Evaluation Report for NOAA Ocean Exploration and Research Professional Development Institutes

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I. Executive Summary

In fall of 2003, NOAA's Ocean Exploration (OE) Program began conducting Professional Development Institutes (PDIs) as part of the OE objective to "reach out in new ways to stakeholders to improve the literacy of learners of all ages with respect to ocean issues." These PDIs were conducted in partnership with a network of institutions or Alliances. Between fall of 2003 and the end of 2007, 56 introductory and 22 follow-up PDIs were conducted. These 78 PDIs impacted 1355 participants; 970 through introductory PDIs and 385 through follow-up PDIs. Surveys containing quantitative and qualitative affective and demographic items were administered pre and post to participants in the introductory PDIs and post in the follow-up PDIs.

The results from the 10 quantitative items on the pre/post surveys are very positive. Four of the survey items showed a significant shift from negative to positive perceptions during the PDIs. Three additional items showed positive perceptions by participants prior to the PDIs that became more positive during the PDI. The three remaining items showed very positive perceptions by the participants on the pre PDI survey that did not change during the PDI.

Participants' responses to the qualitative items on the pre survey provided a wide range of topics they would cover if teaching ocean science in their classrooms. The most common responses were related to life science followed by oceanography, and earth and physical science.

Responses to the qualitative items on the post introductory PDI survey were very complementary of the introductory PDIs. Participants found the PDIs to work well as designed; their content knowledge increased as a result of the PDIs, and useful materials, lessons, and resources were provided. Overwhelmingly, participants stated that the PDIs will enable them to improve student learning at their school through the use of the many quality materials and resources provided by OE.

Analysis of the Follow-up surveys indicated very positive perceptions of the value of the PDIs to themselves as teachers and their students. Responses to 13 of the 15 items on the Follow-up survey indicated that more than 65% of participants responded positively to these items. On item 4, which refers to whether Ocean Science is part of school or district standards, 48% of participants indicated that Ocean Science was part of the standards they are required to address. Additionally, responses to item 6 indicate that 39.5% of participants have used components of the OE Web site as homework.

Additional analysis of items on the post survey with analogous items on the follow-up survey indicates that the percentages of participants who agree with the items at both time points remain consistent with positive outcomes from the workshops and do not drop off over time. In addition, the high positive perceptions of the value of OE PDIs on the Follow-up survey indicates that even after participants have had a chance to implement some of the activities and use some of the resources from the PDIs, they still view the PDIs as useful and meaningful.

Overall, the qualitative items on the Follow-up survey were very positive about participants' PDI experience. Suggestions for the website focused on ways to organize the website that would make it easier to search and simpler to use. Improvements to the workshops focused on providing more workshops, workshops for teachers of younger students or specialized audiences, and ways for participants to connect with one another for help implementing lessons. The factors that inhibit use of OE resources and materials include lack of technology, time or bad timing, funds to implement lessons, and a need for more support from OE and school administrations.

The following recommendations are offered to the Ocean Exploration Program Educators:

1. Assessment of OE PDIs should continue. However, the Education Director should consider collecting data that will provide evidence for the level of implementation of the OE curriculum by PDI participants. This is difficult to ascertain based on the results of self-report pre/post surveys.
2. Further assessment is needed to determine the extent of impacts on student learning that can be attributed to the OE PDIs. The current assessment is not designed to assess the impact of OE PDIs on student learning.
3. Future pre/post assessment of participants should focus on participant content knowledge, efficacy and other areas of interest to the OE Education Staff.
4. New assessment tools should be designed to focus on curriculum implementation and student learning. These tools should utilize best practices in both qualitative and quantitative educational research.
5. Reliability and factor analysis reflect the weak structure of the current survey in relation to the development of survey items, factors and overall structure. Future survey items should be developed according to specific factors ("themes"). The items should then undergo content analysis and pilot testing to determine if the survey measures what it is designed to measure.
6. Interviews of participants and classroom observations of implementation of PDI activities and strategies should be considered as ways to determine how the curriculum and website are utilized.
7. All instruments utilizing a Likert scale format should begin with the lowest aspect of disagreement with the statement (e.g., 1 = Strongly Disagree) to the highest aspect of agreement (e.g., 6 = Strongly Agree) to facilitate data analyses.
8. Self-report survey instruments should be redesigned to reflect changes in OE goals and objectives for the PDIs. Survey items should address selected constructs or factors of interest to OE and should be based on revised PDI goals and objectives.
9. Many of the qualitative items on the existing post survey should be revised or eliminated. With analysis of nearly 1000 responses from the post instrument, it is unlikely that any new information will emerge with continued analysis of responses to the existing items.
10. Participants should be strongly encouraged to complete the entire survey to lessen the impact of missing data on the analysis.
11. Continue to reach out to diverse ethnic groups and new audiences (e.g., elementary teachers, informal educators, college/university professors working with pre service teachers). Survey results suggest the PDI participants are very motivated already ("preaching to the choir") as indicated by the high levels of agreement in many survey responses (indicating a potential ceiling effect).
12. Develop "primary", "advanced" or "topic specific" PDIs which address the needs of specific educator groups. These PDIs should introduce OE content at an elementary level or delve deeper into pedagogy and specific biological or physical science content.
13. Utilize the OE listserv as a discussion site for PDI participants to share best practices and ideas for resources in addition to PDI announcements. In other words, make the listserv interactive.
14. Items regarding student learning/enjoyment should be eliminated as this can not be accurately assessed via a third party (e.g., teacher) response.
15. Assessment/evaluation of OE PDIs should continue on a regular (e.g., biennial) basis.

II. Key Findings

1. OE PDIs function well as designed.
2. The overwhelming majority of participants were Caucasian K-12 teachers. Most identified themselves as having less than 11 years of teaching experience and as teachers at the middle or high school level.
3. There was a statistically significant difference from pre to post on 9 of 10 items from the Introductory PDI surveys. In addition, at least 65% of responses to 13 of 15 items on the Follow-up PDI survey were positive. These findings lead to the conclusion that the PDIs are having a positive impact on participants.
4. Results indicate overall satisfaction with OE Introductory and Follow-up PDIs.
5. The majority of PDI participants value their OE PDI experience and are interested in ocean science.
6. Reliability and factor analysis results indicate the need for redesigning any survey used in OE PDIs to better reflect the goals and objectives of the PDIs and to ensure the desired constructs (what NOAA OE Education staff wants measured by the surveys) are measured.
7. Although participants indicate that their experience in the PDI will enable them to increase student learning and/or enjoyment, it is not possible to determine if this is true with the current data set.
8. Data has not been collected to provide evidence for the level of implementation of the OE curriculum by PDI participants.

III. Introduction

In fall of 2003, NOAA's Ocean Exploration (OE) Program began conducting Professional Development Institutes (PDIs) as part of the OE objective to "reach out in new ways to stakeholders to improve the literacy of learners of all ages with respect to ocean issues." The PDIs were conducted with a network of partnering institutions or Alliances. Between fall of 2003 and the end of 2007, 56 introductory and 22 follow-up PDIs were conducted. These 78 PDIs impacted 1355 participants; 970 through introductory PDIs and 385 through follow-up PDIs. Surveys containing quantitative and qualitative affective and demographic items were administered pre and post to participants in the introductory PDIs and post in the follow-up PDIs. This evaluation report provides an analysis of the surveys and synthesis of the results.

IV. Analyses of Pre and Post Surveys Conducted for Introductory Professional Development Institutes (PDIs)

Immediately prior to and at the conclusion of each Introductory PDI, surveys containing quantitative and qualitative affective and demographic items were administered to PDI participants. Two sets of surveys (original and revised) were developed and utilized by the OE program from 2003-2007 in the introductory workshops. Demographic data are listed in Tables 1-5. Qualitative items remained the same on both versions of the survey and are addressed in the Qualitative Analysis section.

A. Demographics

Demographic data for participant employment, subjects taught, grade level taught, years teaching and ethnicity are presented in the following five tables (Tables 1-5). Note that there is missing data in each demographic field. Analysis was conducted on the complete data. Missing data for each table is noted below.

TABLE 1.
Participants' position of employment in OE PDIs.

	Teacher	Informal educator	Administrator	College / University	Pre service teacher	Other
Percent (%)	85.3	2.2	5.9	0.4	1.2	5.0

Note. Calculated n = 848; Total n = 971, missing data = 123 (12.7%)

TABLE 2.
Subjects taught by participants in OE PDIs.

	Science	Math & Science	All	Multiple subjects	Other	Marine/ Ocean	Pre service education
Percent (%)	68.7	13.6	5.4	5.5	6.3	0.5	0

Note. Calculated n = 811; Total = 971, missing data = 160 (16.5 %)

TABLE 3.
Grade level taught by participants in OE PDIs.

	K-5	K-8	K-12	6-8	6-12	9-12	College	Other
Percent (%)	14	4.7	0.5	32.5	1.2	40.6	0.9	5.6

Note. Calculated n = 852; Total n = 971; missing data = 119 (12.3%)

TABLE 4.
Years teaching as indicated by participants in OE PDIs.

	0-5	6-10	11-15	16-20	21-25	26-30	> 30
Percent (%)	34.5	23.4	17.6	7.7	6.2	5.3	5.2

Note. Calculated n = 788; Total n = 971; missing data = 183 (18.8 %)

TABLE 5.
Ethnicity as indicated by participants in OE PDIs.

	African American	Asian American	Caucasian	Hispanic	Native American	Pacific Islander	Other
Percent (%)	3.3	5.3	80.9	4.9	4.6	0.5	0.5

Note. Calculated n = 824; Total n = 971; missing data = 147 (15.1 %)

Discussion

The majority of the participants in the OE introductory PDIs were science (68.7%) or math (13.6%), K-12 (93.5%) teachers (85.3%) who have been teaching for 10 years or less (57.9%). Most are Caucasian (80.9%) with less than 10% of participants from other ethnicities.

B. Pre and Post Quantitative Introductory Survey Analyses

Ten (10) common quantitative items exist on the pre- and post- original and revised surveys as noted in Table 6. Abbreviations for each item (pre-determined by OE Education staff) are provided in ( ) at the end of each item.

TABLE 6.
OE PDI items common to original and revised pre and post surveys.

1. I do not have a clear idea of what the NOAA Ocean Exploration Program is and how the curriculum and website fits in my classroom. ***(Clear)***
2. I know everything I need to know to teach the Ocean Exploration curriculum in my classroom. ***(Know)***
3. I feel confident about teaching physical and earth science as it applies to the world's oceans in my classroom. ***(Physical)***
4. I am confident in my ability to teach biological ocean science in my classroom. ***(Biological)***
5. I have no way to connect my students with real ocean scientists, directly or indirectly. ***(Scientists)***
6. I do not know how to use the Ocean Exploration web site with my students. ***(Web)***
7. I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected to the internet. ***(Internet)***
8. I am afraid to teach ocean science because I do not have a strong content background in ocean science. ***(Afraid)***
9. I would like to be a part of an Ocean Exploration team and have a chance to work with ocean scientists. ***(Team)***
10. I teach earth or life science so ocean science is not what I should be teaching in my classroom. ***(Classroom)***

A coefficient alpha was computed to determine the internal estimate of reliability of the post administrations of the survey. The Cronbach's alpha was 0.64, indicating a reliability estimate just below satisfactory (0.70).

The ten common items of the PDI survey were subjected to principal components analysis (PCA). Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of some coefficients of 0.3 and above. The Kaiser-Meyer-Oklin value was 0.75, exceeding the recommended value of 0.6. The Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. PCA revealed the presence of two components with eigenvalues exceeding 1, explaining 26.3% and 15.8% of the variance respectively. An inspection of the screeplot revealed a clear break after the second component. The two components were retained for further investigation. To aid in the interpretation of these two components, Varimax rotation was performed. The rotated solution revealed the presence of simple structure, as depicted in Table 7, with both components loading substantially on only one component. The two factor solution explained a total of 42.2% of the variance, with component 1 contributing 21.4% and component 2 contributing 20.8%. All positive items and one negative item loaded strongly on component 1, and all other negative items loaded on component 2. As the original survey was not prepared with specific factors or themes (e.g., efficacy, attitudes toward science) in mind, this result of a split in components between positive and negative items is to be expected. Future surveys should carefully consider specific factors of interest and be developed to reflect factors representative of OE PDI goals and objectives.

TABLE 7.
Varimax rotation of two factor solution for OE PDI combined items.

	Component	
Item	**1**	**2**
3. I feel confident about teaching physical and earth science as it applies to the world's oceans in my classroom.	.842	
4. I am confident in my ability to teach biological ocean science in my classroom.	.820	
2. I know everything I need to know to teach the Ocean Exploration curriculum in my classroom.	.678	
8. I am afraid to teach ocean science because I do not have a strong content background in ocean science.	-.364	
9. I would like to be a part of an Ocean Exploration team and have a chance to work with ocean scientists.	.354	
6. I do not know how to use the Ocean Exploration web site with my students.		.722
5. I have no way to connect my students with real ocean scientists, directly or indirectly.		.707
7. I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected		.611

to the internet.	
10. I teach earth or life science so ocean science is not what I should be teaching in my classroom.	.550
1. I do not have a clear idea of what the NOAA Ocean Exploration Program is and how the curriculum and web site fits in my classroom.	.515

B.1. Analyses of Responses

Descriptive statistics were calculated using SPSS v.16 on the survey data provided to the research team for these 10 common items. A total of 970 pre/post surveys were analyzed (162 original and 808 revised pre/post surveys). The NOAA OE PDI pre/post survey design utilized a Likert scale response ranging from 1-6, with 1 = strongly agree; 2 = agree; 3 = slightly agree; 4 = slightly disagree; 5 = disagree; 6 = strongly disagree. Table 8 provides the pre/post means, pre/post standard deviation, p-value, and effect size for each of the 10 Introductory PDI quantitative items common to both the original and revised surveys. Significance and effect size were calculated for post surveys. The + or – after each item indicates whether the item is stated in a positive (+) or negative (-) way. For positively stated items, scores that decrease pre to post indicate a shift from a negative to a positive perception regarding the content of the item. For negatively stated items, scores that increase indicate less agreement with the item or a more positive perception regarding the content of the item. Therefore, the outcome that indicates improvement (pre to post) as a result of the Introductory PDIs is a shift from low to high scores for negative items and a shift from high to low scores for positive items.

TABLE 8.
Pre/post mean, standard deviation, p-value, and effect size values for each of the introductory PDI quantitative items.

Item	Mean (Pre)	Standard Deviation (Pre)	Mean (Post)	Standard Deviation (Post)	p value	Effect size (d)
1. Clear (-)	2.68	1.40	5.10	1.32	<.01	1.23
2. Know (+)	5.22	0.98	2.88	1.22	<.01	1.47
3. Physical (+)	3.18	1.36	2.14	0.89	<.01	0.66
4. Biological (+)	2.93	1.40	2.16	0.94	<.01	0.50
5. Scientists (-)	3.93	1.54	5.26	0.95	<.01	0.76
6. Web (-)	2.58	1.38	5.34	0.91	<.01	1.67
7. Internet (-)	5.05	1.42	5.28	1.19	<.01	0.14
8. Afraid (-)	4.49	1.38	5.16	1.95	<.01	0.29
9. Team (+)	1.73	1.03	1.79	1.18	0.23	N/A
10. Classroom (-)	5.29	1.09	5.47	0.99	<.01	0.12

The pre to post means and p values indicate that there was statistically significant ($p < 0.01$) change in participants' scores on 9 of the 10 items. There was no statistically significant change on item 9 ($p = 0.23$). Effect size for 6 of 10 items was considered to be medium or greater ($d = 0.5$). Effect size indicates how much of a difference an intervention has made and provides an estimate of the magnitude of the relative impact of the intervention.

In the following section, frequencies and percentages of responses were calculated for the ten (10) quantitative items on the pre- and post- surveys administered during the introductory PDIs. Valid percents were utilized to prepare summary tables and percent change for each item. Bar graphs of the percentages for pre- and post- survey, and summary tables, and results of paired samples t-tests for each item are presented on the following pages in Figures 1-20 and Tables 9-20.

One-way analysis of variance (ANOVA) was calculated for each item of the post survey. The present survey was not constructed to compute a score based on a behavioral construct (e.g., efficacy) or related factors to allow for a meaningful analysis on the overall mean score on the survey. The dependent variable is the score for the item; the factor is grade level, with three levels (K-5, 6-8, and 9-12). When applicable, eta squared was used as a measure of effect size. Because the actual sample sizes among the three levels is not the same (K-5 n ~120; 6-8 n ~ 280; 9-12 n ~ 350) and violates the homogeneity of variance assumption, the Dunnett's C procedure was utilized as a post hoc test.

B.1.1. NOAA OE program and use in the classroom

FIGURE 1.

Pre survey results for Item 1: I do not have a clear idea of what the NOAA Ocean Exploration program is and how the curriculum and website fits in my classroom.

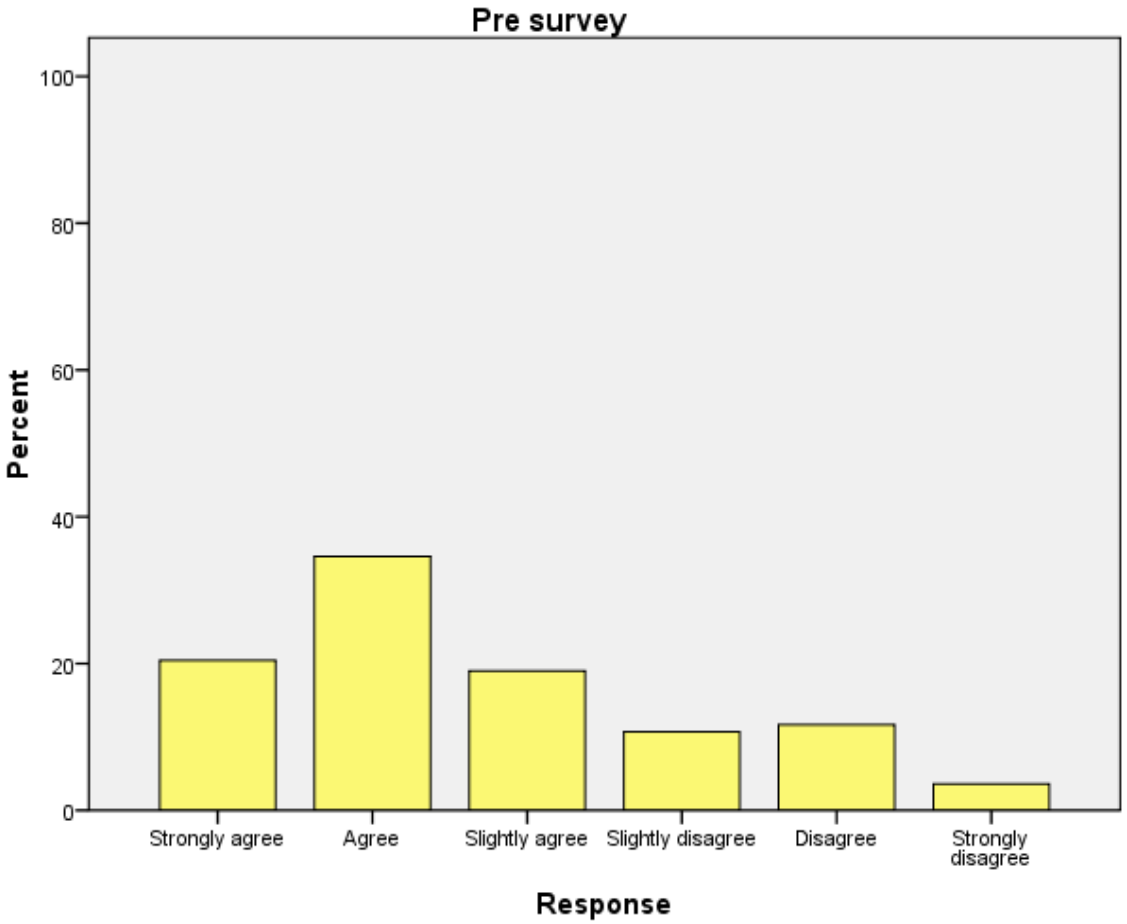

FIGURE 2.
Post survey results for Item 1: I do not have a clear idea of what the NOAA Ocean Exploration program is and how the curriculum and website fits in my classroom.

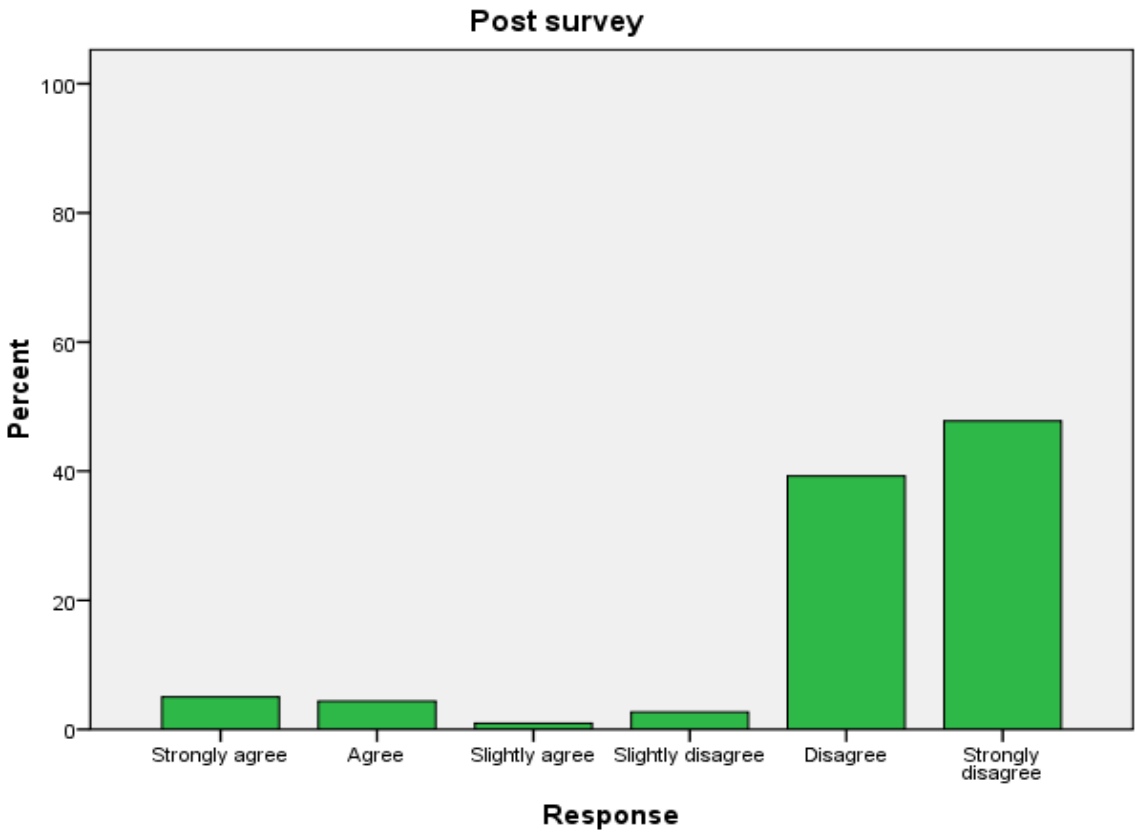

TABLE 9.
Pre/post percent change for Item 1: I do not have a clear idea of what the NOAA Ocean Exploration program is and how the curriculum and website fits in my classroom.

Response	Pre survey	Post survey	% Change
Strongly agree	20.4%	5.0%	15.4
Agree	34.6%	4.4%	30.2
Slightly agree	19.0%	1.0%	18.0
Slightly disagree	10.7%	2.7%	8.0
Disagree	11.7%	39.2%	- 27.5
Strongly disagree	3.6%	47.8%	- 44.2

Figures 1 and 2 and Table 9 demonstrate the shift in participants' responses to: ***I do not have a clear idea of what the NOAA Ocean Exploration Program is and how the curriculum and website fits in my classroom.*** Prior to the PDI 74.0% of the participants agreed with this statement; after the PDI only 10.4% of the participants agreed. This indicates that participants'

perception of their understanding of what the NOAA Ocean Exploration Program is and how the curriculum and website fit in their classroom improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding the NOAA OE program. There was a statistically significant difference in scores from pre (M = 2.68, SD = 1.40) to post survey (M = 5.10, SD = 1.32), $t(882) = -36.67$, $p<.01$. The standardized effect size index, d, was 1.23, indicating a large effect of the PDI. The 95% confidence interval for the mean difference between the two scores was -2.55 to -2.29.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Clear* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Clear*. The ANOVA was not significant $F(8, 840) = 1.32$, $p = 0.23$, indicating there are no significant differences in responses by grade level.

B.1.2. Teaching the OE curriculum

FIGURE 3.

Pre survey results for Item 2: I know everything I need to know to teach the Ocean Exploration curriculum in my classroom.

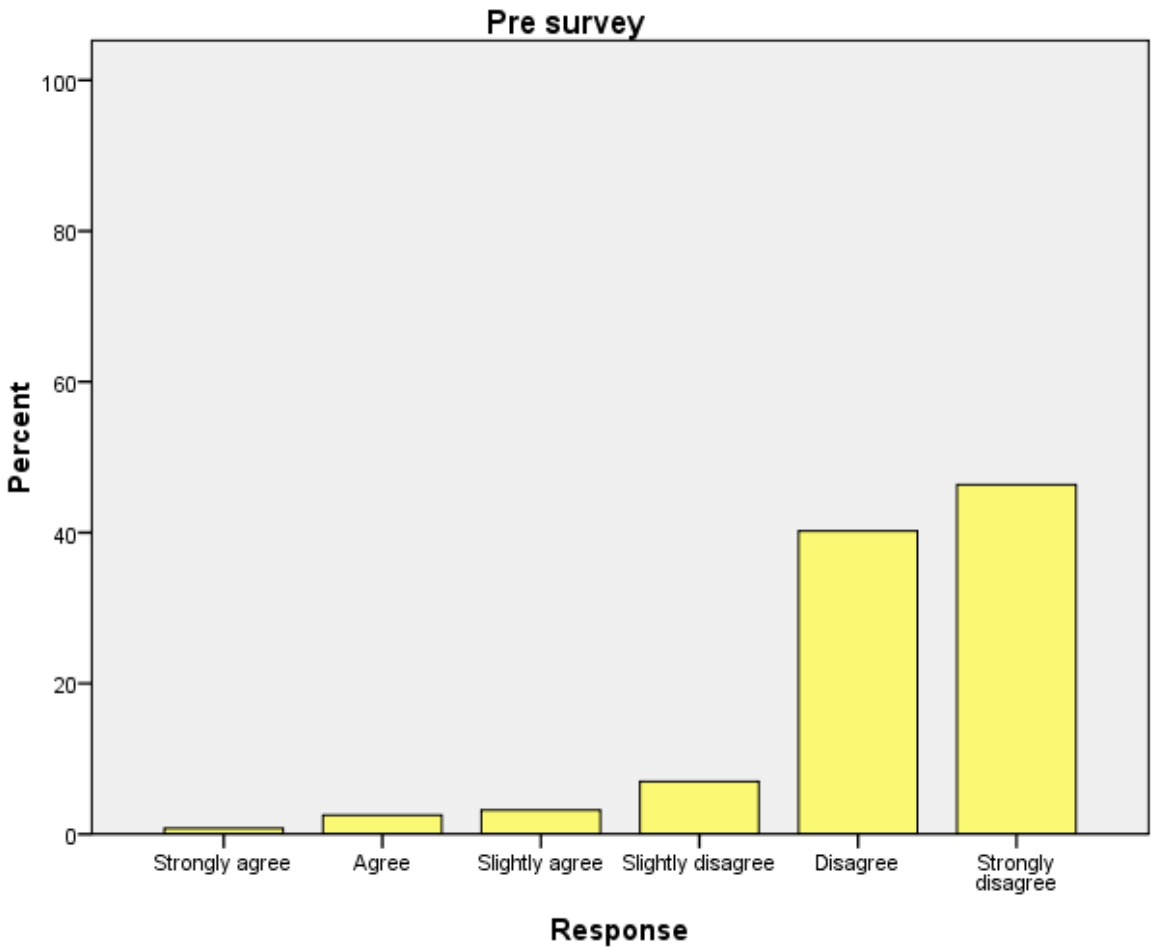

FIGURE 4.
Post survey results for Item 2: I know everything I need to know to teach the Ocean Exploration curriculum in my classroom.

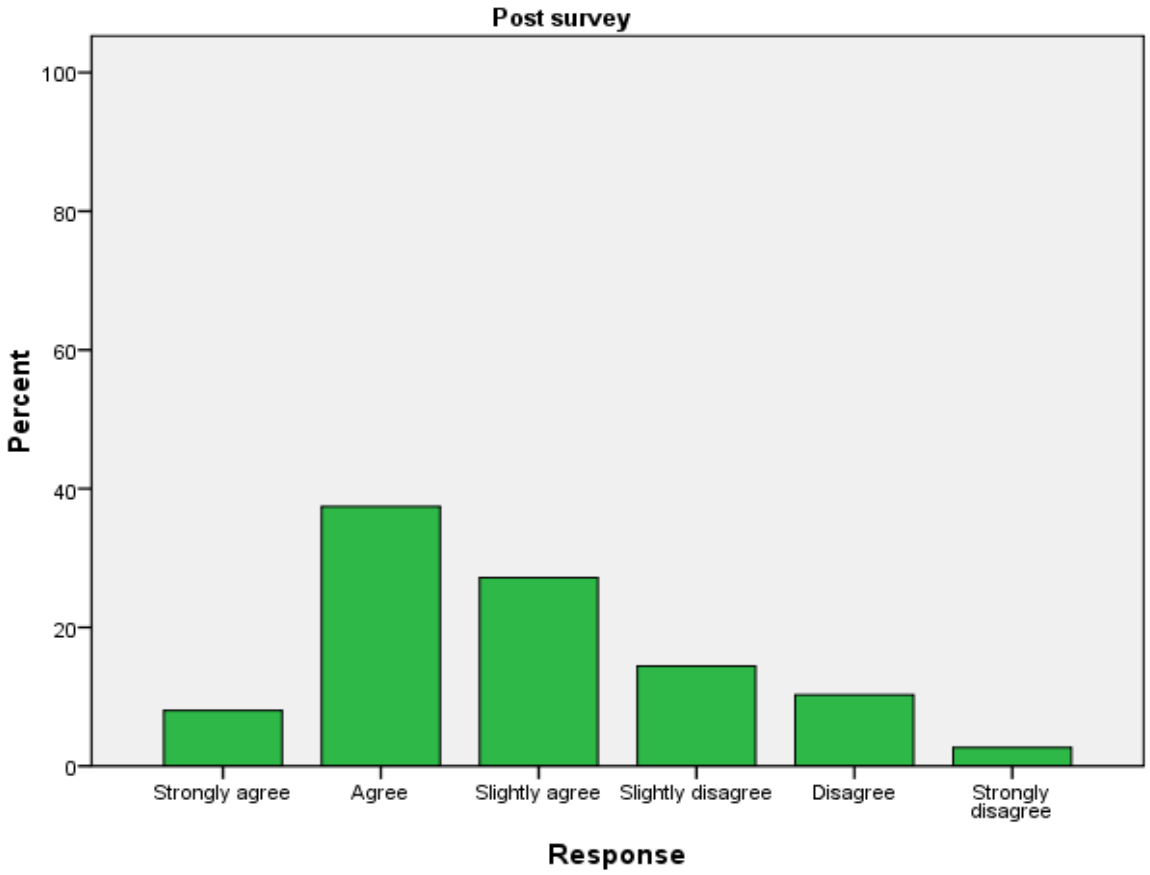

TABLE 10.
Pre/post percent change for Item 2: I know everything I need to know to teach the Ocean Exploration curriculum in my classroom.

Response	Pre-survey	Post-survey	% Change
Strongly agree	0.8%	8.0%	- 7.2
Agree	2.5%	37.4%	- 34.9
Slightly agree	3.2%	27.2%	-24.0
Slightly disagree	7.0%	14.4%	- 7.4
Disagree	40.2%	10.3%	29.9
Strongly disagree	46.3%	2.7%	43.6

Figures 3 and 4 and Table 10 demonstrate the shift in participants' responses to: ***I know everything I need to know to teach the Ocean Exploration curriculum in my classroom.*** Prior to the PDI only 6.5% of the participants agreed with this statement; after the PDI 62.6% of the participants agreed. This indicates that participants' perception that they know everything they

need to know to teach the Ocean Exploration curriculum in their classroom improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding the OE curriculum. There was a statistically significant difference in scores from pre (M = 5.22, SD = 0.48) to post survey (M = 2.88, SD = 1.22), $t(878) = 43.46$, $p<.01$. The standardized effect size index, d, was 1.47, indicating a large effect of the PDI. The 95% confidence interval for the mean difference between the two scores was 2.24 to 2.45.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Know* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Know*. The ANOVA was not significant $F(8, 837) = 1.40$, $p = 0.19$, indicating there are no significant differences in responses by grade level.

B.1.3. Confidence in teaching physical and earth science relating to the ocean

FIGURE 5.

Pre survey results for Item 3: I feel confident about teaching physical and earth science as it applies to the world's oceans in my classroom.

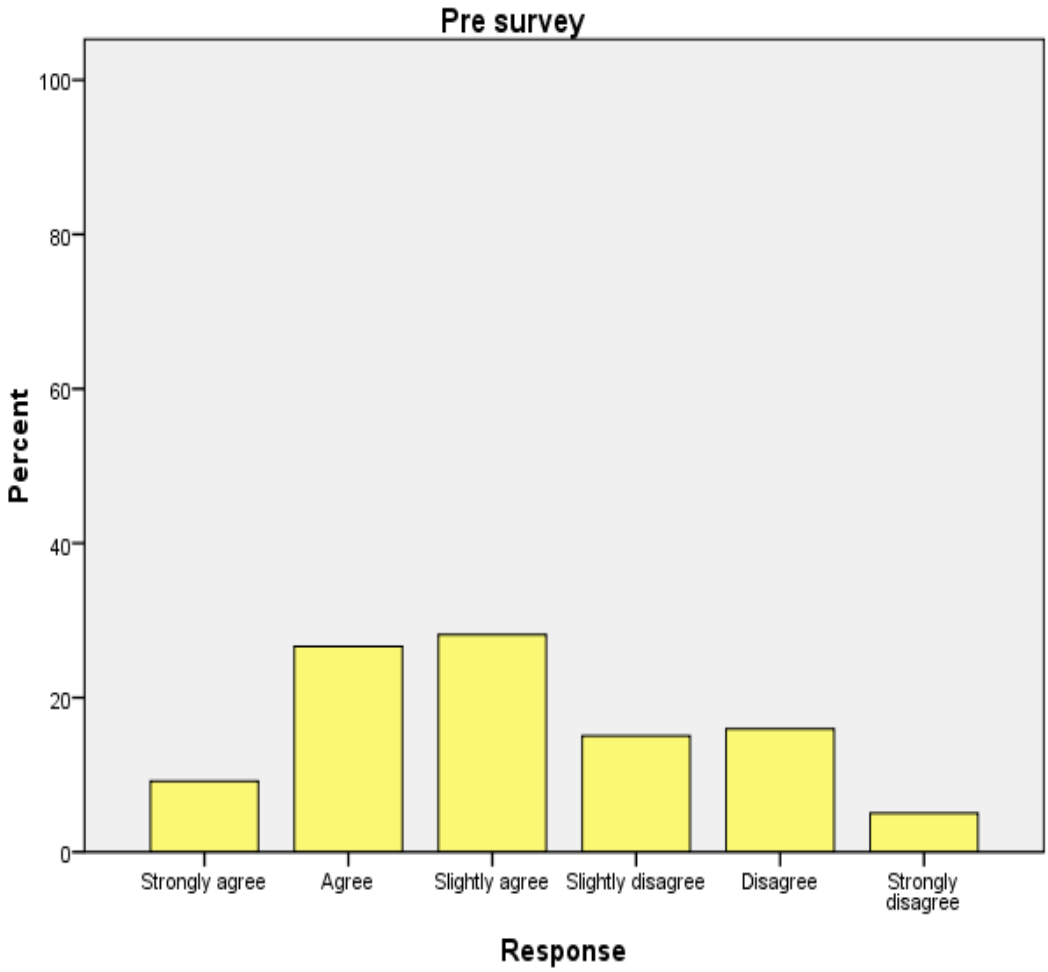

FIGURE 6.
Post survey results for Item 3: I feel confident about teaching physical and earth science as it applies to the world's oceans in my classroom.

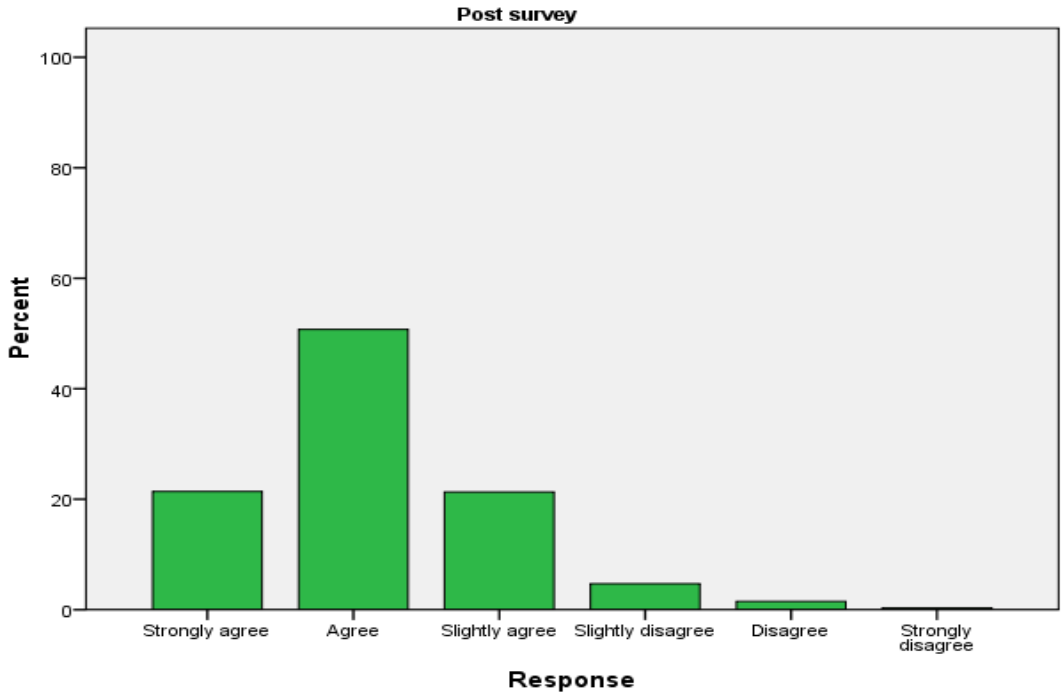

TABLE 11.
Pre/post percent change for Item 3: I feel confident about teaching physical and earth science as it applies to the world's oceans in my classroom.

Response	Pre-survey	Post-survey	% Change
Strongly agree	9.2%	21.4%	- 12.2
Agree	26.6%	50.7%	- 24.1
Slightly agree	28.2%	21.3%	6.9
Slightly disagree	15.1%	4.7%	10.4
Disagree	15.9%	1.5%	14.4
Strongly disagree	5.0%	0.3%	4.7

Figures 5 and 6 and Table 11 demonstrate the shift in participants' responses to: ***I feel confident about teaching physical and earth science as it applies to the world's oceans in my classroom.*** Prior to the PDI, 64.0% of the participants agreed with this statement; after the PDI 93.4% of the participants agreed. This indicates that even though participants' confidence about teaching physical and earth science as it applies to the world's oceans in their classroom was positive prior to the PDI, it improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding teaching physical and earth science with the OE curriculum. There was a statistically significant difference in scores from pre (M = 3.18, SD =

1.36) to post survey (*M* = 2.14, *SD* = 0.89), *t*(878) = 19.62, p<.01. The standardized effect size index, *d*, was 0.66, indicating a medium effect of the PDI. The 95% confidence interval for the mean difference between the two scores was 0.93 to 1.14.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Physical* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Physical*. The ANOVA was significant *F*(8, 836) = 3.10, p = 0.02, indicating there are significant differences in the response by grade level. Using eta squared as the measure of effect size, the grade level accounted for 3% of the variance of the dependent variable.

Follow up tests were conducted to evaluate pairwise differences among the means. Post hoc comparisons were conducted using the Dunnett's C test, which does not assume equal variances among the three groups. There was a significant difference in the means between participants teaching grades 6-8 and 9-12, but no significant differences between those teaching grades K-5 and 6-8, or between those teaching grades K-5 and 9-12. The 95% confidence intervals for the pairwise differences, as well as the means and standard deviations for the three grade levels are reported in Table 12.

TABLE 12.
95% confidence intervals of pairwise differences in mean changes in score on Physical.

Grade level	Mean	SD	K-5	6-8
K-5	2.26	0.83		
6-8	2.27	0.87	-0.30 to 0.28	
9-12	2.00	0.87	-0.24 to 0.54	0.05 to 0.49

B.1.4. Teaching biological ocean science

FIGURE 7.
Pre survey results for Item 4: I am confident in my ability to teach biological ocean science in my classroom.

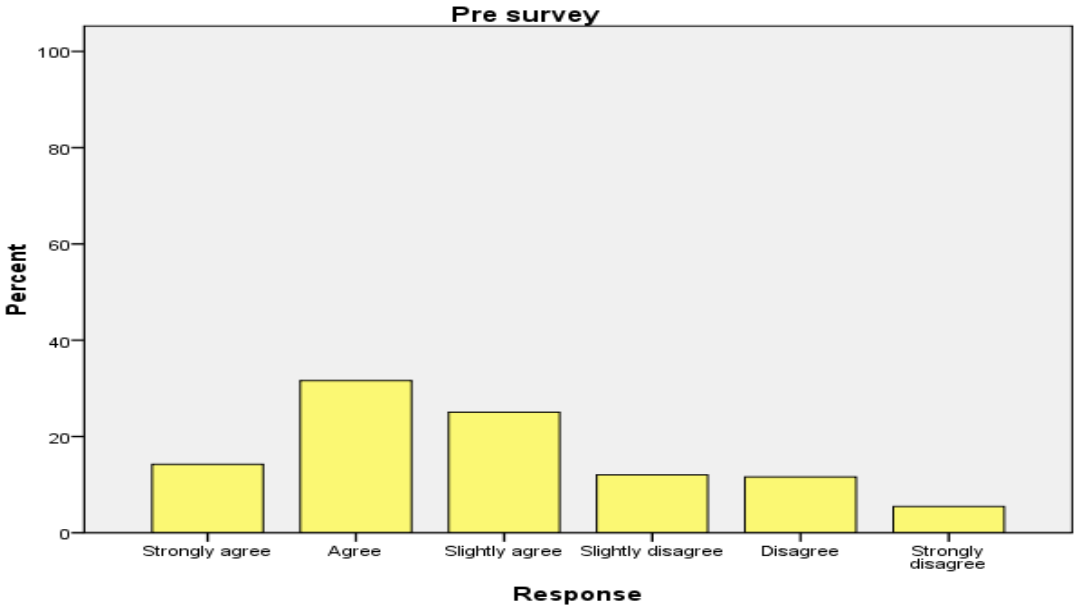

FIGURE 8.
Post survey results for Item 4: I am confident in my ability to teach biological ocean science in my classroom.

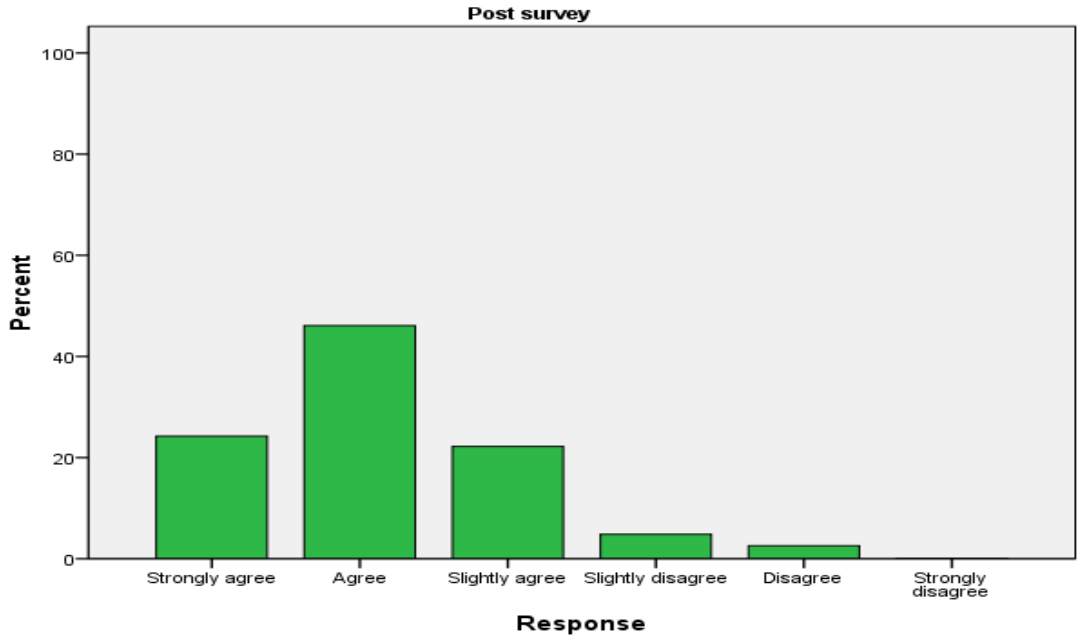

TABLE 13.
Pre/post percent change for Item 4: I am confident in my ability to teach biological ocean science in my classroom.

Response	Pre-survey	Post-survey	% Change
Strongly agree	14.2%	24.2%	-10.0
Agree	31.6%	46.1%	- 14.5
Slightly agree	25.1%	22.2%	2.9
Slightly disagree	12.0%	4.8%	7.2
Disagree	11.6%	2.6%	9.0
Strongly disagree	5.5%	0.1%	5.4

Figures 7 and 8 and Table 13 demonstrate the shift in participants' responses to: ***I am confident in my ability to teach biological ocean science in my classroom.*** Prior to the PDI 70.9% of the participants agreed with this statement; after the PDI 92.5% of the participants agreed. This indicates that even though participants' confidence in their ability to teach biological ocean science in their classroom was high prior to the PDI, it improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding teaching biological science with the OE curriculum. There was a statistically significant difference in scores from pre (M = 2.93, SD = 1.40) to post survey (M = 2.16, SD = 0.94), $t(875) = 14.68$, $p<.01$. The standardized effect size index, d, was

0.50, indicating a medium effect of the PDI. The 95% confidence interval for the mean difference between the two scores was 0.66 to .87.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Biological* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Biological*. The ANOVA was significant $F(8, 837) = 5.15$, $p = 0.00$, indicating there are significant differences in the response by grade level. Using eta squared as the measure of effect size, the grade level accounted for 5% of the variance of the dependent variable.

Follow up tests were conducted to evaluate pairwise differences among the means. Post hoc comparisons were conducted using the Dunnett's C test, which does not assume equal variances among the three groups. There was a significant difference in the means between participants teaching grades K-5 and 9-12 and between participants teaching grades 6-8 and 9-12, but no significant differences between those teaching grades K-5 and 6-8. The 95% confidence intervals for the pairwise differences, as well as the means and standard deviations for the three grade levels are reported in Table 14.

TABLE 14.
95% confidence intervals of pairwise differences in mean changes in score on Biological.

Grade level	Mean	SD	K-5	6-8
K-5	2.47	0.93		
6-8	2.26	0.95	-0.11 to 0.53	
9-12	1.94	0.84	0.22 to 0.83	0.09 to 0.55

B.1.5. Connecting with ocean scientists

FIGURE 9.
Pre survey results for Item 5: I have no way to connect my students with real ocean scientists, directly or indirectly.

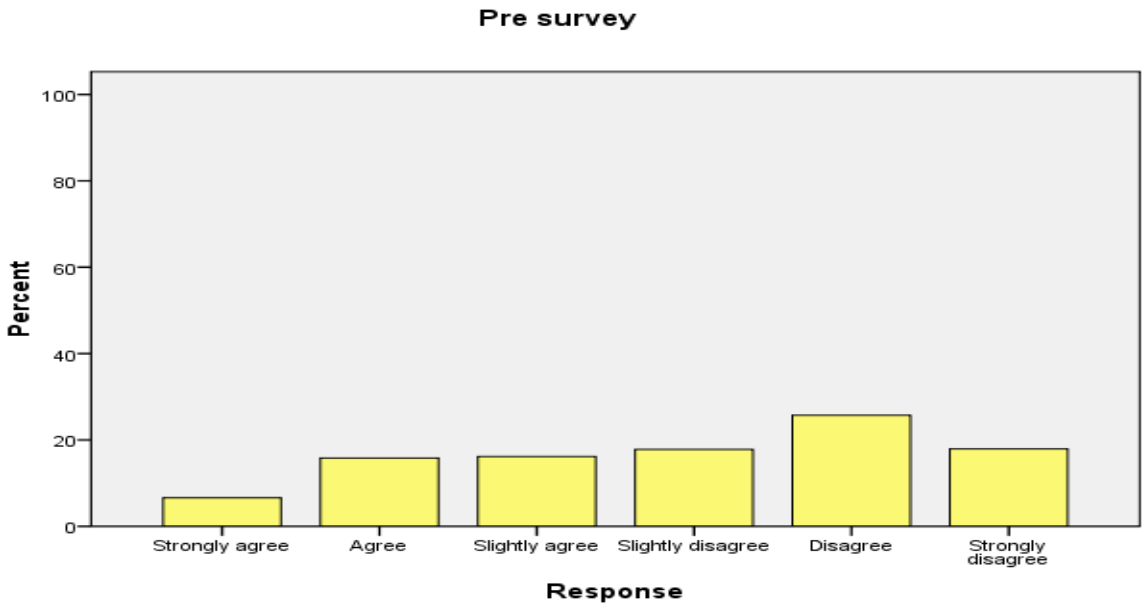

FIGURE 10.
Post survey results for Item 5: I have no way to connect my students with real ocean scientists, directly or indirectly.

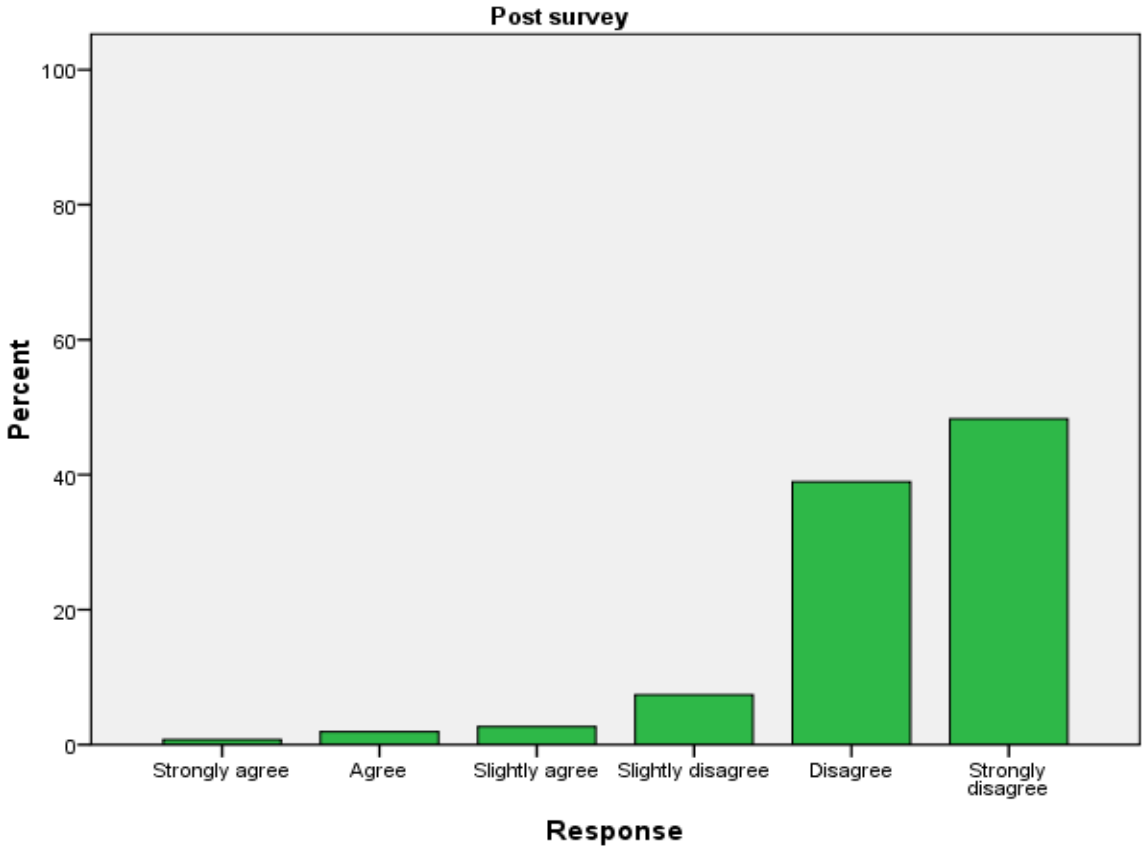

TABLE 15.
Pre/post percent change for Item 5: I have no way to connect my students with real ocean scientists, directly or indirectly.

Response	Pre-survey	Post-survey	% Change
Strongly agree	6.6%	0.8%	5.8
Agree	15.8%	1.9%	13.9
Slightly agree	16.2%	2.7%	13.5
Slightly disagree	17.8%	7.4%	10.4
Disagree	25.7%	38.9%	-13.2
Strongly disagree	17.9%	48.3%	-30.4

Figures 9 and 10 and Table 15 demonstrate the shift in participants' responses to: ***I have no way to connect my students with real ocean scientists, directly or indirectly.*** Prior to the PDI 38.6% of the participants agreed with this statement; after the PDI only 5.4% of the participants agreed. This indicates that participants' perception of their ability to connect their students with real ocean scientists, directly or indirectly improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding connecting students to scientists. There was a statistically significant difference in scores from pre (M = 3.93, SD = 1.54) to post survey (M = 5.26, SD = 0.95), $t(871) = -22.37$, $p<.01$. The standardized effect size index, d, was 0.76, indicating a medium effect of the PDI. The 95% confidence interval for the mean difference between the two scores was -1.46 to -1.22

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Scientists* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Scientists*. The ANOVA was not significant $F(8, 834) = 2.04$, $p = 0.07$, indicating there are no significant differences in responses by grade level.

B.1.6. Using the OE web site

FIGURE 11.
Pre survey results for Item 6: I do not know how to use the Ocean Exploration web site with my students.

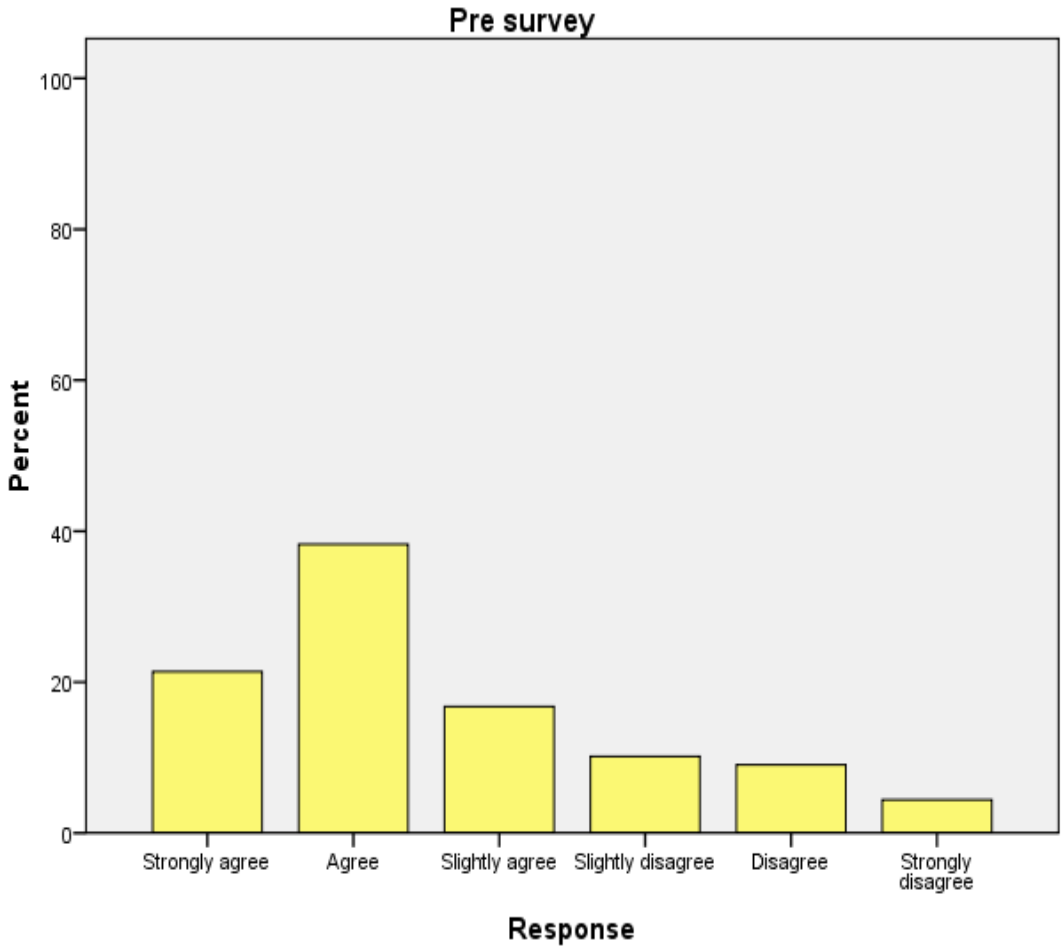

FIGURE 12.
Post survey results for Item 6: I do not know how to use the Ocean Exploration web site with my students.

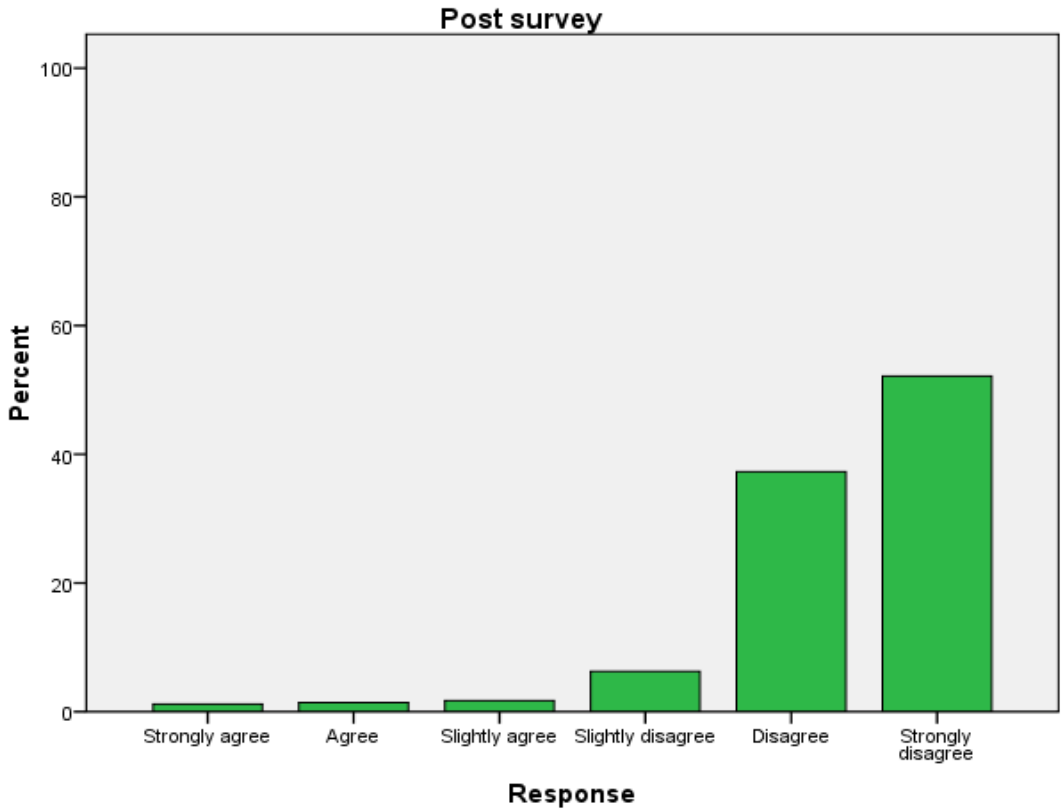

TABLE 16.
Pre/post percent change for Item 6: I do not know how to use the Ocean Exploration web site with my students.

Response	Pre-survey	Post-survey	% Change
Strongly agree	21.4%	1.2%	20.2
Agree	38.3%	1.4%	36.9
Slightly agree	16.8%	1.7%	15.1
Slightly disagree	10.1%	6.2%	3.9
Disagree	9.0%	37.3%	- 28.3
Strongly disagree	4.4%	52.2%	- 47.8

Figures 11 and 12 and Table 16 demonstrate the shift in participants' responses to: ***I do not know how to use the Ocean Exploration web site with my students.*** Prior to the PDI 76.5% of the participants agreed with this statement; after the PDI only 4.3% of the participants agreed. This indicates that participants' perception of their understanding of how to use the Ocean Exploration web site with their students improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding use of the OE web site. There was a statistically significant difference in scores from pre (M = 2.58, SD = 1.38) to post survey (M = 5.34, SD = 0.91), $t(864) = -49.19$, $p<.01$. The standardized effect size index, d, was 1.67, indicating a large effect of the PDI. The 95% confidence interval for the mean difference between the two scores was -2.87 to -2.65.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Web* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Web*. The ANOVA was not significant $F(8, 830) = 0.95$, $p = 0.47$, indicating there are no significant differences in responses by grade level.

B.1.7. Connecting to the OE web site

FIGURE 13.
Pre survey results for Item 7: I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected to the internet.

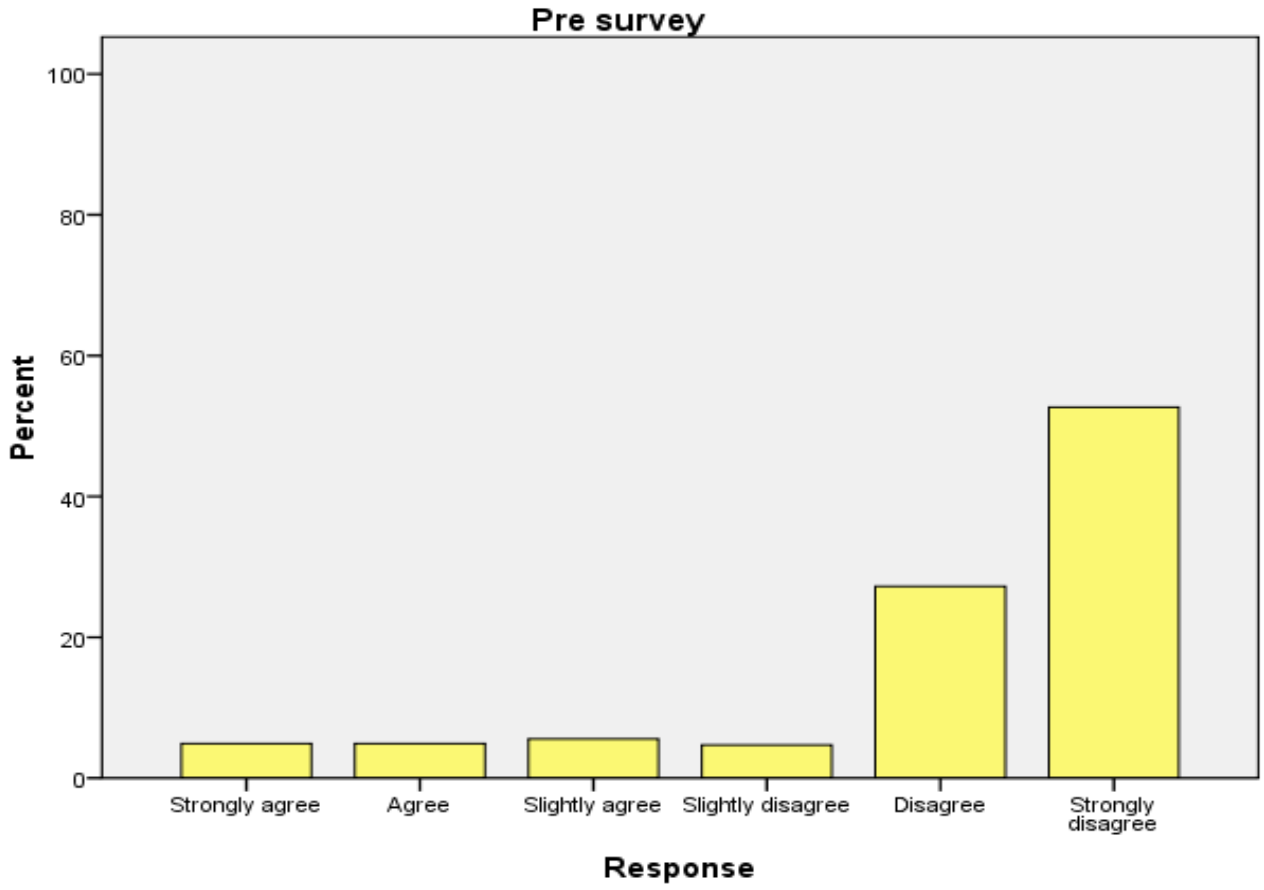

FIGURE 14.
Post survey results for Item 7: I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected to the internet.

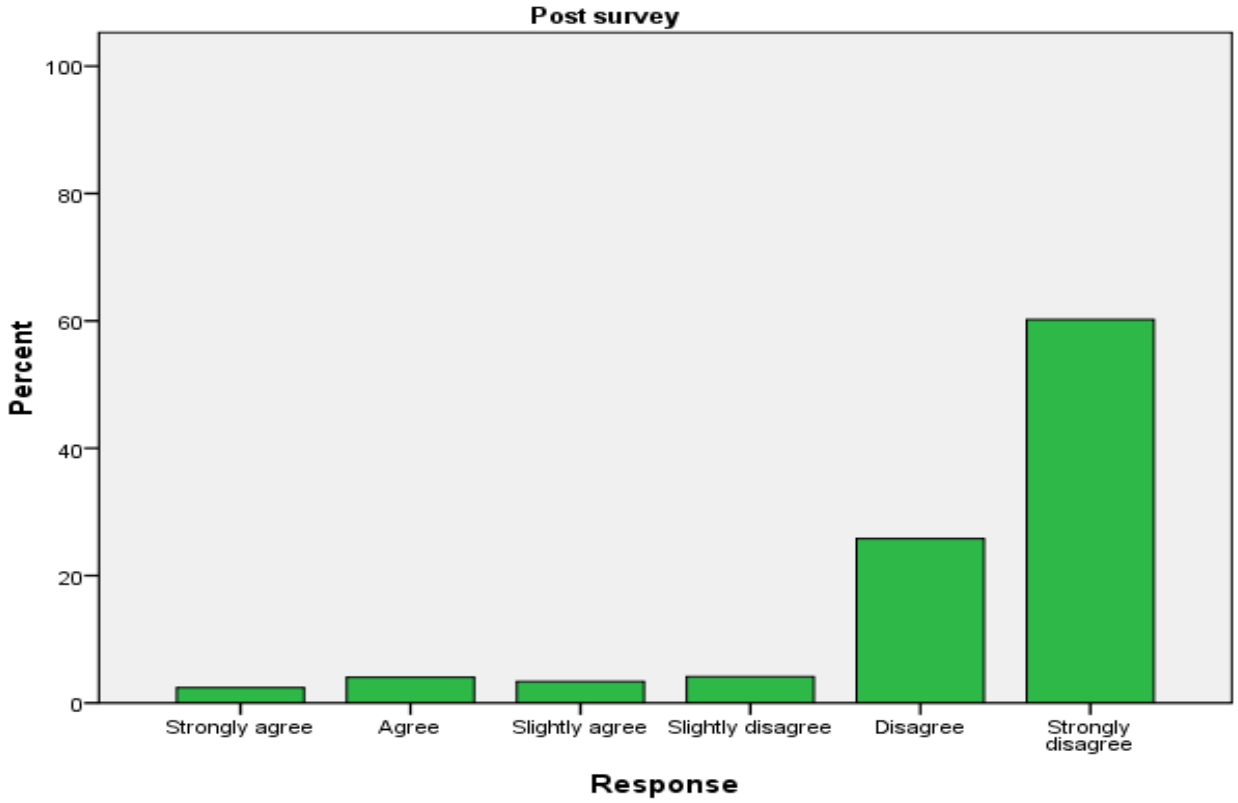

TABLE 17.
Pre/post percent change for *Item 7: I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected to the internet.*

Response	Pre-survey	Post-survey	% Change
Strongly agree	4.9%	2.4%	2.5
Agree	4.9%	4.0%	0.9
Slightly agree	5.6%	3.4%	2.2
Slightly disagree	4.7%	4.2%	0.5
Disagree	27.2%	25.8%	1.4
Strongly disagree	52.7%	60.2%	-7.5

Figures 13 and 14 and Table 17 demonstrate the shift in participants' responses to: ***I cannot use the OE web site with my students because our classroom (or library/ computer lab) computers are not connected to the internet.*** Prior to the PDI 15.4% of the participants agreed with this statement; after the PDI 9.8% of the participants agreed. This indicates that participants do not perceive that their use of the OE web site is limited by internet availability at their school and there was a slight change in their perception as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding accessibility to the OE web site. There was a statistically significant difference in scores from pre (M = 5.05, SD = 1.42) to post survey (M = 5.28, SD = 1.19), $t(843) = -3.97$, $p<.01$. The standardized effect size index, d, was 0.14, indicating little effect of the PDI. The 95% confidence interval for the mean difference between the two scores was -.36 to -.12.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Internet* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Internet*. The ANOVA was not significant $F(8, 824) = 0.57$, $p = 0.80$, indicating there are no significant differences in responses by grade level.

B.1.8. Content background in ocean science

FIGURE 15.
Pre survey results for Item 8: I am afraid to teach ocean science because I do not have a strong content background in ocean science.

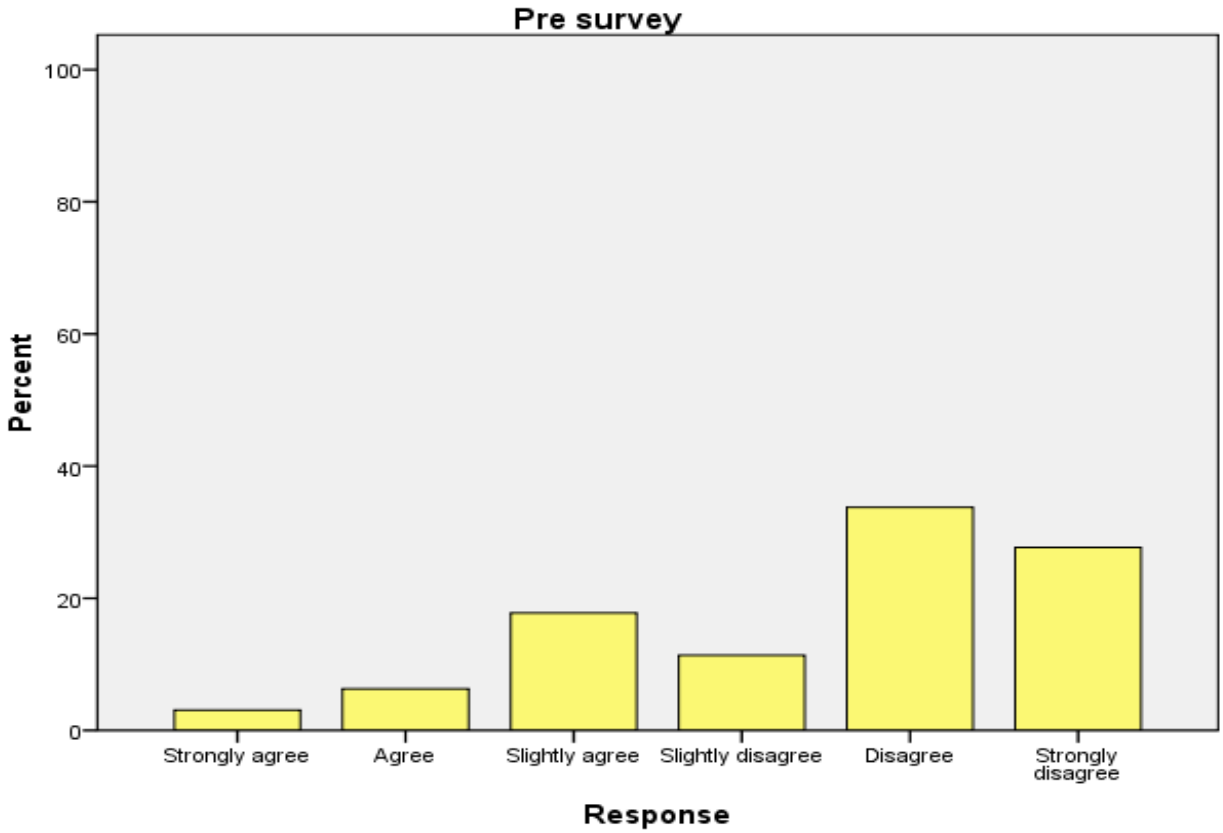

FIGURE 16.
Post survey results for Item 8: I am afraid to teach ocean science because I do not have a strong content background in ocean science.

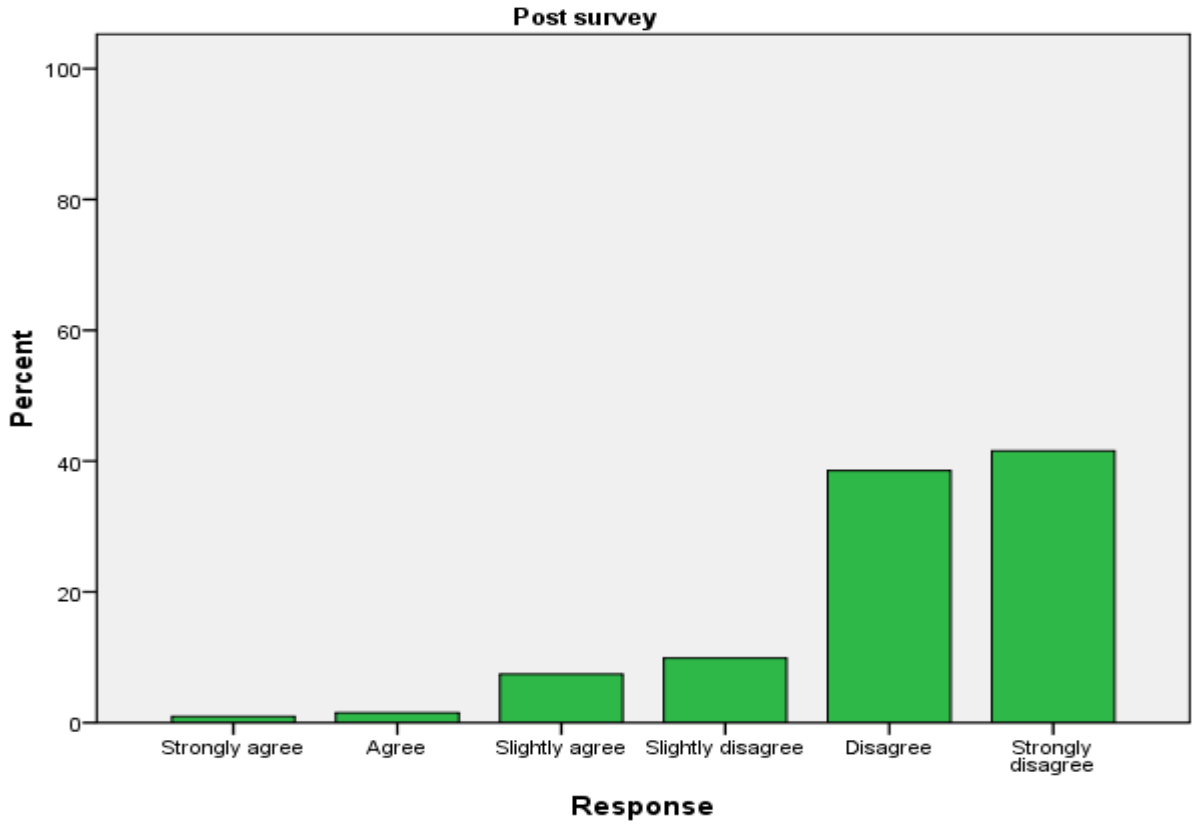

TABLE 18.
Pre/ post percent change for Item 8: I am afraid to teach ocean science because I do not have a strong content background in ocean science.

Response	Pre-survey	Post-survey	% Change
Strongly agree	3.1%	1.0%	2.1
Agree	6.3%	1.5%	4.8
Slightly agree	17.8%	7.4%	10.4
Slightly disagree	11.4%	9.9%	1.5
Disagree	33.8%	38.6%	- 4.8
Strongly disagree	27.7%	41.6%	- 13.9

Figures 15 and 16 and Table 18 demonstrate the shift in participants' responses to: ***I am afraid to teach ocean science because I do not have a strong content background in ocean science.*** Prior to the PDI 27.2% of the participants agreed with this statement; after the PDI only 9.9% of the participants agreed. This indicates that even though participants' confidence in their

ability to teach ocean science because they do not have a strong content background in ocean science was high prior to the PDI, it improved significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding content background in ocean science. There was a statistically significant difference in scores from pre (M = 4.49, SD = 1.38) to post survey (M = 5.16, SD = 1.95), $t(865) = -8.57$, $p<.01$. The standardized effect size index, d, was 0.29, indicating a small effect of the PDI. The 95% confidence interval for the mean difference between the two scores was -.82 to -.52

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Afraid* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Afraid*. The ANOVA was not significant $F(8, 835) = 1.13$, $p = 0.34$, indicating there are no significant differences in responses by grade level.

B.1.9. OE team

FIGURE 17.
Pre survey results for Item 9: I would like to be a part of an Ocean Exploration team and have a chance to work with ocean scientists.

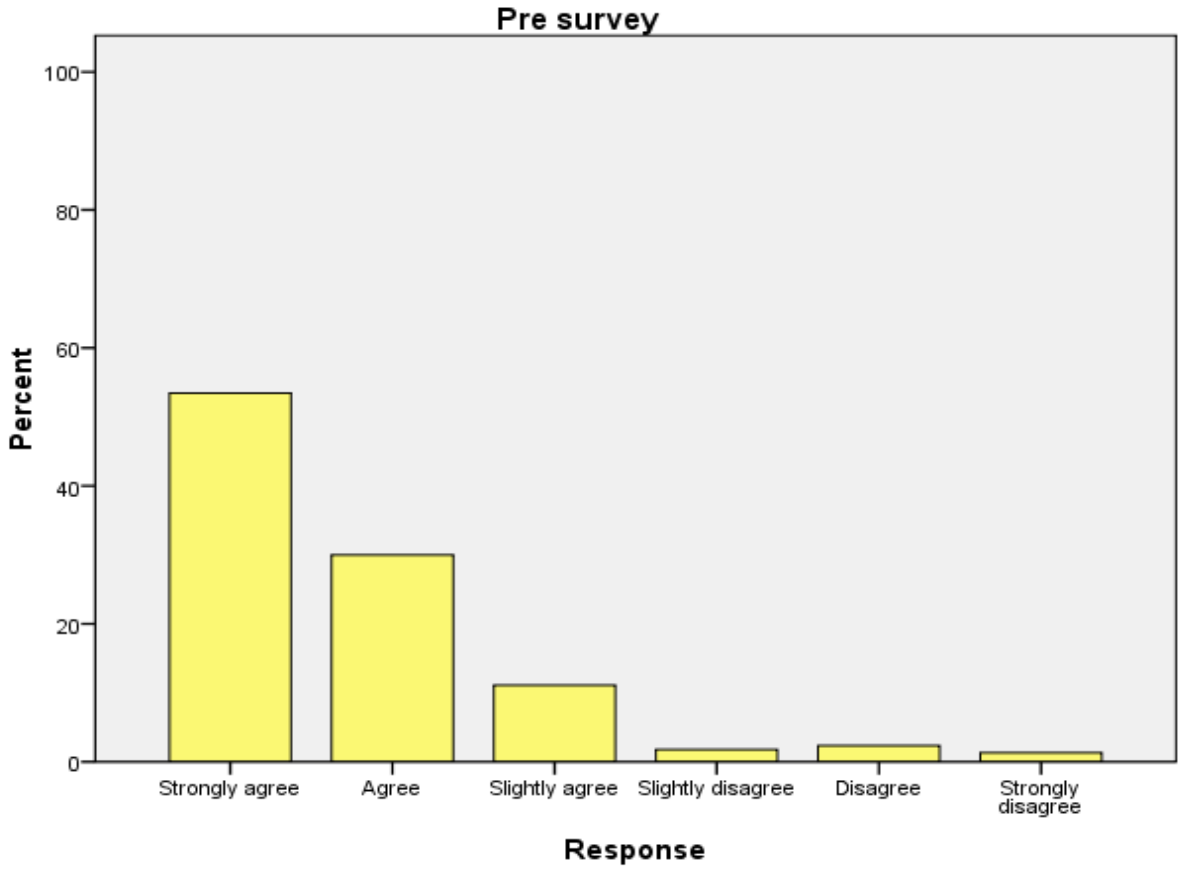

FIGURE 18.
Post survey results for Item 9: I would like to be a part of an Ocean Exploration team and have a chance to work with ocean scientists.

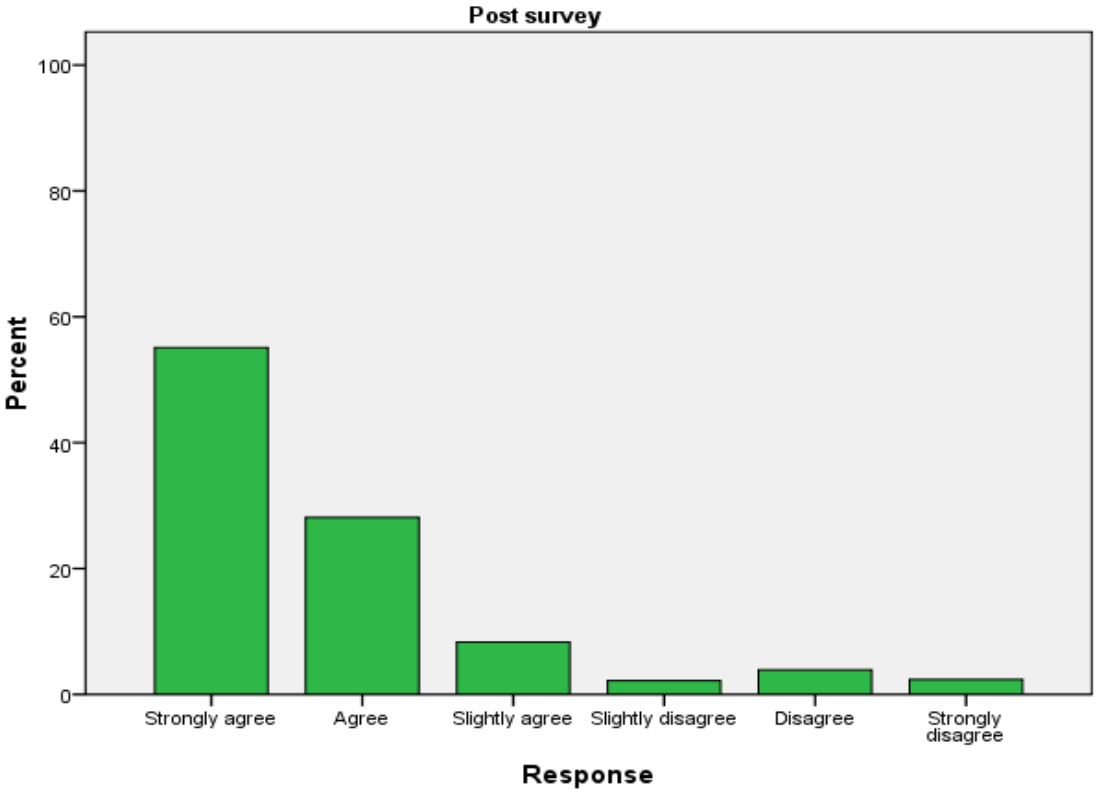

TABLE 19.
Pre/post percent change for Item 9: I would like to be a part of an Ocean Exploration team and have a chance to work with ocean scientists.

Response	Pre-survey	Post-survey	% Change
Strongly agree	53.4%	55.5%	- 2.1
Agree	30.0%	28.1%	1.9
Slightly agree	11.1%	8.3%	2.8
Slightly disagree	1.8%	2.2%	-0.4
Disagree	2.3%	3.9%	- 1.6
Strongly disagree	1.3%	2.4%	- 1.1

Figures 17 and 18 and Table19 demonstrate the shift in participants' responses to: ***I would like to be a part of an Ocean Exploration team and have a chance to work with ocean scientists.*** Prior to the PDI 94.5% of the participants agreed with this statement; after the PDI 91.9% of the participants agreed. This indicates that participants' desire to be a part of an Ocean Exploration team and have a chance to work with ocean scientists was high prior to and after the PDI (e.g., a ceiling effect) and it did not change significantly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding being a part of the OE team. There was a statistically significant difference in scores from pre (M = 1.73, SD = 1.03) to post survey (M = 1.79, SD = 1.18), $t(853) = -1.19$, $p = .23$. The 95% confidence interval for the mean difference between the two scores was -.16 to -.04.

A one-way analysis of variance was conducted t evaluate the relationship between scores on the *Team* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Team*. The ANOVA was not significant $F(8, 827) = 1.56$, $p = 0.13$, indicating there are no significant differences in responses by grade level.

B.1.10. Teaching ocean science

FIGURE 19.
Pre survey results for Item 10: I teach earth or life science so ocean science is not what I should be teaching in my classroom.

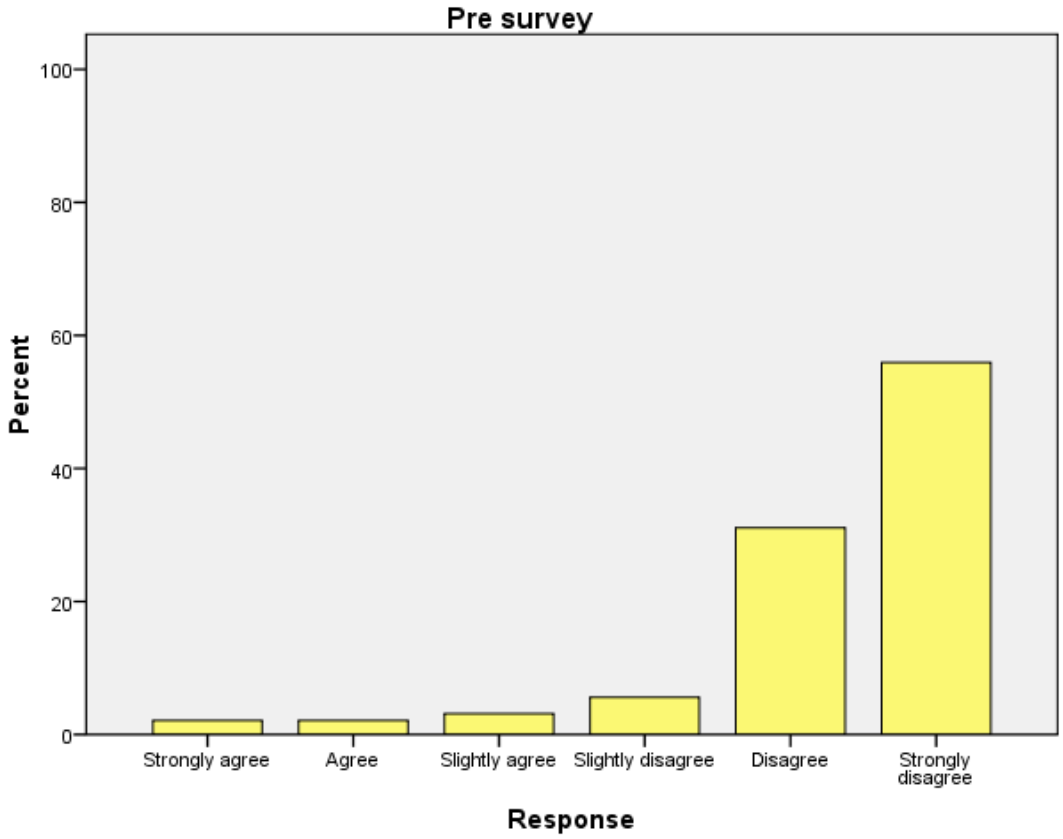

FIGURE 20.
Post survey results for Item 10: I teach earth or life science so ocean science is not what I should be teaching in my classroom.

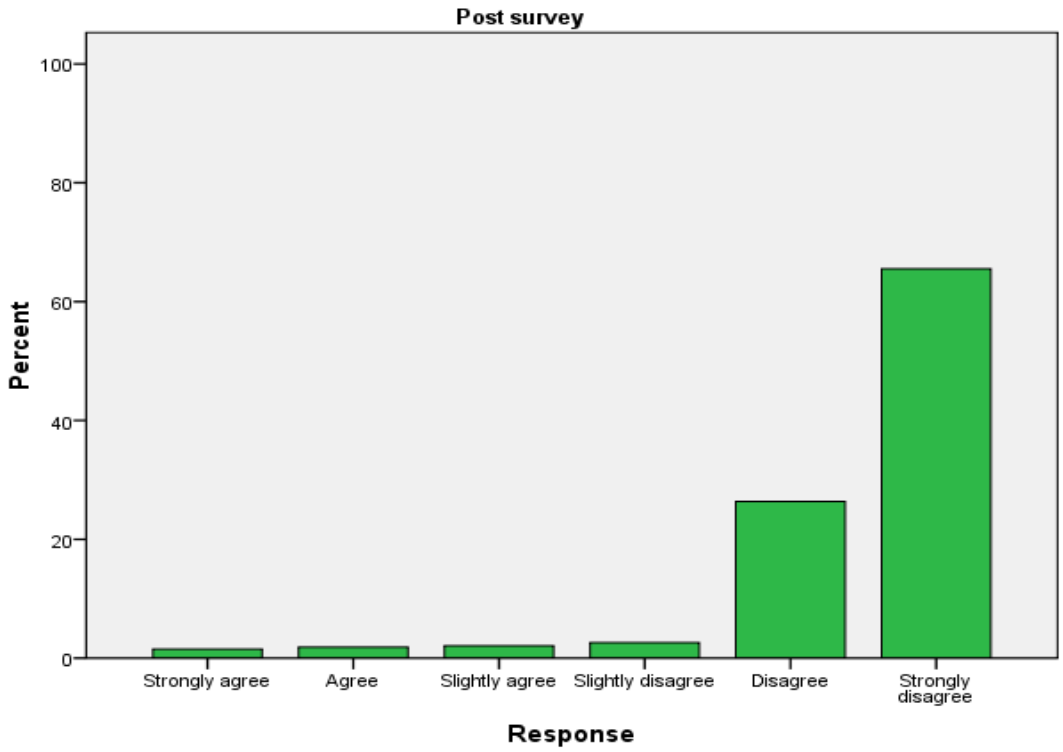

TABLE 20.
Pre/post percent change for Item 10: I teach earth or life science so ocean science is not what I should be teaching in my classroom.

Response	Pre-survey	Post-survey	% Change
Strongly agree	2.1%	1.5%	0.6
Agree	2.1%	1.9%	0.2
Slightly agree	3.1%	2.1%	1.0
Slightly disagree	5.6%	2.6%	3.0
Disagree	31.1%	26.4%	4.7
Strongly disagree	55.9%	65.5%	- 9.6

Figures 19 and 20 and Table 20 demonstrate the shift in participants' responses to: ***I teach earth or life science so ocean science is not what I should be teaching in my classroom.*** Prior to the PDI 7.3% of the participants agreed with this statement; after the PDI 5.5% of the participants agreed. This indicates that participants did not perceive that teaching earth or life science excludes them from teaching ocean science in their classroom and this perception change only slightly as a result of the PDI.

A paired samples t-test was conducted to evaluate the impact of the OE PDI on participants' pre and post scores regarding teaching ocean science. There was a statistically significant difference in scores from pre (M =5.29, SD = 1.09) to post survey (M = 5.47, SD = 0.99), $t(840) = -3.57$, $p<.01$. The standardized effect size index, d, was 0.12, indicating minimal effect of the PDI. The 95% confidence interval for the mean difference between the two scores was .27 to -08.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Classroom* post item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the post survey for *Classroom*. The ANOVA was not significant $F(8, 826) = 0.68$, $p = 0.71$, indicating there are no significant differences in responses by grade level.

Discussion

Overall, the results from the 10 items on the pre/post surveys are very positive. Four of the survey items showed a significant shift from negative to positive perceptions as a result of the PDIs. Five additional items showed positive perceptions by participants prior to the PDIs that became more positive during the PDI. The remaining item showed a very positive perception by the participants on the pre PDI survey that did not change as a result of the PDI. Six of the items that exhibited a significant difference pre to post also had a medium to large effect size.

C. Pre and Post Qualitative Introductory Survey Analyses

C.1. Pre Surveys – Responses from 55 PDIs were analyzed using content analysis. Of the 946 participants who responded to the pre introductory PDI survey, 675 individuals (71.4%) provided a response to ***"Please tell us what content you would expect to teach your students if you are covering ocean science in your classroom. List the topics that you would expect to cover."*** Following are the 25 most common responses. In parentheses after each entry is the percent of respondents who listed each topic followed by the number of respondents who listed each topic.

Life Science

- Diversity/adaptations of ocean organisms (35.3%; n = 238)
- Biology/Life Science/Marine Biology (19.1%; n = 129)
- Ecological Relationships (12.7%; n = 86)
- Ecosystems/Biomes (11.6%; n = 78)
- Human Impacts on Marine Ecosystems (7.6%; n = 51)
- Habitats (6.8%; n = 46)
- Food Webs (6.8%; n = 46)
- Pollution/Toxicology (5.0%; n = 34)

Earth Science

- Plate Tectonics (21.6%; n = 146)
- Underwater Topography/Mapping (13.2%; n = 89)
- Ocean Floor (11.3%; n = 76)
- Geology (10.7%; n = 72)
- Weather/Climate (9.6%; n = 65)

Physical Science

- Chemistry (16.0%; n = 108)

- Physical Science/Physical Oceanography (11.3%; n = 76)
- Properties/Characteristics of Water (8.1%; n = 55)

Oceanography

- Currents (25.0%; n = 169)
- Tides (16.3%; n = 110)
- Zones/Layers in the Ocean (11.3%; n = 76)
- Waves (8.7%; n = 59)
- Salinity/Density (8.4%; n = 57)
- Technology/Instrumentation (7.3%; n = 49)
- Underwater Geography/Features (6.8%; n = 46)
- Oceanography (6.2%; n = 42)
- Ocean Exploration Discoveries (5.3%; n = 36)

Participants provided a wide range of topics they would cover if teaching ocean science in their classrooms. The most common responses were related to life science followed by oceanography, earth science, and physical science.

C.2. Post Surveys – Responses from 56 PDIs were analyzed using content analysis. Of the 951 participants who responded to the post introductory PDI survey, 899 individuals (95%) provided a response to a) ***"How did the OE Curriculum Professional Development help to further your professional goals?"***; 774 individuals (81.2%) provided a response to b) ***"What changes or improvements would you make to the OE Curriculum Professional Development?"***; and 859 individuals (90.3%) provided a response to c) ***"Will this experience enable you to improve student learning at your school and in your area/district? If so, how?"*** Following are the 10 most common responses for each question. In parentheses after each entry is the percent of respondents who listed each topic followed by the number of respondents who listed each topic.

a. "How did the OE Curriculum Professional Development help to further your professional goals?"

- It increased my content knowledge (22.8%; n = 205)
- It provided great resources/materials/support/ information to help me teach about the ocean (19.8%; n = 178)
- It provided wonderful hands-on/inquiry based Labs/Activities/Lesson Plans I can use right away (19.7%; n = 177)
- It provided new/better ideas for incorporating Ocean Science into or enriching courses/curricula with Ocean Science (15.4%; n = 139)
- It exposed me to new information/material/lessons/resources (13.9%; n = 125)
- It offered great new ideas in a lively engaging approach (10.0%; n = 90)
- It makes the science content real for students (7.3%; n = 66)
- It offers new ways to reach students (5.8%; n = 52)
- It increased my desire to teach about the ocean (4.6%; n = 42)
- It helped me make connections to real and current research (3.8%; n = 35)

b. "What changes or improvements would you make to the OE Curriculum Professional Development?"

- Don't change anything (49.7%; n = 385)
- Provide more programs that are more in-depth, more content (6.5%; n = 51)
- Do more lessons especially in the afternoon (5.9%; n = 46)
- Do more activities (4.6%; n = 35)
- Have more breaks/Less sitting (4.6%; n = 35)
- Let participants spend more time exploring the website/having access to the website (4.0%; n = 31)
- Develop more new materials especially for chemistry and physics (3.9%; n = 30)
- Model effective pedagogy (3.6%; n = 28)
- More time doing activities/less time talking (3.4%; n = 26)
- Make the workshops twice as long (3.2%; n = 25)

c. "Will this experience enable you to improve student learning at your school and in your area/district?

- YES. (98.0%; n = 842)
- No. (1.3%; n = 11) – Reasons: Not my content area; not an improvement over existing material.
- Don't know (0.7%; n = 6) - Reason: Need more time to answer.

If so, how?"

- By providing fun engaging hands-on activities (39.5%; n = 339)
- By providing good resources to use with students (38.1% ; n = 327)
- By bringing new content into instruction/presentations (23.4%; n = 201)
- By providing a wider range of ocean science content in ocean science related curriculum (22.0%; n = 189)
- By making real world science connections for students (19.3%; n = 166)
- By strengthening my (teachers') content knowledge (12.1%; n = 104)
- By providing quality information and materials to share with other teachers (12.0%; n = 103)
- By building teachers' confidence enough for teachers to try new things (9.3%; n = 80)
- By increasing students' interest and confidence in learning this material (8.7%; n = 75)
- By making teachers more knowledgeable so they can pass knowledge on to students (8.0%; n = 69)

Discussion

Overall, the responses to the qualitative items on the post introductory PDI survey were very complementary of the introductory PDIs. Participants found that PDIs work well as designed; their content knowledge increased as a result of the PDIs, and useful materials, lessons, and resources were provided. Overwhelmingly, participants stated that the PDIs will enable them to improve student learning at their school through the use of the many quality materials and resources provided by OE.

V. Analysis of Surveys Conducted for Follow-Up Professional Development Institutes (PDIs)

At the conclusion of each Follow-up PDI, surveys containing quantitative and qualitative affective and demographic items were administered to PDI participants. A total of twenty-two (22) follow-up PDIs were conducted in 2004-07. Demographic data are listed in Tables 21-27.

A. Demographics

Demographic data for number of students reached, position, subjects taught, grade level taught, years teaching, ethnicity, and returnee to OE PDI are presented in the following seven tables (Tables 21-27). Note that there is missing data in each demographic field. Analysis was conducted on the complete data. Missing data for each table is noted below.

TABLE 21.
Number of students reached by participants in OE follow-up PDIs.

	1- 50	51-100	101-150	151-200	201-500	500-1000	>1000
Percent (%)	30.3	31.3	23.4	7.8	4.5	1.9	0.9

Note. Calculated n = 218; Total n = 348, missing data = 130 (37.4%)

TABLE 22.
Participants' position of employment in OE follow-up PDIs.

	Teacher	Informal educator	Administrator	College / University	Pre service teacher	Other
Percent (%)	86.1	3.2	2.6	0.6	0.3	7.1

Note. Calculated n = 310; Total n = 348, missing data = 38 (10.9%)

TABLE 23.
Subjects taught by participants in OE follow-up PDIs.

	Science	Math & Science	All	Multiple subjects	Other	Pre service education
Percent (%)	65.7	14.7	8.2	6.2	4.9	0.3

Note. Calculated n = 306; Total = 348, missing data = 42 (12.1 %)

TABLE 24.
Grade level taught by participants in OE follow-up PDIs.

	K-5	K-8	K-12	6-8	6-12	9-12	College	Other
Percent (%)	21	3.0	3.0	28.9	3.6	35.6	0.9	4.0

Note. Calculated n = 329; Total n = 348; missing data = 19 (5.5 %)

TABLE 25.
Years teaching indicated by participants in OE follow-up PDIs.

	Pre service	1-5	6-10	11-15	16-20	21-25	26-30	> 30
Percent (%)	29.2	26.2	15	4	6	4	8.3	7.3

Note. Calculated n = 301; Total n = 348; missing data = 47 (13.5 %)
TABLE 26.

Ethnicity indicated by participants in OE follow-up PDIs.

	African American	Asian American	Caucasian	Hispanic	Native American	Pacific Islander	Other
Percent (%)	4.2	3.5	82.6	4.5	0.6	0.3	4.2

Note. Calculated n = 329; Total n = 310; missing data = 38 (10.9 %)

TABLE 27.
OE PDI returnee indicated by OE follow-up PDIs.

	Yes	No
Percent (%)	80.9	19.1

Note. Calculated n = 345; Total n = 348; missing data = 3 (0.9 %)

Discussion

The majority of the participants in the OE Follow-up PDIs were science (65.7%) or math (14.7%), K-12 (95.1%) teachers (86.1%) who have been teaching for 10 years or less (70.4%). Eighty-five percent of the participants teach fewer than 151 students annually. Most are Caucasian (82.6%) with less than 8% of participants representing other ethnicities. Almost 81% of the participants in the PDI attended an introductory PDI.

B. Quantitative Follow-up Survey Analyses

Fifteen items comprised the follow-up survey as listed in Table 28. Abbreviations for each item are provided in ( ) at the end of each item. Qualitative items are addressed under Qualitative Analysis later in this section.

TABLE 28.
OE PDI follow-up survey items.

1. My students enjoy learning about ocean science through the use of the NOAA Ocean Exploration (OE) curriculum. ***(Enjoy learn)***
2. I have increased my own knowledge about ocean science through my work with the OE curriculum. ***(Increased)***
3. My students enjoy learning about ocean science through the use of the OE Web site. ***(Enjoy web site)***
4. Ocean science is not a required part of my schools/district's science teaching standards. ***(Standards)***
5. I have not used activities from the OE curriculum in my classroom. ***(Activities)***
6. I have used components of the OE Web site as homework. ***(Homework)***
7. The OE Web site has not enabled me to connect my students with the work and lives of ocean scientists. ***(Scientists)***
8. My students think that there are not very many new ocean discoveries left to be made. ***(Discoveries)***
9. I know how to use the Ocean Exploration Web site with my students. ***(Use web site)***
10. I cannot use the OE Web site with my students because our classroom (or library/computer lab) computers are not connected to the Internet. ***(No internet)***
11. Participation in the OE Curriculum Professional Development has not helped me further my professional goals. ***(PD goals)***
12. I believe that my participation in the OE Curriculum Professional Development has

enabled me to improve student learning about the ocean in my classroom. ***(Improve)***
13. I have not shared information about the OE curriculum with other teaching professionals. ***(Shared)***
14. I have a good understanding of NOAA's role in ocean exploration. ***(NOAA's role)***
15. I have found the OE listserv useful in keeping me informed of NOAA OE education program offerings. ***(List serv)***

A coefficient alpha was computed to determine the internal estimate of reliability of the Follow-up survey. The Cronbach's alpha was 0.69, indicating a reliability just below satisfactory (0.70).

The 15 items of the Follow up PDI survey were subjected to principal components analysis (PCA). Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of some coefficients of 0.3 and above. The Kaiser-Meyer-Oklin value was 0.78, exceeding the recommended value of 0.6. The Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. PCA revealed the presence of four components with eigenvalues exceeding 1, explaining 24.8%, 9.9%, 8.1% and 7.5% of the variance respectively. An inspection of the screeplot revealed a clear break after the second component. The four components were retained for further investigation. To aid in the interpretation of these four components, Varimax rotation was performed. The rotated solution, as depicted in Table 29, shows the items loading mostly on one component with double and triple loading on some components. The four factor solution explained a total of 48.9% of the variance, with component 1 contributing 13.5%, component 2 contributing 12.9%, component 3 contributing 11.8%, and component 4 contributing 10.7%. It is difficult to discern the specific factors addressed in the follow-up survey (for example, all of the survey items related to "curriculum" do not load on a single factor). Analysis of this data does not allow organization of the individual items into "themes" (e.g., factors). Future surveys should carefully consider specific factors or components. Survey items should be developed to reflect factors representative of OE follow-up PDI goals and objectives.

TABLE 29.
Varimax rotation of four factor solution for OE PDI follow up items.

	Components			
Item	1	2	3	4
1. My students enjoy learning about ocean science through the use of the NOAA Ocean Exploration (OE) curriculum.	.742			.315
2. I have increased my own knowledge about ocean science through my work with the OE curriculum.				.729
3. My students enjoy learning about ocean science through the use of the OE web site.	.698			.341
4. Ocean science is not a required part of my school / district's science teaching standards.	-.418		.386	.472
5. I have not used activities from the OE curriculum	-.624		.352	

in my classroom.				
6. I have used components of the OE web site as homework.		.734		
7. The OE web site has not enabled me to connect my students with the work and lives of ocean scientists.			.656	
8. My students think that there are not very many new ocean discoveries left to be made.			.701	
9. I know how to use the Ocean Exploration web site with my students.		.643		
10. I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected to the Internet.			.470	
11. Participation in the OE curriculum professional development has not helped me further my professional goals.			.423	-.359
12. I believe that my participation in the OE curriculum professional development has enabled me to improve student learning about the ocean in my classroom.				.558
13. I have not shared information about the OE curriculum with other teaching professionals.	-.340	-.486		
14. I have a good understanding of NOAA's role in ocean exploration.		.427		.305
15. I have found the OE listserv useful in keeping me informed of NOAA OE education program offerings.		.636		

B.1. Analyses of Items

Descriptive statistics were calculated using SPSS v.16 on the survey data provided to the research team for these 15 items. A total of 348 follow-up surveys were analyzed. The NOAA OE PDI follow-up survey design utilized a Likert scale response ranging from 1-6, with 1 = strongly agree; 2 = agree; 3 = slightly agree; 4 = slightly disagree; 5 = disagree; 6 = strongly disagree.

Table 30 provides the mean and standard deviation for each of the 15 Follow-up PDI quantitative items offered on the survey. In addition, the + or – after each item indicates whether the item is stated in a positive (+) or negative (-) way.

TABLE 30.
Mean and standard deviation for follow-up OE PDI survey.

Item	Mean	Standard Deviation
1. Enjoy Learn (+)	1.5	0.6
2. Increased (+)	1.2	0.4
3. Enjoy Web Site (+)	1.6	0.7
4. Standards (-)	3.6	1.9
5. Activities (-)	4.3	1.7
6. Homework (+)	3.9	1.7
7. Scientists (-)	5.2	1.0
8. Discoveries (-)	4.2	1.6
9. Use Web Site (+)	1.9	0.9
10. No Internet	5.2	1.3
11. PD Goals (-)	5.3	1.4
12. Improve (+)	1.3	0.7
13. Shared (-)	4.8	1.4
14. NOAA's Role (+)	1.6	0.6
15. List Serv (+)	1.7	1.0

Bar graphs of the percentage of each response on each item are presented on the following pages. Low scores on positively stated items indicate the greatest agreement with the item or most positive response. High scores on negatively stated items indicate greatest disagreement with the item or the most positive response. Therefore, the outcome that indicates the most positive rating as a result of the Follow-up PDIs is a high score for negative items and a low score for positive items.

One-way analysis of variance (ANOVA) was calculated for each item of the follow-up survey. The present survey was not constructed to compute a score based on a behavioral construct (e.g., efficacy) or related factors to allow for a meaningful analysis on the overall mean score on the survey. The dependent variable is the score for the item; the factor is grade level, with three levels (K-5, 6-8, and 9-12). When applicable, eta squared was used as a measure of effect size. Because the actual sample sizes among the three levels is not the same (K-5 n ~60; 6-8 n ~ 80; 9-12 n ~ 100) and violates the homogeneity of variance assumption, the Dunnett's C procedure was utilized as a post hoc test.

B.1.1. Student enjoyment

FIGURE 21.
Results for follow up survey Item 1: My students enjoy learning about ocean science through the use of the NOAA Ocean Exploration (OE) curriculum.

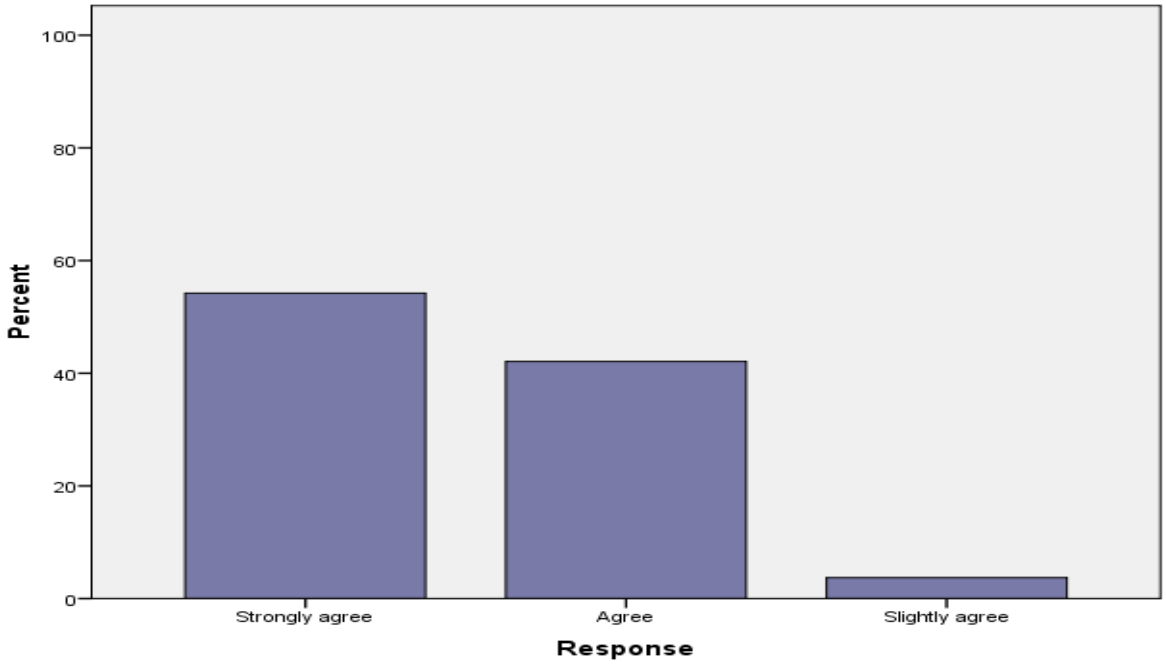

TABLE 31.
Percentage responses for follow up survey Item 1: My students enjoy learning about ocean science through the use of the NOAA Ocean Exploration (OE) curriculum.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	54.2	42.1	3.7	0	0	0

Figure 21 and Table 31 indicate that by the end of the Follow-up PDIs 100% of participants agree with the statement: ***My students enjoy learning about ocean science through the use of the NOAA Ocean Exploration (OE) curriculum.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Enjoy learn* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Enjoy learn*. The ANOVA was not significant $F(7, 273) = 1.16$, $p = 0.34$, indicating there are no significant differences in responses by grade level.

B.1.2. Increased knowledge

FIGURE 22.
Results for follow-up survey Item 2: I have increased my own knowledge about ocean science through my work with the OE curriculum.

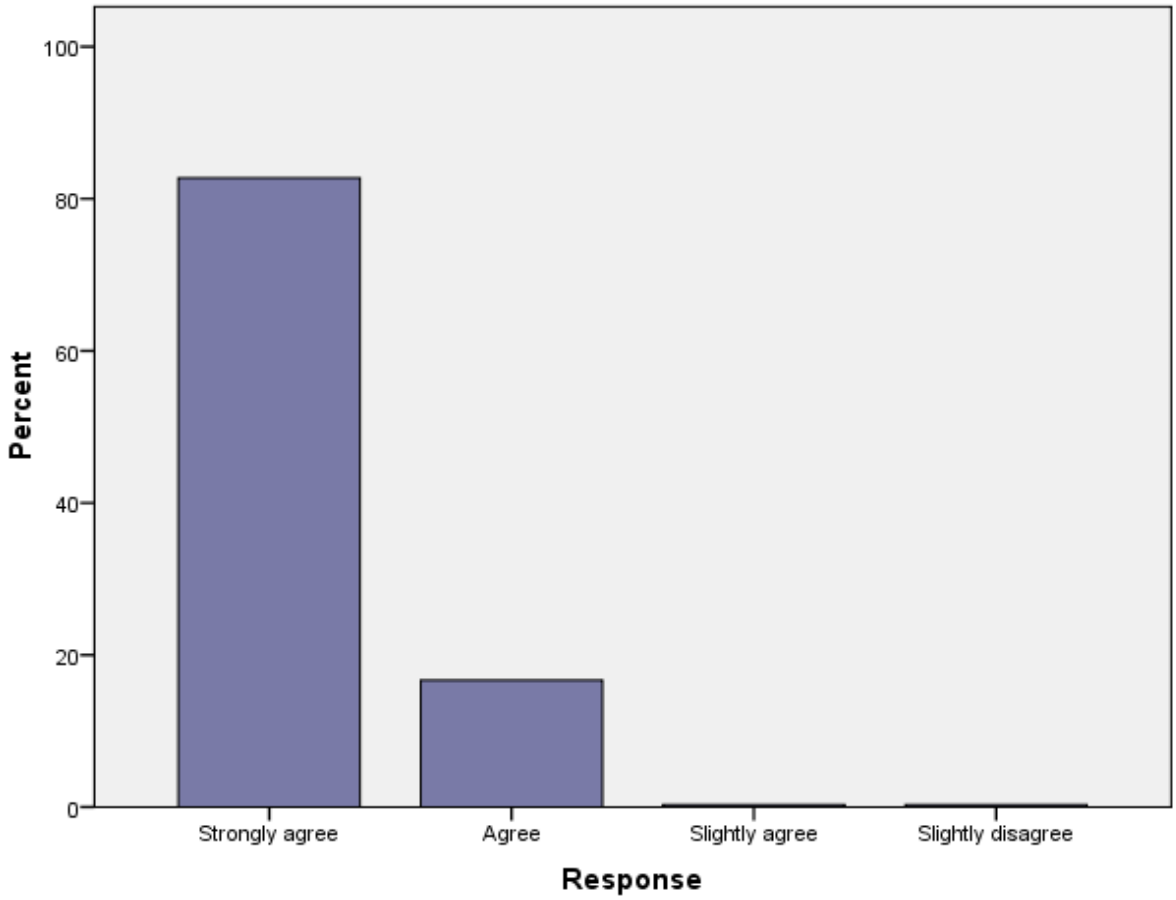

TABLE 32.
Percentage responses for follow-up survey Item 2: I have increased my own knowledge about ocean science through my work with the OE curriculum.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	82.7	16.7	0.3	0.3	0	0

Figure 22 and Table 32 indicate that by the end of the Follow-up PDIs 99.7% of participants agree with the statement: ***I have increased my own knowledge about ocean science through my work with the OE curriculum.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Increased* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Increased*. The ANOVA was not significant $F(7, 310) = 1.29$, $p = 0.25$, indicating there are no significant differences in responses by grade level.

B.1.3. Student learning via OE web site

FIGURE 23.
Results for follow-up survey Item 3: My students enjoy learning about ocean science through the use of the OE Web site.

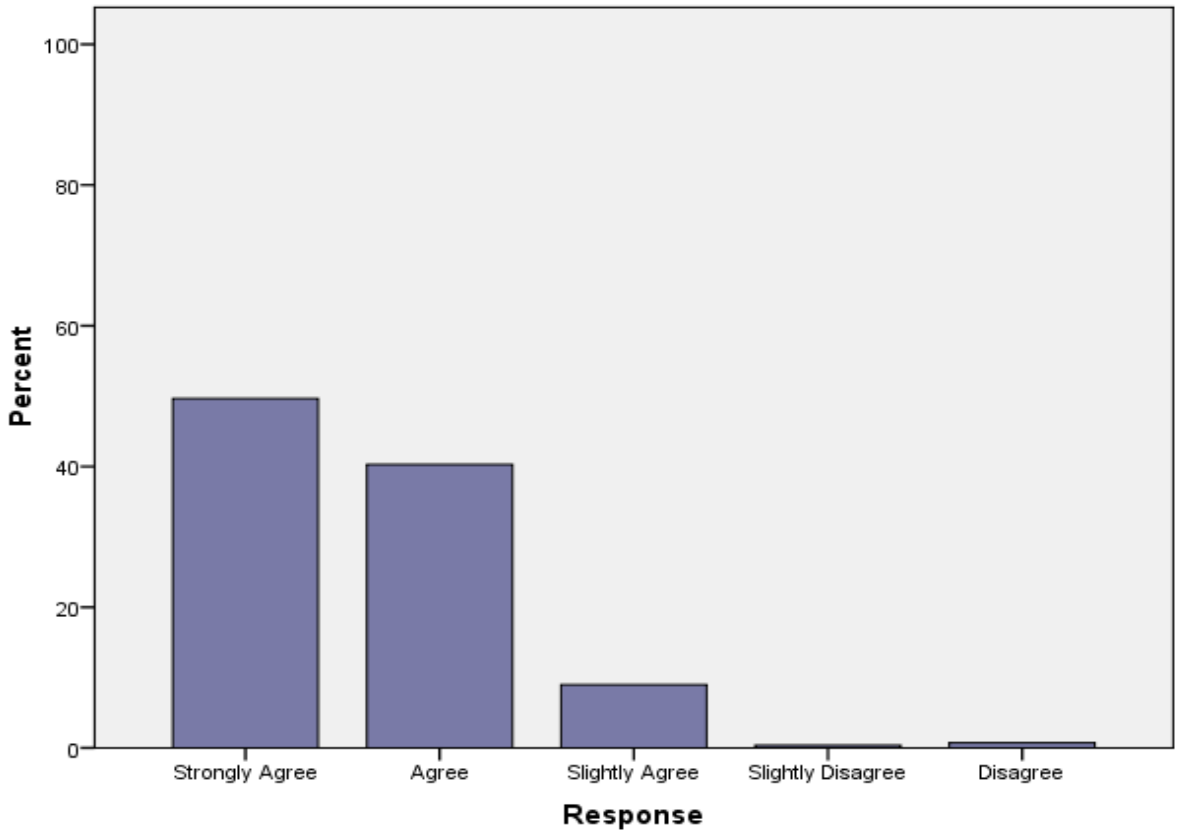

TABLE 33.
Percentage responses for results for follow-up survey Item 3: My students enjoy learning about ocean science through the use of the OE Web site.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	49.6	40.3	9.0	0.4	0.7	0

Figure 23 and Table 33 indicate that by the end of the Follow-up PDIs 98.9% of participants agree with the statement: ***My students enjoy learning about ocean science through the use of the OE Web site.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Enjoy web site* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Enjoy web site*. The ANOVA was not significant $F(7, 255) = 0.51$, $p = 0.83$, indicating there are no significant differences in responses by grade level.

B.1.4. Ocean science in local standards

Figure 24.
Results for follow-up survey Item 4: Ocean science is not a required part of my schools/district's science teaching standards.

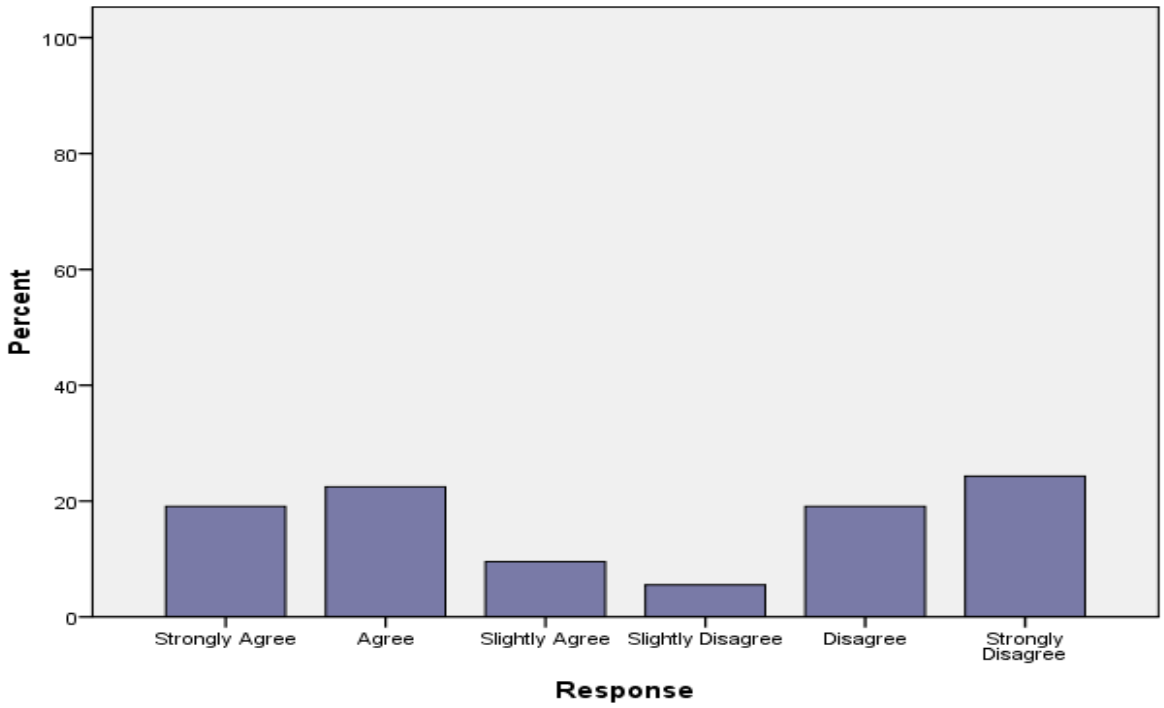

TABLE 34.
Percentage responses for results for follow-up survey Item 4: Ocean science is not a required part of my schools/district's science teaching standards.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	19.1	22.5	9.5	5.5	19.1	24.3

Figure 24 and Table 34 indicate that by the end of the Follow-up PDIs 51.1% of participants agree with the statement: ***Ocean science is not a required part of my schools/district's science teaching standards.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Standards* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Standards*. The ANOVA was significant $F(7, 301) = 2.41$, $p = 0.02$. Using eta squared as the measure of effect size, the grade level accounted for 5% of the variance of the dependent variable.

Follow up tests were conducted to evaluate pairwise differences among the means. Post hoc comparisons were conducted using the Dunnett's C test, which does not assume equal variances among the three groups. There was a significant difference in the means between participants teaching grades K-5 and 9-12, but no significant differences between those teaching

grades K-5 and 6-8, or between those teaching grades 6-8 and 9-12. The 95% confidence intervals for the pairwise differences, as well as the means and standard deviations for the three grade levels are reported in Table 35.

TABLE 35.
95% confidence intervals of pairwise differences in mean changes in score on Standards.

Grade level	Mean	SD	K-5	6-8
K-5	4.11	1.77		
6-8	3.67	1.88	-0.48 to 1.35	
9-12	3.18	2.04	0.02 to 1.84	-.035 to 1.34

B.1.5. Use of OE activities

FIGURE 25.
Results for follow-up survey Item 5: I have not used activities from the OE curriculum in my classroom.

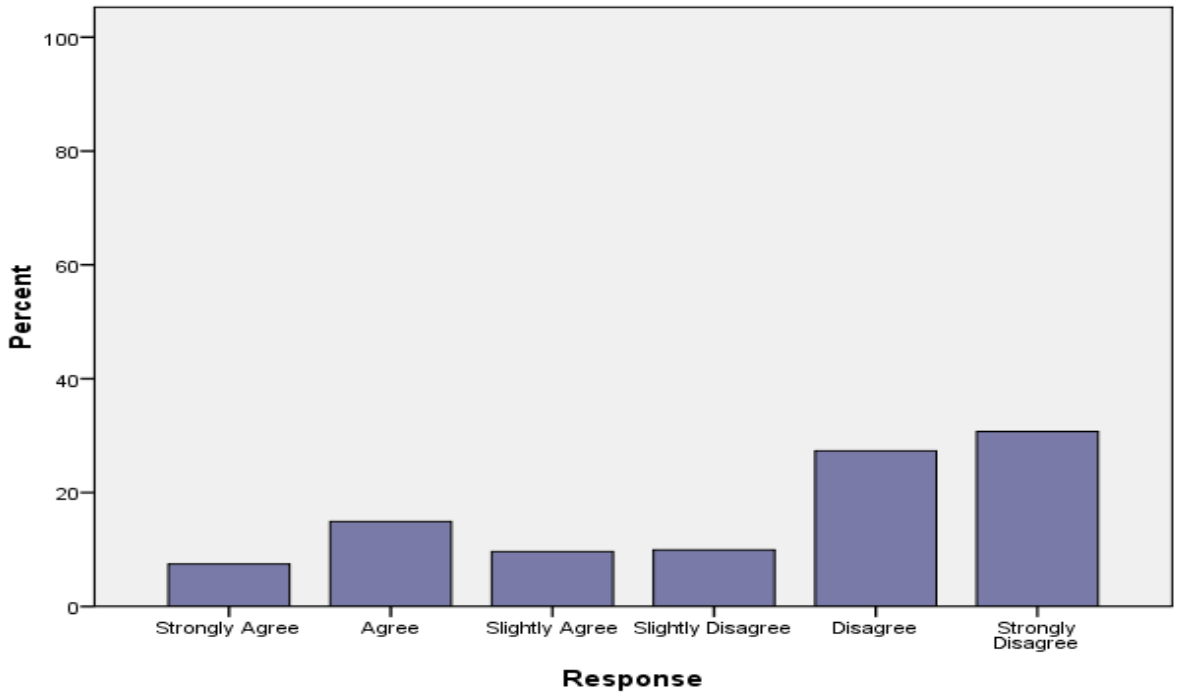

TABLE 36.
Percentage responses for follow-up survey Item 5: I have not used activities from the OE curriculum in my classroom.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	7.5	14.9	9.6	9.9	27.3	30.7

Figure 25 and Table 36 indicate that by the end of the Follow-up PDIs 32% of participants agree with the statement: ***I have not used activities from the OE curriculum in my***

classroom. This can also be interpreted as 68% of participants have used the OE curriculum in their classroom.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Activities* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Activities*. The ANOVA was not significant $F(7, 297) = 0.80$, $p = 0.59$, indicating there are no significant differences in responses by grade level.

B.1.6. OE web site as homework

FIGURE 26.
Results for follow-up survey Item 6: I have used components of the OE Web site as homework.

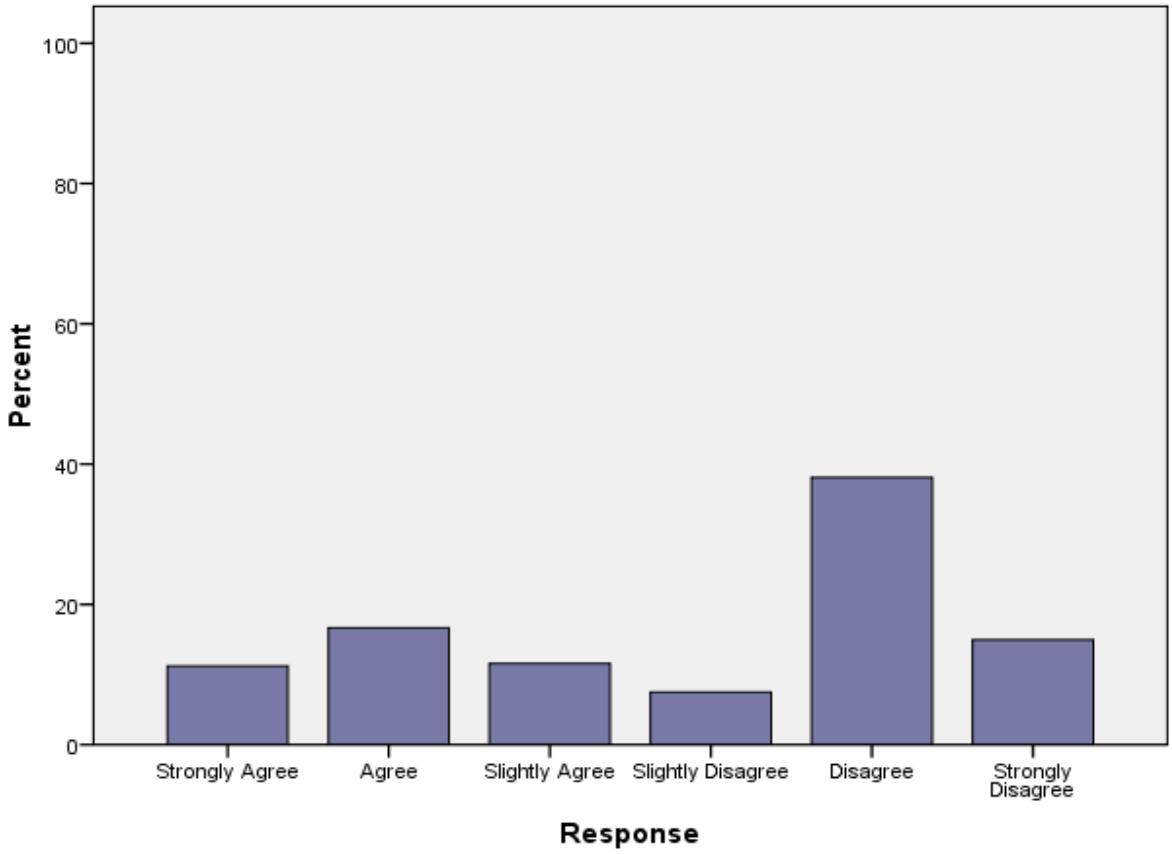

TABLE 37.
Percentage responses for follow-up survey Item 6: I have used components of the OE Web site as homework.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	11.2	16.7	11.6	7.5	38.1	15.0

Figure 26 and Table 37 indicate that by the end of the Follow-up PDIs 39.5% of participants agree with the statement: ***I have used components of the OE Web site as homework.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Homework* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Homework*. The ANOVA was not significant $F(7, 271) = 0.62$, $p = 0.16$, indicating there are no significant differences in responses by grade level.

B.1.7. Connect students to ocean scientists

FIGURE 27.
Results for follow up survey Item 7: The OE Web site has not enabled me to connect my students with the work and lives of ocean scientists.

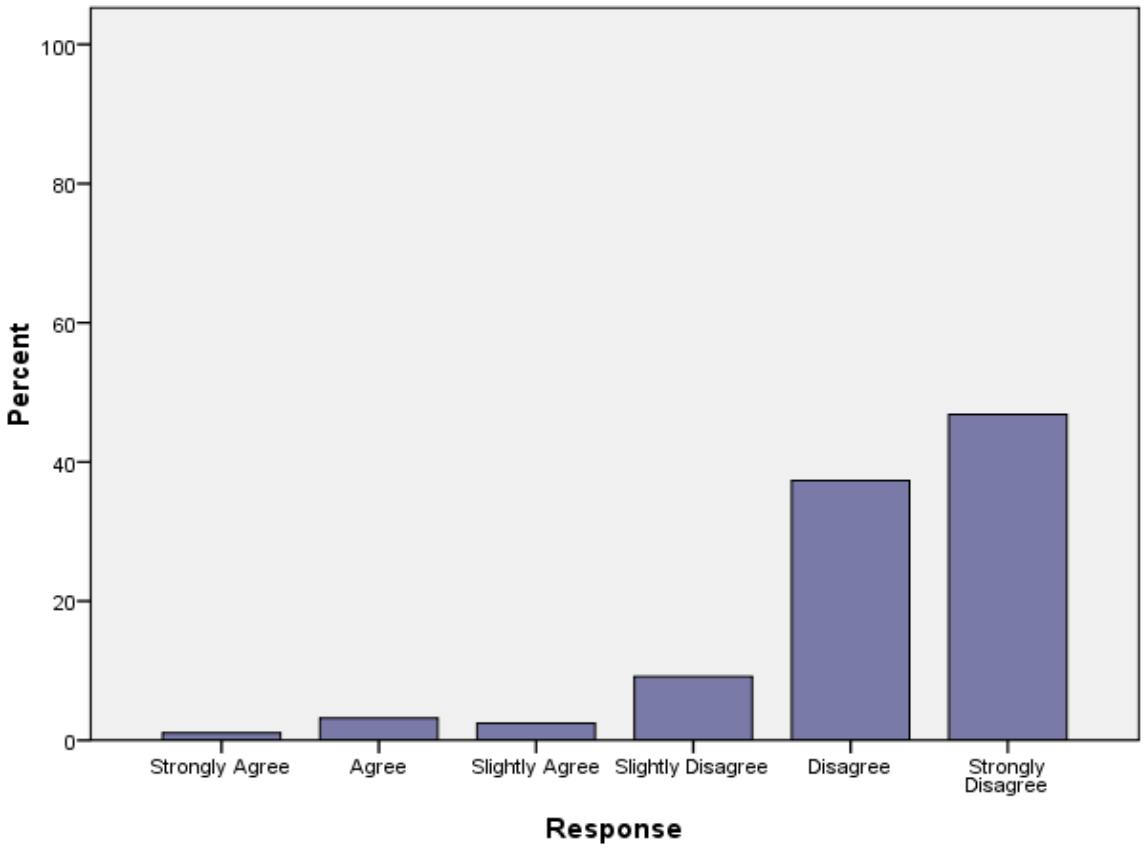

TABLE 38.
Percentage responses for survey Item 7: The OE Web site has not enabled me to connect my students with the work and lives of ocean scientists.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	1.1	3.2	2.5	9.2	37.3	46.8

Figure 27 and Table 38 indicate that by the end of the Follow-up PDIs only 6.7% of participants agree with the statement: ***The OE Web site has not enabled me to connect my students with the work and lives of ocean scientists.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Scientists* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Scientists*. The ANOVA was not significant $F(7, 263) = 0.57$, $p = 0.78$, indicating there are no significant differences in responses by grade level.

B.1.8. Ocean discoveries

FIGURE 28.
Results for follow-up survey Item 8: My students think that there are not very many new ocean discoveries left to be made.

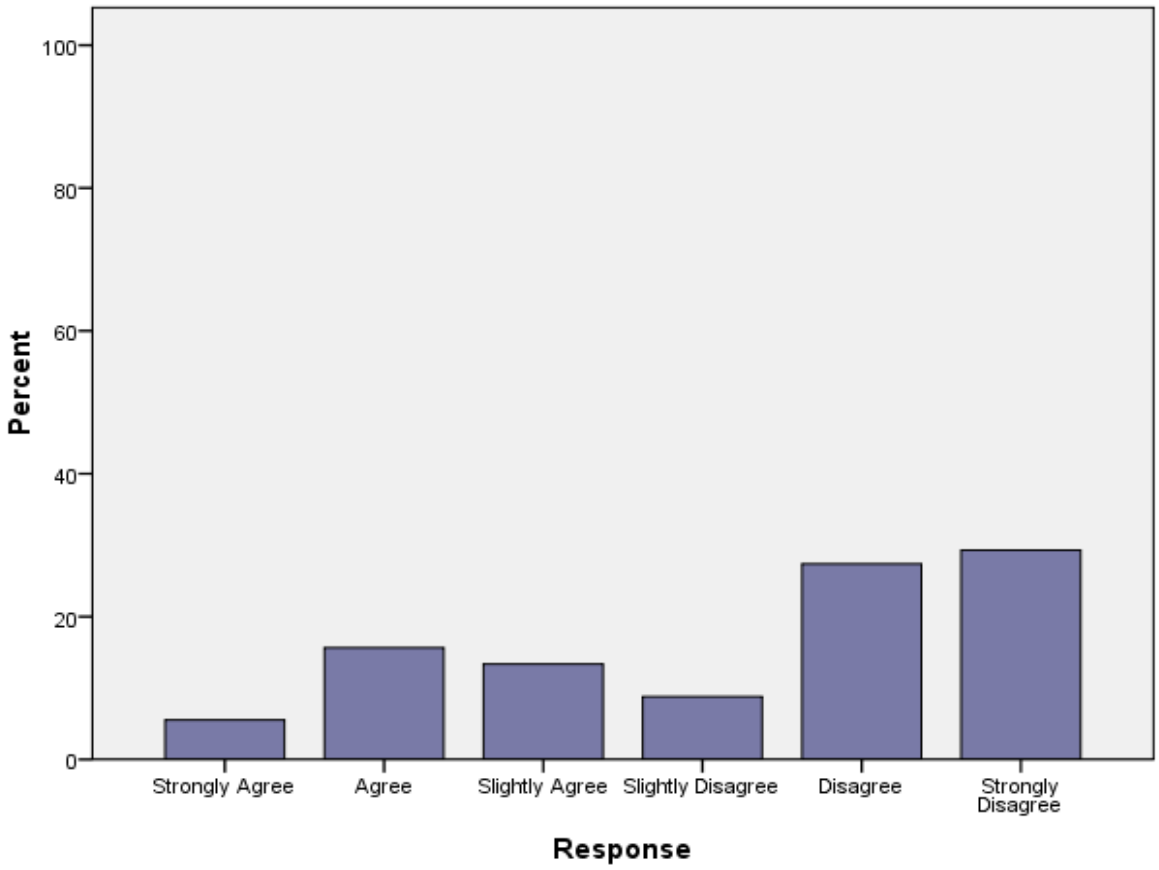

TABLE 39.
Percentage responses for follow-up survey Item 8: My students think that there are not very many new ocean discoveries left to be made.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	5.5	15.6	13.4	8.8	27.4	29.3

Figure 28 and Table 39 indicate that by the end of the Follow-up PDIs 34.5% of participants agree with the statement: ***My students think that there are not very many new ocean discoveries left to be made*.** This result can also be interpreted as 65.5% of participants reported that their students think there are ocean discoveries to be made.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Discoveries* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Discoveries*. The ANOVA was not significant $F(7, 283) = 1.54$, $p = 0.15$, indicating there are no significant differences in responses by grade level.

B.1.9. Using OE web site

FIGURE 29.
Results for follow-up survey Item 9. I know how to use the Ocean Exploration web site with my students.

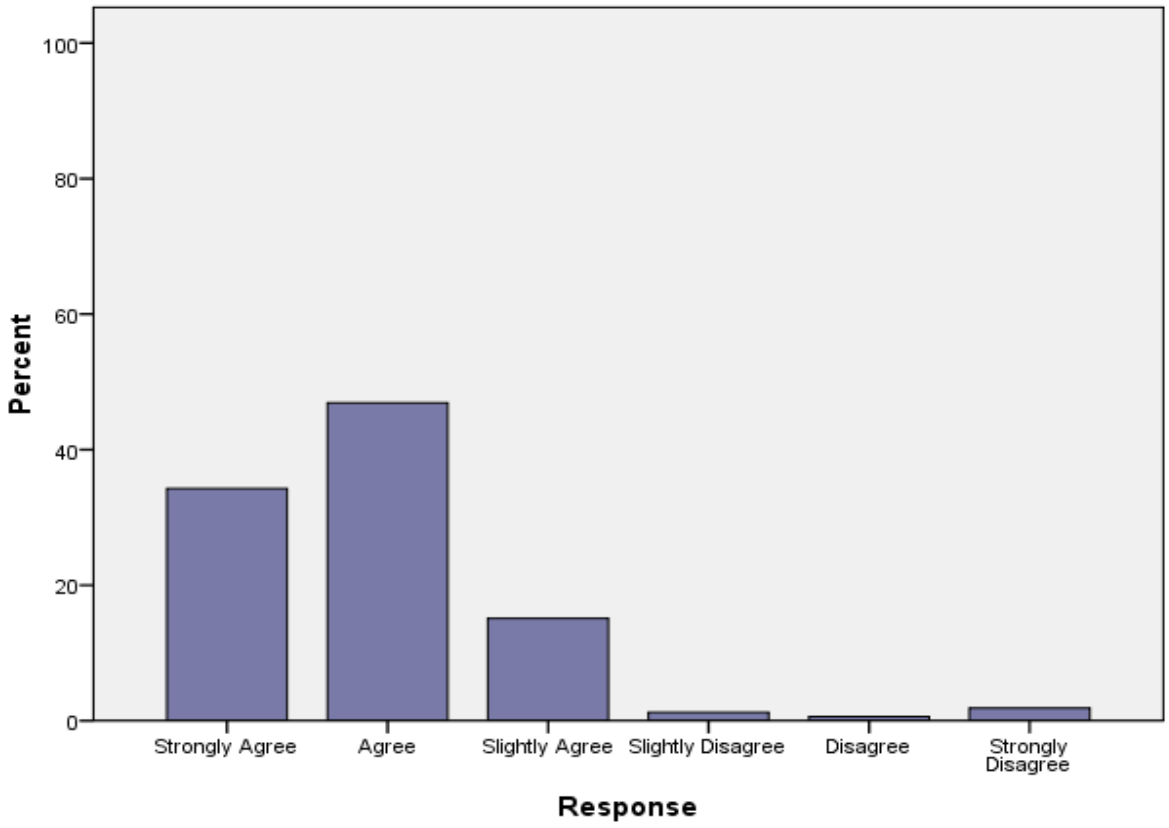

TABLE 40.
Percentage responses for follow-up survey Item 9. I know how to use the Ocean Exploration web site with my students.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	34.3	46.9	15.1	1.2	0.6	1.9

Figure 29 and Table 40 indicate that by the end of the Follow-up PDIs 96.3% of participants agree with the statement: ***I know how to use the Ocean Exploration web site with my students.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Use web site* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Use web site*. The ANOVA was not significant $F(7, 300) = 1.64$, $p = 0.12$, indicating there are no significant differences in responses by grade level.

B.1.10. Internet connection

FIGURE 30.
Results for follow-up survey Item 10: I cannot use the OE Web site with my students because our classroom (or library/computer lab) computers are not connected to the Internet.

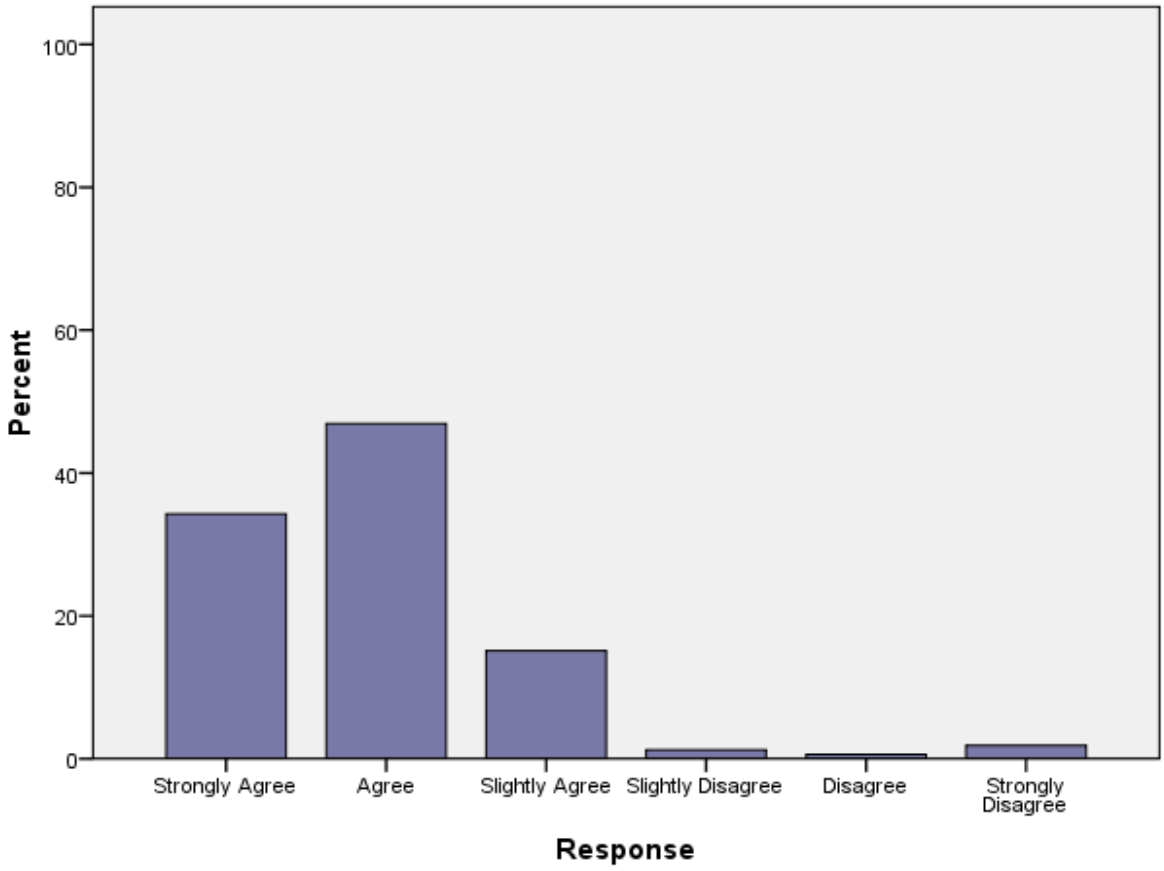

TABLE 41.
Percentage responses for follow-up survey Item 10: I cannot use the OE Web site with my students because our classroom (or library/computer lab) computers are not connected to the Internet.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	3.7	3.1	4.6	2.5	31.4	54.8

Figure 30 and Table 41 indicate that by the end of the Follow-up PDIs only 11.4% of participants agree with the statement: ***I cannot use the OE Web site with my students because our classroom (or library/computer lab) computers are not connected to the Internet.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *No Internet* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *No Internet*. The ANOVA was not significant $F(7, 300) = 3.22$, $p = 0.30$, indicating there are no significant differences in responses by grade level.

B.1.11. Professional goals

FIGURE 31.
Results for follow-up survey Item 11: Participation in the OE Curriculum Professional Development has not helped me further my professional goals.

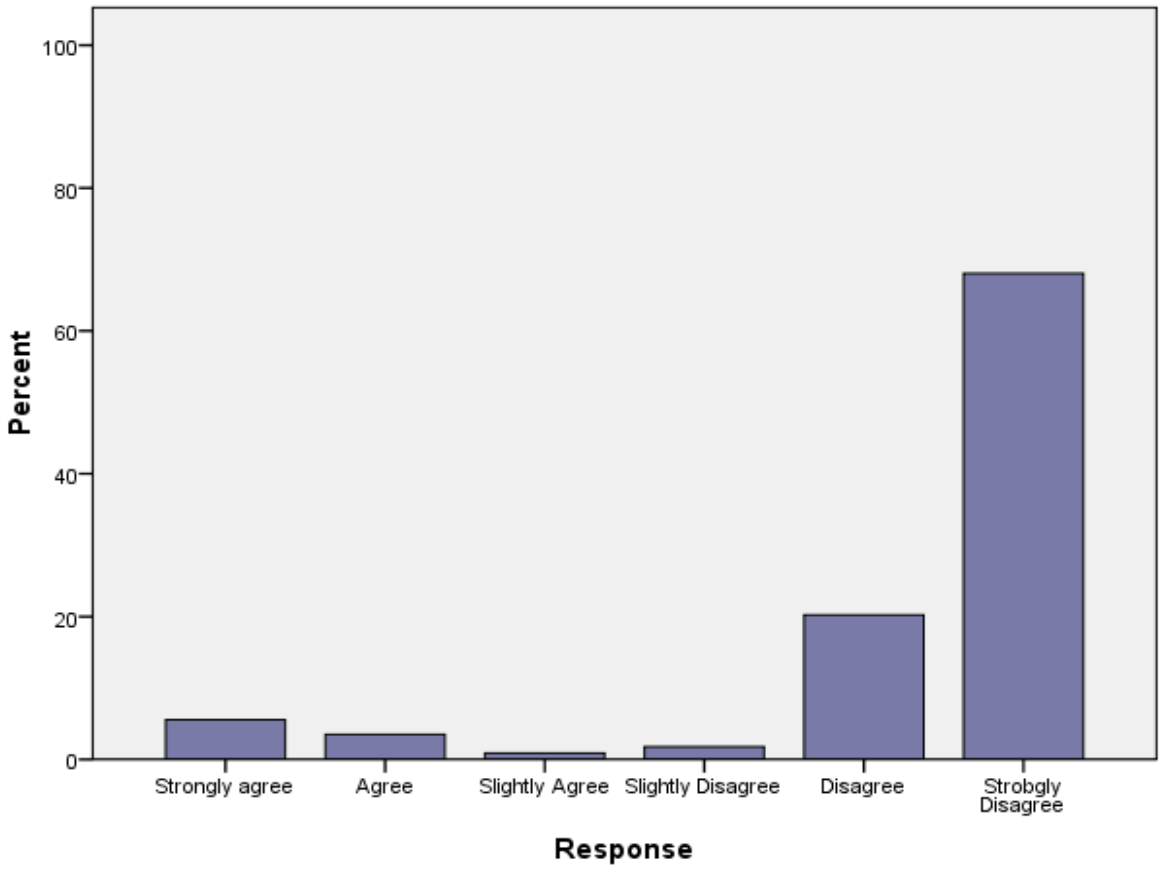

TABLE 42.
Percentage responses for follow-up survey Item 11: Participation in the OE Curriculum Professional Development has not helped me further my professional goals.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	5.6	3.5	0.9	1.8	20.2	68.0

Figure 31 and Table 42 indicates that by the end of the Follow-up PDIs only 10% of participants agree with the statement: ***Participation in the OE Curriculum Professional Development has not helped me further my professional goals.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *PD goals* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *PD goals*. The ANOVA was not significant $F(7, 315) = 0.42$, $p = 0.89$, indicating there are no significant differences in responses by grade level.

B.1.12. Improving student learning

FIGURE 32.
Results for follow-up survey Item 12: I believe that my participation in the OE Curriculum Professional Development has enabled me to improve student learning about the ocean in my classroom.

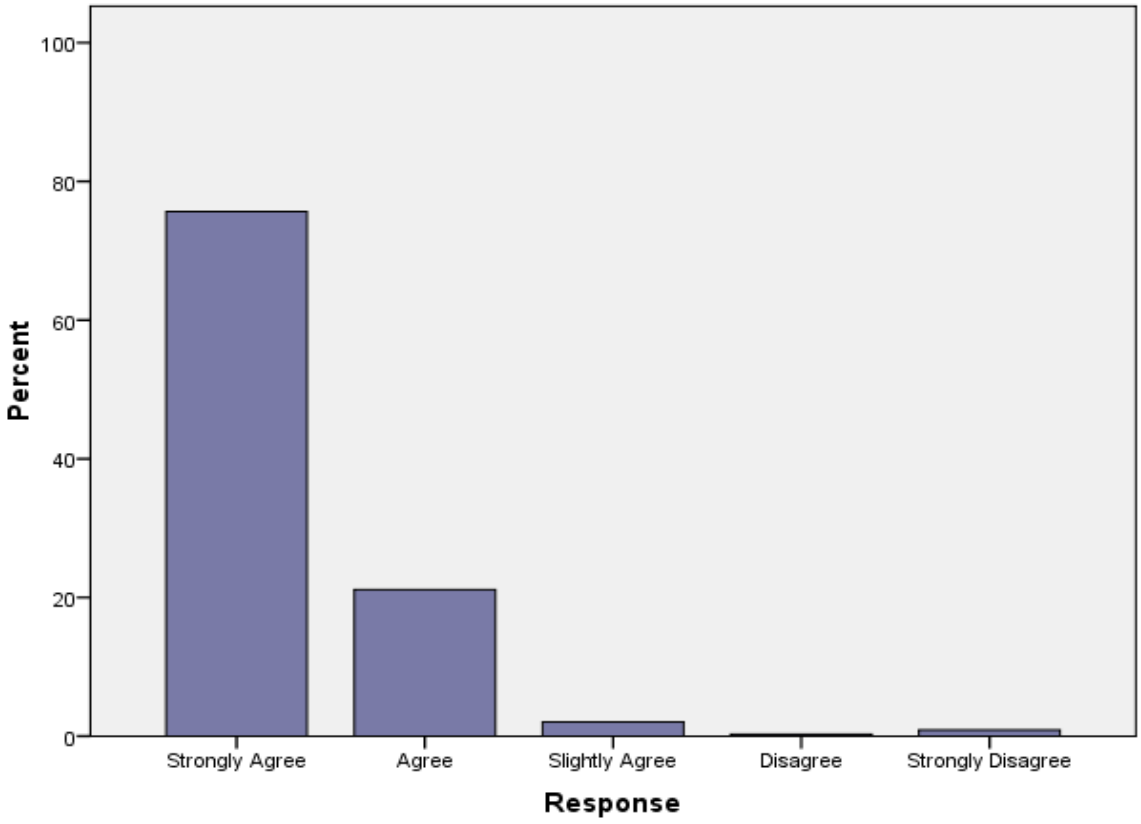

TABLE 43.
Percentage responses *for follow-up survey Item 12: I believe that my participation in the OE Curriculum Professional Development has enabled me to improve student learning about the ocean in my classroom.*

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	75.7	21.1	2.1	0	0.3	0.9

Figure 32 and Table 43 indicate that by the end of the Follow-up PDIs 98.8% of participants agree with the statement: ***I believe that my participation in the OE Curriculum Professional Development has enabled me to improve student learning about the ocean in my classroom.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Improve* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Improve*. The ANOVA was not significant $F(7, 316) = 0.68$, $p = 0.69$, indicating there are no significant differences in responses by grade level.

B.1.13. Sharing OE curriculum

FIGURE 33.
Results for follow-up survey Item 13: I have not shared information about the OE curriculum with other teaching professionals.

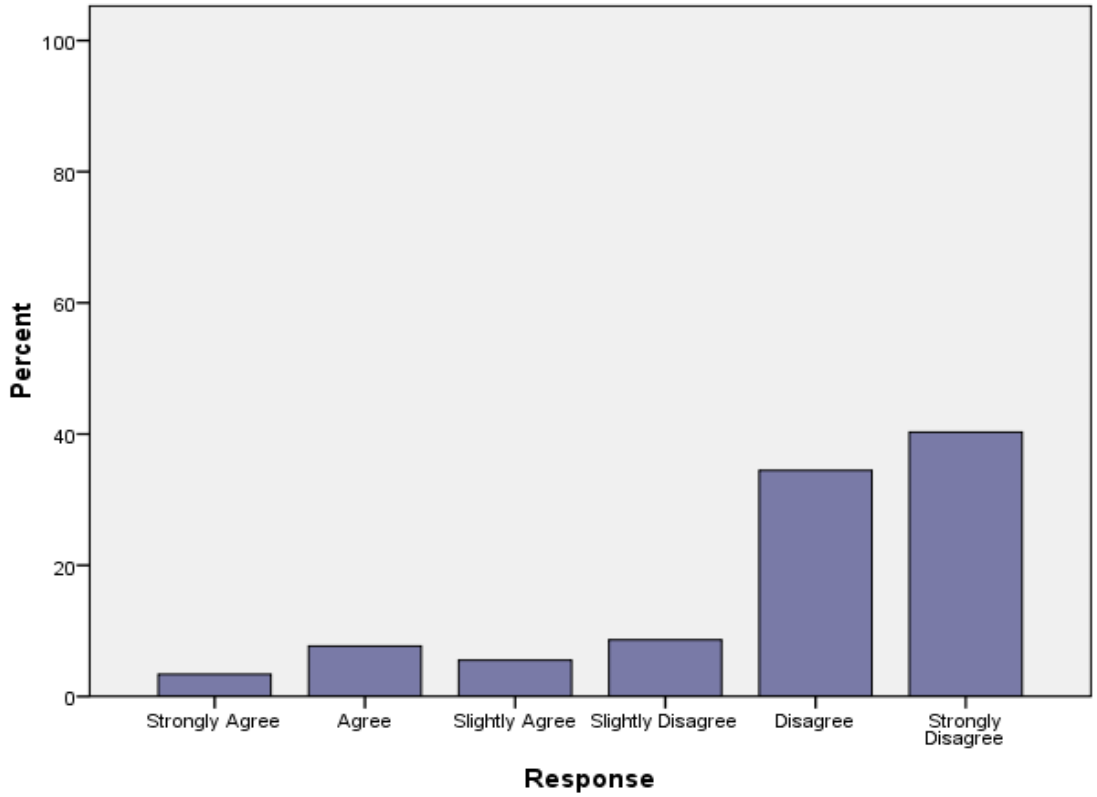

TABLE 44.
Percentage responses for follow-up survey Item 13: I have not shared information about the OE curriculum with other teaching professionals.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	3.4	7.7	5.5	8.6	34.5	40.3

Figure 33 and Table 44 indicate that by the end of the Follow-up PDIs 16.6% of participants agree with the statement: ***I have not shared information about the OE curriculum with other teaching professionals.*** This result can also be interpreted as 83.4% of participants reported that they have shared information about the OE curriculum with other teaching professionals.

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Shared* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *Shared*. The ANOVA was not significant $F(7, 299) = 2.35$, $p = 0.24$, indicating there are no significant differences in responses by grade level.

B.1.14. NOAA's role in ocean exploration

FIGURE 34.
Results for follow-up survey Item 14: I have a good understanding of NOAA's role in ocean exploration.

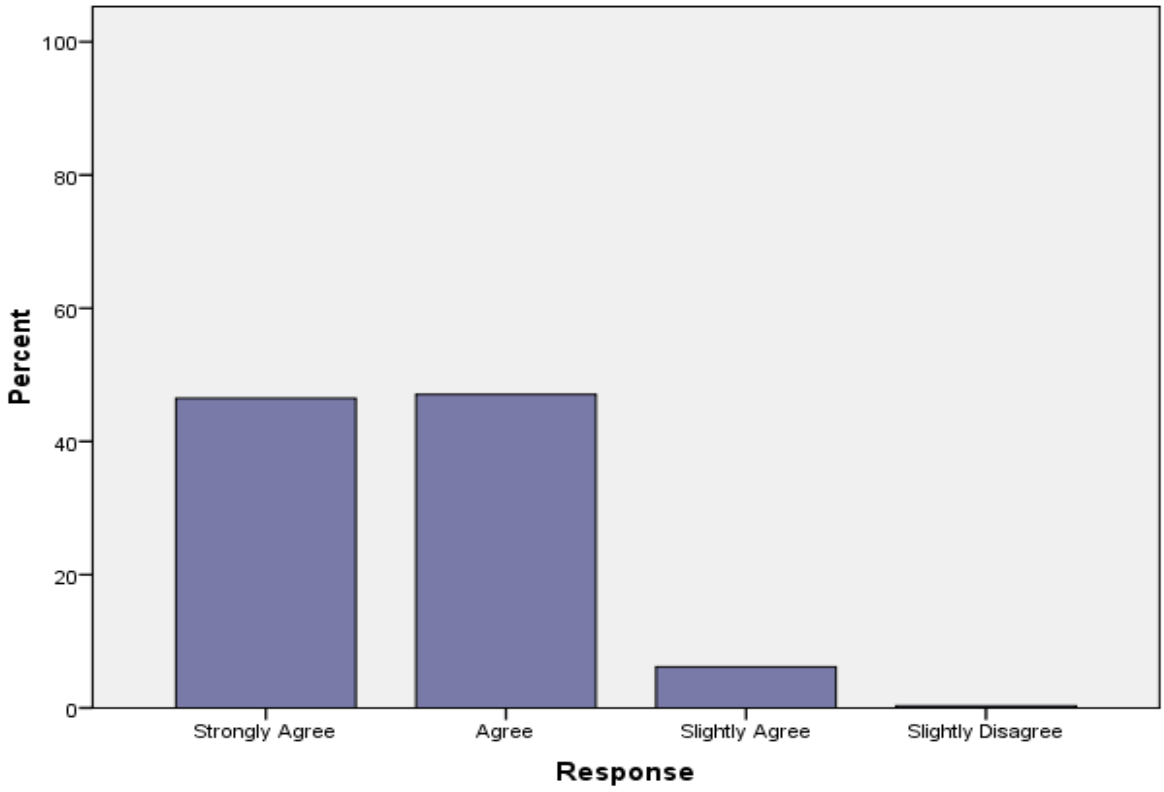

TABLE 45.
Percentage responses for follow-up survey Item 14: I have a good understanding of NOAA's role in ocean exploration.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	46.5	47.1	6.2	0.3	0	0

Figure 34 and Table 45 indicate that by the end of the Follow-up PDIs 99.7% of participants agree with the statement: ***I have a good understanding of NOAA's role in ocean exploration.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *NOAA's role* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *NOAA's role*. The ANOVA was not significant $F(7, 313) = 1.43$, $p = 0.19$, indicating there are no significant differences in responses by grade level.

B.1.15. OE listserv

FIGURE 35.
Results for follow-up survey Item 15: I have found the OE listserv useful in keeping me informed of NOAA OE education program offerings.

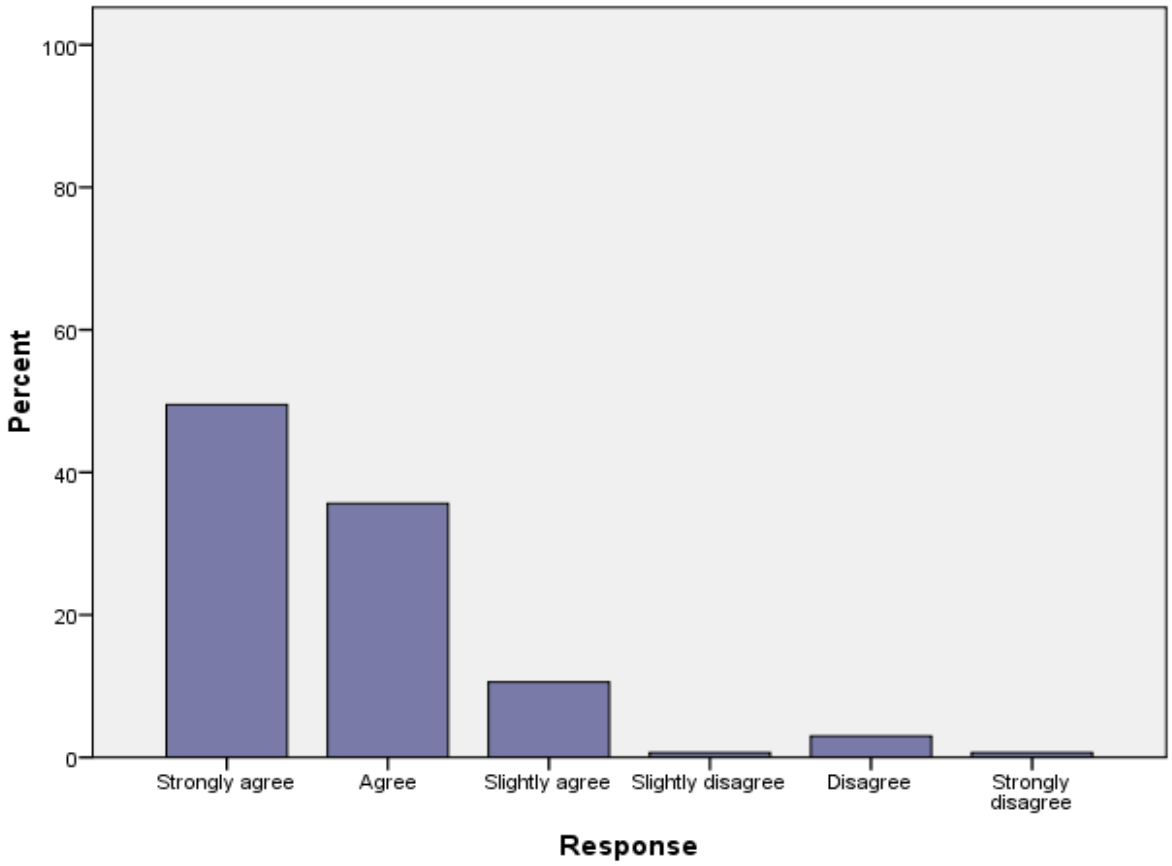

TABLE 46.
Percentage responses for follow-up survey Item 15: I have found the OE listserv useful in keeping me informed of NOAA OE education program offerings.

	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
Percent (%)	49.5	35.6	10.6	0.7	3.0	0.7

Figure 35 and Table 46 indicates that by the end of the Follow-up PDIs 95.7% of participants agree with the statement: ***I have found the OE listserv useful in keeping me informed of NOAA OE education program offerings.***

A one-way analysis of variance was conducted to evaluate the relationship between scores on the *Listserv* follow up item and grade level taught. The independent variable, grade level, included three levels: K-5, 6-8, and 9-12. The dependent variable was the score on the follow up survey for *List serv*. The ANOVA was not significant $F(7, 276) = 1.07$, $p = 0.38$, indicating there are no significant differences in responses by grade level.

B.2. Discussion of quantitative analysis

Overall the Follow-up survey indicates very positive perceptions of the value of the PDIs to themselves as teachers and to their students. Responses to 13 of the 15 items on the Follow-up survey indicate that more than 65% of participants responded positively to these items; on nine of the items 90% or more participants responded positively. On item 4, which refers to whether Ocean Science is part of school or district standards, 48.9% of participants indicated that Ocean Science was a required part of the standards they must to address. Item 4 was the only item where there was an effect of grade level on the responses; means for elementary teachers were statistically different (4.11) than means for high school teachers (3.18). Additionally, responses to item 6 indicate that only 39.5% of participants have used components of the OE Web site as homework.

C. Qualitative Follow-up Survey Analysis

Responses from 22 PDIs were analyzed using content analysis. Of the 400 possible responses, 247 individuals (61.8%) provided a response to a) ***"Suggestions which would make use of the OE Web site easier for you and/or your students"***; 262 individuals (65.5%) provided a response to b) ***"Suggestions which would make OE introductory and/or follow-up workshops more useful for?"***; 300 individuals (75%) provided a response to c) ***"Are there any factors which have inhibited your implementation of OE lessons/Web site use in your classroom?"***; and 221 individuals (55.3%) provided a response to a request for d) ***"Additional comments"***. Following are the 10 most common responses for each question. In parentheses after each entry is the percent of respondents who listed this topic followed by the number of respondents who listed each topic.

a. "Suggestions which would make use of the OE Web site easier for you and/or your students"

- It needs no improvement (14.2%; n = 35)
- Make it easier to find lessons (13.4%; n = 33)
- Provide a searchable lesson index (10.5%; n = 26)
- I have not used it so I don't know (9.7%; n = 24)
- Better computer technology/better computer access (5.7%; n = 14)
- Larger fonts/images to facilitate projection (4.0%; n = 10)
- Simplify/It contains too much information (4.0%; n = 10)
- Create additional learning games/interactives (3.2%; n = 8)
- Arrange lessons by:
    - Age/Grade level (4.9%; n = 12)
    - Subject (3.6%; n = 9)
    - Expedition location (2.8%; n = 7)

b. "Suggestions which would make OE introductory and/or follow-up workshops more useful for?"

- Nothing should be changed; It is great as it is (18.3%; n = 48)
- The lessons and materials are fantastic (12.6%; n = 33)
- The workshop is very well done (9.2%; n = 24)
- Develop a curriculum for younger students; K-7 (6.5%; n = 17)
- Offer more workshops per year (6.5%; n = 17)
- Offer more specialized workshops (6.1%; n = 16)
- Provide some follow-up (CD/website/e-follow-up) so teachers can see how others are implementing material/lessons and dealing with problems (6.1%; n = 16)
- Help us apply our standards to this material (4.2%; n = 11)
- Make computers available to view website (3.8%; n = 10)
- There is not enough time to absorb all the wonderful information and material (3.4%; n = 9)

c. "Are there any factors which have inhibited your implementation of OE lessons/Web site use in your classroom?"

- Lack of Technology/Computers (24.3%; n = 73)
- Time required to prepare and teach the lessons (18.7 %; n = 56)
- No/None (16.0%; n = 48)
- Time required to teach these lessons and to the standards (9.0%; n = 27)
- N/A (7.0%; n = 21)
- Lack of funds for materials (6.3%; n = 19)
- Workshop timing incompatible with classroom curriculum sequencing (4.0%; n = 12)
- I need more support before I can introduce new material/curriculum (2.7%; n = 8)
- Lack of support from administration (2.3%; n = 7)
- Curriculum not appropriate for younger students (2.0%; n = 6)

d. "Additional comments"

- Workshops are outstanding/phenomenal (28.5%; n = 63)
- THANK YOU! (24.9%; n = 55)
- I really appreciate the resource materials for the classroom (20.4%; n = 45)
- The facilitator was enthusiastic/fantastic (17.2%; n = 38)
- My students will benefit from this workshop soon/I will use the lessons/materials when I return to the classroom (12.7%; n = 28)
- One of the best workshops I have ever been to (7.2%; n = 16)
- these workshops are so much Fun (6.8%; n = 15)
- Please offer more workshops (5.9%; n = 13)
- Great content (5.0%; n =11)
- Great background information (4.5%; n = 10)

Overall, the qualitative items on the Follow-up survey were very positive about participants' PDI experience. Suggestions for making the website easier to use focused on ways to organize the website that would make it easier to search and simpler to use. Improvements to the workshops focused on providing more workshops, workshops for younger students or

specialized audiences, and ways for participants to connect with one another for help implementing lessons. The factors that inhibit use of OE resources and materials include lack of technology, lack of time or bad timing, lack of funds to implement lessons, and need for more support from OE and school administrations.

VI. Analysis of Items Common to Introductory and Follow-up Surveys

Five of the post Introductory PDI survey items have analogous items on the Follow-up PDI survey (Table 47). This is not a true repeated measures analysis because the post participants' responses cannot be matched to the follow-up participants' responses; we can only describe comparisons of the % of participants in agreement with the items comprising each pair. In three of the pairs, the item on the post survey and the item on the follow-up survey are both stated as either positive or negative as indicated in the ( ) after each item. However, in two of the pairs (Pair 1 and Pair 4), the post survey items are stated negatively while the follow-up item is stated positively (*). In order to make appropriate comparisons of the percentages for these items, one of the %s must be reversed. Therefore, think of the post item in Pair 1 as 89.6% and the post item in Pair 4 as 95.7%.

TABLE 47.

Percent of participants agreeing with paired items on post and follow-up surveys.

Pair	**Post** Item	%	**Follow-up** Item	%
1.	1. I do not have a clear idea of what the NOAA Ocean Exploration Program is and how the curriculum and website fits in my classroom. (-)*	10.4	14. I have a good understanding of NOAA's role in ocean exploration. (+)*	99.7
2.	2. I know everything I need to know to teach the Ocean Exploration curriculum in my classroom. (+)	72.6	2. I have increased my own knowledge about ocean science through my work with the OE curriculum. (+)	99.7
3.	5. I have no way to connect my students with real ocean scientists, directly or indirectly. (-)	5.4	7. The OE Web site has not enabled me to connect my students with the work and lives of ocean scientists. (-)	6.7
4.	6. I do not know how to use the Ocean Exploration web site with my students. (-)*	4.3	9. I know how to use the Ocean Exploration Web site with my students. (+)*	96.3
5.	7. I cannot use the OE web site with my students because our classroom (or library/computer lab) computers are not connected to the internet. (-)	9.8	10. I cannot use the OE Web site with my students because our classroom (or library/computer lab) computers are not connected to the Internet. (-)	11.4

Comparisons of the item pairs suggest that Item Pairs 3, 4, and 5 show essentially no change in the percentage of participants who agree (or disagree) with the item from post to follow-up. In Item Pairs 1 and 2 there is an increase in the percentage of participants who agree with these items (when stated positively) from post to follow-up. Overall, this indicates that the percentages of participants who agree with the items at both time points remain consistent with positive outcomes from the workshops and do not drop off over time. In addition, the high positive perceptions of the value of OE PDIs on the Follow-up survey indicates that even after participants have had a chance to implement some of the activities and use some of the resources from the PDIs, they still view the PDIs as useful and meaningful.

VII. Recommendations

1. Assessment of OE PDIs should continue. However, the Education Director should consider collecting data that will provide evidence for the level of implementation of the OE curriculum by PDI participants. This is difficult to ascertain based on the results of self-report pre/post surveys.
2. Further assessment is needed to determine the extent of impacts on student learning that can be attributed to the OE PDIs. The current assessment is not designed to assess the impact of OE PDIs on student learning.
3. Future pre/post assessment of participants should focus on participant content knowledge, efficacy and other areas of interest to the OE Education Staff.
4. New assessment tools should be designed to focus on curriculum implementation and student learning. These tools should utilize best practices in both qualitative and quantitative educational research.
5. Reliability and factor analysis reflect the weak structure of the current survey in relation to the development of survey items, factors and overall structure. Future survey items should be developed according to specific factors ("themes"). The items should then undergo content analysis and pilot testing to determine if the survey measures what it is designed to measure.
6. Interviews of participants and classroom observations of implementation of PDI activities and strategies should be considered as ways to determine how the curriculum and website are utilized.
7. All instruments utilizing a Likert scale format should begin with the lowest aspect of disagreement with the statement (e.g., 1 = Strongly Disagree) to the highest aspect of agreement (e.g., 6 = Strongly Agree) to facilitate data analyses.
8. Self-report survey instruments should be redesigned to reflect changes in OE goals and objectives for the PDIs. Survey items should address selected constructs or factors of interest to OE and should be based on revised PDI goals and objectives.
9. Many of the qualitative items on the existing post survey should be revised or eliminated. With analysis of nearly 1000 responses from the post instrument, it is unlikely that any new information will emerge with continued analysis of responses to the existing items.
10. Participants should be strongly encouraged to complete the entire survey to lessen the impact of missing data on the analysis.
11. Continue to reach out to diverse ethnic groups and new audiences (e.g., elementary teachers, informal educators, college/university professors working with pre service teachers). Survey results suggest the PDI participants are very motivated already ("preaching to the choir") as indicated by the high levels of agreement in many survey responses (indicating a potential ceiling effect).
12. Develop "primary", "advanced" or "topic specific" PDIs which address the needs of specific educator groups. These PDIs should introduce OE content at an elementary level or delve deeper into pedagogy and specific biological or physical science content.
13. Utilize the OE listserv as a discussion site for PDI participants to share best practices and ideas for resources in addition to PDI announcements. In other words, make the listserv interactive.
14. Items regarding student learning/enjoyment should be eliminated as this can not be accurately assessed via a third party (e.g., teacher) response.
15. Assessment/evaluation of OE PDIs should continue on a regular (e.g., biennial) basis.

Appendix A

NOAA OE PDIs
Total Data Set

Sponsor	Location	Type	Date	Facilitator	Surveys
Aquarium of the Pacific (1)	Long Beach, CA	Intro – pre (revised)	12/3/05	Valerie Chase	24
Aquarium of the Pacific (1)	Long Beach, CA	Intro – post (revised)	12/3/05	Valerie Chase	24
Aquarium of the Pacific (1)	Long Beach. CA	Follow-up	5/13/06	Cindy Renkas	18
Aquarium of the Pacific (1)	Long Beach. CA	Post surveys (revised) mistakenly given at the Follow-up	5/13/06	Cindy Renkas	5
Aquarium of the Pacific (2)	Long Beach, CA	Intro – pre (revised)	2/4/06	Valerie Chase	0 (Facilitator forgot to distribute pre-surveys)
Aquarium of the Pacific (2)	Long Beach, CA	Intro – post (revised)	2/4/06	Valerie Chase	23
Aquarium of the Pacific (2)	Long Beach, CA	Follow-up	9/9/06	Alie Lebeau	26
American School for the Deaf	Mystic Aquarium / IFE	Intro – pre (revised)	3/24/06	Cindy Renkas	12
American School for the Deaf	Mystic Aquarium / IFE	Intro – post (revised)	3/24/06	Cindy Renkas	8
American School for the Deaf	Mystic Aquarium / IFE	Follow-up (different Follow-up survey)	3/24/06	Cindy Renkas	3
Audubon Aquarium of the Americas (1)	New Orleans, LA	Intro – pre (OLD survey)	6/28/05	Information not provided	16
Audubon Aquarium of the Americas (1)	New Orleans, LA	Intro – post (OLD survey)	6/28/05	Cindy Renkas, Valerie Chase	16
Audubon Aquarium of the Americas (2)	New Orleans, LA	Intro – pre (OLD survey)	6/29/05	Information not provided	14
Audubon Aquarium of the Americas (2)	Audubon Zoo, New Orleans, LA	Intro – post (OLD survey)	6/29/05	Cindy Renkas, Valerie Chase	15

Audubon Aquarium	Audubon Zoo, New Orleans, LA	Follow-up (see notes – lots of issues)	8/12/06	Cindy Renkas	24
Audubon Aquarium of the Americas (3)	New Orleans, LA	Intro – pre (revised)	10/13/07	Information not provided	8
Audubon Aquarium of the Americas (3)	New Orleans, LA	Intro – post (revised)	10/13/07	Valerie Chase	10
University of North Carolina Wilmington	Wilmington, NC	Intro – pre (revised)	4/22/06	No information provided	22
University of North Carolina Wilmington	Wilmington, NC	Intro – post (revised)	4/22/06	Cindy Renkas	22
Center for Marine Science	Wilmington, NC	Follow up	5/20/06	Cindy Renkas	18
COSEE West	UCLA, CA	Intro – pre (revised)	2/11/06	Information not provided	28
COSEE West	UCLA, CA	Intro – post (revised)	2/11/06	Valerie Chase	24
CT Sea Grant	GMRI, Portland, ME	Intro – pre (OLD survey)	Summer 2005	Information not provided	7
CT Sea Grant	GMRI, Portland, ME	Intro – post (OLD survey)	Summer 2005	Diana Payne; Ivar Babb	4
Dauphin Island Sea Lab (1)	Dauphin Island, AL	Intro – pre (revised)	9/16/06	Charlene Dindo	22
Dauphin Island Sea Lab (1)	Dauphin Island, AL	Intro – post (revised)	9/16/06	Charlene Dindo	23
Dauphin Island Sea Lab (1)	Dauphin Island, AL	Follow-up survey	3/24/07	Charlene Dindo	16
Dauphin Island Sea Lab (2)	Dauphin Island, AL	Intro – pre (revised)	9/15/07	Information not provided	24
Dauphin Island Sea Lab (2)	Dauphin Island, AL	Intro – post (revised)	9/15/07	Charlene Dindo	24
Georgia Aquarium (1)	Atlanta, GA	Intro – pre (revised)	9/30/06	No information provided	27
Georgia Aquarium (1)	Atlanta, GA	Intro – post (revised)	9/30/06	Cindy Renkas	27
Georgia Aquarium (1)	Atlanta, GA	Follow-up	3/10/07	Cindy Renkas	21
Georgia Aquarium (2)	Atlanta, GA	Intro – pre (revised)	10/6/07	Information not provided	28
Georgia Aquarium (2)	Atlanta, GA	Intro – post (revised)	10/6/07	Stacia Fletcher	29
Hatfield Marine Science Center	Newport, OR	Follow-up (different Follow-up	2/4/06	Cindy Renkas	17

		survey)			
MBARI / Monterey Bay Aquarium	Monterey, CA	Intro – pre (OLD survey)	11/13/04	No information provided	17
MBARI / Monterey Bay Aquarium	Monterey, CA	Intro – post (OLD survey)	11/13/04	Valerie Chase, Stacia Fletcher, George Matsumoto, Rita Bell	17
Montgomery Co. Public Schools	Montgomery Co, MD	Intro – pre (revised)	5/13/06	No information provided	13
Montgomery Co. Public Schools	Montgomery Co, MD	Intro – post (revised)	5/13/06	Valerie Chase	13
MTS / IEEE	Washington, DC	Intro – pre (revised)	09/18/05	No information provided	13
MTS / IEEE	Washington, DC	Intro – post (revised)	09/18/05	Valerie Chase	12
Nauticus (1)	The National Maritime Center, Norfolk, VA	Intro – pre (revised)	1/19/06	No information provided	15
Nauticus (1)	The National Maritime Center, Norfolk, VA	Intro – post (revised)	1/19/06	Cindy Renkas	16
Nauticus (2)	The National Maritime Center, Norfolk, VA	Intro – pre (revised)	1/20/06	No information provided	11
Nauticus (2)	The National Maritime Center, Norfolk, VA	Intro – post (revised)	1/20/06	Cindy Renkas	11
Nauticus (1 or 2)	The National Maritime Center, Norfolk, VA	Follow-up	06/1/06	Cindy Renkas	13
Nauticus (1 or 2)	The National Maritime Center, Norfolk, VA	Follow-up	06/2/06	Cindy Renkas	9
Nauticus (3)	The National Maritime	Intro – pre (revised)	12/8/06	No information	22

	Center, Norfolk, VA			provided	
Nauticus (3)	The National Maritime Center, Norfolk, VA	Intro – post (revised)	12/8/06	Cindy Renkas	21
Nauticus	The National Maritime Center, Norfolk, VA	Follow-up	03/14/07	Beth Day-Miller	24
Nauticus (4)	The National Maritime Center, Norfolk, VA	Intro – pre (revised)	10/29/07	No information provided	20
Nauticus (4)	The National Maritime Center, Norfolk, VA	Intro – post (revised)	10/29/07	Beth Day-Miller	21
NC Aquarium at Fort Fisher	Wilmington, NC	Intro – pre (revised)	7/28/06	No information provided	6
NC Aquarium at Fort Fisher	Wilmington, NC	Intro – post (revised)	7/28/06	Cindy Renkas	6
New England Aquarium (1)	Boston, MA	Intro – pre (OLD survey)	5/6/04	No information provided	13
New England Aquarium (1)	Boston, MA	Intro – post (OLD survey)	5/6/04	Diana Payne	11
New England Aquarium (2)	Boston, MA	Intro – pre (revised)	10/29/05	No information provided	33
New England Aquarium (2)	Boston, MA	Intro – post (revised)	10/29/05	Valerie Chase	34
New England Aquarium (3)	Boston, MA	Intro – pre (revised)	4/8/06	Cindy Renkas	2 (Note: Are these the 2 new to OE mentioned below???)
New England Aquarium (3)	Boston, MA	Intro – post (revised)	4/8/06	Cindy Renkas	2 (Note: Are these the 2 new to OE mentioned below???)
New England Aquarium	Boston, MA	Follow-up (different Follow-up	4/8/06	Cindy Renkas	17 (Note: Cindy notes that 2 are

		survey)			new to OE but all in this survey answered as returnee)
New England Aquarium (4)	Boston, MA	Intro – pre (revised)	9/30/06	No information provided	17
New England Aquarium (4)	Boston, MA	Intro – post (revised)	9/30/06	Valerie Chase	17
New England Aquarium	Boston, MA	Follow-up	5/12/07	Cindy Renkas	19
New England Aquarium (5)	Boston, MA	Intro – pre (revised)	9/29/07	No information provided	22
New England Aquarium (5)	Boston, MA	Intro – post (revised)	9/29/07	Valerie Chase	22
NMEA 2005	Maui CC, Hawai'i	Intro – pre (OLD survey)	7/11/05	No information provided	8
NMEA 2005	Maui CC, Hawai'i	Intro – post (OLD survey)	7/11/05	Paula Keener-Chavis, Valerie Chase	9
NMEA 2006	NY, NY	Intro – pre (revised)	7/16/06	No information provided	21
NMEA 2006	NY, NY	Intro – post (revised)	7/16/06	Valerie Chase	30
NMEA 2007	Portland, ME	Intro - pre	7/23/07	No information provided	27
NMEA 2007	Portland, ME	Intro - post	7/23/07	Valerie Chase	27
NSTA Regional	Baltimore, MD	Intro – pre (revised)	11/2/06	No information provided	8
NSTA Regional	Baltimore, MD	Intro – post (revised)	11/2/06	Valerie Chase	6
Oregon Sea Grant (1)	Oregon State Univ., Corvallis, OR	Intro – pre (revised)	6/16/06	No information provided	13
Oregon Sea Grant (1)	Oregon State Univ., Corvallis, OR	Intro – post (revised)	6/16/06	Cindy Renkas	15
Hatfield Marine Science Center Alliance (2)	Oregon State University Corvallis, OR	Intro – pre (revised)	6/17/06	No information provided	24

Hatfield Marine Science Center Alliance (2)	Oregon State University Corvallis, OR	Intro – post (revised)	6/17/06	Cindy Renkas	24
Oregon Sea Grant (1 & 2)	Oregon State Univ., Corvallis, OR	Follow-up	12/2/06	Cindy Renkas	14
Oregon Sea Grant (3)	OMSI (Oregon Museum of Science and Industry), Portland, OR	Intro – pre (revised)	10/27/07	No information provided	17
Oregon Sea Grant (3)	OMSI, Portland, OR	Intro – post (revised)	10/27/07	Cindy Renkas	16
G Works, Inc. - Gretchen Guzman	Universidad Metropolitana, Puerto Rico	Intro – pre (revised)	3/31/07	No information provided	16
G Works, Inc. - Gretchen Guzman	Universidad Metropolitana, Puerto Rico	Intro – post (revised)	3/31/07	Cindy Renkas	17
South Carolina Aquarium (1)	Charleston, SC	Intro – pre (OLD survey)	11/15/03	No information provided	16
South Carolina Aquarium (1)	Charleston, SC	Intro – post (OLD survey)	11/15/03	Valerie Chase, Stacia Fletcher, Paula Keener-Chavis	14
South Carolina Aquarium (2)	Charleston, SC	Intro – pre (OLD survey)	9/25/04	No information provided	10
South Carolina Aquarium (2)	Charleston, SC	Intro – post (OLD survey)	9/25/04	Katrina Bryan, Carmelina Livingston	10
South Carolina Aquarium (3)	Charleston, SC	Intro – pre (OLD survey)	10/16/04	No information provided	6
South Carolina Aquarium (3)	Charleston, SC	Intro – post (OLD survey)	10/16/04	Katrina Bryan, Carmelina Livingston	6
South Carolina Aquarium (4)	Charleston, SC	Intro – pre (OLD survey)	3/12/05	No information provided	12
South Carolina	Charleston,	Intro – post	3/12/05	Katrina	13

Aquarium (4)	SC	(OLD survey)		Bryan, Carmelina Livingston	
South Carolina Aquarium (5)	Charleston, SC	Intro – pre (OLD survey)	9/24/05	No information provided	3
South Carolina Aquarium (5)	Charleston, SC	Intro – post (OLD survey)	9/24/05	Katrina Bryan, Jaime Coomes	3
South Carolina Aquarium (6)	Charleston, SC	Intro – pre (revised)	2/17/07	No information provided	16
South Carolina Aquarium (6)	Charleston, SC	Intro – post (revised)	2/17/07	Cindy Renkas	16
South Carolina Aquarium	Charleston, SC	Follow-up	6/16/07	Cindy Renkas	16
South Carolina Aquarium (7)	Charleston, SC	Intro – pre (revised)	9/22/07	No information provided	15
South Carolina Aquarium (7)	Charleston, SC	Intro – post (revised)	9/22/07	Stacia Fletcher	16
Seattle Aquarium (1)	Seattle, WA	Intro – pre (revised)	10/21/06	No information provided	20
Seattle Aquarium (1)	Seattle, WA	Intro – post (revised)	10/21/06	Cindy Renkas	19
Seattle Aquarium (1)	Seattle, WA	Follow-up	1/27/07	Cindy Renkas	21
Seattle Aquarium (2)	Seattle, WA	Intro – pre (revised)	2/10/07	No information provided	28
Seattle Aquarium (2)	Seattle, WA	Intro – post (revised)	2/10/07	Valerie Chase	27
Seattle Aquarium	Seattle, WA	Follow-up	5/19/07	Stacia Fletcher	22
Sea World (1)	San Diego, CA	Intro – pre (revised)	10/7/06	No information provided	23
Sea World (1)	San Diego, CA	Intro – post (revised)	10/7/06	Cindy Renkas	23
Sea World (1)	San Diego, CA	Follow-up	2/3/07	Cindy Renkas	18
Sea World (2)	San Diego, CA	Intro – pre (revised)	3/3/07	No information provided	25
Sea World (2)	San Diego, CA	Intro – post (revised)	3/3/07	Valerie Chase	24

Sea World (2)	San Diego, CA	Follow-up	6/9/07	Stacia Fletcher	16
Sea World (3)	San Diego, CA	Intro – pre (revised)	10/20/07	No information provided	22
Sea World (3)	San Diego, CA	Intro – post (revised)	10/20/07	Stacia Fletcher	23
Shedd Aquarium (1)	Chicago, IL	Intro – pre (revised)	11/11/06	No information provided	21
Shedd Aquarium (1)	Chicago, IL	Intro – post (revised)	11/11/06	Cindy Renkas	21
Shedd Aquarium (2)	Chicago, IL	Intro – pre (revised)	11/3/07	No information provided	20
Shedd Aquarium (2)	Chicago, IL	Intro – post (revised)	11/3/07	Cindy Renkas	20
Shedd Aquarium	Chicago, IL	Follow-up	4/21/07	Stacia Fletcher	16
SMILE (1)	University of Rhode Island, Kingston, RI	Intro – pre (revised)	7/18/07	No information provided	18
SMILE (1)	University of Rhode Island, Kingston, RI	Intro – post (revised)	7/18/07	Cindy Renkas	19
SMILE (2)	University of Rhode Island, Kingston, RI	Intro – pre (revised)	7/19/07	No information provided	18
SMILE (2)	University of Rhode Island, Kingston, RI	Intro – post (revised)	7/19/07	Cindy Renkas	14
University of Rhode Island (1)	URI Narragansett Bay campus	Intro – pre (OLD survey)	7/27/05	No information provided	15
University of Rhode Island (1)	URI Narragansett Bay campus	Intro – post (OLD survey)	7/27/05	Diana Payne, Ivar Babb	19
University of South Florida (1)	St. Petersburg, FL	Intro – pre (OLD survey)	6/24/05	No information provided	18
University of South Florida (1)	St. Petersburg, FL	Intro – post (OLD survey)	6/24/05	Cindy Renkas, Tim Birdsong	19
University of South Florida College of Marine Sciences (1)	St. Petersburg, FL	Intro – pre (revised)	11/18/06	No information provided	18

University of South Florida College of Marine Sciences (1)	St. Petersburg, FL	Intro – post (revised)	11/18/06	Cindy Renkas	14
University of South Florida College of Marine Science	Clam Bayou Education Center, St. Petersburg, FL	Follow-up	3/17/07	Beth Day-Miller	16
University of South Florida College of Marine Science (2)	Clam Bayou Education Center, St. Petersburg, FL	Intro – pre (revised)	4/21/07	No information provided	18
University of South Florida College of Marine Science (2)	Clam Bayou Education Center, St. Petersburg, FL	Intro – post (revised)	4/21/07	Charlene Dindo	19
University of South Florida College of Marine Science	Clam Bayou Education Center, St. Petersburg, FL	Follow-up	9/22/07	Cindy Renkas	21
Waikiki Aquarium (1)	Waikiki, HI	Intro – pre (revised)	2/18/06	No information provided	27
Waikiki Aquarium (1)	Waikiki, HI	Intro – post (revised)	2/18/06	Paula Keener-Chavis, Beth Jewell, Renee Carson	28

Green text indicates specialty PDI