



Hannah Nolan,  
Danielle Miller,  
Tracy Crews,  
Flaxen Conway

## Promising Practices and Considerations for RCRV Outreach and Education

Lessons Learned from Research on How the Next Generation of Regional  
Class Research Vessels Can Support Equitable Data Literacy Education.

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## Introduction and Background

In 2013, The U.S. National Science Foundation (NSF) selected Oregon State University (OSU) as the lead institution to oversee the design and construction of three new Regional Class Research Vessels (RCRVs). The RCRVs are a new class of monohull, diesel-electric research ship designed with advanced capabilities for next generation, interdisciplinary, oceanographic operations in areas from coastal bays and estuaries to the deep ocean beyond continental margins. Onboard instrumentation such as multi-beam sonar and dynamic positioning systems, advanced anti-roll systems, and a focus on energy efficiency throughout ship design will allow for a smoother, safer, and more efficient research cruise.



*Figure 1: Artistic Rendition of the R/V Taani*

Three RCRVs are currently being built with funding from NSF for operation within the U.S. Academic Research Fleet (ARF) and as part of the University-National Oceanographic Laboratory System (UNOLS). UNOLS is an organization with a membership in 2020 of 59 academic institutions and National Laboratories involved in oceanographic research, and it assists in the coordination and scheduling of the ARF and associated research facilities. The current ARF has a number of vessels that have been in operation for over 30 years with a variety of associated issues including dated technology, which impact the effectiveness and efficiency of scientific research. As a result, at least three vessels are scheduled to be retired to make room for the RCRVs. The new RCRVs will increase efficiency and the ability to address stakeholder needs, as they are equipped with advanced technology, such as datapresence capabilities.

Datapresence refers to the capability of live-streaming data from a suite of shipboard instruments; something not routinely available in the existing ARF. The new RCRVs will have the ability to transmit data to shore with very little delay which allows for land-based research crews to participate in real-time. It also allows other stakeholders a unique view into research at sea. Real-time data are not to be confused with "near real-time data," which generally means data that receives more quality control and formatting, thus, takes longer to become available to those interested. Telepresence,

or the ability to transfer live video feeds, is another technology currently utilized by other research and exploration vessels. Telepresence has proven effective for engaging classrooms and the general public with ocean exploration as seen through the work of the Ocean Exploration Trust, NOAA's Okeanos Explorer, and the Schmidt Ocean Institute (Marlow et. al, 2017).

Datapresence technologies enable virtual participation, situational awareness, and adaptive sampling at sea. The RCRVs will contain a network that is able to integrate data from their broad suite of ocean and meteorological sensors, and to facilitate data visualization and shore-side participation through satellite communications with shore-based computing systems as well as groups of investigators and educators. Simply described, datapresence is a way to communicate data from the ship to the shore. Datapresence will involve the creation of a public data-portal and subsequent outreach and education (O&E) materials and strategies that allow people to access, interpret, and use this data.

The datapresence capabilities also provide a unique opportunity to foster equitable collaboration between researchers, teachers and students – in an effort to situate them with the skills they need to support both ocean research and data literacy. These skills are critical in today's data-saturated world, where the public has ever-increasing access to data. The US currently exists in a "data economy" in which exponential amounts of data are placed unanalyzed into repositories. There is a national call to turn the data economy into a "knowledge economy" in which data is utilized in actionable decision making and information discovery. Transforming the data economy into a knowledge economy will require a *data literate workforce* (Manyika et. al, 2011). Furthermore, jobs requiring high-level data literacy skills are projected to grow 22-33% by 2030 (U.S. Dept. of Labor Statistics). With this growing industry need, it is important that researchers and educators learn practices that support equitable collaborations between researchers, teachers, and students, and that ocean data serves to broaden participation in the booming "data economy."

The overarching O&E goal of the RCRVs is to improve science, the sharing and use of ocean science data between scientists and others, and to facilitate ocean science education and workforce development. **But what exactly is the best way to do this?** A team of O&E specialists and researchers was established to design and implement an O&E plan to address this question through three O&E goals:

1. ***Educator Professional Development and Student Engagement:*** To develop educational materials useful for educators that show how scientific observations made at sea are the crux of understanding, discovering, tracking and predicting

natural- and human-impacted processes within the ocean and its boundaries with land, atmosphere and seafloor environs.

2. **Researcher Education and Professional Development:** To build and maintain effective infrastructure services aboard each RCRV ship that can enable each science party to set and achieve meaningful broader outreach and education goals seamlessly and with minimal costs.
3. **Public Education:** To develop or contribute educational programs and exhibits that help the public understand the importance of the ocean to the world, country, and local communities.

One of the integral parts of this O&E plan was to bring onboard two OSU Marine Resource Management graduate research assistants from 2017-2020 to conduct research that focused on how to meet the overarching goal. This report shares the highlights from this research and begins to lay out the commitment of time and other resources needed to create and implement O&E that is *effective* (in that it improves understanding and brings together scientists, educators, and students in the pursuit of a more data-literate society) AND *inclusive* (in that it recognizes that O&E needs to be culturally responsive and employ strategies that engage diverse audiences).

## The Data Stream and Data-Portal Design

Our research clearly indicated that it's important to understand the "data stream." Think of the data stream as a cyclical system (see Figure 2). Simply, the data stream begins with data being supplied by scientists. This data then flows to educators who can then teach it to students. As the students begin to understand and use data, they increase their understanding, thereby gaining data-literacy skills in order to participate in the future workforce; some of them will become the scientists of tomorrow. In this way, it becomes a cyclical system. All stakeholders (e.g., scientists, educators, and students) in the data stream make decisions (e.g., what data to collect, what tools to use, and/or what data portal to use) that affects how others see, access, use, and interpret the data collected upstream.

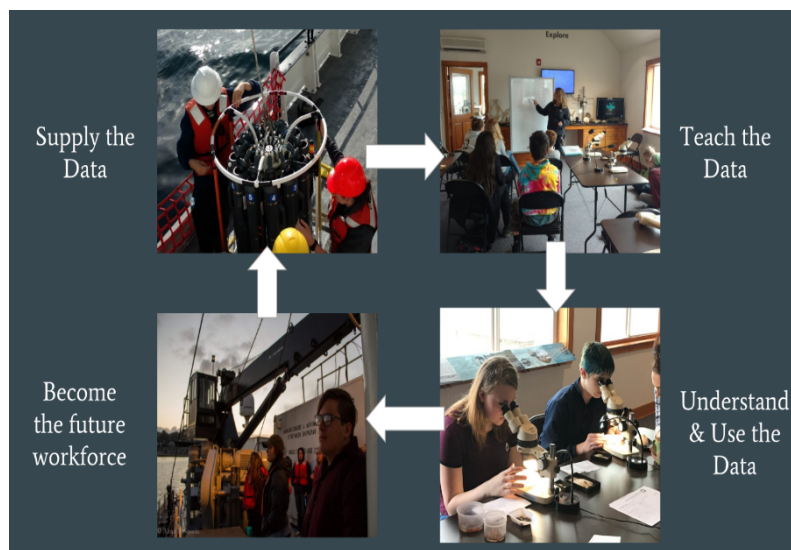


Figure 2: The Data Stream

The data stream connects learning, teaching, and research settings. The common strategy is to use a data-portal: a webpage with a user interface that displays data in an interactive way. Stakeholders can access the data and use it in their related work as researchers, educators, and students. Therefore, how a data-portal and user interface is designed is critical for ensuring access and usability for all stakeholders.

There is no “one-size fits all” when it comes to data-portal design. While the goal is to increase access and ease of use, a data-portal designed for scientist-to-scientist communication and data sharing would not be accessible as a data-portal (and web page) designed for educators, classrooms, and other learning environments. This is because a scientist-to-scientist data-portal requires a high level of data literacy. This kind of portal presents loosely structured datasets with ill-defined problems the data are related too. Whereas a scientist-to-teacher and student data-portal is designed to support and build on lower levels of data literacy. Scientist-to-teacher and student data-portals must also have supporting online educational resources; resources that are complete, engaging, and readily usable for teachers and students as is.

These additional O&E resources and supports ensure *all* stakeholders (scientists, educators, and students), regardless of their level of data literacy, can access and utilize the available oceanographic data and develop an interest in data-driven ocean related careers. Thus, while the design of the data-portals is vital to the success of the RCRV project and academic research, robust data literacy curriculum on how to use and interact with the portal is needed to equitably support teacher and student access and data literacy.

## Data Literacy

The term data literacy refers to the ability to find, interpret, and use data. Making the data accessible via a data-portal does not address one’s ability to interpret and use the data. Data literacy is an emergent literacy that supports scientific and statistical literacy. Many US citizens have been classified as having poor scientific literacy; the ability to comprehend how data is transformed into useful information (Bishop, Thomas, Wood, & Gwon, 2010). There continues to be concerns that K12 education is not adequately preparing students with either the skills or abilities that they will need to become scientific leaders and problem solvers (National Academy of Sciences, 2007). High school students in particular struggle to find, discern credibility, critically evaluate, or make meaningful connections from data (Brem, Russell, & Weems, 2001; Schmar-Dobler, 2003). Data literacy is incredibly valuable in the modern workforce, especially in the age of big data and the “Open Data Movement.” Data literacy is a skill that is highly valued,

and for which the demand will only continue to grow in today's and tomorrow's workforce.

Our research indicated that there is a gap in data literacy skills within the data stream. That said, K12 education needs to change to meet the needs of the growing data-driven workforce (not just science) that is in need for highly data literate professionals. Beyond the workforce, data literacy is especially pertinent for everyday participation in a democracy. Given the quantity of data the average person encounters, sorting through misinformation and utilizing data in public decision-making is now commonplace. The lack of data literacy (particularly in the US) is significant especially during a time where misinformation runs rampant regarding everything from climate change to COVID-19 and presidential elections.

The topic of data literacy cannot be addressed without acknowledging that demographics of K12 classrooms (tomorrow's scientists and educators) and the national workforce are changing. Today's and tomorrow's workers will reflect the diversity of the population. The US Census Bureau predicts that 45% of the population will be racial and ethnic minorities by 2030 (49% by 2040, and 50% by 2042). Furthermore, in order for the RCRVs and other data-focused projects to recruit proficient data scientists well into the future, broadening student and teacher participation in the data stream is essential.

Historically, geoscience fields have struggled to recruit diverse students and researchers and thus have seen no significant growth in diversity over the past forty years (Bernard & Cooperdock, 2018). The lack of diversity is also a place of lost value, as research points to diversity strengthening collaboration and ingenuity (Johnson et. al. 2016). Geosciences, and other Science, Technology, Engineering, and Math (STEM) fields can change by embracing actions that have proven to support historically underrepresented youth in developing interest in STEM and STEM professions.

While data literacy is a critical skill, there is not a short-term or clearly defined route to ensuring *all* stakeholders adopt practices that support collaboration and building those skills. Given that the overarching O&E goal of the RCRVs is to improve science and data sharing between scientists and others by facilitating ocean science education and workforce development, what can project educators do to ensure that stakeholders will actually use the scientific data shared via RCRVs?

### **How Can RCRVs Support Data Literacy?**

To address this question, our research indicated that it is important to first identify barriers that inhibited stakeholders' access and use of data between each part of the

data stream. To help explore this question further, the RCRV O&E Team implemented planned activities and conducted research on activities that would:

- Provide professional development for **researchers** to increase the effectiveness of their communication, education, and outreach to different audiences, etc. Examples include the science communication workshops conducted at OSU by Dr. Shawn Rowe and those provided by the American Association for the Advancement of Science.
- Provide professional development for **teachers** that increases their efficacy. This includes but is not limited to raising *teachers'* data literacy and helping them to develop lessons and curriculum, which teach *students* about data and the data process. Examples include hosting Monterey Bay Aquarium Research Institute's weeklong Education and Research: Testing Hypotheses (EARTH) workshops at OSU's Hatfield Marine Science Center, the creation of the Oregon Marine Scientist and Educator Alliance, and providing Educator at Sea opportunities on OSU research vessels. As for **students**, our research highlights the importance of scaffolding, relevance, and cultural responsiveness. This includes but is not limited to (1) building curriculum and lesson plans centered on how to find and use data, and how to make data relevant to all students in formal and informal learning environments, and (2) hiring and supporting personnel who are dedicated to this work and/or can ensure that there is at least one member of the RCRVs team who is knowledgeable about effective O&E and will be able to continue the work. Another option is to collaborate with others who are skilled and committed to this. Examples include Oregon Sea Grant, and OSU's SMILE (Science Math Investigative Learning Experience) and Juntos programs.
- Develop or contribute educational programs and exhibits that help **the public** understand the importance of the ocean to the world, country, and local communities. A RCRV exhibit was created for the OSU Hatfield Marine Science Center's public wing. The exhibit includes a simulator that allows participants to pilot an RCRV vessel under various conditions and scenarios. In addition to providing hands-on engagement with ship technology, this exhibit also highlights the diverse crew and researchers associated with these vessels. A variety of public outreach activities at festival-type events and open houses introduce the RCRVs, associated technology and research capabilities, and engages participants in hands-on activities to deepen engagement and understanding.

### Ensuring Data Literacy is Accessible and Inclusive

Our research strongly suggests that providing data and combining it with outreach will not automatically ensure *all* students, teachers, or other stakeholders develop data literacy skills. We must acknowledge and remediate structures of white supremacy



within our institutions, including education, which actively undermine the success of non-white people. While RCRV O&E will not solve systemic racism, leveraging educational strategies proven to meet the needs of our diverse students and the teachers who teach them will be a way we can work to support a more equitable society. This can be encouraged through designing *culturally responsive* programming that engages students from many backgrounds in career connected learning.

In this endeavor, it is important for all stakeholders to acknowledge that it is impossible to know everything when embarking on this work. In order to create equitable partnerships and broaden participation in ocean sciences, we need to continually learn from students and educators to enhance the vitality of the data stream needed to build data literacy skills. For example, when facilitating teacher professional development or student instruction, O&E should:

1. Focus on what each stakeholder needs to be successful. Consider what is best for a teacher, best for a student, and/or best for a researcher.
2. Focus on how to make the experience relevant to them. Consider how to tailor each of their experiences to be engaging for them.
3. Focus on making sure the project is designed *with* teachers, students, and researchers (or other outside organizations) *and NOT for* teachers, students and researchers. Consider building collaborative partnerships that are representative of the communities the project is attempting to impact.
4. Focus on how the project's ongoing work supports each partner to meet their community goals. Consider how the collaboration can support stakeholders' goals in their community.
5. Focus on using boundary spanners (e.g., community members or partners) to build on-going collaborations with each community. Consider who can connect with these communities, inform the ongoing work, and share the ongoing impacts of the project.
6. Focus on the reality that technology access can also be an issue. Consider that low-income schools are less likely to have access to high quality technology for supporting data literacy.

In action, the RCRV O&E team, through Oregon Sea Grant and the Oregon Coast STEM Hub, was able to provide immersive onboard ship opportunities by collaborating with those who serve historically underrepresented youth. For these at sea research experiences, tribal and EEL (Ever English Learners) educators were recruited to engage cohorts of high school seniors in daylong research cruises. The cruises took place onboard OSU operated research vessels. Participating students engaged in onboard research, learned how research vessels support mainland science, and engaged with OSU crew. Post-cruise surveys showed that participating students experienced an

increased in both STEM knowledge and interest. In addition, several students took the initiative to seek out additional job shadowing opportunities and internships with participating researchers. This further demonstrates the impact of these programs, which are worthy of implementing on a larger scale as nearly all ARF vessels engage in some form of onboard O&E with students.

## Meeting the RCRV O&E Goal

The overall O&E goal of the RCRVs is to improve science and data sharing. Scientists are data experts, but in order to effectively share data, an understanding of complexities in the data stream is needed. Our research indicated that understanding the data stream should be foundational to outreach efforts designed to build data literacy and should be included in researcher professional development.

The research undertaken sought to identify promising practices of using oceanographic data in education and outreach efforts to support the facilitation of data literacy of all stakeholders. After a careful review of relevant literature and practice, a grounded theory research project was designed and implemented. Forty-five people were interviewed including teachers, researchers, and experts in the fields of data literacy and shipboard outreach. The interviews included an in-depth examination of how this work may be done equitably and inclusively for underrepresented students in geosciences. The interviews alongside an examination of current practices were compiled into the following recommendations for how the new RCRVs can effectively support equitable data literacy education.

Presented below in more detail are the challenges and potential solutions identified in the research. We believe that incorporating lessons learned from this research can help mitigate future challenges, can be used to implement solutions, and improve the understanding of all stakeholders involved in the RCRV project as well as those engaged in broader O&E efforts in the geosciences.

## Challenges and Solutions

The remainder of this document presents the four broad challenges identified in this research. For each challenge presented, there are a series of research-based, promising solutions.

## Challenge 1: Low National Data Literacy, Workforce Needs, and Participatory Democracy

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*“A lot of the times we start in the middle of the process and then we ignore the fact that there's all this messy human stuff that came before that. I think a high-quality data literacy activity introduces the whole process and it gives you time and space to do that process well.” ~ A Data Literacy Expert*

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In today's connected world, data is integral to most aspects of our daily lives; whether you are a scientist or not. Waking up to check a social media feed, the weather, or a traffic report for your morning commute – all these actions and your responses are driven by data. The availability of data in the United States is growing rapidly, as is the demand for a society that has the necessary skills to interpret and evaluate data (Building Global Interest in Data Literacy: A Dialogue Workshop Report, 2016). This ability to make sense of data is a desirable skill by many employers, and jobs requiring high level data interpretation skills are anticipated to grow 23% by 2020 (US Department of Labor Statistics).

Beyond the need for a data literate workforce, understanding and interpreting data is essential for democratic participation. A large swath of publicly available data is currently collected and is utilized for decision-making within city, state, and federal government. There has been a strong call for “data-driven decision-making” across institutions from education to business. One of the skills which makes a person data literate is the ability to evaluate the validity of data, which is especially important when data may be used in community decision-making (Deahl, 2014).

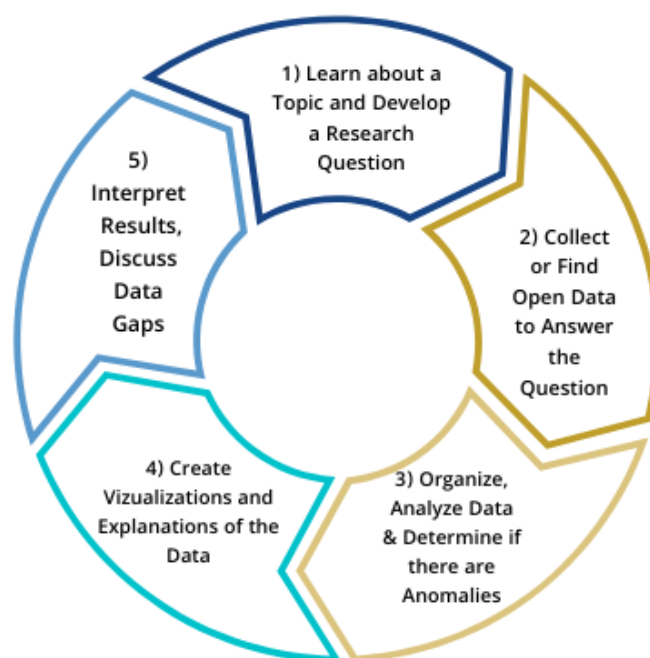
The RCRVs are poised to facilitate the creation of curriculum and activities to support K12 student's data and ocean literacy development across the United States. Oceanographic data is a vital tool for building student's ocean literacy, another underdeveloped literacy in the United States. Ocean literacy is a person's ability to contextualize the value the ocean has for the planet both environmentally and economically, and how a person's actions may directly affect the ocean (Borja et al., 2019). The term was adopted in the early 2000s by a group of marine scientists and educators to describe the lack of and need for ocean education in K12 schools in the United States. The term has been subsequently adopted globally (Borja et al., 2019).

Oceanographic data helps advance ocean literacy and data literacy by helping students understand how to utilize and analyze data, while learning about the vital role the ocean plays in our earth's systems and societies (Benway et. al, 2019). The following are recommendations for outreach and education staff to take to support the flow of the "data stream" to researchers, teachers, and students. Understanding oceanographic data is crucial to support students' conceptual understanding of climate change, weather, marine food webs, and renewable energy sources – and the effects of these phenomena on human life.

## Promising Solutions

### *Supporting Scaffolded Learning Throughout Grade Levels by Using the Data Process Model*

Turning data into information is a process and understanding each step of the process takes time. In the ever-evolving world of big data, a student cannot become data literate with a standalone education intervention. Data literacy should be developed as a student moves throughout their educational pathway, just like with other skills students are expected to acquire and refine throughout formal schooling (e.g., writing, mathematical, scientific practices).



*Figure 3: The Model of the Data Process presented as a cycle as informed by expert interviews.*

The data process can be viewed as similar to the scientific method and involves a cycle that includes developing a research question, creating data collection and storage protocols, collecting data, analyzing data, presenting data, and then developing a new testable question (Figure 3). Learning how to develop the skills for each of these steps takes time and effort. When working with teachers and students it should be emphasized that knowing how to do each step in the data process is a skill. These skills may be developed through curriculum which isolates a step in the process or through a lesson which moves through the entire data process, what is important is that learners get multiple opportunities to enact the data process throughout K12 grade bands.

In elementary school, a student may learn how to make observations, develop testable questions and collect data. During middle school, adolescents deepen their understanding by learning how to analyze and interpret data. High school may be the place in which a student demonstrates proficiency by conducting his or her own research. Alongside learning about data through the scientific process, students should also learn skills, which help them utilize large, online databases. Data science is a growing field that requires computer skills and the ability to synthesize information from big data.

It is important that a student understands which step they are learning and becomes proficient in applying each step in context. Some experts interviewed for this report stated that having students conduct their own research projects and analyzing self-collected data is a necessary step in student proficiency. By contextualizing the data process through student-led projects, students may be better able to work with large databases later in their education. Some experts emphasized student-led projects should utilize place-based data that may help them better understand or solve an issue within their community. Place-based data might include:

- A schoolyard biodiversity survey
- Monitoring regional weather data and looking for patterns
- A survey of plastic waste around campus

In order to help facilitate scaffolded learning and data literacy growth, RCRV O&E should focus on developing age-appropriate lessons across the grade levels. Some of these lessons should focus on developing specific data skills while others should facilitate the entire data process. Curriculum, which helps a teacher or informal educator facilitate student-led, place-based research, should also be developed.

## **Standard Aligned Curriculum Development**

Effective lesson plans are a valuable resource for teachers and should be designed to accommodate a variety of subjects, knowledge levels, and aligned to state/national standards. Currently, the lesson plans offered by the RCRV O&E team are single activities aligned to the Next Generation Science Standards, and range across a variety of topics such as ocean acidification, ship engineering, and marine debris.

All lesson plans should be available for download through a public website. Teachers interviewed for this report stated when seeking out curriculum they typically search by grade level first and then look for the content that helps them meet a learning goal. Once current lesson plans have been organized, the following considerations should be considered when designing future activities. Suggestions for improving the usability of a teacher resource site include grouping lesson plans by grade level and by either subject or topic/issue, similar to NOAA's Data in the Classroom Portal. Furthermore, all lessons should be designed to meet specific learning goals for the appropriate grade level and address the appropriate state standards. To fully support data literacy of students, lesson plans that foster learning using student-collected data, "canned data", and real-time data should be created and implemented.

An example of potential data for a lesson could be archived data from a CTD. Through CTD data, students could learn about how water quality affects the ecosystem, practice graphing temperature and salinity against depth, infer the relationship between the three measurements, and learn about water quality research. Once students finish this activity, they may be better equipped to comprehend the RCRV real-time data.

All lessons stored on the website should be tested and evaluated by teachers for effectiveness. Teachers can be powerful collaborators for developing lesson plans, since they comprehend the learning needs within their classrooms and should be included in curriculum development when possible. Currently, lesson plans are piloted with SMILE and Oregon Coast STEM Hub teachers, who potentially have a higher interest and use of data in the classroom. Other teachers outside of these programs should be included in the review and collaboration process, to accurately reflect the broader teacher population.

## **Teacher Professional Development**

Data-focused professional development opportunities for educators are crucial to the success of the data-focused education and outreach efforts. The review of eight years

of Monterey Bay Aquarium Research Institute (MBARI) EARTH educator workshop pre surveys, as well as the 2018 post surveys provided insight on what was attractive about these data focused workshops, how teacher's comfort levels using data changed over the course of the workshop, and how teacher's perceived knowledge about oceanographic topics changed over the course of the workshop. These two data sets combined with teacher interviews support the following recommendations for data-focused professional development activities:

- The event ideally would take place in late June, when teachers are finishing their current school year, or August, as they prepare for a new school year
- The duration of the event should last over multiple days, preferably lasting 3-5 days
- The attendance should be kept to an average of 20 teachers, in order to provide them with individual support
- To attract teachers to the event some sort of incentive should be offered, for example:
  - Stipends
  - Take-home materials (lesson plans, contact information and branded materials, like stickers)
  - Provided Meals
  - Opportunities to collaborate (with researchers and/or other teachers)
  - Field trips or excursions (for example, touring a research vessel)
- Introduce teachers to oceanographic research, particularly focusing on local topics or issues
- Teach between 1-3 data-focused lesson plans step-by-step with teachers, walking them through each activity and allowing them to ask questions as they progress. Step by step instructions on where to locate data and navigate any websites should be included.
- Maintain contact with "learning cohorts" post workshop to answer questions, request feedback on the workshop, and provide additional support
- In order to enhance engagement with underrepresented or under-resourced populations, teachers who serve in Title I or predominately minority serving schools should be engaged with and invited
- Applications may include questions on commitments to diversity, equity, and inclusion in order to recruit teachers dedicated to creating culturally responsive classrooms

## **Scientist Professional Development**

Researchers utilizing the RCRVs are necessary partners in helping facilitate data literacy education. Researchers can collaborate with education specialists to translate their data into a useable format for K12 students. Researchers possess expert level knowledge, which may be hard for students to comprehend. The following are proven strategies in which researchers can help facilitate data literacy education.

### *Professional Development Opportunities (Meeting & Webinar Format)*

Future professional development opportunities should be valuable for not only researchers at OSU, but also other researchers and those utilizing RCRVs in their research efforts. The professional development (PD) should focus on introducing researchers to what level of language and attention is appropriate for a variety of audiences.

For example, introducing researchers to a variety of outreach techniques including utilizing social media, informal engagements like pub talks, as well as teaching in a formal learning environment. This could potentially lead into coverage of the Next Generation Science Standards, giving researchers a background on what students should theoretically already know by the time they have reached a certain age, as well as education goals for various grade levels. It is also essential that researchers understand what constitutes useful data as identified by teachers so they can design data-focused learning activities in a format that tells a story while also being easy to utilize.

Once a foundational relationship has been established, researchers should work collaboratively with each other and education professionals to design activities based around their own work. PD providers stated that PD opportunities are most effective when workshops are spread across a few days and participants are provided time for collaboration and reflection.

A 2004 study identified best practices for communication workshops geared toward scientists, which utilized the following structure:

- Opening with a question of interest,
- Prior knowledge discussion or assessment,
- Exploration through experiments/experiences,
- Reflection on results, and
- Application of learned concepts to new situations.



The acronym for the format structure is OPERA (Morrow & Dusenberry, 2004). RCRV O&E could use a similar four-day design structure, and a potential professional development-meeting schedule could be:

- Day 1: Welcome, Introduction to Outreach Efforts, Assessing Misconceptions
- Day 2: Informal Learning and Formal Learning Environments
- Day 3: State Standards
- Day 4: Applying Skills: Designing Activities Using Your Research

Researchers interviewed for this report expressed a lack of time as a key barrier. Researchers may struggle to find space in their schedules for attending PD opportunities. A more convenient PD format for researchers may be a webinar series. Webinars focused on science communication are a commonly used method for programs, such as those sponsored by the American Geophysical Union, American Water Resources Association, Materials Research Society, National Oceanic and Atmospheric Administration (NOAA), and the University-National Oceanographic Laboratory System (UNOLS). Webinars could be focused on a variety of topics surrounding K12 outreach. Webinars should be posted to a website for researchers to access at their convenience. In a 2015 study regarding the way scientists could achieve broader impacts through K12 collaboration, researchers identified the importance of supporting knowledge regarding K12 in scientists, as well as encouraging scientists to collaborate with teachers (Komoroske et. al., 2015). These findings help to inform this list of possible webinar topics:

- 1: Overview of Topics & Introduction to Outreach Techniques
- 2: Focus on Informal Learning
- 3: Focus on Formal Learning
- 4: Introduction to NGSS
- 5: Working with Teachers
- 6: Designing Your Own Activities

### *Outreach Quick Guides*

For researchers who are already confident in outreach, interested in a particular outreach topic, or just don't have the time for a meeting or webinar, providing a series of short guides via a website is a third option for providing the information. The guides would be a compilation of information listed above, albeit in a condensed format. Additional resources in the guide such as example activities, FAQ's, videos, and "how to" information could be provided in order to supplement the condensed information. The University Navigation Satellite Timing and Ranging Consortium (UNAVCO) offers a similar resource to this, offering a series of worksheets and handouts covering topics

such as, planning for a social media strategy, tips for communicating their science broadly, and assistance in mapping how scientists research may connect with a potential audience (see *Science Communication / Education*).

### *Science Outreach Aboard Research Vessels*

#### **1) *Data Biographies and Dictionaries***

Prior to expeditions researchers should be encouraged to fill out a data biography and create a data dictionary. The Data Biography should include information about the researcher, why they are collecting the data, what anomalies and trends to look for in the data, etc. A data dictionary may include definitions of acronyms, tools used, and explanations of the metadata.

#### **2) *Ship to Shore Experiences***

The E/V Nautilus, R/V Falkor, and JOIDES Resolution all facilitate scientist in the classroom experiences in which scientists are broadcasted live into a K12 classroom or to an interest group. Activities and personnel interacting with the students vary depending on the learning goals of the teacher. All research vessel communication specialists interviewed stated that high-tech equipment and a crisp video feed are not essential. In fact, a lower quality video feed is more true to what it is like to speak to a scientist broadcasting from the middle of the ocean. Low quality video creates an experience in which students feel like they are talking to someone in the middle of the ocean. The E/V Nautilus has a communication guide for their staff to follow for student in the classroom experiences.

#### **3) *Humanizing Scientists***

Scientists aboard the research vessel should be presented as community members and regular people. This will help students grasp that people who have developed expertise in their respective fields collect the data they are using. This could be done through online biographies about the scientists on board the vessel. The biographies could include their journey to becoming a scientist, hobbies, and something that they are excited to learn about while on their voyage. E/V Nautilus and R/V Falkor both maintain webpages with the biographies of each expedition's science party.

## Challenge 2: Broadening Participation in the Geosciences through Outreach and Education

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*“To create an environment that's representative of the success of underrepresented students of color is special. Obviously, it can be done, (but) it takes, first of all, accepting there's a problem.” - An Oceanographer/ DEI Specialist*

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The geosciences are reported to have the lowest proportion of doctoral degrees awarded to minority groups of all academic STEM programs in the United States (Bernard & Cooperdock, 2018). In 2016, only 6% of PhDs awarded in the earth, ocean, and atmospheric sciences for permanent US residents were given to people who identify as Black, Latinx, or Native American. Only 3.8% of tenure or tenure-track faculty in the top 100-geoscience programs in the U.S. identify as non-white (Dutt, 2020). Research vessels are a vital tool for many geoscientists. Creating a research vessel O&E culture and actionable practice which supports diversity, equity and inclusion is a step towards broadening participation in the geosciences. For geoscience learners from non-dominant groups, equity starts by having access to learning opportunities while using data in ways that are relevant and useful to them.

As previously stated, data literacy is a necessary skill for all youth in the modern workforce and creating tools and education materials, which facilitate this learning, is crucial (D'Ignazio & Bhargava, 2016). Through effective O&E efforts, RCRVs may spur interest in geosciences and empower students to gain data skills they will need to understand and potentially contribute to the geosciences.

The RCRVs may spark interest in the geosciences for minoritized youth through specifically designed education programming. This work requires intentional community engagement, which in turn requires institutional change (Miriti, 2020).

The following are recommendations from twelve expert interviews on how research vessel and data literacy O&E may be more equitable. One key theme emerged from these interviews around fostering inclusivity. Providing youth ownership in the learning space is critical in order to create an inclusive environment and broaden participation in the geosciences, as well as other STEM fields. The following recommendations were gleaned from expert interviews and are also supported by current literature on culturally responsive teaching and data teaching strategies geared towards culturally and linguistically diverse youth.

## Promising Solutions

### *Investing in Collaborative Partnerships*

Building and maintaining relationships with leaders from communities that have historically been locked out of the geosciences and most STEM professions, such as Black, Latinx, and Indigenous communities, will be vital for creating programming and curricular resources relevant to youth from these communities. Leaders embedded in these communities are better equipped to support the development of effective relationships with stakeholders from these communities, and to recruit youth in learning about ocean science. These leaders may also possess a clearer understanding about the topics and activities students may respond to positively. Collaborative partnerships could include having community leaders from these groups lead workshops for the RCRV team, the RCRV staff participating in community events as appropriate, and co-collaborating on projects (Bevan, Calabrese & Barton, 2018).

The OSU RCRV O&E team already has a designated partnership with SMILE, which provides professional development for science teachers, hosts family science nights, and supports afterschool STEM clubs. SMILE primarily serves low-income students of color. A similar partnership exists with the Oregon Coast STEM Hub, which is a collaborative effort of over 60 organizations, aimed at providing and supporting equitable STEM experiences for students living in coastal communities, many of which contain significant populations of migrant and tribal youth. Other potential OSU collaborators could be the Juntos and Gear Up programs, both aimed at college preparation and career connected learning.

Once relationships are established, they must be maintained. Bevan, Calabrese and Barton (2018) state that relationships with co-collaborators must be built into the institution seeking to serve minoritized students. In order to develop and nurture these relationships, workshops and participation in community events should be a regular occurrence as opposed to one off events. Co-collaborators are essential for the effective recruitment of program participants in addition to helping the RCRVs O&E staff comprehend how to design materials for specific audiences. Outreach and engagement staff should investigate local organizations and community leaders in their own regions with which they can build partnerships to help address equity and inclusion in their O&E efforts.

### *Boundary Spanners*

Seeking out community leaders who work as boundary spanners between the geosciences and minoritized communities will also be necessary for the success of

building and maintaining collaborative partnerships. Boundary spanners are people who are able to communicate between two historically divided parties, namely a university and a minoritized group, and work between them to create a common goal. They often are a designated employee of the university or an outside community group who has an understanding of the outreach topic and are a part of the minoritized community. Effective boundary spanners are characterized as communicative, understanding of multiple perspectives, and able to come up with visionary ideas (Adams, 2014).

### ***Experiential Learning Programming***

Experiential learning has been shown to be incredibly influential for shaping undergraduate student's career aspirations in STEM, as well as useful for building student's applicable job skills (Thiry, Laursen, & Hunter, 2011). Examples of experiential learning are lab work, field research, and internships. Entering into experiential learning with a diverse peer group has also been demonstrated to be effective for building student's self-efficacy in pursuing STEM careers (Palmer, Maramba, & Dancy, 2011). Experiential learning may also be a powerful tool for building data literacy, as it contextualizes steps in the data process as students conduct their own research. Several experts interviewed for this report stated students tend to be more invested in learning data analysis when examining data that they collected. Providing experiential learning aboard research vessels for undergrads has been core to many oceanography programs in the United States and has been identified as successful strategy at lower grade levels as well.

### ***Student at Sea Experiences***

Student at Sea experiences which utilize a peer-cohort and a near-peer mentoring model could be an effective strategy for building an interest in oceanographic careers. Student at Sea experiences that are intentionally designed for ethnically diverse groups of students and are led by diverse and knowledgeable staff could be especially powerful for raising interest in oceanographic careers.

Oregon Sea Grant and Oregon Coast STEM Hub ran several Student at Sea experiences for high school and community college students in 2016, 2018, and 2019. The model incorporated multi-level, near-peer mentoring in which both graduate students, ship crew, and scientists mentored student groups. Through sixteen 1-4-day cruises, over 130 high school seniors were actively engaged in rigging, deploying and retrieving oceanographic equipment, sorting samples, entering and analyzing data. Post-surveys demonstrated that the majority of students emerged from the programs with elevated interest in marine careers. Due to the demonstrated effectiveness of this

program, the operating institutions of the RCRVs might consider allotting berths and ship time for student experiential learning aboard the vessels, during research cruises, or in between regularly scheduled research cruises.

Experiential learning does not require fully dedicated O&E cruises; it can be components of regular research cruises as well. However, the previously described O&E cruises were made possible through multiple competitive grants to cover the cost of ship time and other expenses. While UNOLS is not a source of support because their funds come from the agencies, the NSF, state, or university support for student at sea experiential activities could be an effective strategy for maintaining these types of shipboard learning programs.

### STEMSEAS

Science, Technology, Engineering, and Math Student Experiences Aboard Ships (STEMSEAS) is a pre-existing, NSF-funded program which provides experiential learning programs for underrepresented undergraduates aboard research vessels. STEMSEAS is partnered with UNOLS and occurs on NSF-funded ships. The program primarily serves minority students and women and works to recruit diverse mentors for 6 to 10-day research excursions. The program occurs when ships are transiting between research expeditions. Participating students in the program are not required to be declared STEM majors or have an interest in STEM. The RCRV operating institutions could consider collaborating with STEMSEAS.

### Cultivating Mentors

Positive, engaged, and culturally competent mentorship has a strong correlation with maintaining students of color, especially Black and Latinx women, on a pathway to a STEM career. Plentiful research has pointed to the necessity of providing strong and positive mentorship for minorized students as they pursue careers in STEM (Johnson et. al., 2016), and it is important for *all* youth to see others like them succeeding in a career they are engaged in. The RCRV project could potentially cultivate mentors through:

- Trainings and workshops for researchers around effective onboard mentoring for undergraduate and graduate students.
- Developing a manual for chief scientists and PIs on effective onboard mentorship.

Effective mentoring requires a significant amount of time from faculty. Recognition for faculty mentorship may include stipends or awards in order to incentivize the training

and time for developing culturally competent mentors. RCRVs can target programs and faculty that have historically served minoritized youth, while also being active in the geosciences.

### ***Culturally Responsive Activities, Lessons, and Curriculum***

Culturally Responsive Teaching, a framework developed by Dr. Geneva Gay, was developed to effectively support students of color in the United States. Gay's work is an expansion upon Dr. Gloria Ladson-Billing's theory of culturally relevant teaching. Ladson-Billings theorized that in order to foster a culturally relevant classroom, a teacher must require cultural competency from their students, empower their students to be critical of socio-political and economic systems, and demand academic success (Brown, 2017). Gay asserts culturally responsive teaching is "validating, comprehensive, multidimensional, empowering, transformative, and emancipatory (Brown, 2017, pgs 1146-1147)." Gay states that while culturally responsive classrooms will not solve systemic racism and socio-economic barriers, they are a necessary tool in supporting the success of minoritized youth (2018). To consider a classroom or curriculum culturally responsive, indigenous and multicultural ways of knowing are embraced and validated as equal to western practices. Science education in particular has been scrutinized for alienating students from non-dominant populations (Bevan, Calabrese Barton & Garibay, 2018).

Culturally relevant teaching was developed to center and validate the culture of students of color in the United States within the classroom. Gay expanded upon the theory to assert culture is a multi-dimensional component of a student and impacts how students learn and thusly should impact how teachers teach (Gay, 2018). Both pedagogies are typically used in classroom spaces designed to engage culturally and linguistically diverse youth (Muñiz, 2019). Informal learning environments may also be culturally responsive or relevant, if intentionally designed (Simpkins et al., 2017). Culturally responsive teaching strategies have resulted in increased interest, engagement, and academic gains of students that are traditionally not represented in STEM careers. Culturally responsive and inclusive STEM curriculum can be created to be to validate cultural knowledge and practices of specific communities, but there is no certainty the curriculum will be culturally responsive if used by a teacher who does not utilize culturally responsive pedagogy (Brown, 2017).

The RCRV O&E team may support culturally responsive pedagogy through creating intentionally designed programs that utilize appropriate curriculum and teaching strategies, and train program staff on how to apply the pedagogy in their teaching. As culturally responsive curriculum validates multicultural ways of knowing and teaches

students to question socio-economic structure, local and actionable data may be a source for creating culturally responsive curriculum. The following could be applicable topics to develop curriculum around for the Oregon-based team:

- The geological and meteorological conditions that led to the flood of Vanport. This could be followed up by historical and sociological data describing what happened to the Black community in Portland, Oregon after the Vanport flood.
- An in-depth examination into the Dungeness crab fishery in Oregon, the industries it supports, ecological reasons the industry is suffering (hypoxia), and the economic impacts should the industry collapse.
- Consulting with the Confederated Tribes of the Siletz to develop lessons around traditional boat building practices, traditional ecological knowledge (TEK) of Oregon's fisheries like the salmon runs, or TEK on the Cascadia subduction zone. OSU should offer to pay Siletz collaborators for this work if they are approached.
- An examination of microplastics in watersheds and their connection to the ocean. A pilot program was already tested on this topic and curriculum exists. However, there is potential for multiple add-ons like a social science component where students survey classmates on their plastic use or use plastic pollution to examine ocean circulation.

### *Creative Data Literacy*

When designing curricular resources for the classroom, RCRV O&E teams should consider incorporating Catherine D'Ignazio's tactics for Creative Data Literacy (CLD). D'Ignazio outlines five tactics for ensuring data literacy is taught "creatively." The first strategy is working with community-centered data, specifically data that informs the learner about themselves or an issue they are facing. The second strategy is creating biographies for the data, something a data specialist may refer to as "metadata." Data biographies help the learner discern why the data was collected and by whom so they might contemplate the intentions behind the data. Data biographies tie into the third strategy: *make data messy*. Professionals who work with data spend the majority of their time cleaning and organizing it. It is important for students to understand that not all data is useable data (D'Ignazio, 2017).

The fourth strategy is to build or utilize learner-centered tools. D'Ignazio asserts that learner-centered data tools strive to do one thing well, are guided with sample data in order to get the user started, are visually appealing and humorous, and help the student progress onto the next steps of understanding data. D'Ignazio's fifth strategy for creative data literacy is celebrating community-centered creativity in data analysis. How data is utilized may not be what the researcher expects when a non-expert



engages with it. Students may produce data murals, data-based awareness campaigns, data art, or a performance based on data like a skit or a dance (D'Ignazio, 2017).

### **Organizational Commitment**

Committing to Justice, Equity, Diversity and Inclusion (JEDI) goes beyond the efforts of O&E and must also be core values within the institutions operating the O&E initiatives. The literature and expert interviews both elucidate the necessity of addressing systemic barriers within institutions, which inhibits the success of non-white, especially Black, Latinx, and Indigenous people. Several communications specialists were asked what their institutions were doing to engage with minority youth, and all responded they were doing internal work with staff first in order to create a culture conducive to the success of minority students.

Historically, O&E initiatives for non-white students were created to address perceived deficits in the student's community. However, these initiatives come under scrutiny if the operating institution has not done the work to address systemic barriers for non-white within the institution itself (Miritri, 2020). While creating community partnerships and developing specific programming is important for diversifying the geosciences, it is just one component in a long-term effort. Luckily, the three academic operating institutions for the new RCRVs recognize the importance of and seem committed to working towards diversifying the geosciences.

OSU's College of Earth, Ocean, and Atmospheric Sciences (CEAOS) recently revoked the GRE as a requirement for graduate student admissions. CEAOS is the academic branch that will oversee operations of the R/V Taani. No longer requiring GRE scores for admission removes a significant barrier for recruiting minoritized students. Other regions are making changes as well. The University of Rhode Island's Geoscience program signed the "No Time for Silence" pledge, committing to anti-racist practices within their institution. The Louisiana Universities Marine Consortium states that creating opportunities for underrepresented students in the marine sciences is a core value to their mission.

These efforts are certainly commendable; however, there is always more learning and work to be done within the realm of equity and inclusion. Some other tactics recommended by experts may include:

- Hiring outside experts who work in JEDI to conduct an external audit of geoscience programs in order to identify policies and procedures which create barriers for minority success.

- A mandatory in-person JEDI course for faculty and staff affiliated with operating the RCRVs.
- A statement of commitment to anti-racism from UNOLS leadership followed up by the appropriate actions. This would be a continuation of the bold actions UNOLS has done in the past to engage with underrepresented students and investigate sexual harassment aboard vessels.

### *Visibility in Outreach Materials*

Portraying diverse groups of people in outreach and engagement materials is a fundamental step towards demonstrating a commitment to diversity, equity, and inclusion. Imagery of diverse people working about research vessels and in oceanography may help students see themselves in the role of Chief Scientist or ROV Pilot. However, these images must be grounded in reality. Portraying a diverse and inclusive space without having created one is misleading and exacerbates the problem of retaining diversity (Pippet, Essenburg, & Masset, 2013).

One expert interviewed for this research advised that audience-specific visualizations are critical to effective outreach materials. Images that make research vessels seem exciting for middle-class white students might be different from images that are exciting for a non-white, especially working class, students. The expert gave an example of people working on the back-deck of a vessel with hard hats on. This image is commonly used for portraying work aboard a research vessel. However, the image is not dissimilar from visuals of construction work; work viewed as common and achievable for many non-white lower income youth. The expert encouraged research vessel outreach images to be aspirational for non-white kids interested in STEM. People of color should be shown driving an ROV or conducting research in a wet lab, as opposed to just on the deck of the boat with a hardhat on.

### *Social Media*

To reach an even wider audience and spark interest in the RCRVs, appropriate social media platforms should be utilized.

- Instagram can be used to share exciting pictures of the vessel building process, and research aboard the vessel once it is fully operational
- Twitter can be used to share links to research involving the RCRV project, as well as sharing links to blogs and providing general updates
- Facebook could be used to also share pictures and links, but could also be updated with information about educational resources

- Selecting a hashtag to use across all social media channels provides cohesion and makes it so audiences can search for the project with one cue. For example, “#RVTaani”.

### Challenge 3: Website and Portal Design

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*“Available data does not mean accessible data.” ~ A High School Teacher*

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Web-based access to data via data portals has increased in recent years, with the implementation of programs such as Data.gov, the federal government’s open data site. Launched in 2009 by the U.S. General Services Administration (GSA), Data.gov has grown from 47 to over 200,000 publicly available datasets from hundreds of data sources including federal agencies, states, counties, and cities (Kim, 2019). The use of web-based technologies to improve scientific relevance, awareness of oceanographic and stewardship issues, and knowledge of the current state of the oceans appears to be a valuable and feasible option for both researchers and educators (Reed, Payne, & Babb, 2005). Effectively designed sites can allow us to bring real world research experience to teachers and their students (McLaughlin, 2010). Additionally, utilizing websites showcasing authentic data can promote deeper learning of science and math concepts, as well as foster engagement using real-world investigations (McKay, S., Lowes B., McGrath P., Lin E., Leach, M., 2007).

When it comes to successful website design, developers have approximately 50 milliseconds to make a good first impression on those visiting (Lindgaard, Fernandes, Dudek & Brown, 2006). What constitutes a good first impression? According to the 2014 study *Evaluating the Usability of Educational Websites Based on Students' Preferences of Design Characteristics*, usability is key. Researchers identified five areas that are critical to designing a website for the best usability. These areas include navigation, organization, ease of use/communication, design, and content (Hasan, 2014). The Data Science for the Public Good Program (DSPG) at the Social and Decision Analytics Laboratory (SDAL), a part of the Biocomplexity Institute of Virginia Tech, stressed the importance of having a well-designed homepage that displays data categories and a search function (*Criteria for Open Data Portals Offer Best Practices for Websites*, 2016).

## Promising Solutions

### *Separate Portal for Education*

The best way to provide teachers with lesson plans and information about PD opportunities is through a web portal. Ideally, this portal would be linked on the Operating Institution's website, to reduce clicks to content (1-2 clicks maximum) and time spent locating lesson plans or data. If and when the educator portal is completed, a focus group or survey should be conducted on its effectiveness with a diverse group of teachers. Educator interviews and website surveys determined effective education portals possess:

- A link for teachers for additional help, such as "need help?" link which directs to an email form or a live-chat
- Step by step instructions on how to navigate the website, as well as how to locate and download data (if possible, this would be especially helpful in video format)
- Lesson plans organized and searchable by topic, subject, or state standard
- Contact information for someone to answer teacher questions ("connect with us")
- Contact information for researchers interested in classroom participation ("connect with a researcher")
- Information on upcoming professional development opportunities
- Video resources including vessel building efforts, highlights of gear and research techniques, and videos of researchers talking about their work
- Links to any social media pages or blogs
- An email list, where teachers receive information on upcoming events, lesson plans, etc.

### *Build Learner-Centered Data Tools*

Data literacy is best built through tools created for the learner as opposed to the expert. Bharghava and D'Ignazio assert most data tools are built for users with high-level knowledge, as opposed to people attempting to learn. Bharghava and D'Ignazio believe data tools built to support data literacy should be focused, guided, inviting, and expandable. Focused tools teach one thing really well; guided tools have example data and outputs and support the learner at each step; inviting tools are interesting and fun visually; and expandable tools move the learner onto the next step for deeper learning. Other key features of a learner-centered tool were identified from the interviews and include:

- Easy to Find: The portal is easy to find on the website
- Easy to Use: Not much domain expertise is needed for examining the data
- Fun and Playful: The portal is visually appealing for kids
- Facilitates Active Learning: Students are actively learning and investigating instead of just clicking
- Addresses Specific Learning Goals: The portal is built around a concept a student needs to learn
- Utilizes Relevant and Relatable Data: Data is recent and interesting to students

### ***Relevant, Relatable, Contextual Data***

Data literacy experts and shipboard educators both brought up that open data on a web platform is meaningless without context. For many of the experts, context meant the human aspect of data. The web portal may help create context through:

- Data dictionaries: a guide which defines terms and acronyms on the web portal
- Data collection protocol guides: the exact guidelines a researcher is following for collecting the data and an explanation of the technique
- Data biographies: like metadata, information about who is collecting the data and why, what the purpose of the data is, what questions it might help answer, what trends and anomalies to look out for in the data, what the trends and anomalies might mean

Ultimately, students cannot learn from the data if they do not understand the context of the data. If data seems purposeless to a student, without a question or a reason, then the student may lose sight of the reason behind the data collection. While context is crucial, so is making sure students care about the data.

Alongside the need for context when students analyze data, experts insisted that data used in building data literacy should be relevant and relatable. Relevant data was usually referenced as recent data or data which fit the learning need. Both shipboard educator's and data literacy experts interviewed for this report stated that for educational data to be relevant, it should be easy to adapt to a teacher's needs. Teachers are unlikely to use data if it does not help them meet a learning goal for their students. Teachers who work to build culturally responsive classrooms may look to use relatable data for their students. Relatable data could be:

- Local data (Ex. watershed data, schoolyard data, neighborhood data)
- Current issue data (Ex. Covid-19 data, Black Lives Matter protest data)

- Data on a novel or intriguing topic (Ex. charismatic macrofauna, sea star wasting disease)

Beyond relatable data, literacy experts mentioned utilizing data that can empower students to solve an issue in their community as being incredibly pertinent for engaging minoritized populations with data. In addition, it is also believed data activities which empower a student to impact change in their community may be one of the best strategies for building data literacy.

### Challenge 4: Time

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*"If it's a priority for your research team to reach the education and outreach goal then it needs to be prioritized, in time and in personnel. Just like if you want a sensor to collect data the whole cruise, you're going to make sure you have the right staff for operating that sensor."*  
~Shipboard Educator

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Researchers and teachers lead incredibly busy professional lives, as was expressed across all researcher and teacher interviews. Teachers and researchers have limited time and expertise for turning raw data into curricular activities.

In the office, researchers are expected to write grants, conduct research and publish in academic journals. At sea, they are often subjected to specific schedules packed with setup, research activity and data analysis, with little time to squeeze in writing a blog post or skyping with a classroom. Teachers often work overtime to stay on top of things and are expected to balance everything from lesson plans and grading to large class sizes and meeting state standards. Teachers felt strongly about the time commitment involved with attempting to use real-time data or develop curriculum around data. Some major barriers they identified were difficulty locating a reliable source of "good" data and using web-portals, confusion in downloading and reformatting data-sets, while also having to match activities to NGSS requirements.

### Promising Solutions

#### Science Communication Fellowships

Science communication fellowships are a common outreach tactic amongst research vessels. The E/V Nautilus is known for its science communication fellowship and

provides three berths per cruise to communication fellows. The JOIDES Resolution has one berth per cruise for a science communication fellow. A stipulation of both these vessels is that Principal Investigators plan to have the specified number of berths set aside for communication. The E/V Nautilus fellows participate in one cruise and attend professional development workshops throughout the year. Cohorts are typically made up of classroom teachers, informal educators, and scientists interested in becoming better communicators. For both ships, the fellows develop curriculum and outreach materials and manage social media for the vessel and in return receive professional development, time at sea, and coverage of travel expenses. Science Communication Fellows may be an excellent tool for developing resources around the RCRVs data portal.

In conversations with the E/V Nautilus, it was made very clear that the vessel relies on a “communication culture.” The communication culture entails everyone introducing themselves and their role aboard the vessel on the first day. Each role is given the same level of respect. Everyone aboard the vessel has instructions and quick guides on science communication. There are specific protocols in place anytime the Nautilus does a livestream. It should be noted a primary focus of the Nautilus is public engagement with its research.

### ***Full-Time Education and Engagement Specialist***

Having a permanent, designated employee(s) to oversee the education and outreach efforts (on land and/or sea) would be a valuable asset that would allow them to adapt O&E efforts to the changing needs of classroom teachers, students, and scientists. Ideally, this liaison would have experience in marine science as well as both formal and informal learning. The liaison would be the central point person for all ship education and outreach efforts and able to communicate with diverse audiences with varying degrees of data literacy, once the current education and outreach team has concluded their work. Education liaisons or an outreach contacts are used by other research vessel programs such as the Nautilus and the JOIDES Resolution. R/V Falkor has a team of three communication specialists and R/V Sikuliaq has a dedicated communication specialist for working with Alaska’s tribal governments. In this scenario, the primary responsibilities of a liaison(s) could include:

- Managing social media accounts
- Assisting researchers in their outreach efforts both onboard and onshore
- Answering any teacher questions regarding the website or lesson plans
- Helping to design and pilot lesson plans

- Attending educator conferences to raise awareness around the vessel and its educational resources
- Running professional development opportunities
- Reporting education and outreach effort information to the other stakeholders (e.g., RCRV O&E boundary crosser)

## Conclusion

The three new RCRVs will be an enormous source of critical, real-time oceanographic data and platforms that facilitate innovation in outreach and education. To make sure data from sea are being utilized to full potential, school students must have a strong foundation in scientific literacy and data literacy. Such efforts also support the development of a diverse future workforce. However, data will not be used by students until it is effectively transferred from researchers to teachers. Engaging with minoritized students in order to diversify the geosciences requires an even more dedicated and intentional effort.

Conversations with marine researchers, teachers and educational professionals as well as reviewing existing web resources, website reviews and MBARI EARTH surveys provided an in-depth look into what researchers and teachers need to be successful in the transfer of data. With a dedicated O&E team along with support from the greater RCRVs team, efforts to facilitate the flow of data from researcher to teacher to student have a high chance of success.

Providing researchers and teachers with the resources required to be successful is key, through professional development opportunities, informative guides, comprehensive data-focused lesson plans and an accessible web-portal. Working with boundary spanners and community groups within minoritized communities to build partnerships will facilitate the success of dedicated programming for underrepresented youth. Additionally, increasing sea-going scientist presence at educator conferences, utilizing social media networks as well as hiring a potential education liaison could all assist the project in raising awareness, promoting success, and maintaining trust with community partners.



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## Appendix A: Terms and Definitions

### *Canned Data:*

A data-set that remains static and has usually been through a significant amount of review.

### *Common Core:*

A set of educational standards for teaching and testing English and mathematics between kindergarten and 12th grade.

### *Data Literacy:*

Data literacy often refers to an understanding of what a set of data mean, which includes reading any graphs or figures accurately, identifying patterns or anomalies in a data-set, pulling supportable conclusions from data trends, and recognizing when and why data may be inconsistent.

### *Data Portal:*

A website allowing access to data, either canned or real-time.

### *MBARI EARTH:*

Monterey Bay Aquarium Research Institute, Education and Research: Testing Hypothesis workshop. This workshop is focused on raising comfort levels of teachers using data in the classroom, and provides incentives for teachers to construct curriculum with the information they learn.

### *Next Generation Science Standards (NGSS):*

K–12 science content standards that set the expectations for what students should know and be able to do. The NGSS were developed by states to improve science education for all students. These standards give local educators the flexibility to design classroom learning experiences that stimulate students' interests in science and prepares them for college, careers, and citizenship. Nineteen states currently utilize these standards, with Oregon having adopted them in 2014.

### *NOAA*

The National Oceanic and Atmospheric Administration is a scientific agency within the United States Department of Commerce that focuses on the conditions of the oceans, major waterways, and the atmosphere.

### *Professional Development (PD):*

A formal training or effort furthering education and knowledge in a teacher or researchers' subject area. In this research, professional development opportunities involve helping researchers with their outreach techniques and expanding teacher knowledge of real-time data usage in the classroom.

### *Real-time Data or near real-time data (RTD):*

A data set that is continuously updated with current or near-current conditions or measurements, without a significant amount of review before-hand.

*Scientific Literacy:*

The definition of scientific literacy encompasses the knowledge of scientific facts as well as understanding how to critically think about, analyze and apply that knowledge in everyday life.

*STEM:*

Science, Technology, Engineering and Math

*SMILE:*

Science and Math Investigative Learning Experiences program at Oregon State University

*UNOLS:*

The University-National Oceanographic Laboratory System is a group of academic institutions and National Laboratories organized in the United States to coordinate research vessel use for federally funded ocean research.

## Appendix B: Methods

### *Stakeholder Interviews*

Interviews were conducted with high school STEM teachers, marine science researchers from a variety of specialties, in addition to other valuable stakeholders such as professional development providers and specialists in data-focused education and outreach. Approximately 100 inquiry emails were sent to the various stakeholder groups, with 32 responses recorded for a response rate of 32%. Interviews lasted an average of 30 minutes, and were then transcribed and coded using the qualitative analysis software MAXQDA. The sampling method was a modified snowball sample, as each interviewee would provide additional contacts they felt would be interested in the project. Because of this, teachers in the sample were at a variety of experience levels when using real data and real-time data, ranging from little or no experience to weekly use of it. The majority of teachers and researchers that responded and were interviewed were located in Oregon. Due to the sampling method and sample group, this report may not be representative of teachers and researchers from other geographic areas.

Affiliation	# of Respondents
Oregon State University (OSU)	3
Oregon Institute of Marine Biology (OIMB)	3
University of Washington (UW)	1
Ocean Observing Institute (OOI @ OSU)	2
Monterey Bay Aquarium Research Institute (MBARI)	1
National Oceanic Atmospheric Administration (NOAA)	1

Table 1: Break down of interviewed researchers and their affiliations

Affiliation	Subject Taught	Grade Level Taught	Years of Teaching Experience
Salem-Keizer School District (SKSD)	Anatomy, Honors Physics, Chemical Systems	High School: 9-12	6-10 years
SKSD	Environmental Science, Biology, Marine Biology	High School: 9-12 (mainly 10-12)	20+ years
SKSD	Biology, Earth Science, Forensic Science	High School: 9-12 (mainly 10-11)	0-5 years
SKSD	Biology, AVID II, Marine Science, Environmental Issues	High School: 9-12 (mainly 10-12)	6-10 years
Corvallis School District (CSD)	Biology	High School (mainly 9-10)	6-10 years



CSD	Applied Science, Chemistry	High School: 9-12	6-10 years
Lincoln County School District (LCSD)	Biology	High School 9-12	N/A
LCSD	Biology, Anatomy	High School 9-12	11-15 years
LCSD	Biology	High School 9-12	N/A
Other (out of state, unspecified Oregon school district)	Science – unspecified topic	High School 9-12	N/A
Other	General Science, Honors Biology, Oceanography, Physics	High School 9-12	11-15 years
Bandon School District	Biology, Marine Biology, Environmental Science	High School 9-12	15-20 years
Warrenton-Hammond School District	Math – unspecified topic	High School 9-12	11-15 years
Forest Grove School District	Science – unspecified topic	High School 9-12	20+ years
Astoria School District	Fisheries Biology, Marine Biology, Fisheries Technology	High School 9-12	20+ years

Table 2: Breakdown of interviewed teachers and their affiliations

Affiliation	# of Respondents
National Oceanic Atmospheric Administration	2
Oregon State University	1
Rutgers University	1
Oceans of Data Institute	1
University of Maryland	1
University of Washington	1
MIT Media Lab	2
Monterey Bay Aquarium	1
E/V Nautilus	1
JOIDES Resolution	1
GMRI	1

Table 3: Breakdown of educational professionals and their affiliations

### *Website Review & Website Survey*

A collection of 15 data-portals were reviewed (see Appendix F) for a number of factors including:

- If there was an “education” or “teacher” tab
- How many clicks it took to find required content
- If tutorials on how to use the portal/resources were offered
- If there were lesson plans or activities offered on the portal
- If there was a “feedback” option on the portal
- If the portal offered canned data, real-time data or both

Once interviews had been completed, 6 additional data-focused resources were collected from suggestions by participating teachers.

These portals were then provided to middle and high school teachers attending a data-focused workshop with the *Science & Math Investigative Learning Experiences (SMILE)* program at OSU. Teachers were asked to explore web portals for approximately twenty minutes, before reflecting on the portal’s accessibility, their comfort level, what challenges they encountered on the portal, resources needed to fully use the portal and any recommendations on improving it. The sample size in this group was small (12 individuals) with limited access to the portals due to a lack of computers. A federal government shutdown prevented access to some of the websites so not all portals in the original review were included in the teacher review. In the case that the RCRVs project moves forward with the design of a more teacher focused portal, a more comprehensive website survey could be useful in providing additional feedback.

### *Review of MBARI EARTH Surveys*

The Monterey Bay Aquarium Research Institute (MBARI) Education and Research: Testing Hypotheses (EARTH) workshop is a 5-day professional development opportunity for formal educators, emphasizing the use of real data in the classroom. This research also included a review of survey data from the MBARI EARTH 2010, 2012-2017 workshops (2011 data was unavailable), located in Newport, Oregon. Additionally, 17 pairs of pre and post surveys from the MBARI EARTH 2018 workshop were reviewed. These surveys were reviewed to identify what attracted educators to the workshop, preferred timing, and other likes and dislikes regarding the workshop format and activities. Surveys were coded to identify any key themes in participant feedback. Pre-survey reviews were intended to help inform development of the workshops, in terms of identifying prior knowledge and experience of data-use, and marine science content. Post-surveys included important feedback about the data-focused workshop including components that were most impactful and what materials and resources they found most engaging and effective.

## Appendix C: Interview Guides

### Teacher Interview Guide

- How would you define good data to use in a classroom?
  - Can you recommend any examples of “good data” to use?
    - Why do you like this specific data set/website/etc.?
- What about real-time data? How would you define and/or describe good real-time data to use in a classroom?
  - Can you recommend any good examples of “good real-time data” to use?
    - Why do you like this specific data set/website/etc.?
- What are some of the barriers you see associated with using real-time data in the classroom?
- Do you have any suggestions to help overcome those barriers?
  - How have you specifically overcome any barriers?
    - Do you think that your solution could be helpful for other educators as well?
- What are some effective resources for teachers to learn how to use data in the classroom?
  - Can you provide any specific examples?
  - Do you have any suggestions on how to improve these teacher resources?
- Do you have any suggestions for other people to reach out to? Teachers, PD providers, or researchers?

### Researcher Interview Guide

- How would you define “effective outreach?”
- Do you use your own data in outreach?
  - Why or why not?
- Do you think scientists in general are doing a good enough job at translating science to broader communities?
  - Why or why not?
- Do you feel more comfortable working with a particular audience?
  - Which one? Why?

- What are some of the challenges associated with outreach for a K-12 audience?

Do you have any suggestions for resources that could be useful in overcoming these challenges?

### **Research Vessel Outreach and Engagement Professional Interview Guide**

(Read introduction). Hello, thanks for taking time to participate in this research. As you know we're doing research on how to make sure the educational resources we're designing for the new fleet of research vessels supports data literacy for K-12 Students and how this might support the greater goal of creating equitable and inclusive outreach programs and curriculum for the new fleet. I'm particularly interested in your experiences working in oceanographic research vessel outreach and education. Everything that you tell me is confidential and I will not attach your name to anything that you say or tell anyone else what you have told me. If I ask you anything that you do not feel comfortable answering please feel free to tell me that you do not want to answer that question. Do you have any questions for me before we begin? Do you consent to participating in this research?

1. Could you give a general description of the work you do?
2. What skills are crucial for effectively doing your job?
3. What do you think is necessary for high quality ship outreach and education?
4. What are some of the challenges of your job?
5. What are your strategies for making research vessels accessible to people historically underrepresented in the sciences?
6. Do you incorporate cruise data into your educational materials?
  - a. If yes, what would you say makes for high quality educational data?
7. Do you use real time data in your outreach?
  - a. If yes, what types of real time data would you say are good for education and outreach?
8. Do you have any people you recommend I reach out to?

## Data Literacy Expert Interview Guide

(Read introduction). Hello, thanks for taking time to participate in this research. As you know we're doing research on how to make sure the educational resources we're designing for the new fleet of research vessels supports data literacy for K-12 Students and how this might support the greater goal of creating equitable and inclusive outreach programs and curriculum for the new fleet. I'm particularly interested in your experiences working data literacy. Everything that you tell me is confidential and I will not attach your name to anything that you say or tell anyone else what you have told me. If I ask you anything that you do not feel comfortable answering please feel free to tell me that you do not want to answer that question. Do you have any questions for me before we begin? Do you consent to participating in this research?

1. Could you give a general description of the work you do?
2. What makes for high quality data literacy activities?
3. What makes for high quality data literacy curriculum?
4. What are some challenges in making data accessible for the public?
5. What are some recommendations you have for utilizing opensource research vessel data in K-12 education?
6. What are challenges in utilizing real-time data for K-12 data literacy education?
7. What opportunities do you see in utilizing real-time data for K-12 data literacy education?
8. What are your strategies for making data accessible for populations historically underrepresented in the sciences?
9. What are your strategies for engaging scientists in data literacy for K-12 students?
10. What are your strategies in engaging teachers in facilitating data literacy for K-12 Students?
11. What are the challenges of engaging scientists with K-12 data literacy?
  1. How do you personally overcome those challenges?
12. What are the challenges of engaging k-12 teachers in teaching data literacy?
  1. How do you personally overcome those challenges?
13. Do you have any recommendations for people I should reach out to?

## **Blended Diversity, Equity, Inclusion Interview Guide**

(Read introduction). Hello, thanks for taking time to participate in this research. As you know we're doing research on how to make sure the educational resources we're designing for the new fleet of research vessels supports data literacy for K-12 Students and how this might support the greater goal of creating equitable and inclusive outreach programs and curriculum for the new fleet. I'm particularly interested in your experiences working to create a DEI culture in the geosciences and supporting equity and inclusion through outreach initiatives. Everything that you tell me is confidential and I will not attach your name to anything that you say or tell anyone else what you have told me. If I ask you anything that you do not feel comfortable answering please feel free to tell me that you do not want to answer that question. Do you have any questions for me before we begin? Do you consent to participating in this research?

1. Can you give me a description of the work you do?
2. Do research vessels play a role in your work?
  1. If so, what do they mean to you?
  2. What do you think research vessels mean to the field of oceanography?
3. What does outreach mean to you?
4. How do you incorporate DEI into your outreach?
5. What do you think are best practices in DEI for geoscience outreach?
6. How can the next fleet of research vessels support DEI in the geosciences?
7. How can outreach for the new fleet of research vessels support DEI in the geosciences?
8. What do you believe might be best practices for research vessel outreach?
9. Do you have any recommendations for people I should reach out to?

## Appendix D: Website Survey & Results

1) (Please Circle One) How comfortable are you navigating the education portion of this website? (For example: is it easy to find data related educational content? Are educational materials presented in a clear and organized way? How many clicks does it take to find content?)

Not Comfortable At All    Somewhat Comfortable    Comfortable    Very Comfortable

2) (Please Circle One) How comfortable would you feel using this website for future data related classroom activities?

Not Comfortable At All    Somewhat Comfortable    Comfortable    Very Comfortable

3) What about the educational materials portion of this website was challenging or confusing?

4) What sort of supportive materials would you need in order to successfully use data given by this site?

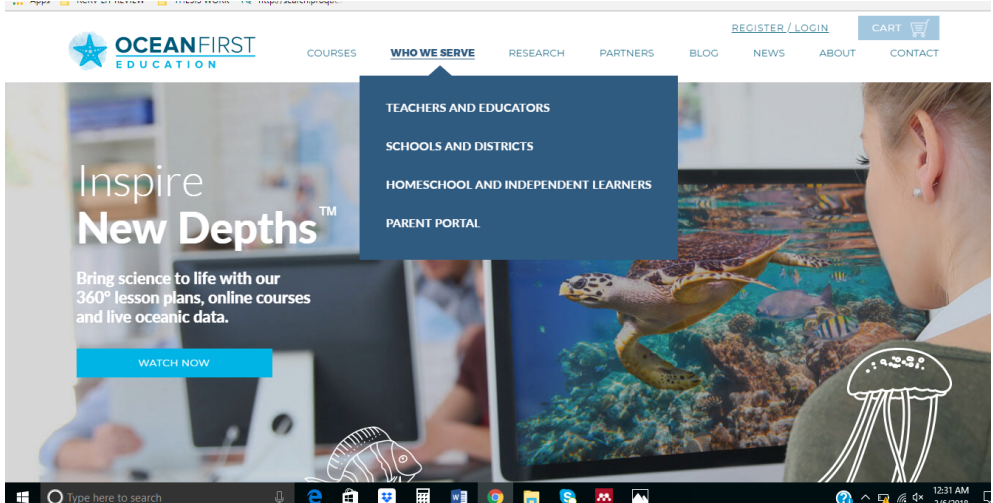
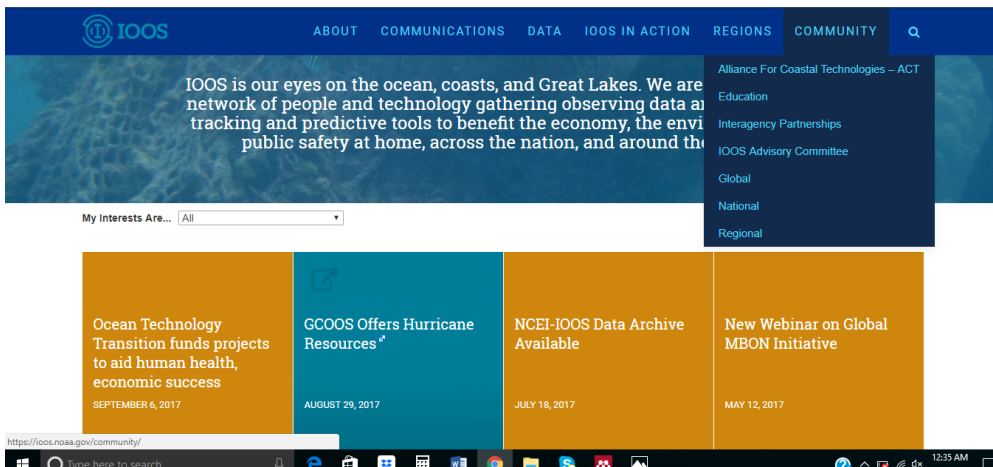
5) Do you have any suggestions for improving this website for educator access and use?


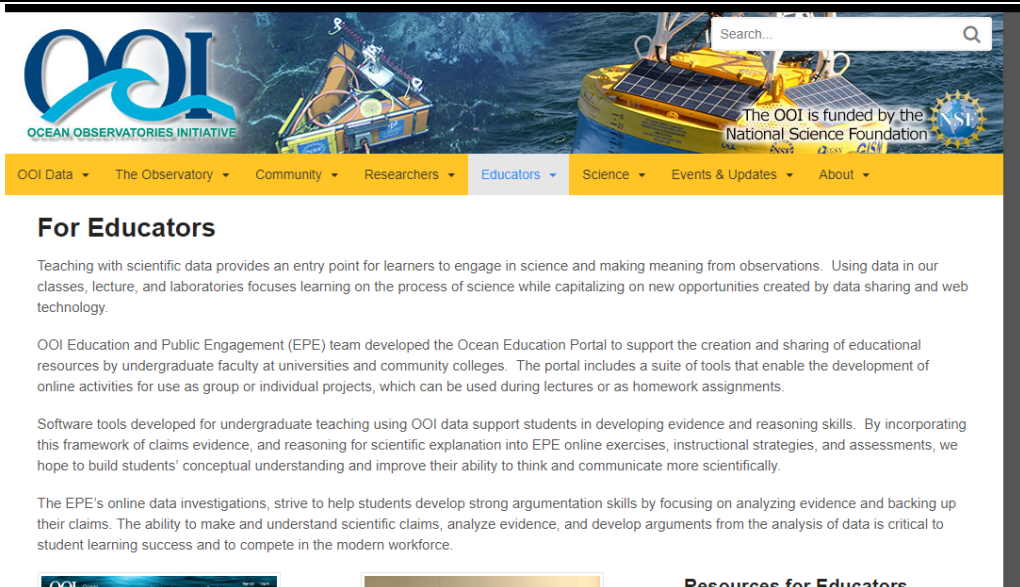
Name of Website	Ratings or Feedback Available	Education Tab	Tutorials or Supplemental Information Available	Curriculum and/or Lesson Plans Offered	Clicks to Content	Data or Real-Time Data offered?
NOAA's Data in the Classroom*			X	X	0	BOTH
JOIDES Resolution*		X	X	X	1	BOTH
Ocean First Education		X		X	6	DATA
IOOS		X		X	2	BOTH
NANOOS	X	X		X	3	BOTH
OOI		X		X	2	BOTH
Schmidt Ocean		X		X	1	BOTH
Ocean Data Portal			X	X	3-4	BOTH
Argo Floats		X	X	X	4	BOTH
SECOORA		X		X	2	BOTH
MARACOOS				X	3	BOTH
CENCOOS				X	3	BOTH
AOOS						BOTH
NOAA's Ocean Explorer		X		X	1-2	BOTH
MBARI*		X	X	X	1-2	BOTH
USGS*	X	X	X	X	3	BOTH
NERRS*		X	X	X	2	BOTH
NOAA Buoys			X		1-4	BOTH
OKEANOS*		X		X	1-2	BOTH
OCEARCH		X		X	1-2	BOTH


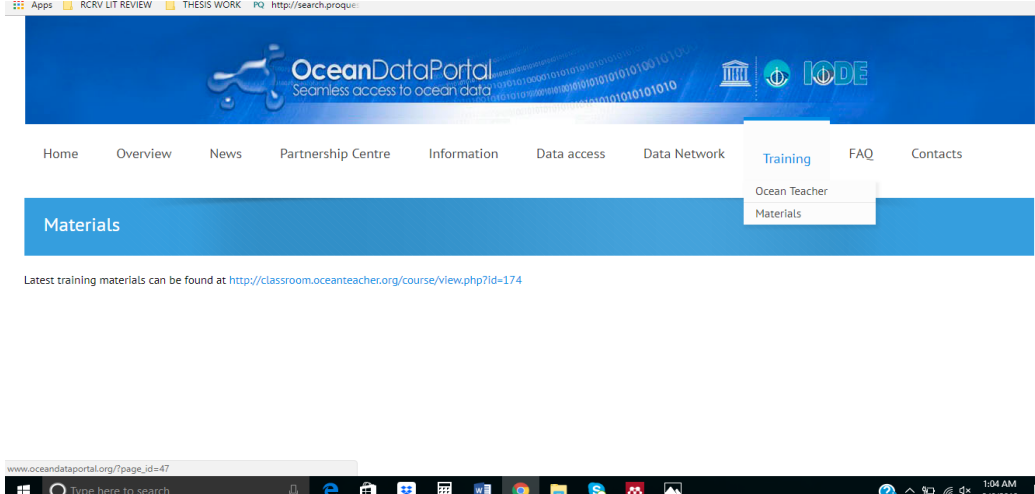
Table E1 shows a comparison of 20 data resource websites. \* represents exemplary websites indicated by this review and/or teacher feedback




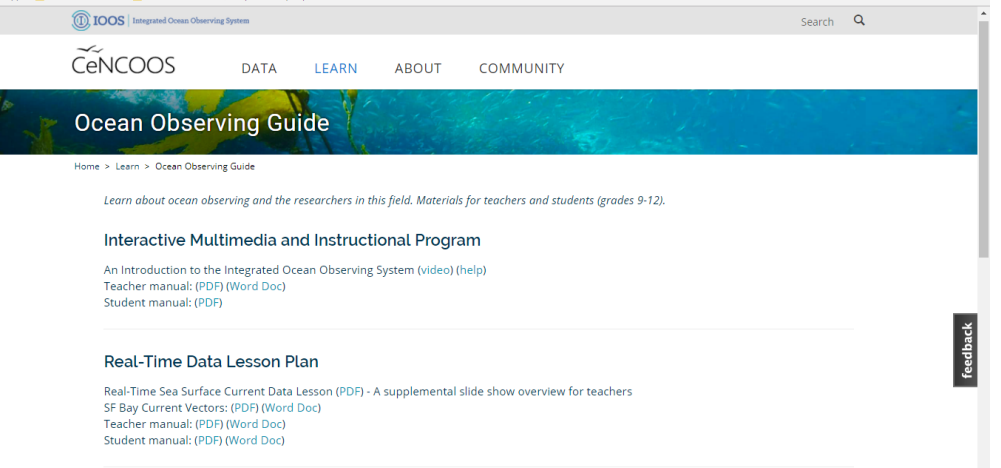
<p>NOAA’s DATA IN THE CLASSROOM</p>	<p>NOAA’s Data in the Classroom is a website that requires no additional clicks to locate education materials. It is easy to navigate, and offers curriculum and lesson plans corresponding to “hot topic” marine science issues. The website also offers tutorials on how to use the website as well as corresponding lesson plans. It offers activities with both canned data and real-time data, and shows how each activity lines up with NGSS.</p>	
<p>JOIDES RESOLUTION</p>	<p>The Joides Resolution Web Page requires two clicks to get to the educational content under the “Educators” tab, where it provides both classroom materials and activities, based off both canned and real-time data. There are no tutorials and no way for visitors to rate the website. Overall – easy to navigate, but could potentially be challenging in the downloading and analyzing of data.</p>	



<p>OCEAN FIRST EDUCATION</p>	<p>Website requires 3 clicks to access education materials. Education materials are not organized by type of data or marine science issue, and it takes 6 clicks to get to a data portal. No tutorials provided, no rating system provided.</p>	
<p>IOOS</p>	<p>IOOS Took two clicks to find the educational content links, where each activity link attempted to reroute to an outside NOAA page, but there was technical difficulties and would not load. Access to real- time data and canned data with a variety of visualization tools to observe it with. No tutorials for educators, no rating system.</p>	


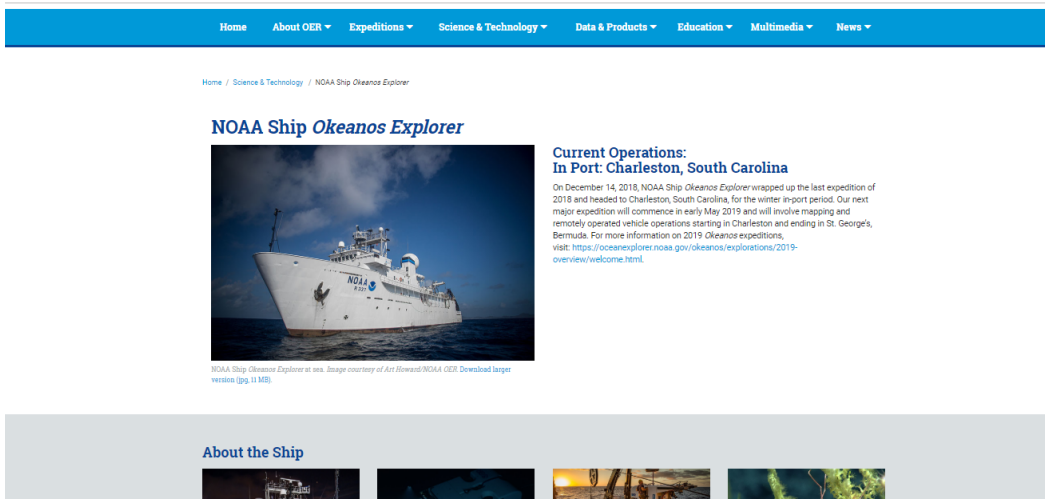
<p>NANOOS</p>	<p>NANOOS requires three clicks to access educational content. It offers lesson plans, background information on areas of emphasis such as coastal hazards, and educational resources like links to workshops and other websites. There aren't any specific tutorials, but it does provide an email address and a request for feedback. Activities are a mixture of teacher tested and rough draft forms, and offers canned and real-time data.</p>	
<p>OOI</p>	<p>OOI requires two clicks to access educational material. It focuses on bringing the use of their data to undergraduate classrooms, not for incorporating into K-12 classrooms. There is a data portal, which has concept mapping, data visualization and a creating investigations tool. No tutorials or areas to rate or review website.</p>	

<p>SCHMIDT OCEAN INSTITUTE</p>	<p>Schmidt Ocean Institute only requires 1 click to access education materials. There, you can find lesson plans, additional resources, an application to “ask a scientist,” ship to shore connections, etc. Some lesson plans use videos to better explain content, but I don’t see any videos for tutorial purposes. Overall, easy to navigate and informative.</p>	
<p>THE OCEAN DATA PORTAL</p>	<p>The Ocean Data Portal takes four clicks to access content, and transports you to an adjacent website. However, there are video tutorials meant to guide educators in understanding what data means and how to use it. No areas for reviews or rating.</p>	

<p><b>ARGO FLOATS</b></p>	<p>The Argo Floats webpage offers a variety of educational resources, but it is difficult to distinguish between them and follow the links to the actual activity. There isn't explicit organization or instructions, no place for ratings or feedback and requires at least 4 clicks before settling on some sort of educational content.</p>	
<p><b>SECOORA</b></p>	<p>SECOORA Requires 2 clicks to access educational content, but there are very few lesson plans provided. Instead, they offer detailed descriptions of what observing systems are and what the technology does. They also provide fact sheets. There are no tutorials for accessing or using data and no place for rating or feedback. There is a large amount of data associated with this website, and it could be challenging to work through.</p>	

MARACOOS	MARACOOS does not have an explicit education tab, so it takes 3 or 4 clicks until you find an education link under “talks and reports.” Once there, activities and lesson plans are offered, but they are linked to outside sources such as COSEE. No tutorials, no area for rating or feedback.	
CENCOOS	CENCOOS does not have an education tab, but they do offer tutorials, teachers manuals and lesson plans on using real-time data. Materials were created and tested by a teacher. Easy to navigate and informative.	

<p>AOOS</p>	<p>AOOS does not offer a specific education tab, nor does it offer any activities or other lesson plans. The website focuses its attention on the variety of data tools, without any in depth explanation of how to use them. This website would most likely not be of high use to educators.</p>	
<p>NOAA's Ocean Explorer</p>	<p>NOAA's Ocean Explorer offers an education page filled with a variety of activities. There are both one off activities based on canned data from previous cruises, as well as modules formed around when the Ocean Explorer is out to sea and transmitting data. It only takes 1 to 2 clicks to access activities, and there are instructions and background activities for educators, as well as activities, videos, etc., for their students.</p>	

<p>MBARI – Monterey Bay Aquarium Research Institute</p>	<p>This website provides an abundance of resources for both their research science efforts and education efforts. Educational resources are tied to both canned and real-time data, and provide detailed outlines of how to utilize each lesson. This website may be representative of what RCRVs potentially could face in terms of trying to fit abundant science and ed information on one site. There are a bit more clicks to content (2-3) but the direction is clear. MBARI Earth workshop surveys were reviewed as part of this research.</p>	
<p>OKEANOS – NOAA Ocean Explorer</p>	<p>Overall, this website is one of the most content-rich yet easy to use resources in this review. There is an overview of the research vessel and its technical information, links to both canned and real data as well as an education tab. The education tab leads to OKEANOS focused lesson plans, ocean knowledge lessons plans, etc., in 1-2 clicks. This could be a good example to model RCRVs portal after.</p>	



NERRS –  
National  
Estuarine  
Research  
Reserve System

NERRS provides both real-time and canned data from a variety of estuarine reserves across the country. It provides k-12 curriculum with detailed teacher guides, videos, etc. NERRS has an especially useful graphing application (see second screenshot) that asks directive questions that help guide the user to what they want out of a specific graph. Additionally, this tool has a “need help?” tab which provides even more information on how to utilize the tool and its data.

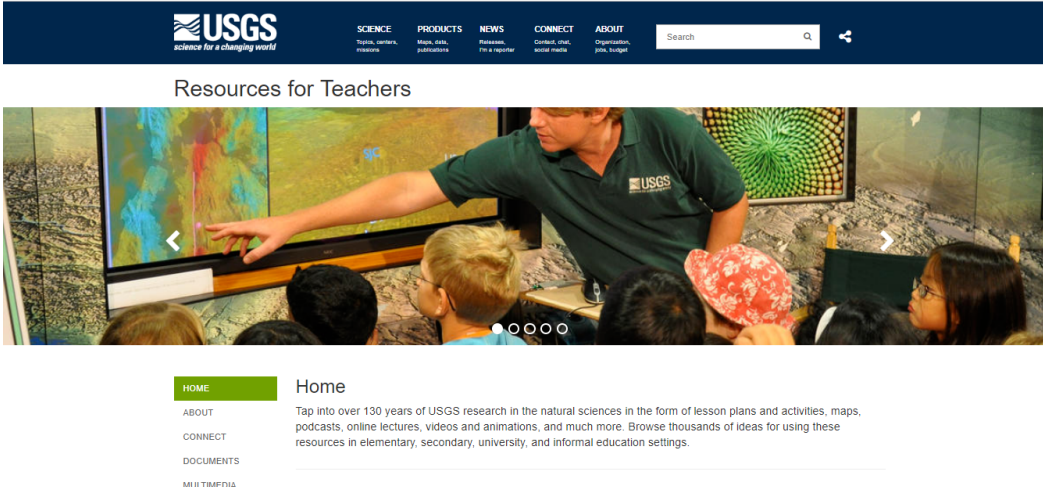
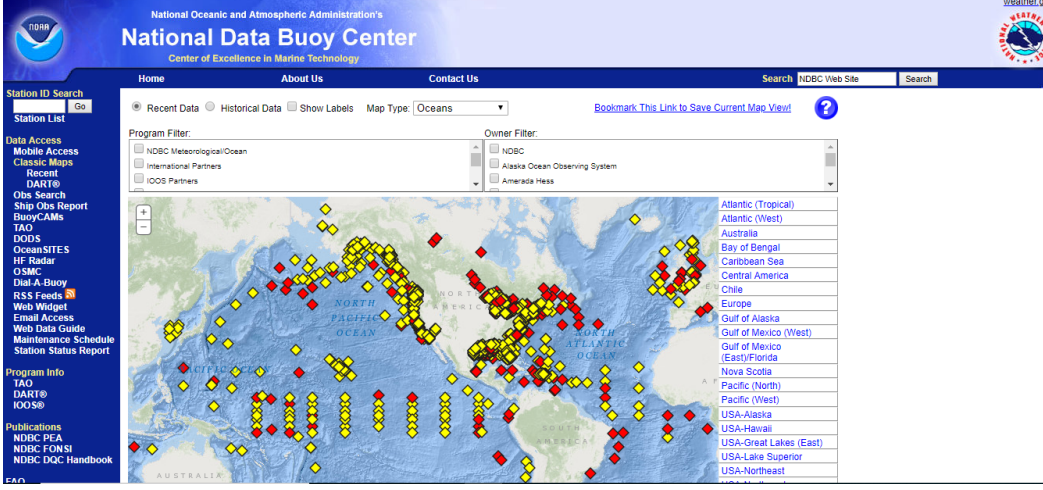
The screenshot displays the NERRS Estuary Education website. At the top, the logo for the National Estuarine Research Reserve System (NERRS) and the text "ESTUARY EDUCATION" are visible. Navigation links for "CURRICULUM", "TEACHERS ON THE ESTUARY", "SCIENCE & DATA", and "ESTU" are present. The main header features a large aerial photograph of an estuary with the text "ESTUARY EDUCATION" and the tagline "Where Rivers Meet the Sea".

Below the header, the page is titled "Estuary Education" and includes a descriptive paragraph: "Estuaries are invaluable resources for coastal dwellers, whether of fin, fur, or feather. For people, these ecosystems offer protection, recreation, and a wealth of learning opportunities. On this site, educators and estuary enthusiasts will find a variety of resources, including specially developed curricula, videos, teacher training webinars, real-time data, and opportunities to volunteer at a local reserve. This information will..."

The main content area is titled "System Wide Monitoring Program (SWMP) Graphing Application". It includes a "Need help?" link and a series of interactive steps:

- Which Data? (Step 1 of 5)**: A selection interface with three radio buttons: "Water Quality" (selected), "Meteorologic Factors", and "Nutrient Levels". Each radio button is accompanied by three icons representing "Real Time", "Non Real Time", and "Inactive" data availability.
- Specify Date Range (Step 2 of 5)**: Fields for "Start Date:" and "End Date:". Below these are preselect options: "1 Day", "1 Week", and "1 Month".
- Which Station? (Step 3 of 5)**: A dropdown menu labeled "Select a Station".
- Which Parameter? (Step 4 of 5)**: A dropdown menu labeled "Which Parameter?".
- Select an Output Format (Step 5 of 5)**: A section for choosing the output format.

On the right side of the interface is a map of the United States and parts of Mexico and Canada. The map is overlaid with numerous colored markers (green, yellow, and black) indicating monitoring stations. A status bar at the bottom of the map shows coordinates: "Lat: 42.48830197960227" and "Lng: -137.4609375".

<p>USGS – United States Geological Survey</p>	<p>The USGS website is extensive, and the educational materials can be somewhat difficult to find (it’s listed under the “science” tab). However, there are numerous lesson plans and activities sorted by grade level and content. Activities include real-time data as well as canned data, and USGS include abundant additional resources for educators to learn how to do anything from read and filter maps to sort through data. They have a specific “connect” tab that links to the manager of youth and educational programs contact information, which is a plus.</p>	
<p>NOAA Buoy Center</p>	<p>While there have been other NOAA educational webpages reviewed on this list, the Buoy Center website is strictly a data portal. There are no links to educational content, but there is a FAQ sections as well as an extensive data guide that can be downloaded. Navigating the portal is fairly straight forward in selecting a buoy and observing any results it brings up. However, it is difficult to find a specific filtered result.</p>	

*OCEARCH*

OCEARCH provides tracking information on a variety of marine species, with a particular focus on sharks and marine mammals. There is real-time data available as animals with trackers are pinged, and canned data as well. Educational resources are easy to find (1-2 clicks) and are organized for both grade level and subject, focusing mainly on math and science. They also provide STEM packets for special for days like Earth Day and World Oceans Day. This particular setup could be a strong example for RCRVs to utilize.

