The Many Currents of Ocean Literacy: A Case Study of Ocean Wise Programming

Maria Albuquerque & David B. Zandvliet, Simon Fraser University, Canada

Abstract

Recent scientific studies demonstrate conclusively that our planet faces an ocean crisis and efforts to mitigate this crisis should be addressed urgently. As many species are lost to extinction, conservation steps need to be taken and are indicated by targets such as those outlined by the 2030 Agenda for Sustainability and Development. Similarly, a clear agenda for ocean education should be encouraged as the first step toward broader conservation goals. Recently, the concept of ocean literacy has been described as a way to help communities and individuals develop a more holistic understanding of their influences on the ocean and the ocean's influences on their lives. Still, ocean literacy has not yet been fully enacted in the K–12 curricula in Canada, and many environmental education programs are taking the lead to provide program participants with a broader understanding of the term. In this study, we provide a broad overview of ocean literacy initiatives as enacted by the Ocean Wise NGO. We examine how these have influenced the diffusion of ocean literacy in British Columbia. In our paper, we include a case study highlighting the diversity of Ocean Wise programs to provide a broad view on activities from the perspective of program participants. We selected a range of education programs for data collection, including school visits to the Vancouver Aquarium, off-site mobile programming (with AquaVan), and teacher professional development programs, both on-site and via an online learning platform. We explore what each initiative offers students with regard to connection to the ocean. Through an instrumental case study design, we combine qualitative approaches with observations, focus groups, and interviews to describe many currents of ocean literacy flowing from Ocean Wise and its broad and diverse ocean literacy programming.

Résumé

Des études scientifiques récentes montrent de façon concluante que notre planète est en pleine crise océanique et qu'il est urgent d'agir. De nombreuses espèces sont vouées à l'extinction; des mesures de conservation doivent être prises pour respecter les cibles fixées, notamment dans le Programme de développement durable de l'ONU, qui définit des objectifs pour 2030. Pour atteindre ces objectifs généraux de conservation, nous avons besoin d'un programme sur la connaissance de l'océan. Ce concept, plutôt récent, est défini comme un outil pour enseigner aux communautés et individus une compréhension holistique de leur influence sur l'océan et de l'influence de l'océan sur leurs vies. Cependant, la connaissance de l'océan n'est pas encore complètement intégrée au programme scolaire canadien de la maternelle à la 12ᵉ année. De nombreux programmes d'éducation relative à l'environnement prennent toutefois les devants et expliquent ce terme dans le cadre

de leurs activités. Dans la présente étude, nous brossons un portrait global des initiatives de connaissance de l'océan mises en œuvre par l'ONG Ocean Wise. Nous examinons l'influence de ces initiatives sur la diffusion de la connaissance de l'océan en Colombie-Britannique. Notre étude de cas souligne la diversité des programmes d'Ocean Wise, le but étant de donner un aperçu général des activités selon le point de vue des participants au programme. Pour la collecte de données, nous avons sélectionné différents programmes éducatifs, notamment des visites scolaires à l'Aquarium de Vancouver, des programmes mobiles (avec AquaVan), ainsi que des programmes de perfectionnement professionnel des enseignants, offerts tant en milieu de travail que sur des plateformes d'apprentissage en ligne. Nous explorons également les enseignements sur la relation avec l'océan que les élèves retirent de chaque initiative. Notre étude de cas instrumentale combine approches qualitatives, observations, groupes de discussions et entrevues pour cerner les nombreux courants de la connaissance de l'océan provenant d'Ocean Wise, de même que la variété de ses programmes d'éducation sur ce thème.

Keywords: ocean literacy, marine education, environmental education, place-based education

Mots-clés : connaissance de l'océan, éducation relative à l'océan, connaissance de la mer, éducation relative à l'environnement, éducation axée sur les réalités locales

Introduction

The ocean plays a major role in defining key features of the Earth and is home to between one and two million different species. Humans' relationship with the ocean goes beyond a simple source of food and resources. For example, the enormous mass of water around the globe influences the planet's climate, weather, biodiversity, and ecosystems. Currently, our ocean system is threatened by many unsustainable human activities, such as plastic pollution, overfishing, and increasing levels of carbon dioxide, causing ocean acidification and changes in water temperatures (International Union for Conservation of Nature [IUCN], n.d.) While practical solutions are being discussed and implemented, environmental awareness through ocean education should be the first step to mitigate human impacts on the environment and ocean system. According to Santoro et al. (2017), changes in the way we think about and understand our relationship with the ocean can be addressed by a focus on ocean literacy, which they defined as "an understanding of the ocean's influence on you and your influence on the ocean" (p.15). When learners become ocean literate, they understand their relationship with a complex web that links humans with a diversity of other organisms that also rely on the ocean.

Education is the most important tool available to support the growth of ocean literacy, yet most North American schools do not include this as part of their learning outcomes (Guest et al., 2015). Bringing an ocean literacy approach to schools can engage learners in experiences with marine ecosystems and may impact our personal connections to the ocean. To become truly ocean literate, individuals need to be empowered with knowledge and further inspired by direct experiences (Wharton et al., 2019). These experiences provide meaningful reference points when exploring ocean topics so that knowledge becomes associated with behaviour change and a more caring attitude toward the marine environment. Real-world experiences develop animal empathy, ocean appreciation, and long-lasting learning moments (Wharton et al., 2019). If we teach students about the ocean in the early years of school, this may increase their potential to foster deep and lasting appreciation of the ocean.

Children are especially open to new and exciting ideas as well as to improving their connection with marine environments and its living dwellers. This type of connection nurtures a sense of caring and ocean stewardship (Blenkin & Kelly, 1994; Bruce, 2004; Joyce, 2013; Joyce et al., 2019). Direct experiences in nature benefit not only students but also the local community who may also become more encouraged to caring, sharing, and understanding their relationship with the natural environment. However, these characteristics have not yet been described in the context of ocean literacy. As stated by Joyce et al. (2019), "educators need to make learning about the ocean an experience which is not only intellectual but also, and perhaps more importantly, emotional" (Seamon, 1984; Bogner, 1998)" (p. 172).

Conceptual Frameworks

In combining ocean literacy with an experiential learning perspective (Kolb, 1984), we understand that learning is a process grounded in experiences by transactions between the person and the environment. Our study is grounded in the conviction that place-based ideas about learning are central to experience. The notion of a place-based education was described by Sobel (1993, 1996), whose ideas were then expanded by others (Gruenwald, 2003; Orr, 1992, 1994; Thomashow, 1996; Woodhouse & Knapp, 2000). Describing exactly what constitutes place-based education becomes clouded partly due to the multifaceted and interdisciplinary nature of the literature where this notion seems to reside. Gruenwald (2003) writes that the idea of place-based learning connects theories of experiential learning, contextual learning, problem-based learning, constructivism, outdoor education, Indigenous education, and environmental education. Connecting ocean literacy to an experiential and place-based learning framework is also a central idea in British Columbia's (B.C.) framework for environmental education (B.C. Ministry of Education, 2007).

This study aims to contribute to the broader agenda on ocean literacy in B.C. and across Canada by connecting it to the larger environmental education discourse. Ironically, Canada is surrounded by three oceans and has the world's longest coastline; yet, ocean education is only a compulsory course in two provinces—Nova Scotia and Prince Edward Island (McPherson et al., 2018). Importantly, the ocean is also associated with the overall well-being of all Canadians (Canadian Ocean Literacy Coalition, 2019). In a series of recent reports, the Canadian Ocean Literacy Coalition (COLC) gathered data on current understandings of ocean literacy as part of a strategy to improve and increase ocean awareness across the country. COLC research "will lead to a better understanding of Canadians' relationship(s) with the ocean, different approaches and challenges to ocean literacy, and effective ways to promote positive ocean actions" (COLC, 2019). This is important as most previously published studies on ocean education and programming originate from the United States (Mogias et al., 2019). Without more published studies on ocean education in Canada, it becomes difficult to evaluate, learn, and improve on our current programs and curricula aimed at fostering ocean literacy.

Meaningful collaborations among ocean/marine educators, researchers, and communities are foundational to promoting a healthy ocean (Fortner, 2019). Ocean education programs can facilitate direct interactions with the ocean and its wildlife, and these experiences influence in students' pro-environmental attitudes and the connections to the environment (Myers & Saunders, 2002; Wharton et al., 2019). In B.C., several environmental education programs incorporate ocean education through hands-on experiences, both in the K–12 environment and though informal education programming. Some initiatives also provide professional development for teachers and leadership development opportunities across a broad spectrum of programs. For our study, we focused on the special case of Ocean Wise as a unique context that offers programming in all of these areas.

The "Ocean Wise" Context

Ocean Wise is a global conservation organization based out of the Vancouver Aquarium, which is located in B.C. Ocean Wise's mission is to inspire the global community to become "ocean wise: by increasing its understanding, wonder, appreciation, and stewardship of our oceans." It fulfills this mission via four key pillars— engagement, aquarium management, education, and research. As part of a rebranding in 2017, the Vancouver Aquarium launched a website (https://ocean.org/) that aims to be a storytelling hub that transcends international borders. The site shares information about ocean related issues, such as overfishing, climate change, urban development, and pollution. It also describes how these contribute to disturbing the natural balance in the ocean realm. A press release about this transition to the brand Ocean Wise stated:

When the Vancouver Aquarium was deciding on what to call this new, global conservation initiative focused on an international audience of ocean and nature lovers, Ocean Wise was a natural choice. Our name is the shortest expression of our story. (Ocean Wise, 2018)

The Vancouver Aquarium is a long-standing institution that has been an education leader in ocean conservation through sustainability and education for more than 60 years. The organization offers a broad range of programming for youth, the general public, K–12 schools, and teachers in B.C. With its long history as an educational leader and its broad range of programming, Ocean Wise offered us a unique and ideal context for an in-depth case study.

Research Problem and Methodology

To date, there are few studies that explore how ocean literacy programs are reaching their goals within the community and within participating classrooms (Fauville, 2019; Fortner, 2019). The limited number of studies about marine issues in the fields of education limits our potential to improve the range and quality of ocean education programming (Fauville, 2019). A more in-depth understanding of how programs are performing would encourage broader discussion and reflection on the lessons and challenges that current ocean literacy programs face and how these should be addressed in the future.

We selected a case study methodology for a variety of reasons. This method has been described as ideal when a holistic, in-depth investigation is needed. For our purposes, we deemed that an exploratory and instrumental approach would best suit the study context of Ocean Wise (Yin, 2018; Stake, 1995). What is more, case studies tend to be selective, focusing on a few issues that are considered fundamental to understanding the system (or program) under study. The main line of inquiry for this research (for all selected programs) focused on the following research questions:

- How are the programs generally perceived by students and/or teachers?
- Do the programs' activities inspire or motivate students to become ocean literate? (If so, how?)
- Do the programs allow for local/community/individual interpretations of ocean literacy?

We considered non-experimental phenomena "in-context" for our study (Kostoulas, 2010; Leavy, 2017; Yin, 2018). In addition, the development of the case study allowed us to develop a complete understanding of a process, program, event, or activity and had further potential to yield insight into and in-depth understandings of Ocean Wise programming.

Methods

The richness of the study lies in the strength of the research methods themselves. Our aim was to produce deep and descriptive data from the programs through semi-structured interviews and observations. A wide variety of Ocean Wise programming was studied, including detailed observations of an "in-school" visit of the mobile AquaVan program at a local elementary school. We made further observations during an elementary school field trip (on-site) at the Vancouver Aquarium. Additional data collection came from focus groups with participating students (from school and university classrooms) as well as from email communications with supervising teachers. In summary, qualitative methods of data collection included researcher field notes, participant observation, and open-ended questions in a questionnaire and during the focus groups.

Data Collection and Analysis

To gather the data for this study, we were present throughout the Ocean Wise program to build a positive relationship with the teachers, students, and student-teachers. As Stake (1995) stated, "observations work the researcher toward greater understanding of the case" (p. 60). We focused primarily on the interactions between the students and the program activities, as well as on the students' reactions to these activities. After making our observations, we adjusted our questions for the focus groups and questionnaires with both methods helped us better comprehend the program. Importantly, the global pandemic COVID-19 in the midst of our study affected the direction of our research with regard to our ability to follow up with participants and teachers in a face-to-face manner. Moreover, some programs that we had intended to study were suspended because of Provincial Health and Safety orders. Despite the challenges, we collected sufficient data to come to a broader understanding of how Ocean Wise programming functions and to understand the programming's potential influence on participants' ocean literacy. We continue now with a description of how the case study unfolded. In the course of this description, we interact with a variety of forms (or *currents*) of ocean literacy programming. The analysis was done by triangulation of our results from the field notes, focus groups, and responses from open-ended questionnaires.

Ethical Considerations

Prior to our data collection methods (observation, focus groups), all participants were informed about the purpose of the study and their voluntary participation. In some cases, this information was provided by classroom teachers (for

elementary students), and written and informed consent was obtained from parents and the local school district. For adult participants, consent procedures were in accordance with institutional and national guidelines, and our study underwent a full ethics review.

Results

Ocean Wise Mobile Programming (the AquaVan)

The AquaVan is a mobile ocean literacy program that brings Ocean Wise programming directly into schools and communities through the transport of a curated collection of live organisms and preserved specimens (e.g., live aquaria, whale skeletons, sea otter fur). The collection is accompanied by an experienced Ocean Wise education team and aquarium staff who care for the live collections when travelling.

Our study begins at a small elementary school in Chilliwack, B.C.—: a school that had arranged to have a day-long AquaVan program delivered as part of their school wide environmental programming efforts. The city of Chilliwack is located approximately 100 kilometres inland from the coast. It is common for students attending an inland school to have never visited the ocean. Still, viewing salmonids and other marine species is a common occurrence in the nearby Fraser River. While Chilliwack is distant from the sea, the ocean still brings a range of important economic, cultural, and social impacts to the community (Waddington, 2017). Participants in the research included students in Grades 3 to 6, teachers from School District 33 (Chilliwack), and Ocean Wise leaders who worked to deliver the program.

We observe the program activities with four different cohorts of classes. The lessons are enacted in the school's gymnasium with four program leaders on site. Each leader is responsible for leading an "ocean station," each of which focuses on an ocean theme: Cetaceans (bones and krill); Fur and Pinnipeds (representing sea otters, sea lions, seals); Plastic and Sea Animals; and Live Aquaria, such as sea stars, sea urchins, sea anemones, an assortment of snails and fishes (some with touch pools). The leader announces that all of these stations include samples from the Salish Sea, and that they are found near downtown Vancouver. Classes participated in the activities for one hour, and we conducted observations on eight classes (using two observers).

The briefing activity begins with leaders and students coming together in a large circle. The leader tells stories about the ocean and invite the children to participate. They introduce why the ocean is important to them and also how the health of marine lives is being threatened. One of the leaders subdivides the large group into four smaller groups. Each is directed to one of the themed stations. The groups spend 20 minutes at each station with a different leader. Students listen to stories and lessons related to each station theme. They are invited to ask questions and share stories about the ocean and what they are learning.

At the Fur and Pinnipeds station, one leader talks about a food chain that links the kelp forest to the sea otter (who feed on sea urchins) and asks what would happen if one of these animals (the otters) were no longer there: "That is how a species can go extinct," says the leader (referring to the relationship between kelp, urchins and sea otters). She also shares that kelp is found in our medicine and our food, so it is good not only for sea animals but for "everyone." Students then touch the sea otter fur. "Sea otters get old just like us, they will get white hair," says the leader and then, touching a specimen of sea urchin, states, "You will see a live one today." One of the students responds with, "This is such a good school day!"

At the Cetacean station are several artifacts —cervical bones from a grey whale and an orca's jaw. As the children are from Grades K–4, the leaders incorporated more storytelling. They use body movements to mimic whales feeding. Students are welcome to touch the samples and are surprised by the size of the grey whale vertebra: "Oh my God, this is the biggest thing I could see from an animal today!" says one student. The students are observed comparing their own vertebrae by rubbing a classmate's back. It is interesting to note a sort of discomfort with students as they are told to touch the samples. "Ugh, this is gross!" says one while touching the orca's teeth and grey whale's baleen. The leader explains the difference between the specimens and how the structures relate to the diet for each.

At the Plastic and Sea Animals station, students are very talkative. They share examples of how their lives are related to plastic. The session includes a turtle shell and a photo album with animals who had ingested plastic into their bodies. The leader asks, "What do you see in a healthy ocean?" One student answers, "No plastic, colourful fish, clean water." Another shares, "When I was in Mexico I saw a bottle of water in the ocean and I tried to get it with my sister." To close the session, after first talking about seafood, the leader then discusses the use of fishing lines and nets and asks which one would bring the lowest impact to marine lives.

Last is an interactive station—Live Aquaria—where students walk around a series of small aquaria. Using stories, the leader invites students to mimic the movements of the animals inside the aquaria. The excitement begins when the leader tells students that they will be touching the animals. The leader invite them to use their little finger to touch the animals. The leader also explains that the animals are alive and can feel their touch so they need to be gentle. The leader gives special emphasis to the sea urchin, explaining the importance of sea urchins' feet: "It is like having eyes on your feet," says the leader. The leader shares that the tube feet help pull the urchin along and are the most sensitive part of the sea urchin, helping the sea urchin to sense its surroundings. As students touch the sea urchin, they make such remarks as, "It is so soft! I can't believe it doesn't hurt" while others agree, "Yes, it is very soft!"

After students complete the tour of stations (around 45 minutes to one hour), they return to the large circle for a program debrief. The leader wraps up the program by asking students how much they learned and if they liked the tour. Students share their comments out loud and ask further questions. The leader proposes a final "Hi 5 Challenge," indicating they should share what they learned in the activity with five people they know. Overall, students are participative, and few are left out during the conversations with leaders. No prior knowledge is required for the program and it seems that for many students, this is their first time learning about ocean topics. In one hour, the program touches on many content areas and the structure helps the leaders to fit all the content into one dynamic flow. As observers, we try to narrow the amount of activity down to one word, and we land on the word "intense."

Focus Groups

After the program, we conducted two focus groups with a subset of the participants; each group included six students from the same class. The first focus group comprised younger children (Grades 2 and 3), and the second was composed of older children (Grades 4 and 5). Having age-defined groups helped students to feel more comfortable and encouraged them to speak freely. We arranged for a studio space for the conversations with couches and comfortable chairs so that they wouldn't feel they were in a formal setting, and we provided snacks. The students were also welcome to come and go any time they wished. Focus questions were the same for each group, though we adapted the vocabulary for the younger set to make it age-appropriate. To create dialogue, we began by posing open-ended questions to the students. We clarified for students that this was an open space where they could say anything they wanted about their learning and that their comments would be kept private (no names). The conversations lasted approximately 45 minutes each. Below are the highlights from the focus group transcripts.

Interviewer: "What is your favourite thing from the activity today and how is it different from your classes?"

> Salmon: "Live animals—you never see animals in school."
> Blue whale: "Seeing the starfish and touching it."
> Blue whale: "I also like to touch myself during the animals' movements we had to mimic."
> Oyster: "Yes, I like to touch the sea urchin' spines it didn't feel spiky only if you press it hard … to protect from other animals."
> Oyster: "Because I don't know how to swim, I see things that I can't see in the water."
> Sea Lion: "We never bring nature to class, we always go there"

Interviewer: Really? Where? Sea Lion: "Close to the school around here."

Turtle: "See live animals and the history of the animals."
Kelp, Bear, Squid: "Real life animals, like starfish."
All: "Touch live animals."

Interviewer: "What was your least favourite activity today?"

Blue whale: "I didn't really like touching the skeleton of the animals, like the shark jaw. … And the water was too cold to touch the animals."
Salmon: "I hate the fact that there were no games. … It is a gym, it's supposed to have games … and it was way too long. We had no time for recess."
Everybody agrees
Sea Lion: "Touching the sea urchin. I would prefer to see the animals in the nature, not at the school."
Shark: "I like everything!"
Polar Bear: "I didn't like the whales section. It was kind of gross…"
Squid: "The turtle shelf."
Polar Bear:– "It is very sad to know how animals are dying from pollution…"
Most students: "The whale section skeleton."

Interviewer: "What was new for you today?"

Oyster: "I have seen seals before in the aquarium only time in my life I saw live seals, but I never touched it. I thought their fur was thick and not smooth. When I touched it today was sooo smooth and beautiful. They are lucky to have that hair."
Shark: "Yeah, that's right, it was shiny and smooth."
Oyster: "My leader said that sea otters are like us, they turn their hair blond/white when they get old. I didn't know they were similar to us like that."
Blue whale: "I saw seals when I was going to Victoria in the ferry. But I didn't know about the fur… I didn't know we could swim inside a whale … and how they eat is new to me—with the big mouth they eat such tiny animals."
Sea Lion: "I have never touched a starfish and fishes before. It is very nice."
Salmon: "Yeah they were in that small cup like little shrimps."
Sea Lion: "Krill!"
-Students start to imagine themselves in a whale's mouth and them escaping through their blowhole. Some were making fun of going out through their second hole.
Sea Lion: "Seals fur (is) waterproof—black oil for the fur."
Turtle, Dolphin and Kelp: "Touching the live animals, starfish (sea stars) and sea urchin."

Interviewer: "What are the threats that humans cause for sea animals?"

Blue Whale: "Yes! (thinking) The whales can eat plastic by mistake because they could be small like the animals they eat … it can get trapped in their baleen."
Salmon: "Orcas are endangered too … too much garbage in the ocean."
Blue whale: "There are so many plastics in the ocean, once I saw a commercial where they take plastic and make bracelets and sell it."

Interviewer: "What is your relationship with the ocean?"

Turtle: "I like to surf."
Polar Bear: "I have never been in the ocean."
Fish: "I have seen starfish [seastars] and turtles but I don't know if it was in Vancouver?"
Polar Bear: "Is the water on the beach the ocean?"
Interviewer: If it is salty, it is!"
Polar Bear: "So I swim there!"

Interviewer: "Can you see anything in your town that has a connection to the ocean?"

Everyone thinking…
Kelp: "I think the rain is a connection. When it rains here the garbage can go to the ocean."
Turtle: "Yes, the garbage from school and homes can go to the river and get in the ocean."
Sea Lion: "I think some invasive species we have came from the ocean."

Interviewer: "How can we protect sea animals?"

Shark: "They are way too cute - we have to stop littering."
Blue whale: "We need to grab the garbage in the river so it doesn't go to the ocean and buy the bracelets!"
Shark: "Yeah, we should stop throwing garbage in the lake and recycle."
Salmon: "We should clean up the coastal areas, not throwing garbage in the river and recycling."
River: "We need to take care of them."
Turtle: "We should use reusable bags and recycle more. We need to stop buying plastic."
River: "Think about our actions before we do it."
Squid: "Recycle."

Overall, students were excited to see and touch live animals, and they showed enthusiasm for learning about local sea animals. They were able to link these experiences to previous learning, and they related animal welfare to pollution reduction actions. Most participants noted that addressing animal consumption of plastic was the most urgent action required. By experiencing be in proximity to features from the ocean, students demonstrated genuine care for the marine life that they studied in the program.

Supervising teachers also gave valuable feedback about the AquaVan program, including offering information about why they chose the program. When asked why they had participated, they shared that children did not usually get the opportunity to go to the ocean or an aquarium and that this program allowed for hands-on learning and a fun and engaging experience with aquarium staff. One noted, "I thought it would be a different and interactive activity for my students … also, doing hands-on activities with artifacts and living things is so engaging for students."

Figure 1. The AquaVan Program

Teachers shared that the live animals were a "huge hit." Students were surprised at the textures of the animals they touched. They appeared to have grasped key concepts from their experience. One teacher noted, "They were excited to touch the artifacts. They were excited to tell me about the furs, bones, and teeth that they saw and touched." Lastly, when asked whether the program had met their expectations, teachers noted that it used knowledgeable, enthusiastic educators who clearly liked being around kids. One said, "It was well organized. It was engaging. The presenters had good management. Time was used wisely and effectively."

Other constructive suggestions included that students would have benefited from more time at the live animal exhibit and that the gym set-up was distracting and loud at times. One suggestion was that since some activities were rushed, they could be spread out over two days.

Research in Action

Research in Action takes place on-site at the Vancouver Aquarium (n.d.). As the name suggests, the program engages students in research as if they were "scientists" for a day. The activity enhances observation skills, curiosity, and appreciation for local marine ecosystems. The program is rooted in a story of rockfish research and conservation in Howe Sound, B.C. The program provides a research experience where students link conservation with observation, exploration, and research. Students also examine the internal anatomy of fish through a herring dissection.

One week after the AquaVan came to the Chilliwack school, one elementary class, which included some of the same student participants from our earlier

focus groups, travel to Vancouver to attend a four-hour on-site program. The students spend a half-day informally exploring the exhibits at the aquarium before participating in the Research in Action program, which is led by the Aquarium staff. We observed student interactions and took notes on their activities. We describe the goals of the program and note how Ocean Wise leaders covered ocean topics, which they then put into a local context. We recorded information about the program through photos, document review, and informal conversation with aquarium leaders and staff.

The students arrive at the Aquarium early in the morning by school bus. The Grades 4 and 5 students are organized into two groups, each with one teacher and a parent chaperone. They explore the aquarium exhibits for about two hours. Students are very excited. For many, this is their first time at the Aquarium. The students ask many questions about the interesting animals they are seeing. The Aquarium hosts a number of exhibits that highlight not only the Salish Sea ecosystem but also tropical marine ecosystems (such as coral reefs). It also presents a simulation of the Amazon rainforest.

After their "free time," students gather for the formal program, Research in Action. Students are directed to a classroom where the leader asks, "What did you do today that you liked the most?" Students have different responses but they all relate to the animals they saw. One student replies, "The sea otter knocking a rock into the sea urchin and then playing with a ball, I remember when we talked about it in school." The leader then asks what the students like most about their community in Chilliwack. Responses vary but include reference to the school area, playgrounds, swimming pools, and frequently-seen wildlife (e.g., raccoons). The leader adds to their discussion by telling a story about her commute to Stanley Park, where the Aquarium is located:

> We are not just people living in a place, we are sharing it. … I need to see and listen to this place, very often I commute without realizing how my path is affecting others. … I am not paying attention to my surroundings. I acknowledge that this place is on the unceded land of the Musqueam, Squamish, and Tsleil-Waututh Nations.

From there, the leader introduces a story about an Indigenous man who fought for a fish species to survive in spite of overfishing in his community's traditional fishing areas nearby. To tell the story, she asks students to pretend they are this man and to find out which fish species live in Howe Sound. The program is then divided into three parts: a game, field research, and dissection.

The game. The students become excited when they hear the word "game," and they engage with the activity. They are put into four groups for this activity. Similar to other memory games, students hold cards of two types: fishes and anatomical descriptions. In groups, students match the image of the fish with the card best describing its anatomy. They are learning about fish anatomy at the same time as they are showing what they already know. One student says, "What is the name of the fish's [cheek] again, something with G?" Another

student in the same group answers, "They are gills." The groups finish the game, matching all the cards. They show their work to their teacher when they are done. Transitioning to the next part, the leader says that now that they know the anatomy of each fish in Howe Sound, "It is time to dive in—please wear your wetsuits before we go to the Sound." In this role-playing activity, students pretend to wear wetsuits while the leader says that now they cannot hear each other because they are underwater. One says, "We can talk to each other using our hands."

Field research. In teams of two, students are given a worksheet with fish names and a catalogue, which they are asked to complete. To do so, they are released from the classroom and instructed to look for answers in the Salish Sea exhibit. As students try to locate the fishes from the worksheet, they put a check mark next to the ones they find. Working in silence, the students pretend to be exploring the ocean, learning once more about the fishes from Howe Sound. As the students continue their search, they keep pointing at the aquaria and fishes, locating most of them before the activity ends. The leader calls to them to "get back in the boat." Finally, back in the classroom, the leader sums up the activity by saying that now that we have evidence that some fish are missing or are very hard to find: "Howe Sound should be a protected area."

Figure 2. Ocean Wise Rockfish Exhibit (Research in Action program)

Fish dissection. Based on the level of student engagement in creating and sharing their "scientific study" with each other, it seems that dissection (a voluntary activity) is the best part of the program. Students are excited to touch and dissect a real fish from B.C. waters—a fresh-caught herring. A few students say "Ew" while others say, "They [fishes] are not gross at all!" The leader challenges them to look for something they are curious about, which can be come the basis for their scientific research. "Do not open or cut the fish without an explanation," she says, and then provides an example: "I want to open the fish to see their brain anatomy and to see how different they are from our brain." Each group has two fish they can dissect and investigate however they want. "Wow that is so exciting, I have never touched a fish before!!" says a student before asking, "Can I touch the fin? I want to know how it feels."

The inquiry continues with lots of excited questioning. "Why are you making the fish bleed … that is not good?" asks a student. Another shows us what he is doing: "I am trying to find plastic in their body or any injury." A young girl who first says she doesn't want to touch the fish does so anyway and says, "We have discovered the inside of their eyes. … Wait, what is that?" Her partner replies: "The gills … that is how they breathe!" The students are excited, and as observers we notice that the excitement increases with every new activity. To wrap up, the leader challenges the students to find one new thing in nature during their bus ride home. She states, "Every day we can observe new things and how we can take care of them."

Teacher Professional Development

Ocean Wise also provides resources to deliver custom professional development (PD) opportunities for teachers. These involve visits to the Vancouver Aquarium for such celebrated offerings as "teacher appreciation night," which is hosted yearly, as well as a variety of day or multi-day programming. These are augmented by a range of online resources and course modules developed around "emergent" ocean literacy themes. In this study, we followed two different programs of pre-service teachers engaged in PD, both of which were hosted by Ocean Wise. The first involved face-to-face visits to the Aquarium over several days as part of a university course; the second involved pre-service teachers only with a newly developed online education platform.

PD at the Vancouver Aquarium

In-person teacher PD at the Vancouver Aquarium involves a sampling of the various programs that are available to K–12 schools. These are adapted for an adult audience (e.g., Wet Lab or Research in Action). Teacher education programs often include "behind the scenes" tours, providing participants with a sampling of the varied conservation efforts and associated research that is

also conducted by Ocean Wise in and for local communities. The pre-service teachers that we observed appreciated the modelling of the programs, which are typically delivered to K–12 schools. They enjoyed the opportunity to try out a variety of ocean literacy strategies. Typically, a discussion followed an activity: Program staff and teachers discussed how various activities could be adapted for target age groups or specific grade levels. In the program we observed, educators were offered a range of experiences related to the Wet Lab programs. These were augmented by other programming, such as a "sustainability scavenger-hunt," which was conducted in the marine exhibits. Program staff encouraged dialogue about on-going controversies, including one involving marine mammals in captivity.

Overall, the teacher candidates were impressed with the ocean literacy programs. An overarching theme emerging from participant comments related to a greater awareness of ocean literacy and its importance for the broader movement of environmental education. This could be described as a "bluing" of their ideas about environmental education, an area that more typically focuses on terrestrial (or green) issues. A sampling of representative comments for this theme included the following:

Student teacher (ST): "The whole planet is connected by water and oceans."
ST: "Everything is living and they are all connected. Trees, rocks, water, kelp."
ST: "Ocean Wise topics shed light on infinite number of systems we are connected to …"
ST, referring to jellyfish in an exhibit: "Oh my god, when you look at the details, it's really complex …"

Many teachers became more aware of specific controversies at play in their community. There was a realization that controversy in and of itself is not a bad thing, and that handled professionally, considering all aspects of a controversy with K–12 students may create excellent opportunities for learning. Some representative comments for this theme were as follows:

ST: "Education is a failure when things were labelled as black or white, right or wrong."
ST: "Not that plastic is bad. It's our attitude … [for example], our money is made of plastics just like (drinking) straws, but you don't see money at the bottom of the ocean."

Another perception was that Indigenous knowledge and pedagogy needs to be better reflected in both Ocean Wise exhibits and programming. This was acknowledged by education staff, who indicated this is emerging as a strategic initiative for Ocean Wise. Representative student comments included:

ST: "I liked the controversy part … more indigenous aspects would be awesome."
ST: "Ethically this is indigenous territory."

We hoped to include some of these attempts at decolonizing education exhibits at the Aquarium and in Ocean Wise programming within our case study, but this was interrupted by complications related to COVID 19. A variety of Provincial Health and Safety orders led to the temporary closure of the Vancouver Aquarium to the public and a further suspension of the in-person aspects of their programming (including AquaVan, on-site visits, and teacher PD). As our research continued, we pragmatically shifted the focus to the online platform that was rapidly expanding in its attempts to serve the needs of teachers and K–12 students during the pandemic.

Online Platform and Educator Resources

The online platform by Ocean Wise features a newly developed Educator Resource Library—a comprehensive and curated collection of resources, lesson plans, and classroom activities designed to help educators include ocean literary curricula in their classrooms. The resource is free for teachers and is an easily navigated tool that has everything teachers need to "bring the ocean" to the classroom. In the resource library, teachers can find detailed information, activities, lesson plans, resources, and supportive media to help them incorporate ocean literacy in their classrooms. The website also breaks up the content into three main resource categories: Elementary (Grades 3–6), Middle School (Grades 7–9), and High School (Grades 10–12).

The online platform is also designed so that students can take the courses, working through the principles themselves at their own pace. For some teachers, this is a way to add a "blended learning" element to a class, or to entirely "flip the classroom." As students interact with the courses, they earn "virtual badges" by completing quizzes and assignments. Alternatively, they can read through the material and explore the resources (including a range of curated multimedia and interactive tools). The online courses are linked to the United Nations (UN) Sustainable Development Goals, and they also align with principles outlined in the UN Decade of Ocean Science for Sustainable Development.

As part of our study, we asked a cohort of teachers and teacher-candidates (enrolled in a university course) to interact exclusively with the education courses and resources available to them on the online platform. Participants were assigned to user groups that were linked to their classroom and grade level experience. They were then asked to provide feedback to the Ocean Wise staff and course designers. Feedback ranged from comments on the "usability" features of the website to the quality and age appropriateness of content and resources made available for the courses at each of their intended grade levels (Table 1).

Positive	Constructive
Great video resources	Reading level is too high and complicated
Included story maps are awesome	Too much text not enough visuals
Teacher resources are good	Need easier connection to the curriculum components – include in descriptions of each resource so they don't have to read through
Love the lesson plans	
The curriculum achievements are helpful – they link to specific activities that match the 'big idea'	Include more interactive resources
	Include more French resources

Note. Middle School Level (Grades 7–9, ages 12–14): See https://education.ocean.org/oceanlitmid/

Table 1. *Summary of Feedback from Teacher-Candidates*

Overall, feedback from participating teachers was positive with regard to the utility of the online platform provided. Educators were thankful for the provision of a comprehensive and content rich resource, especially as it had been provided free of charge to educators since the beginning of the pandemic. The widespread use of this ambitious and developing resource has assisted many educators through a challenging time for the K–12 education system.

As with any new platform, educators had much to say about how the online resource could be improved over time. Many felt the platform should make its "curriculum achievements" clearer for each resource or assignment, arguing that students are more likely to use the platform if it is easy to find and access these achievements. Teachers also argued the resource could be improved with more visuals and more interactive components. Some recommended shorter courses in order to reduce the amount of student time spent at the computer.

Participating teachers also noted that the usability of the online platform would be improved if it were there were two designs: one for students and one for teachers. They further recommended that the provision of briefing and debriefing information for the entire course would improve the overall quality of the online platform and its associated educational resources.

Discussion

This case study provides only a brief snapshot of the range of Ocean Wise's ocean literacy programming. Although the concept of ocean literacy has been explored by Ocean Wise for several years, our study provides a first glimpse into how the programs have been designed and the perceptions that participants have as they interact with them. Importantly, this research set out to understand students' and teachers' unique experiences with programming using a mixed methods approach with the intent to inform future program design. We return now to our guiding research questions in order to structure the discussion of our case study results.

It is important to note that Ocean Wise has developed a positive reputation in the education field and is widely regarded as a leader in ocean literacy programming. The perceptions of both students and teachers were very positive, especially with regard to those parts of the programs that incorporated aspects of experiential education. For example, the observed excitement level of students during and after the activities are broadly highlighted in our results.

Students felt that the AquaVan program provided some unique opportunities to touch and observe animals up close in a familiar environment. The program was perceived positively across age groups, though feedback between the different ages varied. While younger students perceived the activity to be "very long," older students claimed the opposite. This suggests that the length of the program should be adjusted relative to the age group involved as it did not appear from the feedback that the same format works well for all grade levels. Younger children also suggested that because the program is run in the gym it should incorporate more games. Some students considered the opportunity to feel, see, and act like marine mammals to have been rushed and intense. When we asked older students about how to improve the program the following comment was typical: "AquaVan should give us more time to see the animals and the stations, it is all way too fast." This comment indicates that a few changes in the design could be made, including its intensity. Despite some constructive criticism, students indicated they would participate in the program again and would recommend it to friends and family. All students told us they had an exciting first-time experience seeing and touching live animals and that they hoped to see more animals in nature. This type of positive experience is important especially for children as it has been shown to influence intellectual, social, and emotional development as well as fostering positive attitudes toward the environment (Gill, 2014; Joyce, 2019).

Other positive perceptions were witnessed in our interactions with the Aquarium-based Research in Action program. During a visit to the Aquarium, we observed students' interest in and excitement about activities escalating from moderate to high. The way the activity was led was important for the engagement of everyone involved, with the leader providing time and freedom for students to explore and engage in ways that developed their inquiry skills. All students were active in finding a rationale for dissecting the herring and even those initially hesitant were actively engaged by the end. Similar observations were made within the Teacher Education programs, with participants excited to touch live invertebrates in the touch pools of the WetLab or to "muck about" in hip-waders in the inter-tidal zone during a beach cleanup activity.

Do the Program's Activities Inspire or Motivate Students to Become Ocean Literate?

Through the range of programming observed, it was clear that the type of activities designed work to inspire and motivate students to become ocean literate across programs and grade levels. With its inquiry-based approach, Ocean Wise leaders encourage students to ask their own questions. Our results indicate that the activities provided by AquaVan (for example) created a closer intimacy with and understanding of the marine lives that rely on the ocean. The variety of ocean specimens (e.g., seawater with krill, curated preserved specimens, live invertebrates) attracted the attention of both students and teachers.

Since our study school was not located near the sea, most students were seeing these ocean creatures for the first time. One pupil was not sure if she had swam in the ocean before, realizing only for certain that she hadn't when she realized that the ocean has salty water. By studying ocean literacy in such a removed context, where people possess varying levels of knowledge about the ocean, we realized the goal of ocean literacy may have a long way to go. Further, many activities are designed with open-ended space for students who have had rich experiences with the ocean to recall moments near the sea (eg. interacting with marine life or in quiet contemplation simply watching the sunset from shore). Although the program included narratives and facts about the ocean, students were also welcomed and encouraged to share their thoughts.

Importantly, Ocean Wise leaders also emphasized the concept of ocean pollution and encouraged students to relate their experiences in the sea to plastic pollution. As observers, we also noted that Ocean Wise program goals and practices are closely aligned with the drive among environmental educators to highlight the importance of understanding ocean complexity in order to foster student "connection" with nature and help them comprehend the cruciality of nature conservation.

Our conversations with students revealed that they cared about and empathized with the animals they met or those about whom they heard stories. By speaking about their past actions (e.g., collecting waste on the beach), and by stating that we need to reduce, reuse, and recycle more, students demonstrated their concern for the environment. For example, when they were asked to touch a sea urchin with their little finger so they would not hurt the animal, students were provided with an opportunity to empathize. Reinforcing these feelings can also increase students' understanding of animals' behaviour and needs, as well as improve their awareness of how animals might respond to stimuli. These practices can nurture students' sense of care and actions to benefit all wildlife (Bandura, 2000; Chawla, 2009; Wharton et al., 2019).

Students also demonstrated an understanding of the ocean's influence on human needs, such as its provision of food and medicine. They also exhibited an appreciation for marine organisms in the food chain and the benefits

humans receive from the sea. The impact of plastic pollution on marine species is an example of human influence on the ocean. By sharing a turtle shell from the B.C. coast, leaders showed how the Leatherback Turtle is a visitor to the local sea. They warned students that a single plastic bag in the ocean and can be mistaken for a jellyfish, which is a turtle's main source of food. Activities such as these fostered understanding about the impacts the ocean has on us, and vice versa. Most notably, one of the students in a focus group stated that the only negative aspect of the program was her realization that many animals are dying from pollution. As stated by Wharton et al. (2019), "Empathy is a stimulated emotional state that relies on the ability to perceive, understand and care about the experiences or perspectives of another person or animal" (p. 158). They add that these feelings are primordial.

Implications

In our case study, we hoped to better understand how Ocean Wise programming increased students' connection to local (aquatic or coastal) environments. Research in Action was a good example of a program that intended to make such connections. The program we observed explored the Howe Sound marine ecosystem through a dynamic and interconnected group of activities organized around narratives in which students were the main agents. Using storytelling and hands-on activities, the program inspires students to become ocean literate.

In our view, Research in Action plays a critical part in a localized (place-based) ocean literacy program. As described above, in this program, children spend one day playing, watching, and doing activities related to the nearby Salish Sea during an in-person visit to the Aquarium. Students showed enthusiasm throughout the day as they played the role of researchers investigating the local marine environment. When students play interactive roles in a learning environment that is closely connected to place, they understand and connect to the world being showed to them in a meaningful way (Payne & Zimmerman, 2010).

As also described above, students participating in this program used their imagination and engaged in hands-on activities to explore and find answers to their own questions. When looking for local species of fish, students were quiet but very keen to identify specific local species. By providing locally-referenced experiences, the program allowed students to go beyond curriculum expectations and scripts, planting a seed of inquiry that perhaps can become a scientific journey or a more personal adventure. Students were deeply engaged when the leader indicated students could look for anything they wanted in the third part of the activity (herring dissection) as long as there was a "scientific" reason. Experiential moments such as these can inspire students to "think outside the box" and appreciate their important role in revealing the mysteries of the ocean.

For a broader, individual interpretation of Ocean Wise programming, teacher education programs that we observed also allowed participants to use critical thinking and inquiry skills in developing their own personal conceptions of ocean literacy. All PD efforts highlighted human activities as the major influence on species extinction. Through localized narratives from Howe Sound and other examples, the programs offered an opportunity for teachers and students to embrace practices that foster critical inquiry skills and to understand the consequences of these skills for place-based educational practice.

In contrast to Research in Action, the AquaVan program did not include specific connections to local community. While children were encouraged to share their experiences with the ocean, leaders did not integrate other possible local and community connections. Since the program was offered inland (on the Fraser River), the program might have included numerous examples of how river systems estuaries, and eelgrass meadows connect them to the Salish Sea. Indeed, many important physical, social and cultural aspects of the local community were not explored. Including a broader community context could work to improve or broaden students' local interpretations of ocean literacy.

Some Challenges

As a final theme for our inquiry, we hoped to uncover some of the key lessons and challenges faced in delivering ocean education programming. It is clear that the core strength of Ocean Wise programs is in how they connect students to the ocean through direct and hands-on experiences with marine organisms. In doing so, children can personalize their understanding. From there, students can ingest what it means to conserve and protect marine fauna and flora. Curated and live specimens can work to bridge students empathy and knowledge of the lives of ocean animals. Many students in our study had never previously experienced living sea creatures. In these cases, without tangible experiences, the ocean becomes a distant reality. Environmental awareness seems to be a key result of Ocean Wise programming; however, there remain some key challenges to overcome.

By enhancing marine education and awareness, Ocean Wise can inspire the next generation to have a greater understanding of and appreciation for the ocean. Still, it cannot effectively do so without a stronger focus on place-based and community engaged forms of learning. Bringing a renewed focus to local contexts would help students to make more connections to their daily lives. A simple solution for AquaVan might be for leaders to dialogue more with school staff prior the delivery of a program or to make further information about specific local impacts available for students to take home. Another challenge we can take from the Ocean Wise approach is that connecting students with the ocean goes beyond textbooks and stand-up delivery approach. As we witnessed, connecting students to the ocean requires action, empathy, and

experiential moments. Attempting to develop or adapt Ocean Wise programming to an online environment creates unique challenges as it is difficult to replicate these types of experiences in the digital environment. Teachers who reviewed the online platform noted confusion about the website's architecture. As stated above, most felt there should be distinct ways for teachers and students to view and interact with the course materials. Moving forward, it is advisable to narrow the scope of online courses and to clarify how they can be student- or teacher-led. A constructive suggestion was that the platform could be separated into two courses: a teacher guidebook on ocean literacy in the classroom and a separate course for home learners and/or distance education students.

Finally, there remains the challenge of including more Indigenous content into all forms of Ocean Wise programming, whether delivered on-site, through mobile programming, or via the online platform. This view was also recognized by the senior Ocean Wise leadership team itself:

> Nine months ago, we started a co-operation with the local Squamish communities … we have very limited knowledge from indigenous perspectives in our exhibits. Yet there is large opportunity for more integrated Indigenous knowledge. … We need to set tangible targets and hold ourselves accountable. (Administrator)

It is important to note here that the goal to include more Indigenous knowledge in educational programming (and curriculum) is a priority for many organizations at this time and is a challenge faced by the K–12 education system across Canada. Universities and teacher education institutions too play a key role in efforts to decolonize our educational practices and to include more Indigenous knowledge and pedagogy in the education of K–12 students and their teachers.

Conclusions

The ocean we rely on is beautiful, important, and inspiring. It faces clear threats that we must mitigate. It is evident from our research that Ocean Wise is a key player in the field of ocean literacy. It employs a multipronged approach involving engagement, research, conservation, and education to promote these concepts in B.C. and across Canada. While relationships among factors such as conservation, education, and behaviour change are complex, we believe that by increasing ocean literacy delivery across Canada, Ocean Wise programming positively impacts students and communities with regard to their environmental awareness by increasing their knowledge about ocean-related issues.

The breadth and depth of ocean literacy programming for teachers and students that Ocean Wise provides is impressive. While our study describes only a handful of Ocean Wise programming our case study gives rich examples of the many currents of ocean literacy that are flowing in B.C. These provide

opportunities for participants to nurture and improve their connection with, understanding of, and appreciation for the ocean. By keeping a local focus on explorations of the Salish Sea, Ocean Wise also plays an important role in educating individuals to better understand the impact of the ocean on their lives and their own influence on ocean environments. As Scully (2018) noted,

> If the intention is to influence behavioural change and build a sense of co-management, then it is essential to ensure that people understand the issue as it relates to them, feel responsibility for it, and feel motivated to take action, and [...] be capable of doing so. (p. 43)

As with any endeavour, there will still be challenges and limitations that can be addressed in efforts to create a better experience for students, teachers, and the general delivery of ocean literacy across Canada. We believe that future research will be essential in promoting these efforts. One idea for future research is to promote a more ecological view of programming—one that focuses on the *relationships* among the different programs on offer rather than on just the programs themselves. It was also interesting to note that even in this case study, a number of participants experienced several different types of programming offered by Ocean Wise and/or other organizations. It would be interesting to explore how different programs reinforce or impede the intended program outcomes. Finally, increased partnerships with schools and communities are encouraged in order to foster more local and long-lasting experiences that could result in stronger outcomes (or actions) with respect to maintaining a healthy marine environment for all to enjoy.

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