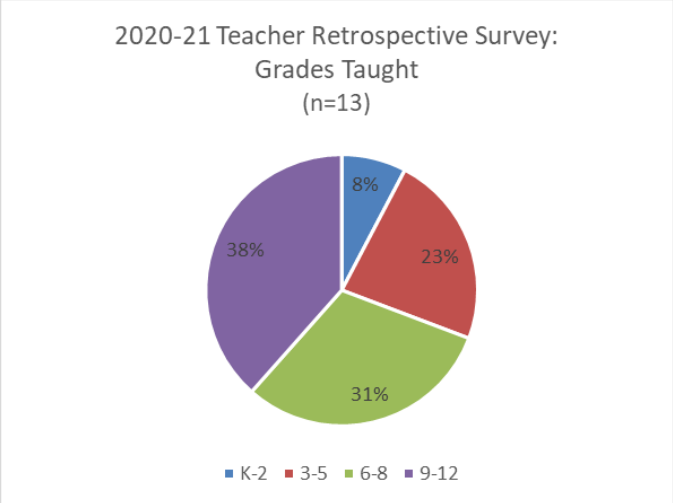
STEM+C Teacher Retrospective Survey Results 2021

Background

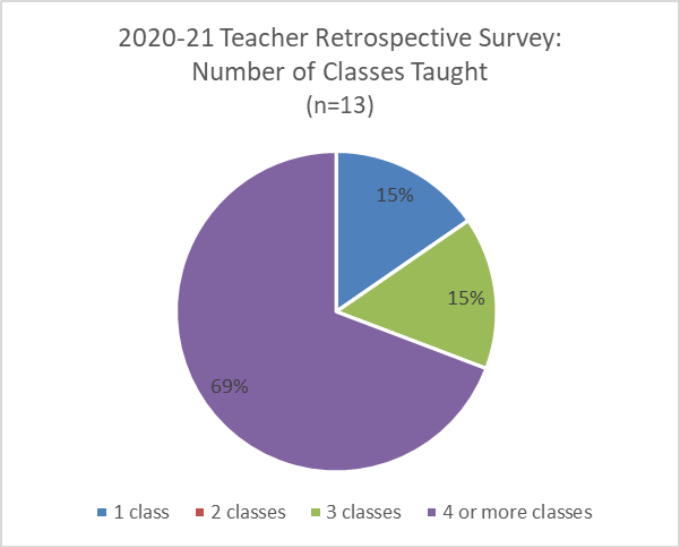
At the end of the 2020-21 school year, evaluators asked teachers who had participated in any Billion Oyster Project professional learning workshop or activities throughout the year to complete a retrospective survey. Teachers responded to questions about how they participated in BOP events, the ways in which BOP participation has impacted their teaching practice, whether they use BOP activities for student research, and ways BOP participation impacts student STEM career interest. In these ways, this survey looks at the larger impact of BOP professional learning sessions for teachers and their students and is more comprehensive than the survey teachers take immediately after their participation in BOP activities.

Retrospective Survey Respondents

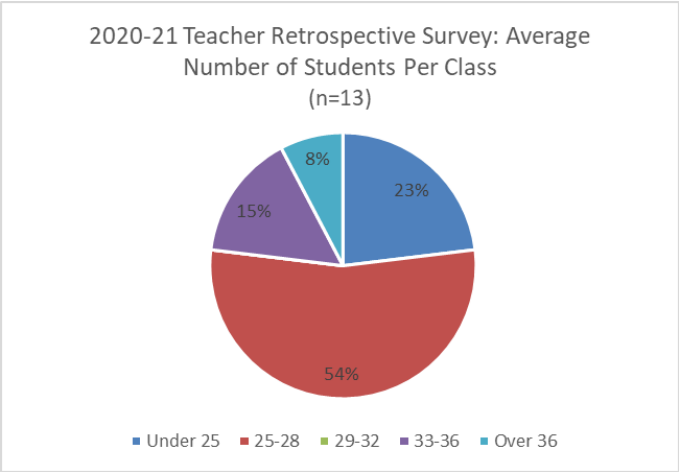
The survey was sent to approximately 135 participants from BOP activities over the school year. Evaluators received 13 qualifying responses from K-12 teachers; some participants received the survey because they self-identified as a teacher or educator but were not K-12 teachers and did not qualify for the survey (evaluators received six responses from this group). Nineteen total responses is 14 percent of those who received the survey. Results from the 13 K-12 teacher surveys are presented below.



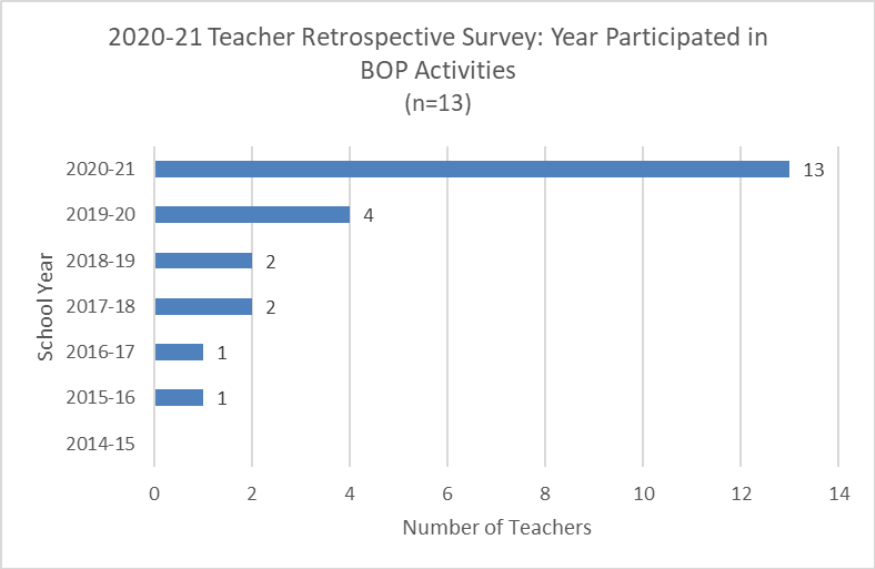
- Respondents taught across the whole K-12 grade range.
- Thirty-eight percent of respondents taught 9-12 grades during the 2020-21 school year. This was the most frequent grade level band reported on the survey.



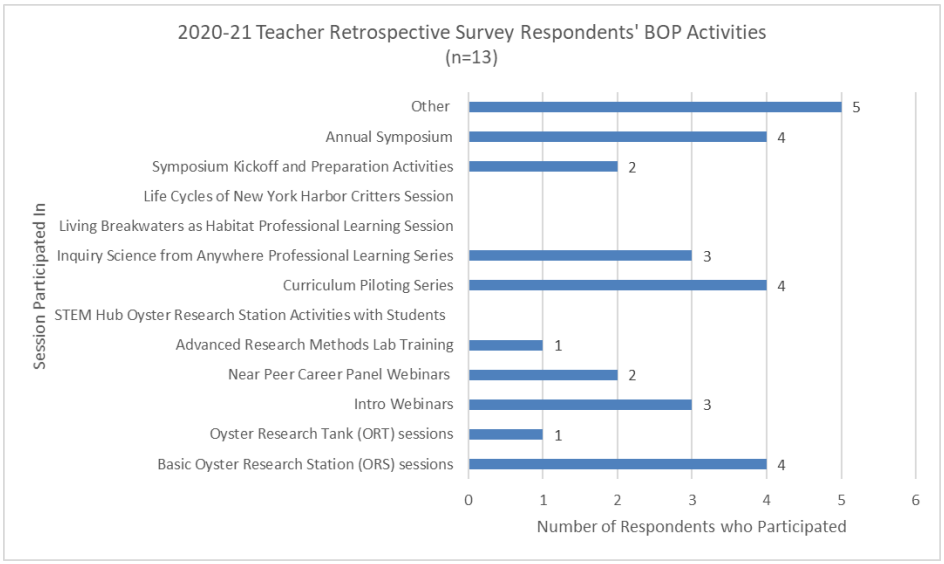
- Sixty-nine percent of respondents taught four or more classes during the 2020-21 school year. This was the most frequent response.
- Fifteen percent taught one class and another 15 percent taught three classes.



- Fifty-four percent of respondents had an average class size of 25 to 28 students.
- Twenty-three percent had an average class size below 25 students.
- Another 23 percent had an average class size of 33 students or higher.



- While all respondents participated during the 2020-21 school year, four teachers had participated in BOP activities in previous years.
- Two teachers first participated last year, during the 2019-2020 school year.
- One teacher began participation in the 2017-18 school year.
- One teacher began participation in the 2015-16 school year.

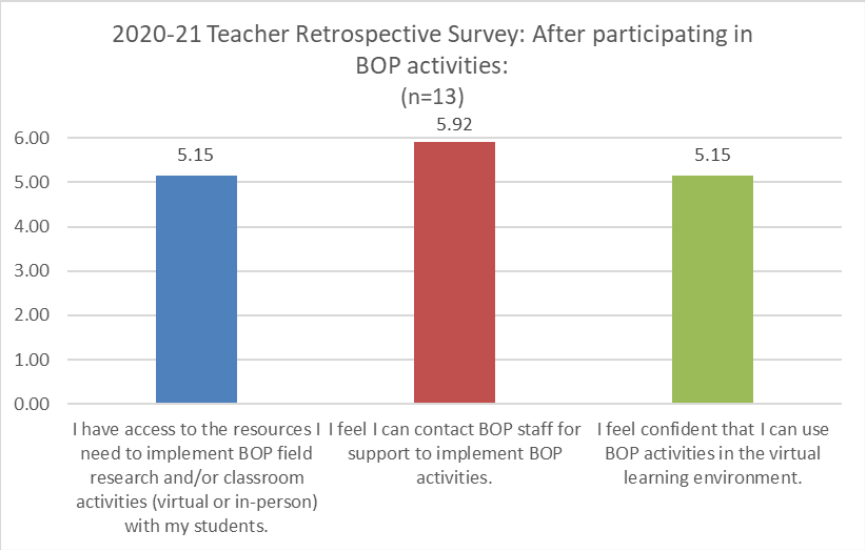


- Respondents attended a range of BOP events over the school year. Sixty-two percent of respondents reported attending more than one type of event during the 2020-21 school year.
- Four respondents each attended the following events:
    - The Annual BOP Symposium
    - The STEM+C Curriculum Pilot Program
    - Basic ORS Training
- No respondents attended the following events:
    - Life Cycles of New York Harbor Critters

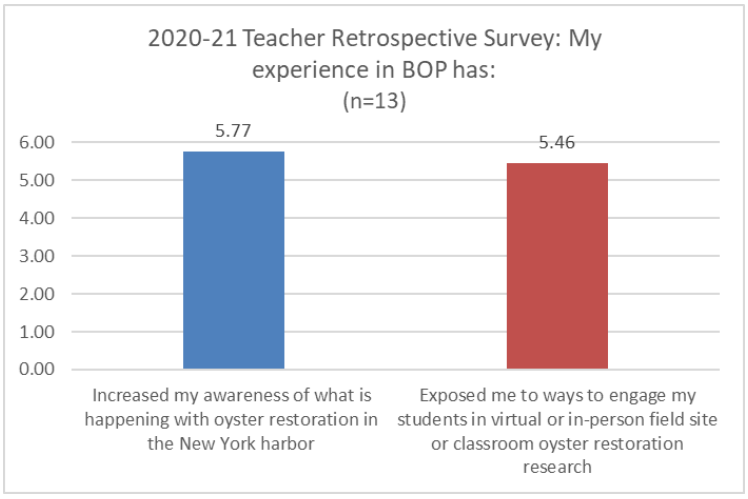
  - Living Breakwaters as Habitat
  - STEM Hub ORS activities with students
- Five respondents also attended other events:
  - Teacher Summer Mingle at Governor's Island (4 teachers)
  - Wild Oyster Survey Earth Day event (1 teacher)

BOP Program Experience and Teaching Practice

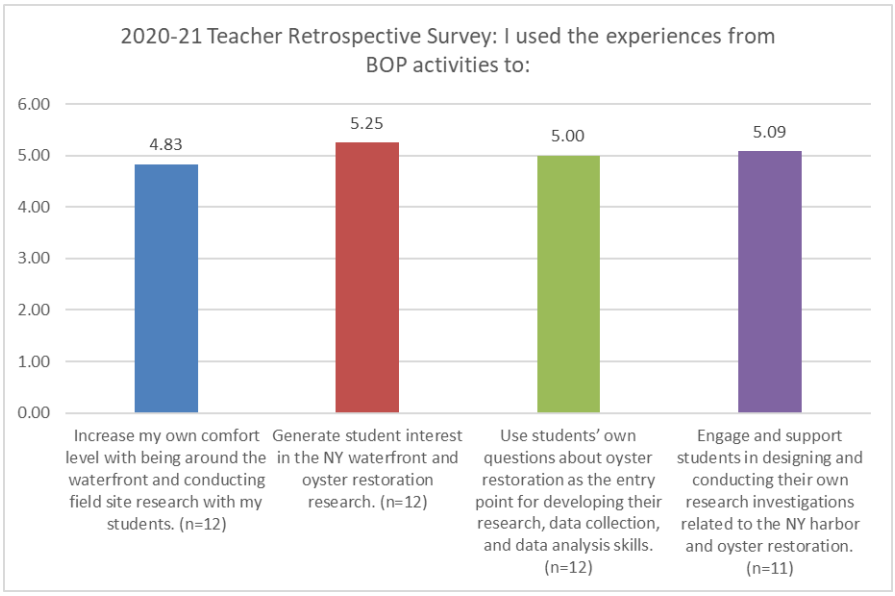
Teachers responded to a series of statements about different aspects of their experience in BOP activities and how their experience has impacted their teaching around oyster and waterfront restoration and use of student research. All statements were rated on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).



- Following participation in BOP activities, respondent felt positively about the support they received from BOP. Average responses to these statements all were between 5 (Agree) and 6 (Strongly Agree)
- The highest average response in this category was to the statement *I feel I can contact BOP staff for support to implement BOP activities* with an average of 5.92 (standard deviation=0.28).
- Two statements received an average of 5.15:
  - *I have access to the resources I need to implement BOP field research and/or classroom activities (virtual and/or in-person) with my students* (standard deviation=1.14).
  - *I feel confident that I can use BOP activities in the virtual learning environment* (standard deviation=1.41).
- High average responses in this category suggests that BOP staff has been successful in providing teachers with the resources and support they need to use BOP activities with their students and in pivoting workshops from an in-person model to virtual programming for both teachers and students.



- Teachers also responded positively to the impact of BOP in their understanding of oyster restoration, with average responses between 5 (Agree) and 6 (Strongly Agree).
- The statement *My experience in BOP has increased my awareness of what is happening with oyster restoration in the New York Harbor* received an average response of 5.77 (standard deviation=0.44).
- The statement *My experience in BOP had exposed me to ways to engage my students in virtual or in-person field site or classroom oyster restoration research* received an average response of 5.46 (standard deviation=1.13).
- These responses suggest that BOP had provided teachers with a range of ways to engage students and met one of their primary goals in raising awareness of oyster restoration in the NY Harbor.



- A third category of questions focused on using BOP experience to conduct research with students. Responses to these statements, while still positive, were lower than others. Average responses to these statements mostly were close to 5 (Agree).

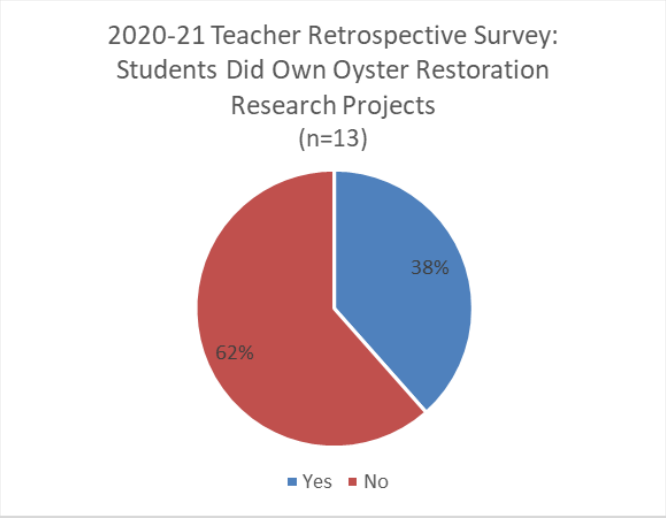
- Response numbers also varied on these statements. One teacher described the first three statements in this category as "not applicable to my BOP activities" and two described the fourth statement as not applicable.
- The statement with the highest average response was *I used the experiences from BOP activities to generate student interest in the NY waterfront and oyster restoration research* with an average of 5.25 (standard deviation=1.14).
- The statement with the lowest average response was *I used the experiences from BOP activities to increase my own comfort level with being around the waterfront and conducting field site research with my students* with an average of 4.83 (standard deviation=1.34).
    - This lower response may reflect that with the COVID-19 pandemic more teachers focused on activities that could be done from anywhere and with fewer specialized materials and less on in-person activities, especially activities that required leaving school campuses.

Teachers were also asked what could improve their experience in BOP activities. Feedback included:

- *Great to visit HQ and all there is present on the [Governor's] island!*
- *I'm interested in a couple print/digital tools to go along with identifying organisms at an ORS. We used the ecosystem engineers curriculum, but I couldn't find animal "cards" to go with the food web lessons, and today I saw a bingo organism game on the dock. Are these available somewhere?*
- *Continue PD Workshops for educators and integration of STEAM In curriculum.*
- *BOP in person again!*

Using BOP for Student Research

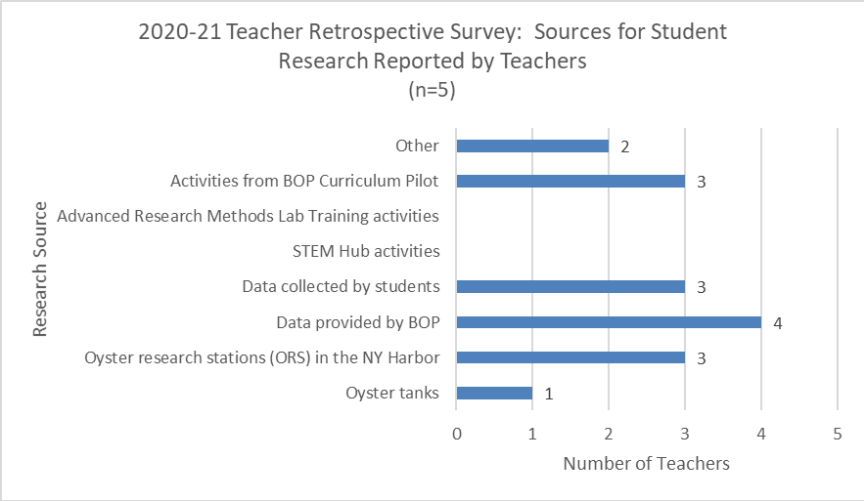
The Annual BOP Symposium is an opportunity for students to present research projects on NY Harbor restoration. Many BOP workshops include ways to extend beyond individual activities for students to do their own research that can be included at the annual event.



- Thirty-eight percent of respondents reported that students did their own oyster restoration research projects. Among those who reported doing research projects, one teacher had elementary age students, one had middle school grades, and three had high school grade students.
- Sixty-two percent did not engage students in their own oyster restoration research projects.

- Among those who did their own research projects, 40 percent (2 out of 5 teachers) reported that they presented at the virtual BOP symposium. The high school teachers' students did not present at the symposium. This may reflect that those students have other opportunities to present research.

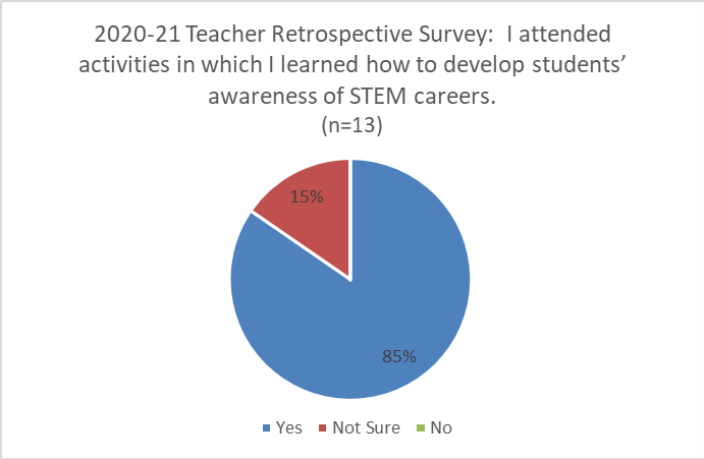
Those who reported students doing their own oyster research projects were asked how BOP materials and data were used in that research. Teachers could select multiple sources of information.



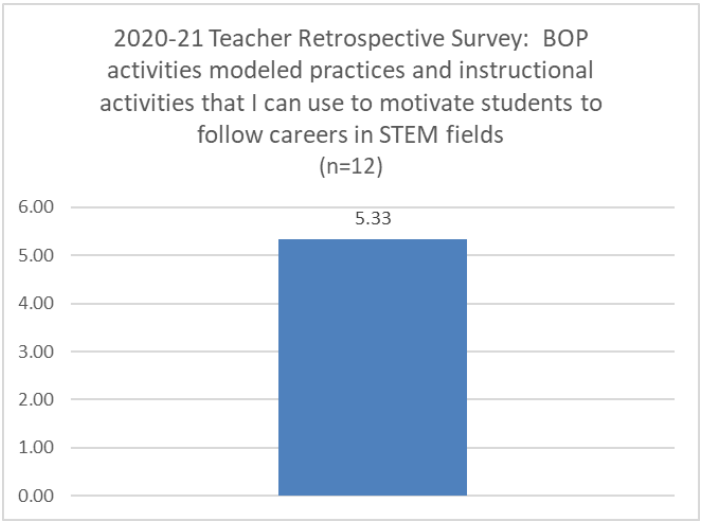
- Four teachers reported using data provided by BOP in their students' research.
- No teachers reported using:
    - Advanced Research Lab training activities
    - STEM Hub activities
        - While no teachers from this survey reported using official STEM Hub activities, three did report using ORS data.
- Two teachers used other sources of data and research for their students:
    - *Eel Mop installation in JC, Morris Canal*
    - *previous year's BOP professional development including engineering and design and the ROV with John Paul, also the plankton studies with the River Project*

Teacher Perspectives on Student STEM Career Knowledge and Interest

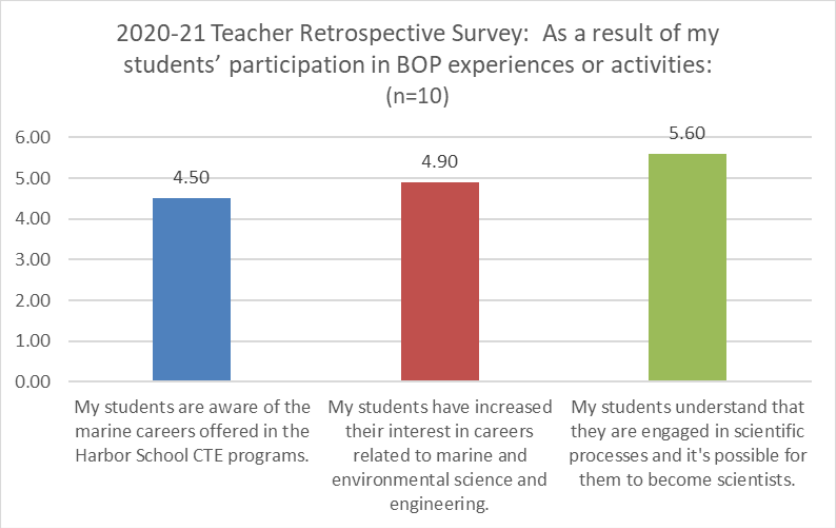
One other goal of BOP activities is for teachers to be able to engage students in learning more about a range of marine STEM careers and build interest in those careers.



- Eighty-five percent of respondents attended activities where they learned how to develop students' awareness of STEM careers.
- Among the two teachers who responded 'not sure,' one reported teaching grades K-2. The other reported teaching grades 9-12.
    - One teacher who was 'not sure' did not answer the questions in the following section.



- One aspect of BOP trainings is that staff not only provide teachers with activities they can use in their classrooms, they also model how to use materials and lessons with students.
- The average response to the statement *BOP activities modeled practices and instructional activities that I can use to motivate students to follow careers in STEM fields* was positive at 5.33 (standard deviation=0.65).



- Responses to STEM career awareness and interest were mixed, but still positive overall.
- The highest average response was to the statement *As a result of my students' participation in BOP experiences or activities, my students understand that they are engaged in scientific processes and it's possible for them to become scientists* with an average of 5.60 (standard deviation=0.70).
    - Two teachers who attended an event after the school year had ended responded that this statement was 'Not Applicable.'
- The lowest average response was to the statement *As a result of my students' participation in BOP experiences or activities, my students are aware of the marine careers offered in the Harbor School CTE programs* with an average of 4.50 (standard deviation=1.43).
    - While marine science careers may be mentioned in a wide range of BOP activities, the Harbor School CTE programs may not be mentioned by name.
- Two elementary school grade teachers responded 'Don't Know' to the first two statements in this category. This response makes sense as younger students developmentally understand the idea of a job or career very differently than older students.

Conclusions

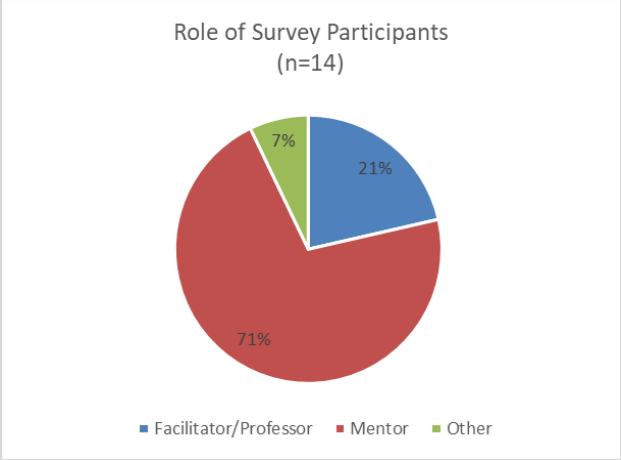
Teachers who participated in the 2020-21 Retrospective survey attended a range of BOP activities during the school year. Participants reported positive experiences both in BOP sessions and in using BOP lessons and activities in their classrooms. All respondents use BOP as a way to teach students about harbor restoration and some use it as an entry to students own scientific research. The majority of respondents thought that BOP activities connected to teachers' abilities to develop students' interest in STEM careers, although what that means varies by grade level and teacher experience. All around teachers had a positive and impactful experience with Billion Oyster Project.

Gaylen Moore Program Evaluation Services
304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

Summer 2020
STEM+C Pace University STEM Institute Mentor and Facilitator Survey

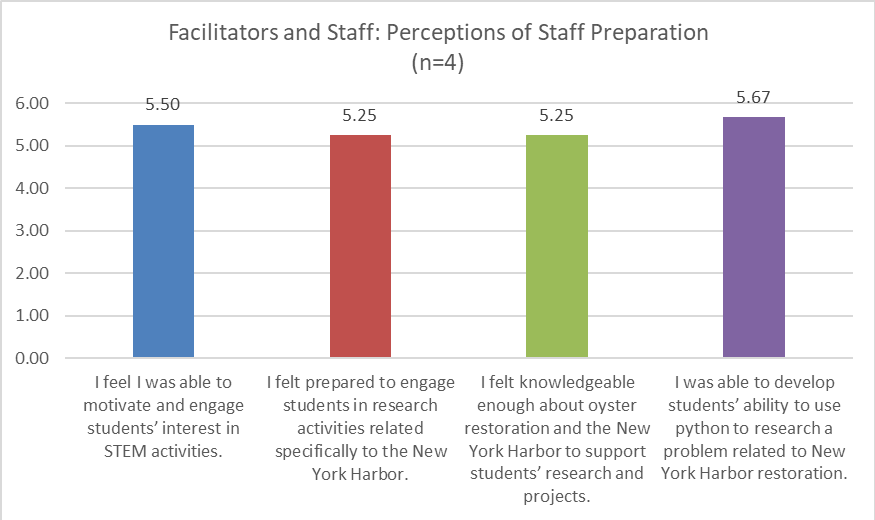
In summer 2020, Pace University conducted its 8th annual STEM Summer Institute for high school students focusing on computer science, design thinking, and Billion Oyster Project data. Due to the COVID-19 outbreak, the program was held virtually for the first time. While this introduced new challenges, the program was able to expand and include more students and mentors than in previous years.

Demographics
Following the program completion, 14 mentors, facilitators and other staff took a post-survey about their preparation for their roles, as well as their students' learning and engagement in the program.



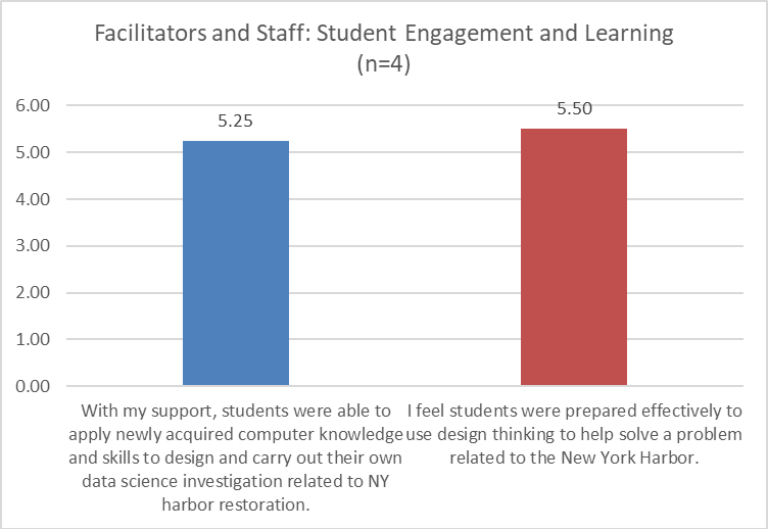
- Seventy-one percent of respondents were mentors who helped student teams on their projects.
- Twenty-one percent were facilitators or professors who led sessions and organized the program.
- Seven percent were other staff. This role was staff coordinator.

Facilitator and Staff Coordinator Responses
Four respondents had a role as a facilitator or other staff. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).
Perceptions of Staff Preparation



- Facilitators and staff responded highly positively to all statements about their preparation to lead students in New York Harbor related research, motivate their interest in STEM activities, and train them in using Python, with average responses to all statements above 5 (Agree).
- With an average response of 5.25 for both statements, statements related to knowledge of the New York Harbor and oyster restoration had the lowest average responses.

Student Engagement and Learning



- Facilitators and staff responded positively to students' ability to engage in harbor research using design thinking and programming skills, with average responses to these statements above 5 (Agree).

Changes Due to COVID-19 Pandemic

For the first time, the STEM Summer Institute was held virtually due to the COVID-19 pandemic. This change allowed ore students to participate than in previous years, but also led to changes in the program in both curriculum and instructional practice.

Curricular changes included:

- *Some exercises [changed] so the students could do them remotely rather than in person*

- *More hands-on sessions*
- *Talks from companies instead of visits*
- *More defined sessions [with a] start and end*
- *Use of tools online*
- *Creating more friendly environment*
- *We used Google classroom and other open platforms that students can interact on virtually.*

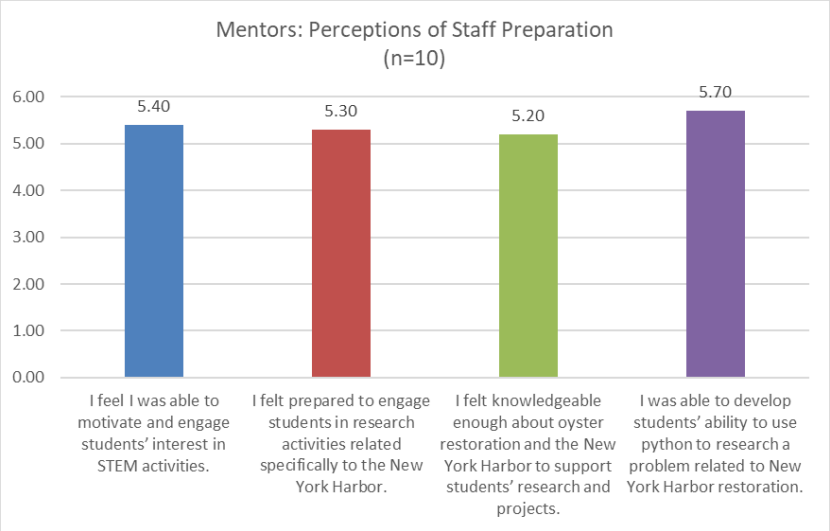
Changes in practice included:

- *Office hours for mentors and instructors*
- *Challenges for team members to know each other - team picture, team video*
- *Students produced videos*
- *Adapting to online meant shortening instructional time in "consumable" portions, and not overloading the student or have them get "Zoom fatigue" from being in front of the computer for long periods of time. We broke it up so that more interactive activities made it less repetitive and lecture heavy.*

Mentor Responses

Ten respondents had the role of mentoring a team of students. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

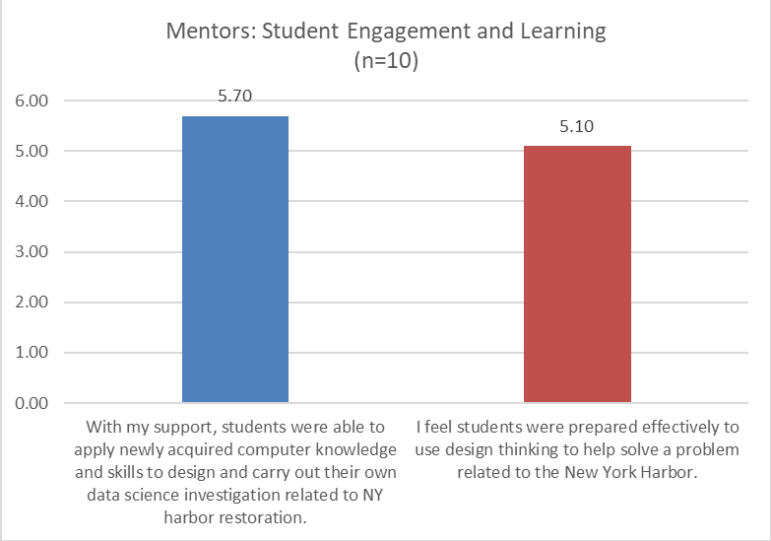
Perceptions of Staff Preparation



- Mentor perceptions of their preparation to work with students were positive, with all statements receiving an average response above 5 (Agree).
- The highest average response was to the statement *I was able to develop students' ability to use Python to research a problem related to new York Harbor restoration*, with an average response of 5.70 (standard deviation=0.67).
- The lowest average response was to the statement *I felt knowledgeable enough about oyster restoration and the New York Harbor to support students' research and projects* with an average

response of 5.20 (standard deviation=0.79). This statement was also rated less positively by program facilitators and staff.

Student Engagement and Learning



- Mentors rated both statements positively, with average responses above 5 (Agree).
- The statement *I feel students were prepared effectively to use design thinking to help solve a problem related to the New York Harbor* had a lower average response at 5.10 (standard deviation=0.57). This is in line with the lower confidence in their own knowledge of NY Harbor restoration.

Changes Due to COVID-19 Pandemic

Mentors also made changes in curriculum and instructional practice due to the program running virtually during the COVID-19 outbreak.

Curricular changes included:

- *It was quite smooth, can keep a single zoom session and then use breakout rooms wherever necessary. This will help avoid jumping between multiple zoom sessions*
- *Using Google Colab. Adapting with break out rooms in zoom meetings to promote collaboration and teamwork. Working with Mural to help and improvise ideas for a good story telling experience.*
- *The Professors guided all the mentors in such a way that mentors could make it easy for the curriculum to adapt to the online zoom teaching and learning.*
- *The Instructors of the course modified the curriculum to adapt to online teaching by introducing google colab for teaching python and to do the project, google drive to collaborate as a team, and work.*
- *Distributing the workload, revising the lecture, creating presentation and sharing it*
- *I had to be more engaged and share documents for easier understanding*

Changes to instruction included:

- *I made sure my group always had our personal zoom link and was always on slack to answer any questions they may have.*

- *Motivating students to take optional quiz as a challenge they were expecting. Giving them scope to think out of the box to come up with creative solutions to a problem. Rest is all perfect.*
- *I went flexible as per the students understanding and availability where me and student could go on same page. It was is really learning experience for both mentors and students.*
- *I followed the instructions as they were perfect and did not need any changes to continue the course successfully.*
- *To let them work on exercises and practices*
- *I tried keeping them engaged, delegated tasks amongst each team members so that every can contribute to their project. Because it was virtual this time, I took an approach of asking one person to share their screen and others should be collaboratively work and provide their inputs making every individual understand that what is a team and even if it is virtual, goals can be achieved. This really helped in getting things done.*
- *Creating zoom meetings, creating breakout room to help students talk to each other and know more*

Facilitator and Mentor Feedback

Facilitators and mentors also shared feedback for improving the program in the future. Comments included:

- *Better understanding of the BOP data*
- *Familiarizing students with tools online, it is necessary to set a baseline coming in. Starting from nothing takes a while for the students to get used to before they are absolutely comfortable.*
- *If there were more ice breaker activities, then they would help students towards strong team building and promote teamwork for better outcomes.*
- *For mentors, the training was given by the instructors and enough material was provided. It was very well designed and carried out.*
- *To add more activities which let them know the people of other teams.*
- *About the ice breaker, if we can have more during first week for eg: more movie nights, tiktok challenges, or online games.*
- *More preparation for the mentors before starting the program*
- *Of course making the switch to virtual took away the face-to-face and in-person trips and lunches, but given the parameters we had to conform to, I believe we made it interactive and immersive. Perhaps next year, we can do a mix of in-person and virtual.*

Recommendations and Conclusions

While mentors and facilitators both had positive feedback on both their preparation and students' learning, there are areas for improvement as well.

- More opportunities to learn about Billion Oyster Project, oyster restoration, and the BOP data. This is especially important as students are unable to visit Governor's Island and BOP due to the virtual nature of the Summer Institute this year. An opportunity to meet with BOP staff once students have started their projects could also allow them to ask questions as they arise throughout the process, instead of relying on Pace University mentors and facilitators for both oyster and computer science content.

- More opportunities for students to get to know each other, as was brought up by several mentors in their feedback

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

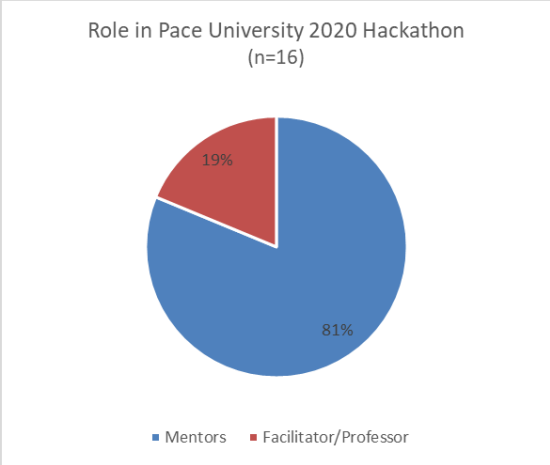
STEM+C Pace University Student Hackathon
Facilitator/Mentor Survey
December 2020 and February 2021

December 2020 Hackathon

In December 2020, Pace University hosted a hackathon, which focused on developing an app or game related to Billion Oyster Project's harbor restoration work, for high school student participants mentored by Pace graduate students and Pace professors in the role of facilitator. Due to the ongoing COVID-19 pandemic, the program was held virtually.

Demographics

Following the program completion, 16 mentors and program facilitators took a post-survey about their preparation for their roles, as well as their students' learning and engagement in the program.

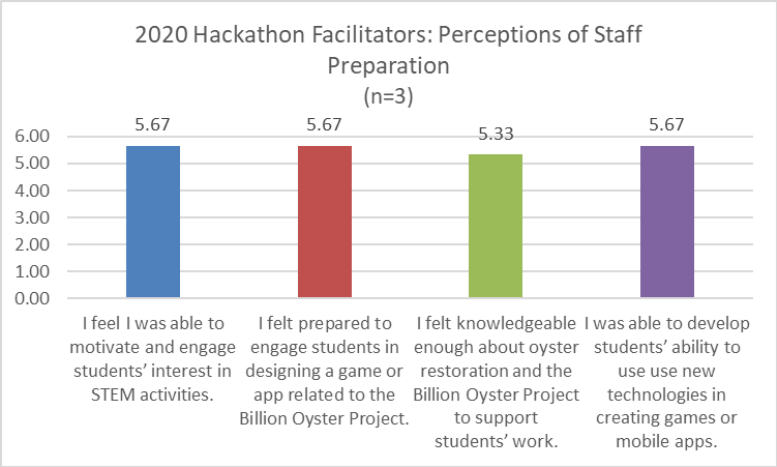


- Nineteen percent or three respondents were in the role of facilitator.
- Eighty-one percent or 13 respondents were in the role of mentor.

Facilitator Responses

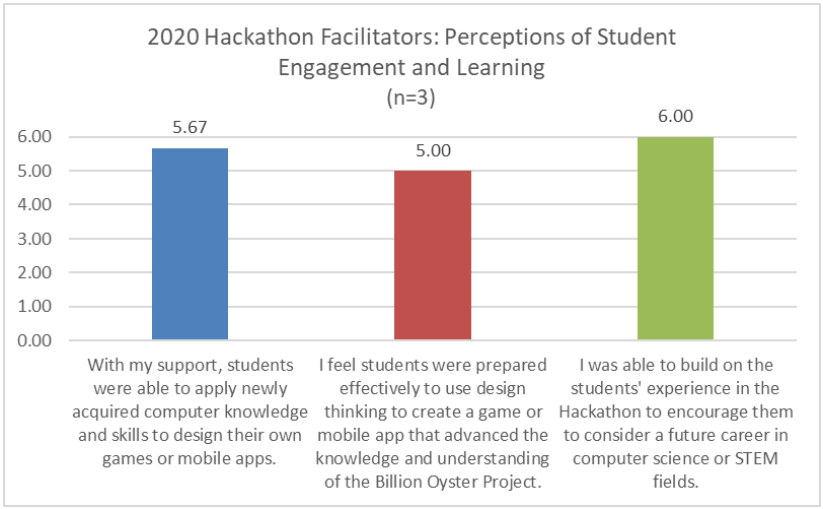
Three respondents had a role as a facilitator in the Hackathon. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

Perceptions of Staff Preparation



- Average responses to all statement were positive with averages above 5 (Agree).
- Three statements received the same average response of 5.67 (standard deviation=0.58). Those statements are:
    - *I feel I was able to motivate and engage student' interest in STEM activities.*
    - *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project.*
    - *I was able to develop students' ability to use new technologies in creating games or mobile apps.*
- One statement received a lower average response at 5.33: *I felt knowledgeable enough about oyster restoration and the Billion Oyster Project to support students' work* (standard deviation=1.15).

Student Engagement and Learning



- Average responses to all three statements were positive and at or above 5 (Agree).
- The highest average response was to the *statement I was able to build on the students' experiences in the Hackathon to encourage them to consider a future career in computer science or STEM fields* at 6.00.

- The lowest average response was to the statement *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project* with an average of 5.00 (standard deviation=1.00).

Changes Due to COVID-19 Pandemic

The ongoing COVID-19 pandemic meant that the Hackathon event was held entirely virtually through platforms like Zoom and Slack. The inability to meet in-person led to both changes in curriculum and instructional practice.

Curricular changes included:

- *Curriculum was delivered fully online with different tools to create engagement and participation with teammates. I assisted in coordinating the online community to ensure students had access to resources and shared knowledge to participate in the hack-a-thon.*
- *Using virtual whiteboard to replace in class activities.*

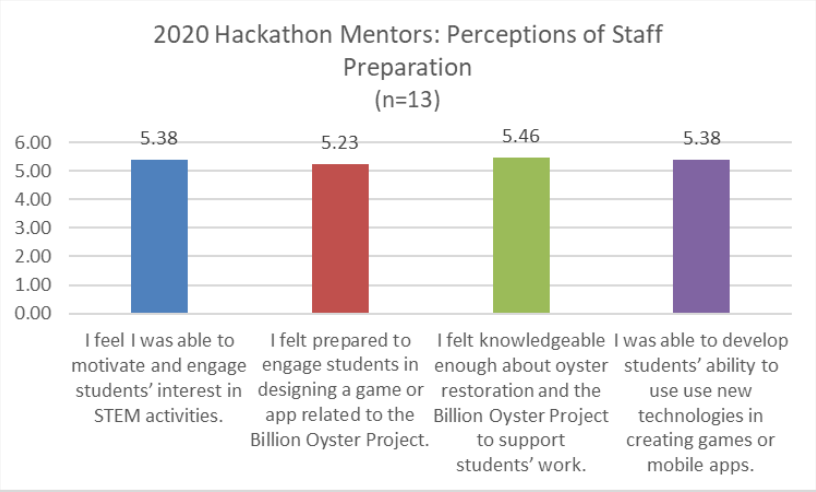
Changes in practice included:

- *Utilizing different technologies was crucial in the delivery of this opportunity so students could participate at any time and had access to proper resources.*
- *This was the heaviest use of slack (in a good way) that I have ever had for a course.*
- *Collaborative and interactive learning*

Mentor Responses

Thirteen respondents had the role of mentoring a team of students. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

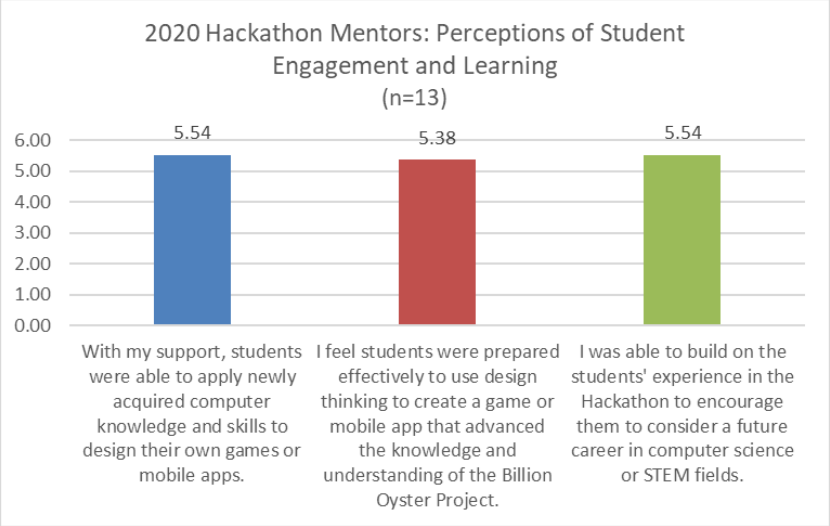
Perceptions of Staff Preparation



- While mentor average responses were generally lower than facilitator responses, they are still positive with average responses above 5 (Agree).
- The highest average response was to the statement *I felt knowledgeable enough about oyster restoration and the Billion Oyster Project to support students' work* with an average of 5.46 (standard deviation=0.78)

- The lowest average response was to the statement *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project* with an average of 5.23 (standard deviation=0.73).

Student Engagement and Learning



- Mentor perceptions of student engagement and learning were also lower than facilitators' perspectives. They were still positive overall with average responses on all statements above 5 (Agree).
- Two statements had the same average response of 5.54:
    - *With my support, students were able to apply newly acquired computer knowledge and skills to design their own games or mobile apps* (standard deviation=0.66).
    - *I was able to build on students' experience in the Hackathon to encourage them to consider a future career in computer science or STEM fields* (standard deviation=0.52).
- One statement had a lower average response, *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project*, at 5.38 (standard deviation=0.77).

Changes Due to COVID-19 Pandemic

Mentors also made changes in how they worked with students due to the event being held online due to the COVID-19 pandemic.

Curricular changes included:

- *I basically led with the direction the students needed to go in based on their behaviors and input based on where they were in the process. We took it from there.*
- *Open times, since not everyone could work at once. I adjusted availability*
- *Strict scheduling and reinforced open communication between members.*
- *Meeting separately, chatting the entire time we developed so that questions were open and always welcome.*
- *It's harder to make them engage in a zoom meeting*

Changes to instruction included:

- *I altered visional aides and the way I explained concepts.*
- *I was listening, and listening skills are mandatory for instructional practices.*
- *By sharing my screen and giving controls to the students every time we had to work on the app*
- *I encouraged participation and made sure all students contributed to the completion to the app.*
- *I gave demonstrations like I would in a physical setting and was able to help them with any issue by seeing the screen or remote controlling it to point things out easier then describing locations*
- *Slow reiteration to the students and making it clear and concise.*
- *utilize sharing screen and sharing of many links and articles. using chat, video and audio features as much as possible. suggesting to students to "share screen" often.*
- *I watched youtube tutorials that were provided by Pace professors*
- *Sharing screens, not copying code but assisting the student in developing a solution. I had made the game in its entirety before and it allowed me to always be of assistance.*
- *I encourage them to have their cameras on, and with the limited time, I had them work on different things*

Facilitator and Mentor Feedback

Facilitators and mentors also shared feedback for improving the program in the future. Comments included:

- *I think the opportunity was great! Finding a platform that allows for in program video-conferencing would be great (discord) to eliminate confusion with students moving from zoom room to zoom room.*
- *I think this Hackathon was the best prep for the next Hackathon.*
- *Mentors would have benefited greatly from advanced meeting and planning to receive direction and explanation concerning the project concerning the event and subject.*
- *Participants often felt they were in the wrong rooms because of wait times regarding adherence to the schedule.*
- *Some more time to work with the students on the app would have been great. Besides, I think everything was good.*
- *A better team building activity that won't crash a server.*
- *felt well prepared and supported for the requirements of the Hackathon. Although some coding questions/bugs were a challenge to find solutions to at times with just google. suggested resources or docs might be helpful and allotted time to troubleshoot. although without this, things were still a success. and QA was available albeit more impromptu.*
- *If there will be a more centralized means of communication and share point the program will benefit greatly. It felt that students had to follow too many platforms of communication and at times it was confusing.*
- *Encouraging more development time/getting more talent for more apps/games*

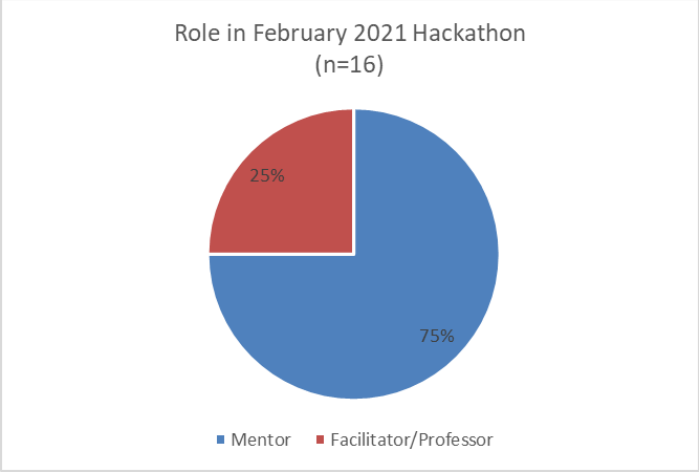
<u>February 2021 Hackathon</u>

In February 2021, Pace University hosted a second hackathon focused on developing an app or game related to Billion Oyster Project's harbor restoration work. Due to the ongoing COVID-19 pandemic, the program was held virtually and included students from the United States and Senegal. Some changes were

made to the program's design based on the feedback of mentors and facilitators from the December hackathon.

Demographics

Following the program completion, 16 mentors and program facilitators took a post-survey about their preparation for their roles, as well as their students' learning and engagement in the program.

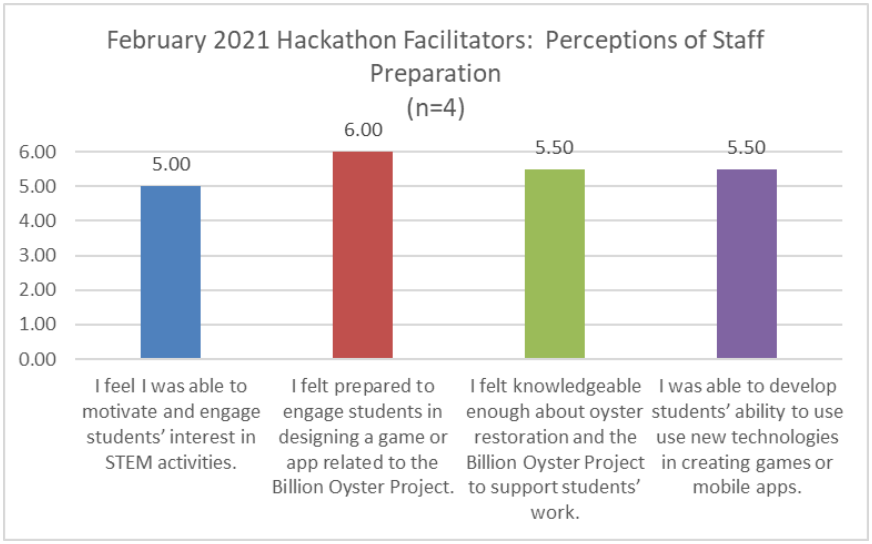


- Seventy-five percent of respondents worked with students in the role of mentor.
- Twenty-five percent of respondents worked with students as a facilitator/professor.

Facilitator Responses

Four respondents had a role as a facilitator in the Hackathon. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

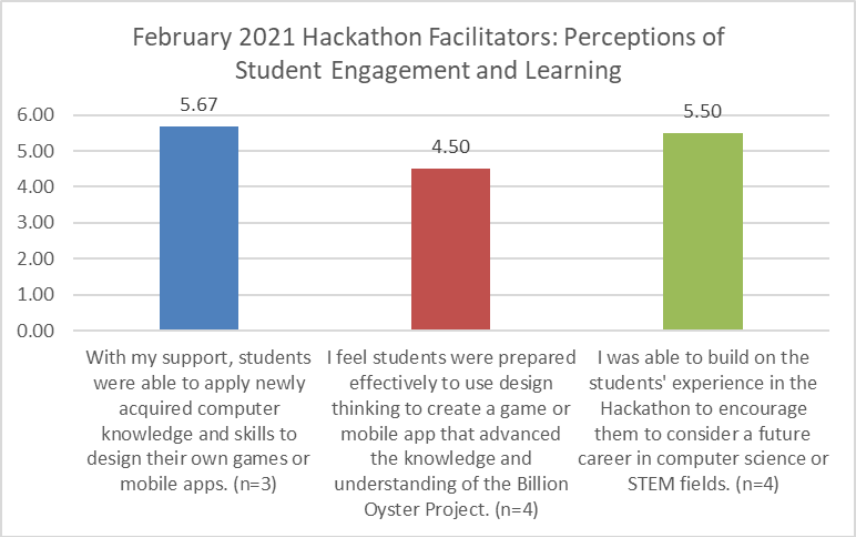
Perceptions of Staff Preparation



- Facilitators agreed that they were prepared for their roles in the Hackathon, with average responses to all statements at 5.00 (Agree) or above.

- The highest average response was to the statement *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project* with an average of 6.00.
- The lowest average response was to the statement *I feel I was able to motivate and engage students' interest in STEM activities* with an average of 5.00 (standard deviation=0.82).

Student Engagement and Learning



- Facilitator perceptions of student engagement and learning were positive overall.
- The statement with the highest average response was *With my support, students were able to apply newly acquired computer knowledge and skills to design their own games or mobile apps* with an average of 5.67 (standard deviation=0.58)
- The statement with the lowest average response was *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project* with an average of 4.50 (standard deviation=1.00).
- Based on these survey responses, facilitators felt that they were well-prepared to teach and engage students with developing apps or games about BOP content, but saw a gap in how the students were able to carry out their goal. The Hackathon time is short by nature, so there is limited time for instruction and work, thus limited time for students to work through aspects they may not understand. Additionally, as mentors mentioned in their feedback below, there were some students for whom there may have been an additional challenge in language and fully understanding the English instruction they were given.

Changes Due to COVID-19 Pandemic

The February Hackathon event was held entirely virtually through platforms including Zoom and Slack, based on experiences with the December Hackathon. The ongoing inability to meet in-person and feedback from the December event led to both changes in curriculum and instructional practice. Curricular changes included:

- *Use of breakout rooms*
- *Diverse activities for less monotony*
- *Overview of the tech for teaching/learning presented*

- *Using of online tools to simulate in-person collaboration*
- *more visual instructions*
- *I created the "before we begin" video to make sure they are prepared. I focused the teaching this time on a particular type of game.*

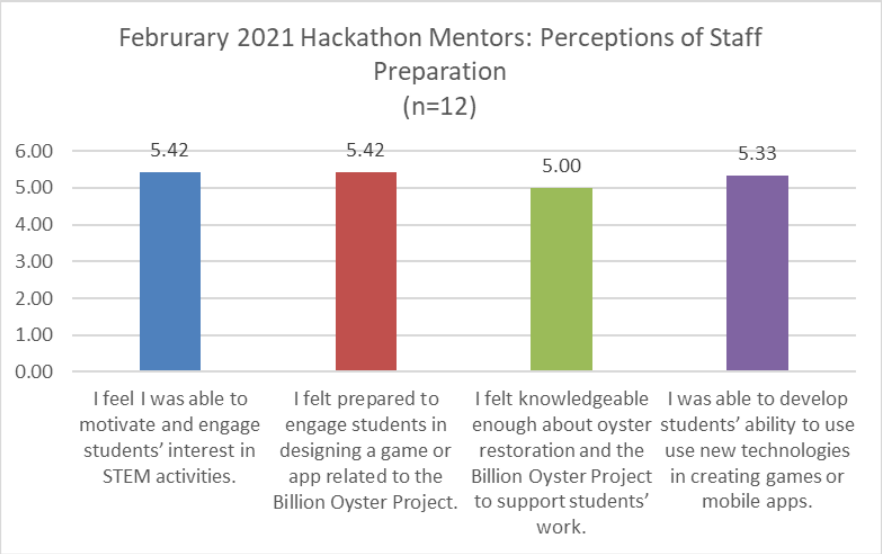
Changes in practice included:

- *More time with mentors*
- *Using online tools like mural*
- *I worked on having better pauses/goal-posts to make sure everyone was at the same place when teaching.*

Mentor Responses

Twelve respondents had the role of mentoring a team of students. Participants were asked about their preparation for working with students on topics of oyster restoration and computer science, as well as student engagement and learning. All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree).

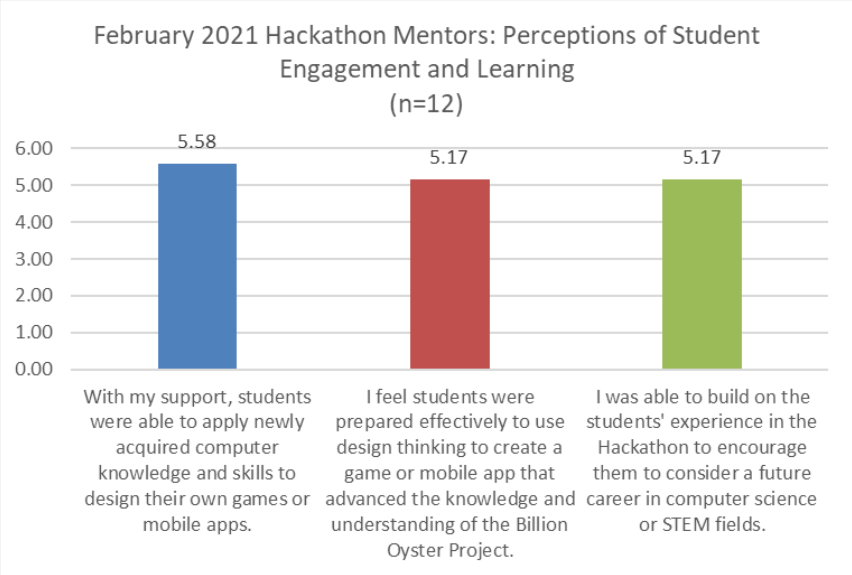
Perceptions of Staff Preparation



- Mentor perceptions of preparation for their role in the Hackathon was positive.
- Two statements had an average response of 5.42:
  - *I feel I was able to motivate and engage students' interest in STEM activities* (standard deviation=0.67).
  - *I felt prepared to engage students in designing a game or app related to the Billion Oyster Project* (standard deviation=0.79).
  - These two aspects are integral to the role mentors play in the Hackathon so receiving high quality preparation is important to the success of the program.
- The statement with the lowest average response was *I felt knowledgeable enough about oyster restoration and the Billion Oyster Project to support students' work* with an average of 5.00 (standard deviation=0.95).

- This is one area where the Hackathon program could improve. Additional time for mentors to learn about oyster content or more involvement from BOP could lead to not only mentors having more knowledge but for students to learn more as well.

Student Engagement and Learning



- Average responses from mentors about their perceptions of student engagement and learning were positive, with all average responses between 5.00 (Agree) and 6.00 (Strongly Agree).
- The statement with the highest average response was *With my support, students were able to apply newly acquired computer knowledge and skills to design their own games or mobile apps* with an average of 5.58 (standard deviation=0.51).
- Two statements had an average response of 5.17:
  - *I feel students were prepared effectively to use design thinking to create a game or mobile app that advanced the knowledge and understanding of the Billion Oyster Project* (standard deviation=0.72).
  - *I was able to build on the students' experience in the Hackathon to encourage them to consider a future career in computer science or STEM fields* (standard deviation=0.72).

Changes Due to COVID-19 Pandemic

Although this was their second online Hackathon, mentors also made changes in how they worked with students.

Curricular changes included:

- *We held logs of who was doing what task at what time and had open communication as the mentors stayed on Zoom for hours available to talk to at any time.*
- *I made sure that my camera was on so that the understanding is simple.*
- *My group utilized zoom and discord to discuss app development. When problems arose, we worked together and used online resources to solve them.*
- *screen sharing and being patient*

- *I applied my experience of Game Jams with people with different skills completely online to point everyone in their own direction of self-learning.*
- *Maintaining a strong structure and important building block of a successful project.*
- *We used collaboration for unity for all to work at once and used zoom remote when I needed to show them something important.*
- *Being able to use breakout rooms was crucial as it eliminated the need for 20 different zoom rooms.*

Changes to instruction included:

- *We involved the sharing screen feature a bit more than usual for a better understanding*
- *As my students were from Senegal language was the barrier so I made sure that they understand the instructions properly by converting English to French.*
- *My group had open discussions about our goals. We would all come up with ideas that helped reach the goals we set.*
- *I tried to let the members of the team think about the solution, before providing them with an answer. Basically if they asked the right questions, I would provide them with an explanation.*
- *Stayed in a zoom while doing any development in case anyone had questions.*
- *I had an amazing opportunity and experience in mentoring students from Senegal. The Hackathon was well organized and was divided into parts, which made it helpful for me to mentor the students. It was scheduled on time which made it competitive and fun for the students. I made sure the right deliverables were submitted on time. I motivated the students from start to end.*
- *We had the students controlling their screen, and screen sharing it to us so that we [could] guide them throughout the process.*

Facilitator and Mentor Feedback

Facilitators and mentors also shared feedback for improving the program in the future. Comments included:

- *I think we should run the schedule a bit differently*
- *I genuinely think that the hackathon was a success and hope for wider reach with advertising for more students to attend.*
- *My experience was really great as a mentor. It's a great opportunity to learn something new and a chance to show your leadership qualities.*
- *More preparation with mentors on the actual material. MIT App Inventor was as new to me as the mentees and I felt I couldn't help them to my full potential.*
- *I think the tutorials and the lessons were a good first step in terms of instruction, however a lot of the students would have benefited if there was literature prepared by pace with documentation on C# and Unity*
- *I feel every mentor should be given 1-day training prior to the event. Overall, the event was amazing and was well organized.*

February 2021 Hackathon Observation

Evaluators observed X mentors and facilitators over the course of the Hackathon.

- During observations, the facilitator was organized and spent time reviewing instructions in multiple ways to ensure that all students understood the goals. Break out sessions happened in small,

focused chunks which encouraged teams to stay on task. The facilitator was able to check in on teams in the break out rooms to troubleshoot issues and encourage them to work together. During student presentations, the facilitator provided clear feedback to the teams and reminded students that there are always ways an app can be improved.

- During observations in breakout sessions with mentors, mentors had different styles of engaging students.
    - One mentor let students take the lead on discussing how they were going to do the project. This created space for the students to show each other how to do things and allowed the students' voices and thoughts on their app to be strong. However, it also led to students working in silence without clear individual roles in the project. Ultimately, students worked individually without realizing that their progress was not being saved to the group project. After encouragement from the facilitator to share screens, the group was able to collaborate more efficiently.
    - Another mentor took on a leadership role within their group. Each student had chosen a specific aspect of the project to be their responsibility. The mentor guided the students with feedback and gave them next step on which to focus. As the mentor asked questions, holes in the project became apparent. Students discussed who would take on those responsibilities, and the mentor offered encouragement for carrying out different tasks.

Recommendations and Conclusions

Facilitators and mentors had positive perceptions of both their preparation for their roles and of student engagement. Issues that arose during the first hackathon in December 2020 were improved upon for the February 2021 iteration. In addition to previously discussed increased oyster content and involvement from BOP, another area of improvement is in the training for mentors. In their feedback, several mentors said they would have liked more training, in particular around learning new platforms. Additionally, while mentors expressed confidence in their instructional practice, having an opportunity to discuss best practices could help mentors effectively guide their teams.

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024

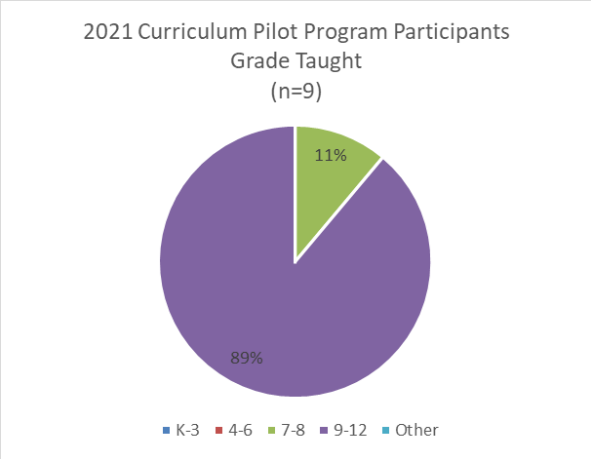
Telephone / Fax (212) 724-8812

gmoore1@nyc.rr.com

STEM+C Curriculum Pilot Program Participant Survey Results 2021

From January through June 2021, thirteen teachers participated in a program to pilot BOP computer science curriculum with their students. Teachers met monthly to discuss lessons and activities and to provide feedback on the curriculum. At the end of their pilot program participation, teachers took a survey reflecting on their experience in the workshop sessions and in using the curriculum with students. Nine participants responded to the survey (69 percent of program participants).

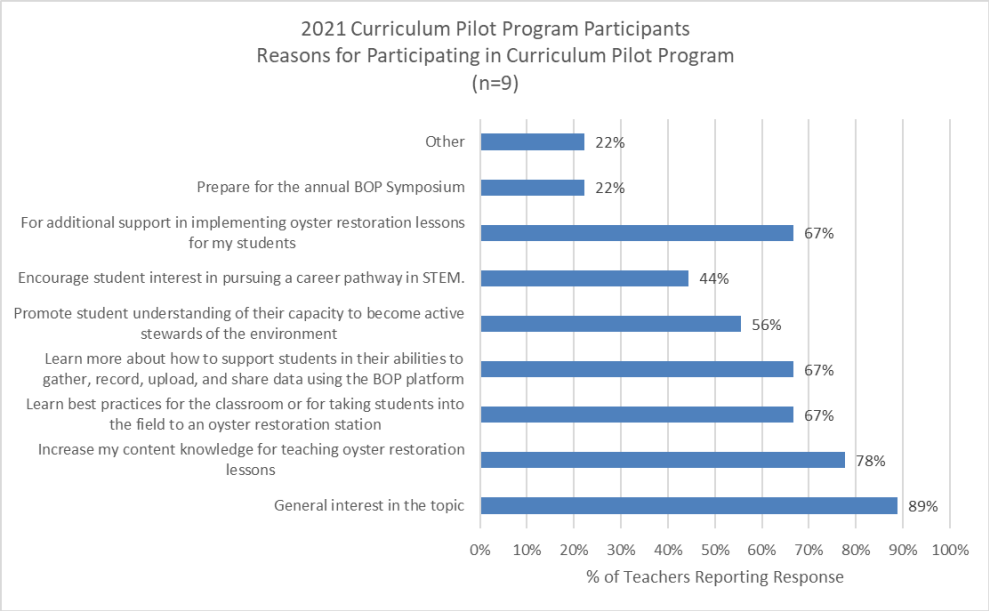
Demographics



- Eighty-nine percent of respondents teach high school (grades 9-12).
- Eleven percent of respondents 7-8th grades.

When asked approximately how many students would participate in the lessons from this curriculum, teachers answered ranged from eight to 100. In total, approximately 440 students participated in lessons from the pilot curriculum program over the semester.

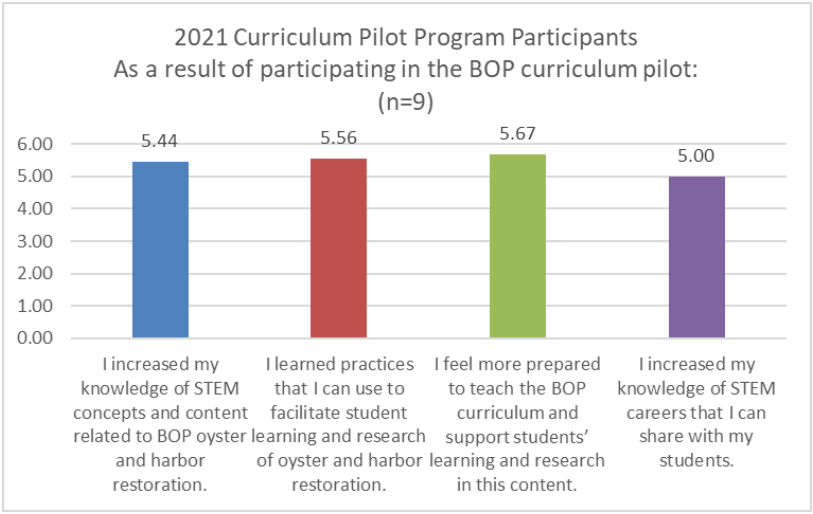
Teachers were asked why they participated in the curriculum pilot program. Teachers could choose multiple responses to this question.



- The most frequent reason teachers cited for program participation was *general interest in the topic*, with 89 percent of respondents.
- *Increase my content knowledge for teaching oyster restoration lessons* was also frequently cited, with 78 percent of respondents.
- Teachers' least frequent response was to *prepare for the annual BOP Symposium*, with 22 percent of respondents.
- Other reasons teachers cited for program participation were:
    - *build teaching skills in relation to data and its analysis*
    - *was provided payment*

Teacher Perceptions of the Program Pilot Workshop Sessions

Teachers responded to a series of statements about what they gained from their participation in the pilot program. Each statement was evaluated on a scale from 1 (Strongly Disagree) to 6 (Strongly Agree).



- Teachers' responses to all statements were positive with all average responses between 5.00 (Agree) and 6.00 (Strongly Agree).
- The highest average response was to the statement *I feel more prepared to teach the BOP curriculum and support students' learning and research in this content* with an average of 5.67 (standard deviation=0.71).
- The lowest average response was to the *statement I increased my knowledge of STEM careers that I can share with my students* with an average of 5.00 (standard deviation=0.71).

Teachers also provided feedback on the sessions in which they met monthly with colleagues and BOP staff to discuss the curriculum and engage in some of the activities. Teachers particularly liked being able to discuss different parts of the lessons with other teachers and having access to "real" data. Specific feedback on helpful aspects of the program included:

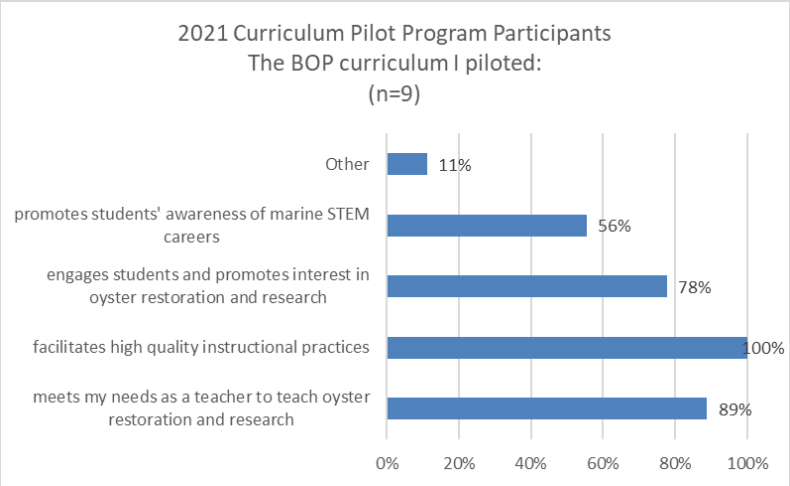
- *Having real data that was collected by students and community members!*
- *I really appreciated hearing how other teachers modified the curriculum for students with disabilities. I also liked meeting before the Symposium to get feedback on my students' work.*
- *reviewing the curriculum and sharing our work - it forced a deep dive into the lessons.*
- *Getting kids using google sheets for data analysis because it helped them navigate data sets and figure out ways of analyze and graphically representing trends they found in the data. This feel more like "real science" compared to more cookbook lab type curriculums*

Teachers provided feedback about what they thought was missing from the sessions to make them more helpful. Feedback included:

- *Ideas of how to scaffold some of the activities for students. Although teachers came up with various ideas, it might be useful to have some suggestions built into the curriculum.*
- *A little more help with making the data digestible*
- *Maybe we could demo. Maybe some direct instruction about the material to help us be experts*
- *Maybe some lessons on stats - the second half of the data analysis chapter is dense and it's been a long time since I've used that level of analysis myself. It would be a challenge to implement without a renewed understanding myself.*
- *It would be nice to have more background info on the science of oysters*
- *I would love more ways to weave into environmental and living environment*

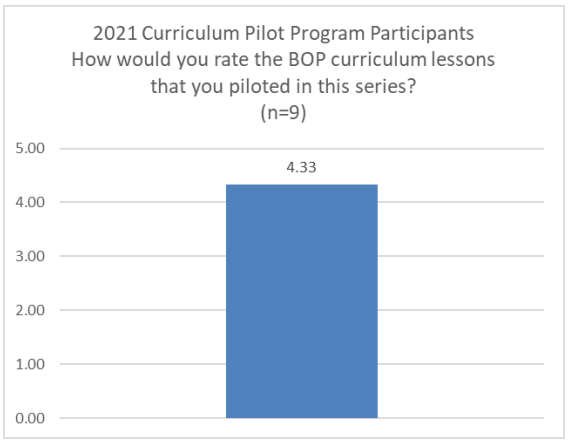
Teacher Perceptions of the BOP Curriculum

Teachers responded to questions that focused on the curriculum more specifically.

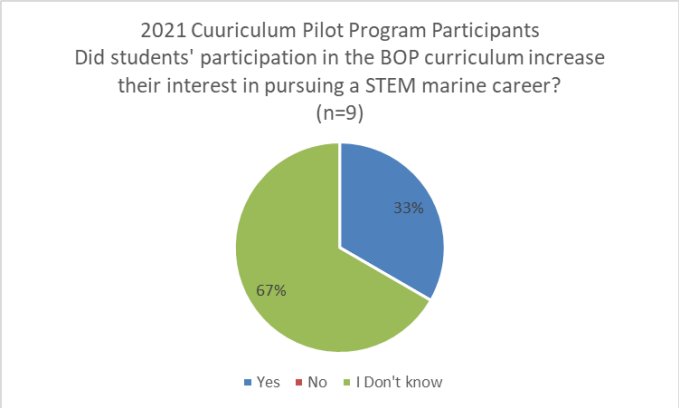


- All respondents thought that the BOP curriculum *facilitates high quality instructional practices.*
- Eighty-nine percent said the curriculum *meets needs as a teacher to teach oyster restoration and research*.
- The lowest response was to *The BOP curriculum I piloted promotes students' awareness of marine STEM careers* with 56 percent responding.
- Other responses included:
    - *required a lot of custom modification based on the time and space I was given to teach it, since I could not teach the entire lesson sequences in their original form*

Teachers rated the BOP curriculum lessons on a scale of 1 (Useless) to 5 (Excellent).



- The average rating of the lessons in the curriculum pilot was 4.33 (standard deviation=0.50). This falls between 4 (Good) and 5 (Excellent).



- When asked if students' participation in the lessons increase their interest in STEM careers, 33 percent of respondents said yes.
- Sixty-seven percent did not know if participation increased student interest in STEM careers.
    - This response is in line with other responses from teachers related to STEM careers. Teachers reported less interest in career content and less awareness of student interest overall.

Additional Program Feedback

Teachers also provided feedback for any other suggestions for improving the curriculum workshops or the curriculum itself. Responses included:

- *The lessons should be more interactive, with more images, etc. It's a bit dense and text heavy*
- *As the semester went on, the teacher presentations became more interesting and focused. I would ask that BOP provide more guidance for teachers when presenting.*
- *Perhaps break up the lessons into smaller chunks; go through a lesson as writers of the curriculum to explain your rationale*
- *stand alone lessons instead of a progressive unit plan*
- *Maybe have a master list of resources that are embedded in the lessons.*

Recommendations and Conclusions

Overall, participants rated the curriculum and associated workshops highly and had a positive experience in the program. Two areas of improvement stand out:

- Making the curriculum more flexible to meet a range of needs for teachers
    - While no curriculum can meet all needs, making it easier for teachers to adapt the activities for their classrooms could lead to more extensive use of the curriculum.
- Placing greater emphasis on STEM marine careers
    - Designing a video series of BOP and BOP partner scientists could be a simple resource for teachers to integrate more information about careers in their classes.

Even with these areas of improvement, teachers' perceptions of the program and curriculum support this being a high-quality program.

Gaylen Moore Program Evaluation Services

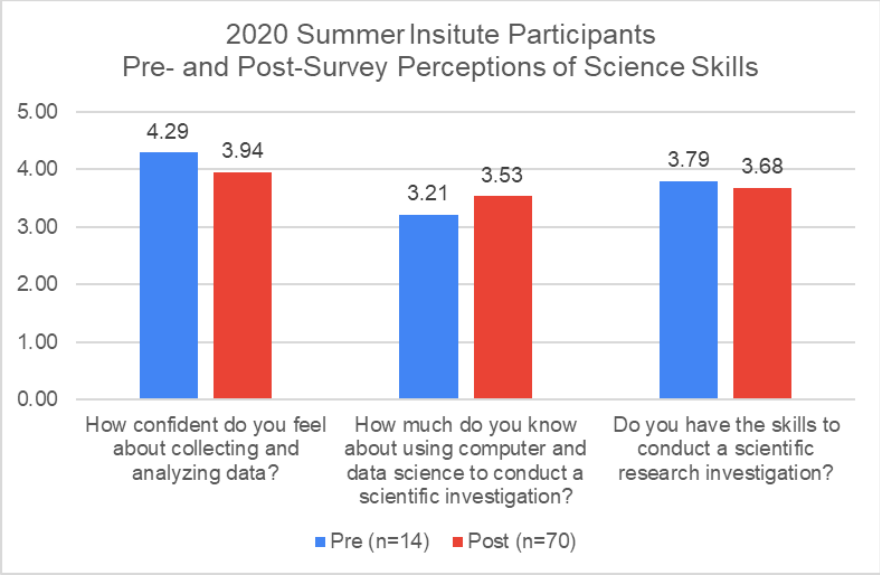
304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

Student Survey Results
STEM Institute and Hackathon Activities
2020-2021

In summer 2020, Pace University conducted its annual STEM Summer Institute for high school students focusing on computer science, design thinking, and Billion Oyster Project data. Due to the COVID-19 outbreak, the program was held virtually for the first time. While this introduced new challenges, the program was able to expand and include more students and mentors than in previous years.

Participating students took a survey both before they started the program and after they completed the program to gauge their perceptions of their scientific skills and their STEM career knowledge and interest. Fourteen students completed pre-surveys, and 70 completed post-surveys. One challenge in comparing pre- and post-surveys is the large difference in the number

Perceptions of Science Skills
Students responded to three questions on the survey about their perceptions of their abilities to engage in scientific processes. All questions were rated on a scale of 1 to 5, with 1 being the most negative response and 5 being the most positive.

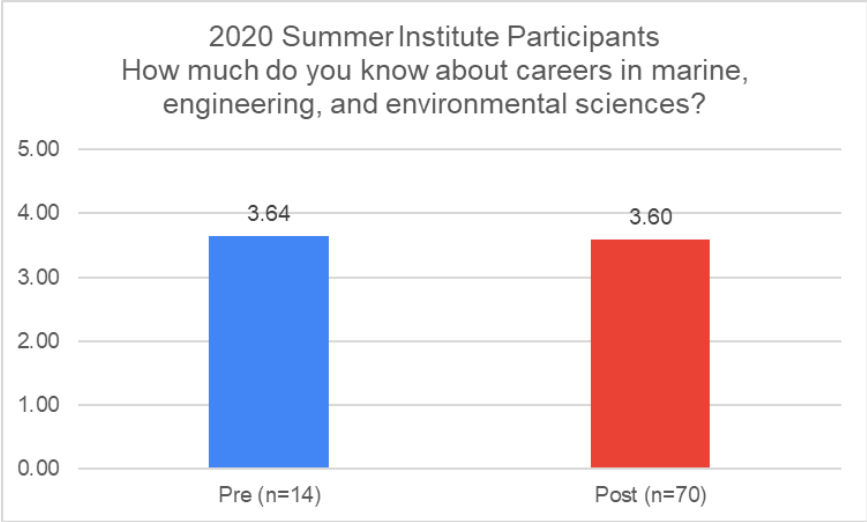


- Average responses to each question on the post-survey were between 3 (a neutral response) and 4 (a positive response).
- Average responses to one question increased from the pre-survey to the post-survey: *How much do you know about using computer and data science to conduct a scientific investigation?*
    - Average scores increased by 0.32 points on the post-survey.

    - The Summer Institute focuses heavily on these topics, and these results suggest this portion of the program is successful in teaching students' computer and data science skills.
- Average responses to two other questions decreased from the pre- to the post-survey:
    - *How confident do you feel about collecting and analyzing data?*
    - *Do you have the skills to conduct a scientific research investigation?*
    - It seems unlikely that participation in the Summer Institute would lead to a decline in students' skills in this area. These results may reflect a discrepancy between students who filled out both the pre- and post-survey and those who only filled out the post-survey.

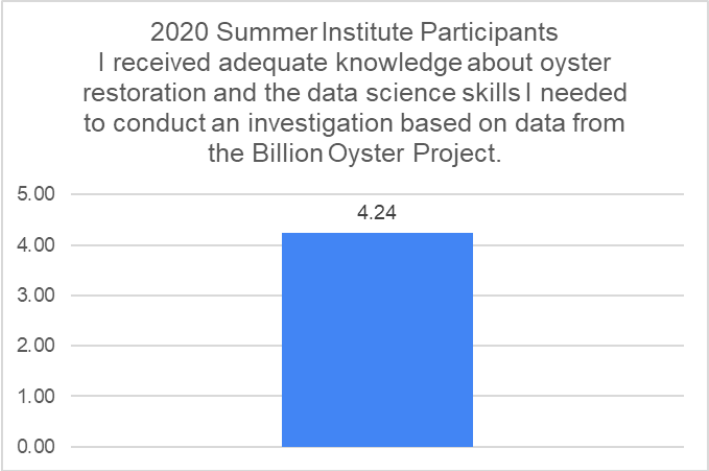
STEM Career Knowledge and Interest

On both the pre- and post-survey, students responded to one question about their knowledge of marine, engineering, and environmental sciences careers. Students responded to this question on a scale of 1 (Almost Nothing) to 5 (A lot).



- Average responses about students' knowledge about careers in marine, engineering, and environmental science did not change from pre- to post-surveys.
- On post-surveys, the average response was 3.60; this suggests that students know some about these careers but could learn more.

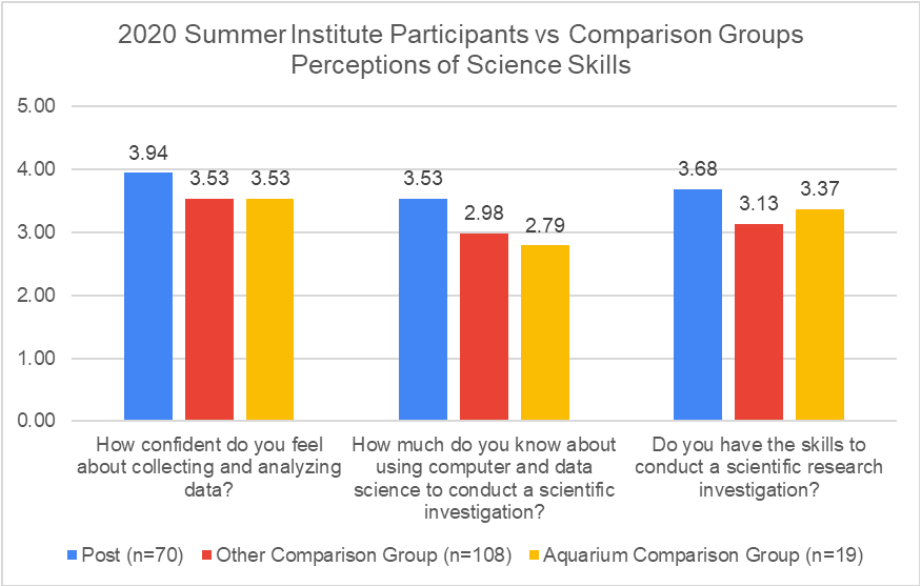
Following participation in the Summer Institute, students also responded to a statement on how well prepared they felt they were to carry out their projects.



- Students felt positively that they did receive adequate knowledge about oyster restoration and data science skills to conduct an investigation using BOP data with an average of 4.24 (standard deviation=0.69) to this statement.

Comparison Group: Perceptions of Science Skills

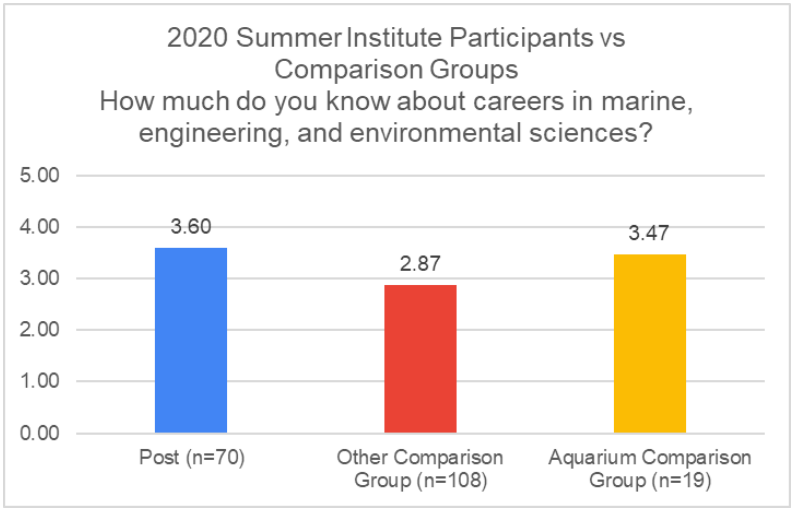
Summer Institute participants post-survey results were compared to two other groups of students: students with no involvement in BOP or other marine science programs (the Other comparison group), and students who were involved in New York Aquarium programming (the Aquarium comparison group).



- Summer Institute participants reported more positive perceptions of their scientific skills than those in either comparison group.
- Unpaired t-tests were conducted to establish statistical significance of the results between these groups. The following results were statistically significant:
    - Summer Institute participants responded more positively to confidence in collecting and analyzing data than the other student comparison group.

- Summer Institute participants responded more positively to knowledge about using computer and data science to conduct a scientific investigation than both the other student comparison group and the NY Aquarium comparison group.
- Summer Institute participants responded more positively to having skills to conduct scientific research than the other student comparison group.

Comparison Group: STEM Career Knowledge and Interest



- Summer Institute participants reported knowing more about careers in marine, engineering, and environmental sciences than students in the comparison groups.
- Summer Institute participants responded 0.73 points more positively than the other student comparison group. In an unpaired t-test between the groups, the results were statistically significant.
- This may suggest that the Summer Institute recruits students who already know much more than the average student about STEM careers.

Gaylen Moore Program Evaluation Services

304 West 89 Street, New York, New York 10024
Telephone / Fax (212) 724-8812
gmoore1@nyc.rr.com

STEM Hub Activities
Student Survey Results:
2020-2021

Following Billion Oyster Project STEM Hub activities and Near Peer Career Panels, students had the opportunity to take an evaluation survey about their perceptions of their scientific skills and STEM career knowledge; this survey was part of a larger research survey. Students who acted as mentors in a near peer mentoring program at the Harbor School also took this survey near the end of the school year and responded to questions about their experience as a mentor.

Evaluation Notes

Results are presented in two sections: January-March and April-July. In April 2021, the survey was briefly taken offline and revamped to streamline the experience for students and make it easier for them to complete the survey. While the goals of the questions remained the same, the wording and answer choice changed. Participation in BOP programming was established by correlating the date of Billion Oyster Project student events to the date when surveys were started. Surveys started within a week of an event were considered participant surveys.

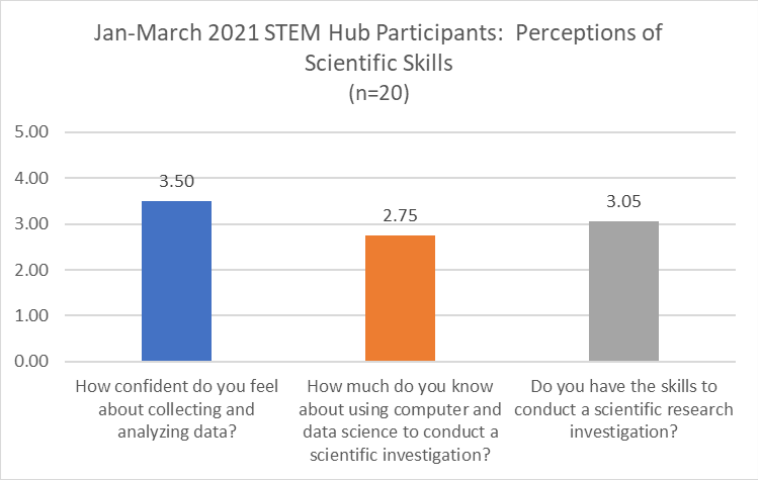
January-March Evaluation

STEM Hub Activities Participants

Evaluators identified 20 students who had attended STEM Hub events from January-March 2021.

Perceptions of Science Skills

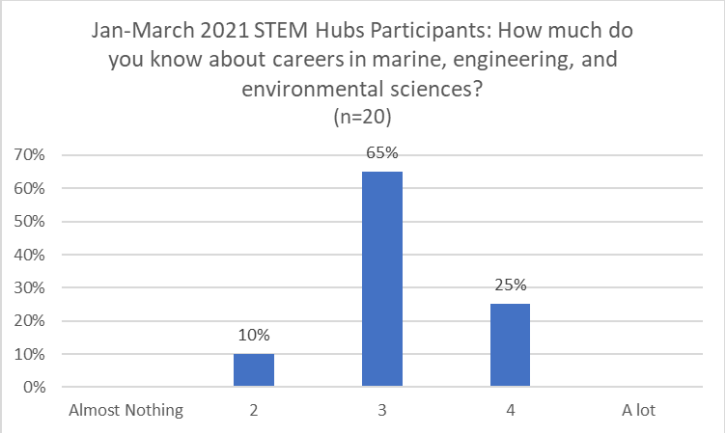
Survey questions were answered on a scale of 1 to 5, which 1 being the most negative and 5 being the most positive.



- The most positive response was to the question *How confident do you feel about collecting and analyzing data?* with an average response was 3.50 (standard deviation=0.89). On average, students report having some confidence in collecting and analyzing data.
- The least positive response was to the question *How much do you know about using computer and data science to conduct a scientific investigation?* with an average of 2.75 (standard deviation=1.07).
- STEM Hub activities focus on harbor restoration and data collection through testing and observation in the field. These activities do not utilize computer science skills.

STEM Career Knowledge

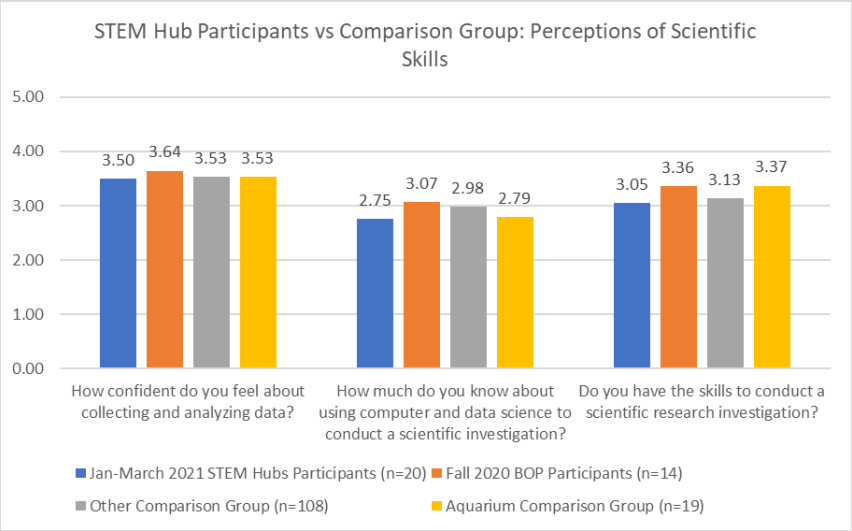
Students also responded to a question about their knowledge of STEM careers connected to harbor restoration and environmental science. Students responded on a scale of 1 (Almost Nothing) to 5 (A lot)



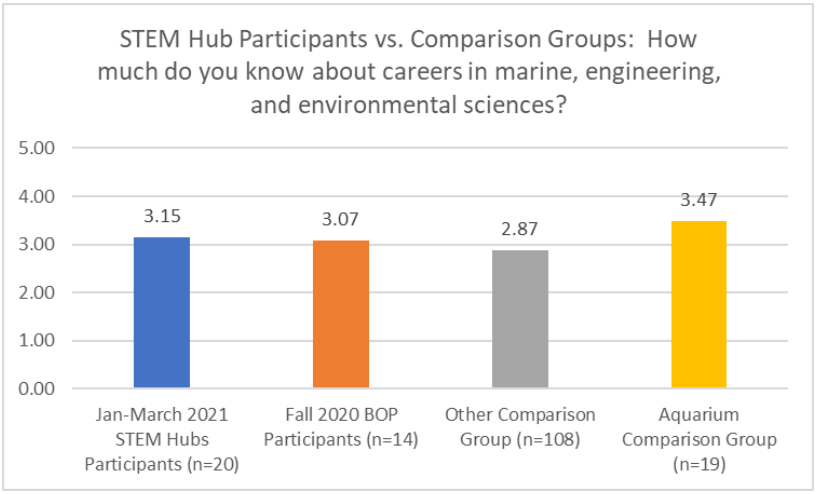
- The average response to STEM career awareness was 3.15.
- Sixty-five percent of students responded in the middle of the scale that they know some about these careers.

STEM Hubs and Comparison Groups

January-March STEM Hub participants' responses were compared to three groups of students: STEM Hub participants from the Fall 2020 semester, students from Fall 2020 who completed a survey but had no experience with BOP or another science organization, and a group of students who participated in New York Aquarium programming.



- January-March STEM Hub participants had lower average responses to all scientific skills questions than the participants from Fall 2020.
- Participants' responses were similar to or slightly lower than students who had not participated in the STEM Hub activities.



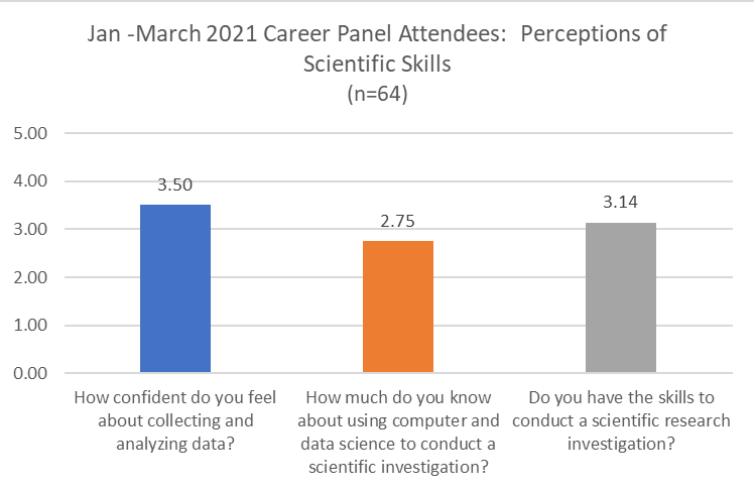
- January-March STEM Hub participants felt more positively about their STEM career knowledge than the Fall 2020 participants and the general comparison group. They responded less positively than the NY Aquarium students.

Near Peer Career Panel Attendees

During the Spring 2021 semester, Billion Oyster Project ran career panels moderated by Harbor School students that focused on one of the marine STEM tracks featured at the Harbor School. Panelists included Harbor School alumni and others who worked in jobs related to those tracks. Students who attended those programs responded to the student evaluation survey.

Perceptions of Scientific Skills

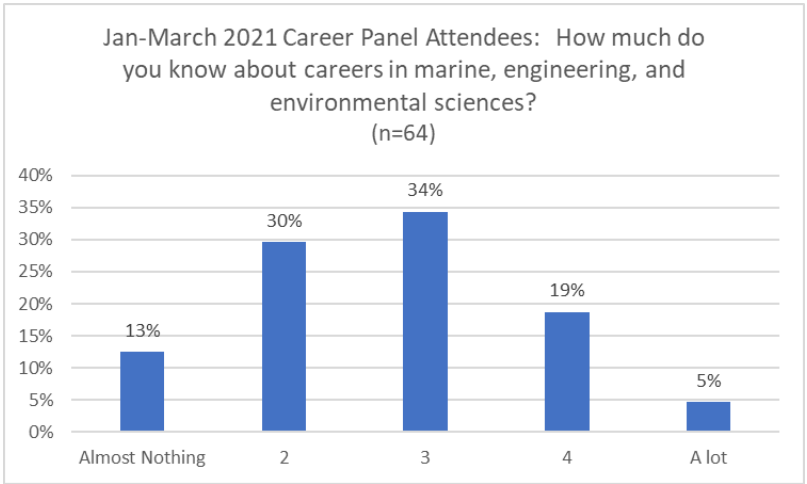
Evaluators identified 64 students who had attended Near Peer Career Panel events from January-March 2021. Survey questions were answered on a scale of 1 to 5, which 1 being the most negative and 5 being the most positive.



- The highest average response was to the question *How confident do you feel about collecting and analyzing data?* with an average response of 3.50 (standard deviation=0.93). Students have some confidence in collecting and analyzing data.
- The lowest average response was to the question *How much do you know about using computer and data science to conduct a scientific investigation?* with an average response of 2.75 (standard deviation=1.05). Building computer and data science skills was not a focus of these panels.

STEM Career Knowledge

Students also responded to a question about their knowledge of STEM careers connected to harbor restoration and environmental science. Students responded on a scale of 1 (Almost Nothing) to 5 (A lot)

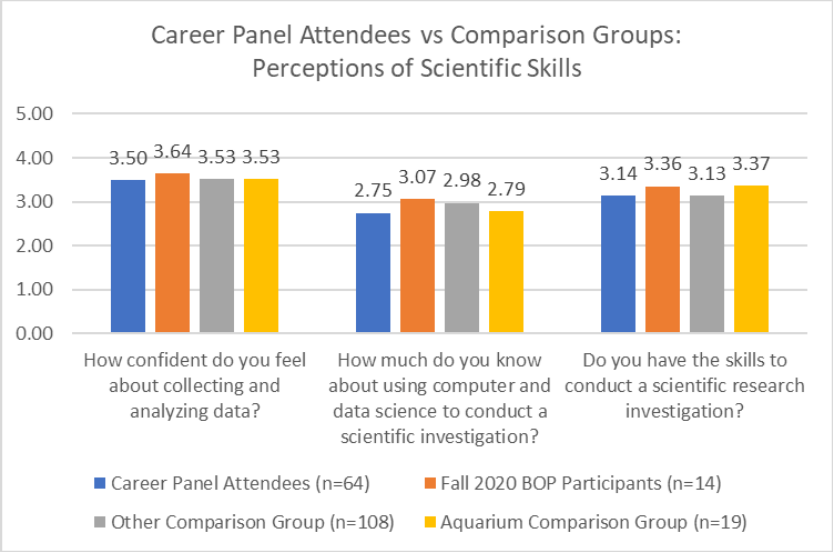


- The average response to this question was 2.74.
- Thirty-four percent response that they knew an average amount about these careers.
- Twenty-four percent responded that they knew a more than average amount.

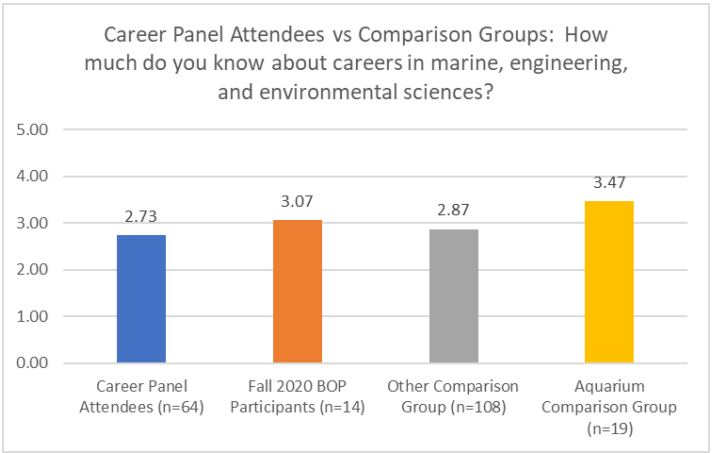
- Forty-three percent responded that they knew less.

Career Panel Attendees and Comparison Groups

Career Panel attendees' responses were compared to three groups of students: STEM Hub participants from the Fall 2020 semester, students from Fall 2020 who completed a survey but had no experience with BOP or another science organization, and a group of students who participated in New York Aquarium programming.



- Career panel attendees' average responses were lower than the Fall 2020 STEM Hub participants responses in perceptions of scientific skills.
- Their average responses on scientific skills were similar to or lower than the students in the comparison groups. The panels did not include activities to actively learn or utilize these skills. These results may reflect that.



- The career panel attendees' average response about their STEM career knowledge was lower than students in all the other groups.
- This result is surprising, and there may be some bias in these results. Evaluators do not know how teachers or students chose to attend the career panels. Teachers may have wanted students to attend because they thought they needed to learn more about STEM

careers. Additionally, in particular when compared with the general comparison group this may be a case of "you don't know what you don't know," in which students who heard about fields they previously did not know about may have been inclined to respond lower to this question that students who had not participated in any program.

April-July Evaluation

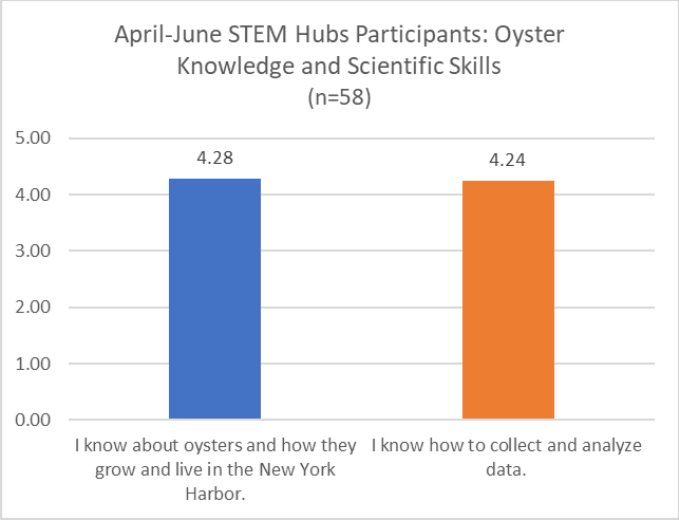
In April 2021, BOP staff and evaluators worked together to revise the student evaluation survey. Questions were changed to more closely align to BOP events in which students were participating and to make the survey process easier for students.

STEM Hub Activities Participants

Evaluators identified 58 students who participated in STEM Hub activities from April-June that took the student evaluation survey.

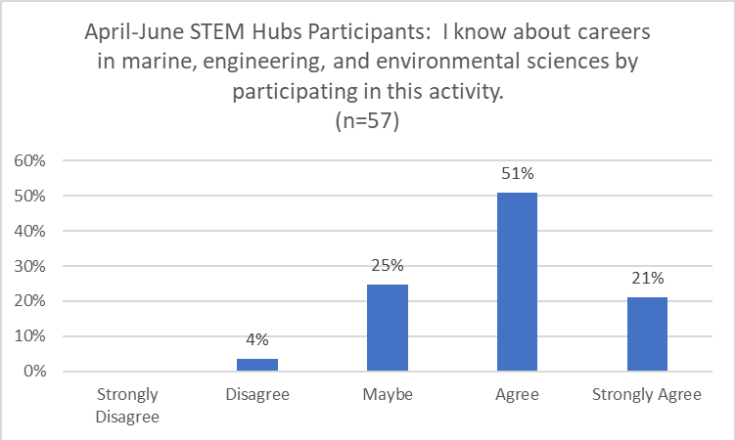
Oyster Knowledge and Scientific Skills

In the new survey, student responded to statements about oyster knowledge and scientific skills. All statements were rated on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).



- STEM Hub participants' average responses to both statements were positive and were between 4 (Agree) and 5 (Strongly Agree).
- *I know about oysters and how they grow and live in the New York Harbor* had an average response of 4.28 (standard deviation=0.67)
- *I know how to collect and analyze data* had an average response of 4.24 (standard deviation=0.68).
    - For students taking the Jan-March version of the survey, the statement about collecting and analyzing data received the most positive response.

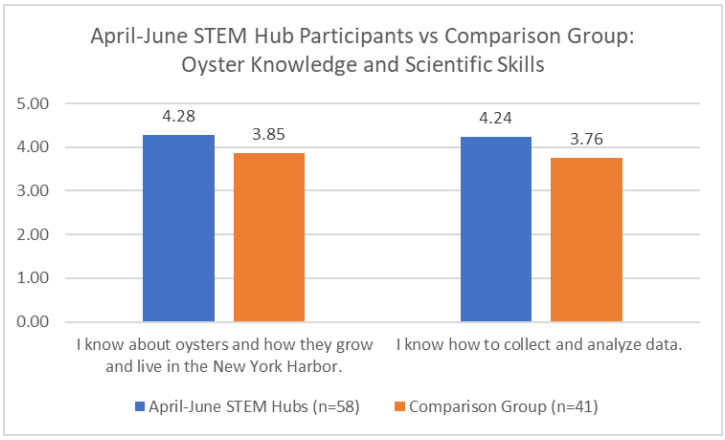
STEM Career Knowledge



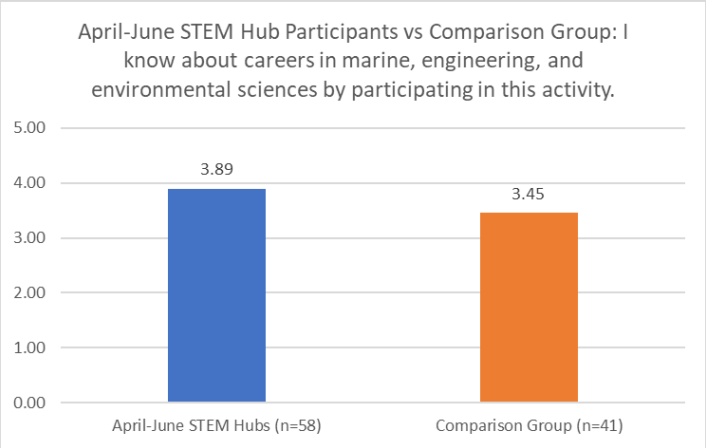
- The average response to STEM career knowledge for April-June STEM Hub participants was 3.89.
- Seventy-two percent of respondents agreed to some extent with the statement *I know about careers in marine, engineering, and environmental sciences by participating in this activity*.
    - *o* This statement was changed to make it more specific to the activity which students attended before taking the survey in order to make responses clearer.

STEM Hub Activities and Comparison Groups

Evaluators compared STEM Hub participant surveys to surveys from students who took the student evaluation survey from April-July but could not be connected to participation in a BOP activity.



- STEM Hub participants reported knowing more about oysters than the comparison group. The average response was 0.43 higher.
- STEM Hub participants' average response to the *statement I know how to collect and analyze data* was more positive than the comparison group by 0.48 points.
- Unpaired t-tests were performed. These results were statistically significant.



- STEM Hub participants reported more marine, engineering, and environmental science career knowledge than the comparison group. The average response was 0.44 points higher.
- Unpaired t-test were conducted on the results for the STEM Hub participants and the control group. The results were statistically significant.

Observation Checklist
for High-Quality Professional Development Training

(Modified for BOP Training Sessions)

The *Observation Checklist for High-Quality Professional Development*[1] was designed to be completed by an observer to determine the level of quality of professional development training. It can also be used to provide ongoing feedback and coaching to individuals who provide professional development training. Furthermore, it can be used as a guidance document when designing or revising professional development. The tool represents a compilation of research-identified indicators that should be present in high quality professional development. Professional development training with a maximum of one item missed per domain on the checklist can be considered high quality.

Date:	Location:
Topic:	Presenter(s):
Number of Participants:	Observer:
GRANT NAME: ITEST STEM+C OTHER	

1. Provides a description of the training with learning objectives prior to training • *EXAMPLE 1: Training description and objectives e-mailed to participants in advance* • *EXAMPLE 2: Training description and goals provided on registration website* • *EXAMPLE 3: Agenda including learning targets provided with materials via online file sharing before training*	
Evidence or example:	
2. Provides readings, activities, and/or questions in accessible formats to think about prior to the training • *EXAMPLE 1: Articles for pre-reading e-mailed to participants in advance* • *EXAMPLE 2: Book for pre-reading distributed to schools before training* • *EXAMPLE 3: Materials made available via online file sharing*	

Evidence or example:	
3. Provides an agenda (i.e., schedule of topics to be presented and times) before or at the beginning of the training • *EXAMPLE 1: Paper copy of agenda included in training packet for participants* • *EXAMPLE 2: Agenda included in pre-training e-mail*	
Evidence or example:	
4. Establishes rapport with participants from the beginning of the session • *EXAMPLE 1: Trainer gives own background, using humor to create warm atmosphere* • *EXAMPLE 2: Trainer praises group's existing skills and expertise to create trust* • *EXAMPLE 3: Trainer uses topical videos to break the ice with the audience* • *EXAMPLE 4: Trainer refers to experiences from a previous session*	
Evidence or example:	
5. Connects topic to participants' context • *EXAMPLE 1: Trainer connects content to participants' curriculum and classrooms* • *EXAMPLE 2: Trainer shares participating district data profiles and asks participants to consider how the intervention might affect students* • *Example 3: Trainer shows examples from classrooms, then asks participants to compare the examples to what happens in their school*	
Evidence or example:	
6. Content builds on or relates to participants' previous professional development • *EXAMPLE 1: Trainer refers to or builds on content provided in previous trainings within the sequence* • *EXAMPLE 2: Trainer uses participants' knowledge of other interventions or experiences to inform training*	
Evidence or example:	

7. Aligns with organizational standards or goals • *EXAMPLE 2: Trainer refers to STEM+C data or computer science goals* • *EXAMPLE 3: Trainer refers to program goals of student motivation toward STEM careers* • *EXAMPLE 4: Trainer aligns content with grade level standards or Scope and Sequence* • *EXAMPLE 1: Trainer refers to the program as part of a federally-funded grant*	
Evidence or example:	
8. Emphasizes impact of content (e.g., student achievement, family engagement, client outcomes) • *EXAMPLE 1: Participants brainstorm the ways the intervention will impact students and student interest in STEM careers* • *EXAMPLE 2: Trainer uses data to show that the intervention is shown to positively impact post-school outcomes or positively impacts future STEM engagement.* • *EXAMPLE 3: Trainer shares research that shows that the use of the instructional strategies improved academic achievement for students*	
Evidence or example:	
9. Builds and reiterates shared vocabulary required to implement and sustain the practice *EXAMPLE 1: Trainer has participants work together to formulate definitions of the intervention components and then goes overs the definitions as a group* *EXAMPLE 2: Trainer defines instructional practices according to program goals.* *EXAMPLE 3: Trainer ensures everyone has the same understanding of what's being addressed.*	
Evidence or example:	
10. Provides examples of the content/practice in use (e.g., case study, vignette) • *EXAMPLE 1: Trainer provides video examples of the intervention in place within classrooms at different grade levels* • *EXAMPLE 2: Trainer provides hands-on demonstrations of how to use new technology tools* • *EXAMPLE 3: Trainer uses a case study to demonstrate how to implement the intervention* • *EXAMPLE 4: Trainers use role play or model practices for participants*	

Evidence or example:	
11. Illustrates the benefits of the material, knowledge, or practice to the participants' context. • *EXAMPLE 1: Trainer describes how the intervention will benefit schools/classrooms* • *EXAMPLE 2: Trainer elicits participants' ideas about how they feel their students could benefit* • *EXAMPLE 3: Trainer presents a case study of a teacher who has successfully implemented the intervention*	
Evidence or example:	
12. Includes opportunities for participants to apply content and/or practice skills during training. • *EXAMPLE 1: Trainer has participants perform a mock lesson using the new instructional strategy* • *EXAMPLE 2: After receiving training on how to complete an activity, participants practice completing the activity with a sample case* • *EXAMPLE 3: Participants practice identifying various instructional strategies from sample videos*	
Evidence or example:	
13. Includes opportunities for participants to express personal perspectives (e.g., experiences, thoughts on concept) • *EXAMPLE 1: Participants use their experiences and prior knowledge to fill in a worksheet on the advantages and disadvantages of various instructional approaches* • *EXAMPLE 2: Participants work together to strategize ways to overcome barriers to implementation in their school* • *EXAMPLE 3: In groups, participants share personal and professional experiences related to the topic.*	
Evidence or example:	
14. Facilitates opportunities for participants to interact with each other related to training content • *EXAMPLE 1: Participants independently answer questions, then discuss those answers as a large group* • *EXAMPLE 2: Participants work in groups to assess implementation progress in their building* • *EXAMPLE 3: Participants think/pair/share about questions within the training*	
Evidence or example:	

15. Adheres to agenda and time constraints • *EXAMPLE 1: Breaks, lunch, and dismissal occur on schedule according to written or verbal agenda* • *EXAMPLE 2: Trainer adjusts training content to accommodate adjustments to agenda (e.g. participants arriving late due to inclement weather)*	
Evidence or example:	
16. Includes opportunities for participants to reflect on learning • *EXAMPLE 1: Participants strategize how to apply the knowledge from the training in their own schools* • *EXAMPLE 2: Participants record 3 main points, 2 lingering questions, and one action they will take* • *EXAMPLE 3: Green, yellow, and red solo cups at tables used to visually check for understanding at key points throughout training*	
Evidence or example:	
17. Engages participants in assessment of their acquisition of knowledge and skills • *EXAMPLE 1: Post-test to assess trainees' grasp of learning objectives* • *EXAMPLE 2: After guided practice on how to complete an observation form, participants use the form to individually rate a video example and compare their responses to the trainer* • *EXAMPLE 3: Participants complete performance based assessment, illustrating that they have mastered the learning targets.*	
Evidence or example:	
18. Offers opportunities for continued learning through technical assistance and/or resources • *EXAMPLE 1: Trainer describes future trainings and explains how training fits into the series* • *EXAMPLE 2: Trainer provides contact information for technical assistance including e-mail address and phone number* • *EXAMPLE 3: Trainer shows participants where to find additional materials and readings on the project website*	
Evidence or example:	

[1] Noonan, P., Gaumer Erickson, A., Brussow, J., & Langham, A. (2015). *Observation checklist for high-quality professional development in education* [Updated version]. Lawrence, KS: University of Kansas, Center for Research on Learning

Authors' Note:

This checklist is not designed to evaluate all components of professional development, because as Guskey (2000) points out, professional development is an intentional, ongoing, and systemic process. However, training (e.g. workshops, seminars, conferences, webinars) is the most common form of professional development because it is "the most efficient and cost-effective professional development model for sharing ideas and information with large groups" (p. 23). Therefore, this checklist is designed to improve and evaluate the quality of training.

References

Archibald, S., Coggshall, J. G., Croft, A., & Goe, L. (2011). High-quality professional development for all teachers: Effectively allocating resources (Research and Policy Brief). Retrieved from National Comprehensive Center for Teacher Quality website: http://www.tqsource.org/publications/HighQualityProfessionalDevelopment.pdf

Cooper, J. D. (n.d.). *Professional development: An effective research-based model.* Houghton Mifflin Harcourt. Available at http://www.washingtonstem.org/STEM/media/Media/Resources/Professional-DeveloPment-An-Effective-Research- Based-Model-COOPER.pdf.

Duda, M. A., Van Dyke, M., Borgmeier, C., Davis, S., & McGlinchey, M. (2011, February). *Evidence-based professional development*. Presented at the 2011 State Personnel Development Grants Regional Meeting, Washington, DC.

Dunst, C. J., & Trivette, C. M. (2009). Let's be PALS: An evidence-based approach to professional development. *Infants & Young Children, 22*(3), 164-176.

Guskey, T.R. (2000). *Evaluating professional development.* Thousand Oaks, CA: Corwin.

Hunzicker, J. (2010). Characteristics of effective professional development: A checklist. Unpublished manuscript, Department of Teacher Education, Bradley University, Peoria, Illinois.

Joyce, B., & Showers, B. (2002). *Student achievement through staff development* (3rd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy*. New York: Cambridge. Knoff, H. M. (2011). Arkansas SPDG research-based professional development: Evaluation form. Unpublished instrument. Learning Forward. (2012). Standards for Professional Learning. Retrieved from, http://learningforward.org/standards-for-professional-learning#.U-EvhPldXFo.

National Research Council. *How People Learn: Bridging Research and Practice*. Washington, DC: The National Academies Press, 1999.

Trivette, C. M., Dunst, C. J., Hamby, D.W., & O'Herin, C. E. (2009). Characteristics and consequences of adult learning methods and strategies (Winterberry Research Synthesis, Vol. 2, No. 2). Asheville, NC: Winterberry Press.

Wei, R. C., Darling-Hammond, L., & Adamson, F. (2010). *Professional learning in the United States: Trends and challenges.* Dallas, TX: National Staff Development Council.

This evaluation instrument was developed under a grant from the US Department of Education, #H323A120018. However, those contents do not necessarily represent the policy of the US Department of Education, and you should not assume endorsement by the Office of Special Education Programs.