

Article

Exploring the Contributions of an Immersive, Environmental Education Workshop on Pre-Service Teachers' Environmental Education Preparedness

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Abstract: Public schools are an important place to cultivate environmental agency in children, and classroom teachers play an important role in this identity process. Teachers who afford opportunities for environmental learning and care behaviors to develop during the school day play an important role in cultivating the next generation of environmental stewards. Pre-service teacher populations bring additional promise to the future development of stewardship in schools, as their teaching philosophies and early career plans are still emerging and amenable. Providing purposeful, interactive, environmental education programming within the context of teacher training programs may be an important factor in positively impacting pre-service teachers' (PSTs) confidence, willingness, and/or sense of preparedness to implement environmental learning in their future classrooms. Utilizing a mixed-methods approach, this study examined the potential impacts an immersive, environmental education workshop conducted at the Monterey Bay Aquarium in Monterey, CA had on a group of 61 elementary education PSTs during their teacher preparation program at California State University Monterey Bay (CSUMB). After participating in a variety of ocean-themed activities and empathy exercises, data collected through pre- and post-surveys indicated that this immersive, environmental experience contributed to PSTs perceived confidence and preparedness as future classroom-based, environmental educators. Through the reported development of their environmental confidence and interest in accessing supplementary resources, PSTs' ability to act on behalf of the environment by planning environmental learning in their future classrooms becomes a springboard for additional training and support.

Keywords: pre-service teacher training; environmental education workshops; environmental preparedness

1. Introduction

The integration of environmental education topics into the school day plays a vital role in cultivating a more sustainable future for us all. School is a formative place, and for some students, school may be the only place where they experience environmental topics in their lives [1]. In this sense, classroom teachers can be one gatekeeper for children's environmental learning and ethics of environmental care. As such, preparing teachers for this great responsibility to their students and to the Earth should be a focus of teacher preparation programs around the world [2,3].

With the integration of the Next Generation Science Standards (NGSS) into most United States public school classrooms, teachers are obligated to teach a number of environmental topics within their grade-level standards [4]. This shines an important light on novice teachers in terms of their readiness for implementing NGSS and teaching environmental science topics. The NGSS-aligned instruction and pedagogical supports provided to (PSTs) during their teacher preparation programs position them as viable future teachers of environmental topics.

While support with the successful implementation of the NGSS is the cornerstone of the Science Methods course, an opportunity still exists within this space to take a more immersive dive into environmental content with PSTs. The environmental experiences provided to PSTs during this formative time will lay the groundwork for the environmental experiences they will provide for their future students [5]. Thus, the need for more immersive environmental education training in teacher preparation programs surfaces. However, many teacher preparation programs are under continued pressure to shorten their programs, streamline their content to state or national teacher performance standards, or to teach in hybrid or fully online models [6]. This asks teacher educators to enact a level of creativity, resourcefulness, and collaboration with community partners to make deepened, environmental learning experiences possible for their PSTs within a shortened and concentrated timeframe.

While it seems the inclusion of environmental education in teacher preparation programs will play a critical role in the sustainability of our world, a need exists to further implement and research models aimed at efficiently and effectively including these efforts into teacher preparation programs. This research, which contributes to the body of literature on the inclusion of environmental education training in PSTs' preparation programs, represents one attempt at this type of innovation [7]. It asks: How does an immersive, environmental education workshop influence PSTs' environmental education preparedness? To deepen PSTs' exposure to environmental content, experiences, and resources, university and aquarium faculty teamed up to provide an intensive training experience to PSTs in their preparation program. Through our research of these efforts, we intend to contribute to the body of literature related to pre-service teacher training in environmental education that is lacking in size and rigor [8].

1.1. Pre-Service Teachers' Preparation in Environmental Education

Environmental education efforts have taken on many forms in teacher preparation programs, including integration across a number of courses [9], the inclusion of focused courses [10], multi-day trainings, supplementary units [11], the creation of integrated units [12], and/or online modules focused on environmental content. While the structure and amount of inclusion differs across these course-based approaches to environmental education inclusion, institutes of higher education have not historically been recognized for playing a key role in the organization of programs for PSTs to develop environmental education competencies [13].

McKeown-Ice (2000) conducted a survey of 715 public and private higher education institutions in the United States to investigate their current efforts around teacher preparation in environmental education. The results indicated that few institutes of higher education actually require teacher preparation in the area of environmental education in coursework or field placements. Of the universities reporting that they did offer this type of training to teachers, most rated their programs as adequately or poorly preparing their teachers in this area. Faculty interest and state requirements were notable indicators prohibiting preparation programs from providing PSTs with environmental training [14].

In another related study, higher education faculty offered varying reasons for their struggle to include environmental education content in PSTs' methods courses, including time, political issues within the institution, student disposition, limited incentives, or issues with PSTs' student teaching placements [15]. Nonetheless, these same faculty members also acknowledged the imperative role PSTs' preparation in environmental education can play on their future students.

O'Flaherty and Liddy (2018) also conducted a thorough review of the literature related to the environmental education landscape within teacher education. Their work indicated that despite the positive attitude PSTs often hold about environmental education, they are not adequately prepared to teach about environmental topics in their teacher preparation programs. They point to the structure of environmental education aims in teacher preparation programs as one reason for this, indicating that

PSTs require hands-on, integrated opportunities to build pedagogical skill in environmental topics. This type of training may not mimic the training PSTs are being offered [16].

Furthermore, for PSTs to infuse environmental topics into their future classrooms, they must also feel a sense of belonging and responsibility to teach about the environment [17]. While there are many factors that can impede or promote this sense of environmental connection and proclivity, educational efforts focused on developing empathy through experience may play a role in encouraging the PST to act on behalf of the environment. After all, there is a difference between building PSTs' awareness around environmental topics and actually promoting PSTs' participation in environmental education efforts through significant life experiences [18].

While PSTs receiving environmental education training in their preparation programs report a higher confidence and effectiveness related to teaching environmental topics [19], universities and faculty are struggling to efficiently and effectively achieve this aim. As such, conducting the critical work of preparing our PSTs to teach the future generation of environmental stewards may be better accomplished in partnership. Crafting innovative approaches to preparing PSTs that are sustained within purposeful partnerships between universities and community organizations, such as a local aquarium, may alleviate many of the aforementioned pressures that faculty face in this area.

1.2. The Monterey Bay Aquarium's Education for Conservation of the Ocean

The teacher education department of the Monterey Bay Aquarium has been providing workshops for PSTs of local colleges and universities since 1999. Since the beginning, the Aquarium has aimed to create programs that help teachers become more comfortable and competent with science content, process, and teaching strategies—particularly as they relate to ocean conservation. These workshops change to meet the needs of updated educational standards, best practices, and the themes of the science methods course that they are a part of. They have included curriculum activities, support for future field trips, and pedagogical discussions around science and environmental education.

The Monterey Bay Aquarium uses an outcome framework focused on building teacher confidence in teaching about the ocean and ocean animals, knowledge of science and environmental science content, and readiness to act for the ocean and environment. To this end, each workshop includes building connections between PSTs and the animals at the Monterey Bay Aquarium. These connections can motivate further learning and action about their natural history and the local ecosystems where they live. Each workshop also helps teachers see the connection between children engaging in nature-based activities and pro-environmental behaviors later in life [20].

2. Materials and Methods

This study used a mixed-methods approach to data collection [21]. Participants completed a survey pre- and post-workshop that included eight Likert scale questions based on confidence, knowledge, and willingness outcomes, and a narrative question on how informal science institutions can support teachers' science teaching and learning. The post-survey also included narrative questions about the parts of the workshop that were most useful and inspiring. Most of the items were developed in 2013 and are based on open-ended data from storyboards and concept mapping grounded in how teachers described outcomes like confidence, knowledge, and inspiration within ocean education contexts.

2.1. The Workshop Experience

The agenda for this immersive day included engaging in three sample classroom activities, a field trip experience, a session on science writing, a presentation on empathy for wildlife, and time to observe and interact with many of the animals on exhibit. This agenda was developed with faculty from both the Monterey Bay Aquarium and California State University Monterey Bay (CSUMB). The sessions were presented by instructors at the Aquarium. All of the instructors are current or former elementary school teachers with backgrounds in ecology and environmental science. An overview of the activities and their connected outcomes is in Table 1.

Table 1. Overview of activities during the workshop.

Name	Location	Activities	Aims/Outcomes
Patterns of Survival-Curriculum Activity	Aquarium exhibits	Teachers worked in teams to identify a habitat, observe three animals that live there, find something they all share and communicate that finding.	<ul style="list-style-type: none"> Build knowledge about marine life. Build confidence in integrating ocean science into teaching.
Amazing Animal Adaptations-Field Trip Experience	Discovery Laboratory	Teachers observed sandy shore and rocky shore invertebrates and discovered patterns in their adaptations.	<ul style="list-style-type: none"> Build knowledge about marine life. Build knowledge of resources that organizations like the Monterey Bay Aquarium can provide
Science Writing	Boardroom	Teachers experienced a writing lesson framework and wrote about their experience in the laboratory.	<ul style="list-style-type: none"> Build knowledge of resources that organizations like the Monterey Bay Aquarium can provide Build confidence in integrating ocean science into their teaching.
Empathy Presentation	Boardroom	Teachers heard about and discussed how to build empathy for wildlife in an effort to encourage pro-environmental behaviors in their students.	<ul style="list-style-type: none"> Build knowledge about environmental issues and actions that are developmentally appropriate to share with my students Build confidence in fostering an ocean conservation ethic in students
Shark Anatomy and Decode a Fish-Curriculum Activities	Boardroom	Teachers engaged in sample curriculum about fish adaptations.	<ul style="list-style-type: none"> Build knowledge about marine life. Build confidence in integrating ocean science into teaching. Build knowledge of resources that organizations like the Monterey Bay Aquarium can provide

2.2. Participants and Instruments to Collect Data

The participants taking part in the research project were 61 students enrolled in the elementary science methods course offered by the California State University Monterey Bay's education department. They were all working to earn a multiple subject teaching credential in the next one to two years. Of those 61 students, 49 completed both the pre- and post-survey. The survey instrument assessed the teachers' confidence, knowledge, and willingness to teach about ocean/environmental science. These outcomes connect to research on developing pro-environmental behavior [22]. The items describing the outcomes are in Table 2.

Table 2. Description of outcomes.

Outcome	Description
Confidence	Integrating ocean/environmental science into your teaching Fostering an ocean/environmental conservation ethic in students
Knowledge	Ocean and marine life Problems facing ocean and marine life Environmental issues and actions that are developmentally appropriate to share with my students Resources that organizations like the Monterey Bay Aquarium can provide
Willingness	To teach about the ocean/nature

An open-ended question was included in both the pre- and post-surveys to address the teachers' understanding of the role of information science institutions. At the end of the workshop, teachers were asked to (1) describe the parts of the day that were most useful and (2) describe the parts of the day that were most inspiring. The Monterey Bay Aquarium has used these questions for 4 years to gain better understanding of the needs of teachers participating in professional development.

2.3. Data Analysis

Quantitative data for this study were analyzed utilizing SPSS. The data from the pre/post Likert-style questions showed some non-normal distributions so crosstabs were run to better understand where participants started and where they moved. Inferential statistics in the form of t-tests and Wilcoxon signed ranks test [23] (where statistical significance was set at 0.01 in attempt to minimize Type I errors) were run to compare the mean scores before and after the workshop. Based on these results, we were interested in further understanding the relationships between the change in confidence and the other factors like understanding about the resource availability and increases in content knowledge. A knowledge composite scale was created from change scores and a multiple linear regression analysis was run to help make predictions about the outcomes. Qualitative data, in the form of participants' narrative or open-ended responses on the pre and posttests, was then analyzed using a general inductive approach [24]. This allowed the researchers to find meaning within the data by exploring potential correlations between the research objective and workshop evaluation data. It also outlined a procedure by which research findings could emerge from the dominant themes in the raw data [25].

Guided by the workshop objectives and the research question itself, the researchers conducted multiple readings and analysis of the survey data. Using emergent categorization, key ideas or processes from the data were coded and then arranged into research categories that were constructed and agreed upon by the researchers. Following prioritization of the numerous categories that emerged within the data, the categories were collapsed into predominant features, or themes, that answered the research question. Finally, to ensure credibility of the qualitative findings, a stakeholder check was conducted to compare the research themes and findings from this workshop with previous pre-service teacher workshop findings [26]. Additionally, the researchers conducted informal conversations about their findings with other staff within the Education Department at the Aquarium.

3. Results and Discussion

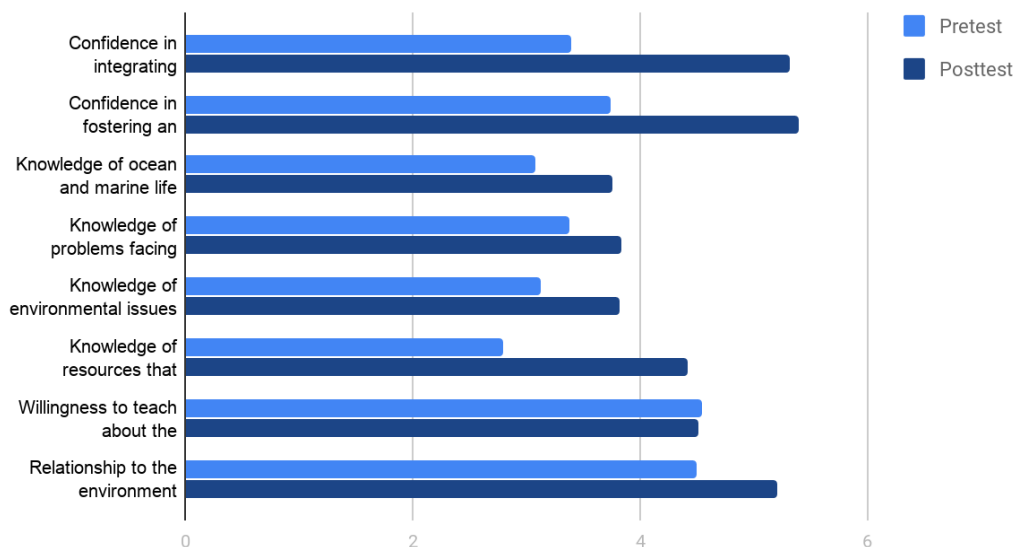
3.1. Confidence, Knowledge, and Willingness

As displayed in Table 3, there are statistically significant differences, at the 0.01 significance level, in pretest and posttest scores for all measures but willingness. A Wilcoxon signed ranks test was also run with the same conclusions. Results show that confidence in integrating ocean/environmental science into teaching and fostering an ocean/environmental conservation ethic in students increased. Knowledge of ocean and marine life, problems facing ocean and marine life, environmental issues and actions that are developmentally appropriate for students, and resources that organizations like the Monterey Bay Aquarium can provide also all increased. The participants' reported relationship to the environment also increased.

Three of the outcomes increased the most (see Figure 1). 90% increased their scores of confidence in integrating ocean/environmental science into their teaching, 88% increased their scores in confidence in fostering an ocean/environmental conservation ethic in students, and 84% increased their scores in their knowledge of resources that organizations like the Monterey Bay Aquarium can provide. Participants' willingness to teach about the ocean/nature was high on the pretest and stayed high in the posttest. 71% of the participants did not change their scores from pre to posttest.

Table 3. Results of t-test and descriptive statistics for each outcome before and after the workshop.

	Pretest		Posttest		95% CI for Mean Difference	t	df
	M	SD	M	SD			
Confidence in integrating ocean/environmental science into your teaching	3.39	1.60	5.31	1.08	−2.28, −1.55	−10.56 *	48
Confidence in fostering an ocean/environmental conservation ethic in students	3.74	1.69	5.39	1.17	−2.07, −1.23	−7.90 *	48
Knowledge of ocean and marine life	3.08	0.91	3.76	0.88	−0.92, −0.42	−5.39 *	48
Knowledge of problems facing ocean and marine life	3.37	0.95	3.84	0.85	−0.75, −0.19	−3.35 *	48
Knowledge of environmental issues and actions that are developmentally appropriate to share with my students	3.12	0.93	3.82	0.88	−0.94, −0.45	−5.74 *	48
Knowledge of resources that organizations like the Monterey Bay Aquarium can provide	2.80	0.98	4.41	0.61	−1.93, −1.30	−10.30 *	48
Willingness to teach about the ocean/nature	4.55	0.61	4.51	0.62	−0.14, −0.47	−5.78	48
Relationship to the environment	4.49	1.50	5.20	1.44	−0.96, −0.47	−5.77 *	48

* $p < 0.01$.**Figure 1.** Item means pre- and post-workshop.

However, the other knowledge outcomes did increase about half of the teachers' scores stayed the same and half moved up (ocean and marine life = 49% increase, knowledge of problems facing ocean and marine life = 43% increase, and knowledge of environmental issues and actions that are developmentally appropriate to share with my students 57%). Again, about half (53%) of the participants increased their scores on their relationship to the environment. This question, in particular, may indicate that an immersive experience like this may jump-start a growing relationship with the environment. The researchers anticipated that this would not change much in a one-day workshop, but the data suggests that a workshop like this can support the development of a more connected relationship between participants and the environment. More research on the sustainability of this outlook is needed.

A multiple linear regression was calculated (see Table 4) to predict the change in confidence based on their change in knowledge composite and change in resources [27]. Based on the reliability index,

knowledge of resources seemed to be based on a different construct than the rest of the knowledge measures which can be treated as a scale. A significant regression was found ($F(2,44) = 12.09, p < 0.000$), with an R^2 of 0.36. Participants predicted confidence scores are equal to $0.83 + 0.84$ (knowledge composite score) $+ 0.34$ (resource score), where the knowledge composite and resources scores are coded or measured from 1 to 7. Both knowledge composite and resources scores were significant predictors of confidence. Both independently predicted change in confidence (each explained a unique portion of variance in the change in confidence scores).

Table 4. Results for linear regression with knowledge and resources predicting confidence.

Variable	B	SE	95% CI	β	t	p
Constant	0.83	0.26	[0.32, 1.34]	0.00	3.25	0.002
Knowledge Scale	0.84	0.23	[0.36, 1.31]	0.44	3.57	0.001
Resource Change	0.34	0.13	[0.08, 0.59]	0.33	2.64	0.011

Note. Results: $F(2,44) = 12.09, p < 0.000, R^2 = 0.36$.

3.2. Resource Availability

The results from the narrative questions help to further explain the above results. The most useful part of the day to the participants was engaging in curricular activities that they can do with their students. These responses were coded using defined categories based on the day's agenda. 61% of participants mentioned these classroom activities as being the most useful. Experiencing these ocean science classroom activities may have aided in their developing confidence in integrating ocean/environmental science into their classroom practices. One participant commented, "The lesson plans that I can use to implement in my own classroom. They are simple, easy to follow, and work well with the NGSS. Moreover, the different apps I can use with my students." Another participant saw the connection to their classroom practice as well, "The most useful experiences were those where we were able to practice and apply different techniques and lessons and use them ourselves. It gave me lots of ideas that I can transfer into my own classroom with my students."

Participants also answered the question, "How can informal science institutions like the Monterey Bay Aquarium support your science teaching and learning?" both pre- and post-workshop. After the workshop, people described informal science institutions as places they can get resources and curriculum (14% increase), and professional development (27% increase) more than before the workshop. This may have contributed to their knowledge of resources that organizations like the Monterey Bay Aquarium can provide. One participant explained in the pretest that "informal science institutions can engage students [sic] in science activities beyond the classroom." This is a common understanding of institutions like zoos and aquariums. After the workshop, the same participant commented that institutions "Provides support for curricula and gives students an opportunity to learn outside the classroom in a way that focuses more on scientific aspects rather than a typical teaching and learning routine." Here, the participant has connected the activities at the science institution to support curricular activities in their own classroom. Another participant said in the pretest, "I am able to reference what I have seen at the aquarium as well as make it more relevant to students, especially if they have visited the aquarium before." This response focuses in on the things that the aquarium exhibits. Then in the posttest, "Informal science institutions have a variety of resources available for teachers and students; other than providing field trip opportunities, places like the Aquarium have curriculum that they have created to target the needs of our students. This curriculum is standards based/aligned as well as provides scaffolds to further assist students who need additional support." This is a much more robust answer that includes an understanding of the supports that informal science institutions may provide, such as standards-based curriculum.

3.3. Empathy

According to the results, the most inspiring part of the day was a presentation about helping students develop an environmental ethic through building empathy for animals [28], age-appropriate environmental topics, and taking action. It included activities that allowed PSTs to discover their own connections to animals and discuss how they can help their students develop empathy for animals, starting with those with which they interact. This session may have impacted their confidence in fostering an ocean/environmental conservation ethic in students. One participant commented, "I am inspired to make science available for my students by simply taking them outside to learn about local animals we may see like butterflies and providing hands on activities." Another connected to the empathy content of the session, "The most inspiring experience was the workshop about empathy. I think encouraging students to have empathy and care about nature is the first step to creating great citizens and helping them take agency in keeping their environment clean and safe for marine life. Making sure students do not form 'ecophobia' and realizing how important that is inspired me as well."

4. Conclusions

This study explored how an immersive, environmental education workshop influenced PSTs' environmental education preparedness. Based on the results previously discussed, the workshop deepened PSTs exposure to environmental content, experiences, and resources.

The research question included the impact of this day on teachers' confidence, knowledge, and willingness to teach about the ocean. Based on the results, there were gains in both confidence and knowledge. The program may have had the strongest influence on three outcomes: confidence in integrating ocean/environmental science into their teaching, confidence in fostering an ocean/environmental conservation ethic in students, and knowledge of resources that organizations like the Monterey Bay Aquarium can provide. This suggests that many aspects of the day were useful to the PSTs. Some workshops can only share sample lessons or field trip opportunities. However, the combination of pedagogy, lessons, and resources seems to be a strong model for future workshops held at informal science institutions like the Monterey Bay Aquarium.

While it was not addressed specifically, it cannot be ignored that the success of this workshop may be linked to the connection PSTs made with the Monterey Bay Aquarium as a local institution. Many of the PSTs will be hired close enough to the Aquarium to take their students on field trips there. Additionally, the fact that the Aquarium provides resources, field trips, and professional learning opportunities for free may have impacted the teachers' positive responses.

There was little change in PSTs' willingness to teach about the ocean/nature. This suggests that they may have been willing to teach about the ocean before the workshop but needed some additional confidence and knowledge to do so. Capitalizing on the willingness of PSTs to teach about the ocean and nature in an immersive workshop where they are shown where to find resources for teaching and professional learning in a local informal science institution is yet another model for future methods courses.

The narrative responses showed excitement for teaching about the environment and using the resources offered by the Monterey Bay Aquarium. A further study on how teachers have implemented these pedagogical and curricular ideas once they have completed their teacher education program would help understand the longer-lasting impacts of this day. However, the excitement and learning that came from just a one-day experience are powerful in and of itself.

Due to the singular day and sample size of this group, caution should be exercised when generalizing the results of this study. However, these results do indicate interesting impacts of an immersive day of professional development at an informal science institution on this group of pre-service elementary teachers.

In conclusion, conducting an immersive, full-day workshop for PSTs at a local informal science institution provides one framework for environmental science instruction focused on facilitating

experience through partnership. Considering the results of this study, including experiences such as these in PSTs' teacher training programs may aid in developing their knowledge of the resources available for teaching science in their future classrooms. For the trainers and teacher educators involved, providing and documenting PSTs' experiences in a science workshop provides detailed information about their experiences with environmental instruction from which to form future supports in their current program or during their first years of teaching.

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