



*Best Practices for Field Days*

## **Environmental Field Days Assessment Tool: Reliability Study**

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*Authors: Martin Storksdieck, Joe Heimlich, Cláudia Figueriredo, and Stephan P. Carlson*

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### **Introduction**

The Environmental Field Day Observation Tool (the Tool) was tested for reliability under two conditions: (1) As original Tool during the Sauk River Water Festival, a traditional Environmental Field Day in Minnesota; and (2) a modified version of the Tool, with fewer items, at the Marine Exploration Weekend, a special event for family visitors at the Pacific Science Center in Seattle, WA. The Sauk River Water Festival represents a traditional Field Day insofar as groups of students (representing a class of about 20 students with at least one teacher and normally one or more chaperones) move together from station to station. These groups can be observed together over the course of the Field Day. The Sauk Water Festival was held in the summer of 2008.

The Marine Exploration Weekend was a joint public event, held in the late spring of 2008 at the Pacific Science Center as part of an NSF-funded project to bring together scientists and other researchers with the public. This event was planned in collaboration with two local branches of the National Oceanic & Atmospheric Administration (NOAA) – Alaska Fisheries Science Center and National Marine Fisheries Service – and focused around the theme of “Marine Exploration Weekend.” More than 50 research scientists participated in this event and engaged the public in topics that included sonar and tsunami research, genetic identification of orcas, the hazards of marine debris, environmental conservation, and “fish guts.” The event took place over the course of an extended weekend, starting on a Thursday and lasting until Sunday. In contrast to the Water Festival, individuals and families were free to move around and stayed at individual stations as long as they wished. There was no set sequence to visiting stations. In contrast to the “nonformal” nature of the Water Festival experience, the Marine Exploration experience was truly free-choice or informal for visitors.

Reliability for the original and the modified Tool (as of spring 2008) was tested in both instances.

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## Methods

### *Sauk River Water Festival*

Individual observers who took part in the study were recruited and trained by the PI. Training consisted of a theoretical and a practical component during which the raters had an opportunity to practice the rating task and compare individual results. Training lasted for about four hours. Each of the stations was viewed simultaneously by two groups of five observers. Five stations were observed during Day 1 and six stations during Day 2. The Holistic Tool that judged the entire Field Day had 10 observers in two groups of five. Since the holistic observation results are closely tied to the individual station results, they are not being presented here.

### *Marine Exploration Weekend*

The Co-PI trained one informal education specialist (ILI staff) on the use of the modified Tool. The trained ILI staff member, in turn, trained science center staff and volunteers on the use of the Tool, providing opportunities for practice and comparing results during the first day of the event (Thursday). Including the ILI staff, six observers took part in the reliability testing at the Pacific Science Center. True to the nature of the event, individual raters were asked to move freely from station to station, repeatedly observing interactions between “presenters” and visitors before rating individual stations. The interrater result for each station was therefore calculated on the basis of uncoordinated observations, i.e., while the raters observed the same station, they did not do so during the same time (“non-linked”). During the third day of the event, four raters moved in unison and observed individual stations together (“linked” observations). These linked observations are equivalent to observations by individual groups of five observers at the Sauk Water Festival. Note that the non-linked observation during the Marine Exploration Weekend should exhibit lower reliability than the linked observations.

### *Calculating Interrater Reliability*

Initially, interrater reliability was to be calculated using Fleiss Kappa. However, Kappa requires a constant number of observers, which could not be guaranteed. We used a modified version of Kappa, based on a “distance” score for each individual observation from the most common observation. These distance scores were then added and divided by the number of observers to make scores comparable between groups of observations based on different numbers of observers.

$$K = \frac{\sum_{i=1}^n (d_i)}{n}$$

with  $d_i$  = Distance for individual observation score on each item and  
 $n$  = the number of observers.

Distance was assessed based on the assumption that differences in assessment should be judged on the degree with which individual raters disagreed; that is, if one rater judged that an item was “done” and another judged it was “partially done”, the difference between raters was seen as smaller than if one rater judged the item as “done” and the other as “not done.” The rater expressions were placed in sequence and the difference simply calculated as categorical distance. Table 1 provides examples of the scoring procedure, based on four or five observers and a scoring rubric for an item that included four expressions: Not needed, Not Done, Partially Done and Done. The four rubrics were placed along a logical sequence. Distance scores were calculated from the mode, added for all observers, and divided by the number of observers. If multiple modes exist, the mode that will lead to the lowest distance score is used.

**Example A:**

The mode is represented by the rubric "Done." One observer observed one distance from the mode (Partially Done) and received an individual distance score of 1. One observer observed two distances from the mode (Not Done) for an individual score of 2, and one observer observed three distances from the mode (Not Needed) for an individual score of 3. Two observers scored the mode for individual distances of 0. The total distance score for the 5 observers is therefore two times zero, plus 1, plus 2, plus 3 = 6. To calculate the average distance score, the total score is divided by the number of observers (n=5) and results in  $K=1.2$ .

**Example C:**

Mode="Done". Two scorers with a distance of 2 (Not Done) for a total score of 2 times 2 = 4 and an average score of  $K=4/5=0.8$ .

**Table 1:** Scoring Example

Example	Not Needed	Not Done	Partially Done	Done	N	Total Score	Average Score
A	1	1	1	2	5	6	1.2
B	0	0	1	4	5	1	0.2
C	0	2	0	3	5	4	0.8
D	0	2	0	2	4	4	1

The maximum score possible for this type of distance measure depends on the number of observers and the maximum distance (based on the maximum number of rubrics). Table 2 summarizes the maximum distance scores for a rubric that allows for four expressions. The maximum average score approaches 1.5. At this stage, we did not normalize the scores.

**Table 2:** Maximum Scores for 4 Rubrics

Number of observers	2	3	4	5	6	7	8	9
Maximum distance for each group of observers for four codes	3	5	6	8	9	11	12	14
Maximum Average Score	1.5	1.67	1.5	1.6	1.5	1.57	1.5	1.56

For the purpose of judging interrater reliability, we compared average distance scores between items and assumed the following qualities for the scores:

- K < 0.3            good
- K = 0.31-0.5    acceptable
- K = 0.51-0.7    problematic
- K > 0.7            not satisfactory

After analysis, problematic or unsatisfactory items were either removed or reworded.

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## Results *Sauk River Water Festival*

Table 3 on the following two pages summarizes the results for the Sauk Water Festival. Only three items exhibited poor reliability of  $K>0.6$ . However, a variety of items revealed K values between 0.3 and 0.5. Some of the interrater reliability can be improved with training.

**Table 3:** Reliability Result Summary for the Sauk River Water Festival

Items	Group 1						Group 2						Total	
	G1/S1	G1/S2	G1/S4	G1/S5	G1/S6	G1/S6	G2/S1	G2/S2	G2/S3	G2/S4	G2/S5	G2/S6	Mean	SD
3. Did it match scheduled time?	0.00	0.00	0.00	1.00	0.67	0.00	0.50	0.60	0.40	0.40	0.40	0.40	0.33	0.47
7. Presenter welcomed participants positively	0.60	0.20	0.00	0.20	0.00	0.00	0.00	0.40	0.80	0.60	0.00	0.60	0.20	0.24
8. Presenter introduced self clearly	0.40	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.40	0.00	0.20	0.20	0.16	0.17
9. Presenter stated upcoming activities for the training clearly	0.40	0.20	0.00	0.50	0.00	0.00	0.25	0.20	1.00	0.60	0.40	0.20	0.22	0.23
10. Presenter asked questions that revealed participants' knowledge	1.00	0.20	0.20	0.25	0.60	0.00	0.20	0.00	0.00	0.60	0.40	0.00	0.45	0.35
11. Presenter provided a clear advance organizer	0.00	0.40	1.00	0.00	0.00	0.00	0.50	0.40	0.80	0.40	0.80	0.80	0.28	0.44
12. Presenter gave equal attention to all participants	0.20	0.00	0.00	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.20
13. Presenter kept participants focused on activities most of the time	0.20	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.11	0.15
14. Presenter used appropriate language (clearly defining new terms when necessary)	0.25	0.00	0.00	0.40	0.00	0.00	0.60	0.20	0.60	0.00	0.00	0.00	0.13	0.19
15. Presenter presented content information appropriate for participants' knowledge and ability	0.40	0.00	0.00	0.25	0.00	0.00	0.20	0.40	0.40	0.00	0.00	0.20	0.13	0.19
16. Presenter provided clear instructions when necessary	0.60	0.20	0.00	0.50	0.00	0.00	0.20	0.80	0.40	0.20	0.20	1.00	0.26	0.28
17. Presenter demonstrated enthusiastic/engaging behavior throughout	0.20	0.00	0.00	0.20	0.00	0.00	0.00	0.20	0.00	0.00	0.20	0.00	0.08	0.11
18. Presenter was seen and heard by all participants nearly all the time	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.18
19. Presenter used questions that allowed participants to voice what they already knew or just learned (i.e., recall questions)	0.60	0.00	0.40	0.80	0.80	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.52	0.33
20. Presenter used questions that challenged participants to apply knowledge to new situations and/or made them think critically about an issue	1.00	0.00	0.50	0.25	0.60	0.00	0.00	0.80	0.40	0.00	0.40	0.40	0.47	0.38
													0.33	0.29
													0.40	0.33

Items	Group 1						Group 2						Group 1		Group 2		Total	
	G1/S1	G1/S2	G1/S4	G1/S5	G1/S6	G1/S6	G2/S1	G2/S2	G2/S3	G2/S4	G2/S5	G2/S6	Mean	SD	Mean	SD	Mean	SD
21. Presenter consistently waited 3+ seconds after asking questions before calling on participants	1.00	1.00	0.80	0.50	1.00		0.20	0.60	0.80	0.40	0.40	0.60	0.86	0.22	0.50	0.27	0.66	0.28
22. Presenter allowed participant questions to influence the direction of the learning experience	0.60	0.75	0.00	0.40	0.25		0.80	1.00	0.80	0.60	0.80	0.80	0.40	0.29	0.80	0.24	0.62	0.29
23. Presenter described how the station topic connected to the overall field day theme	0.80	0.60	0.80	0.00	0.00		0.60	0.60	0.80	0.80	0.80	0.80	0.44	0.41	0.73	0.29	0.60	0.31
24. Presenter described a link or connection to other stations in the field day	0.60	0.00	0.00	0.00	0.20		0.20	0.40	0.80	0.60	0.40	0.80	0.16	0.26	0.53	0.25	0.36	0.31
25. Presenter described the relationship between the station's objectives and the lives of participants (i.e., relate the topic to the audience)	0.60	0.00	0.80	0.20	0.00		0.60	0.80	0.00	0.00	0.60	0.00	0.32	0.36	0.33	0.36	0.33	0.35
26. Presenter summarized the key points of the presentation	0.20	0.40	0.40	0.00	0.20		0.60	0.00	0.00	0.60	0.40	0.40	0.24	0.17	0.30	0.25	0.27	0.22
27. Teaching Strategies: Mark all items below that you clearly observed during the session	0.43	0.56	0.00	0.20	0.00		0.67	0.40	0.38	1.00	1.40	0.29	0.24	0.25	0.69	0.47	0.48	0.42
28. Audience Engagement: During nearly all of the session _____ participants listened attentively when expected	0.20	0.00	0.00	0.40	0.00		0.00	0.00	0.40	0.20	0.20	0.00	0.12	0.18	0.13	0.16	0.13	0.16
29. Audience Engagement: During nearly all of the session _____ participants participated fully when expected	0.00	0.00	0.00	0.20	0.00		0.00	0.20	0.60	0.20	0.20	0.00	0.04	0.09	0.20	0.21	0.13	0.18
30. Audience Engagement: During nearly all of the session _____ participants showed excitement and enthusiasm	0.20	0.00	0.20	0.40	0.00		0.00	0.20	0.40	0.40	0.20	0.00	0.16	0.17	0.20	0.18	0.18	0.17
32. Was there an apparent big idea/issue/theme this station addressed?	0.00	0.00	0.00	0.20	0.00		0.00	0.40	0.20	0.00	0.00	0.00	0.04	0.09	0.10	0.16	0.07	0.13
35. Did the station end at the scheduled time?	0.75	0.00	0.50	0.25	0.00		0.80	0.00	0.80	0.40	0.80	0.20	0.30	0.33	0.50	0.37	0.41	0.34
<b>Mean</b>	<b>0.42</b>	<b>0.17</b>	<b>0.21</b>	<b>0.32</b>	<b>0.17</b>		<b>0.26</b>	<b>0.32</b>	<b>0.44</b>	<b>0.28</b>	<b>0.36</b>	<b>0.29</b>	<b>0.26</b>	<b>0.11</b>	<b>0.33</b>	<b>0.07</b>	<b>0.29</b>	<b>0.09</b>

## Results *Marine Exploration Weekend*

The following tables 4 through 17 summarize the results for the modified Tool used at the Pacific Science Center. Results are presented as part of the Tool (Presentation Strategy, Teaching Strategy, Audience Engagement and Way-finding – Tables 4 through 7). The Tables distinguish between linked and non-linked observations. As expected, linked observations tend to have lower distance scores. Tables 8 through 17 summarize the results across individual stations and by observation date. Overall, reliability was high, and items performed similarly to the Sauk River Water Festival.

### **Presentation Strategy Items**

**Table 4:** Distance Scores, across Stations (Linked and Not-Linked)

<b>PRESENTATION</b>	<b>Linked</b>		<b>Not-Linked</b>	
	<b>Mean</b>	<b>St Dev</b>	<b>Mean</b>	<b>St Dev</b>
<b>Beginning: Presenter(s)...</b>				
... welcomed participants positively	0.08	0.14	0.33	0.26
... introduced self clearly	0.08	0.17	0.17	0.19
... stated upcoming activities clearly	0.18	0.19	0.50	0.22
... asked questions that revealed participants' knowledge	0.39	0.29	0.47	0.24
... provided a clear advance organizer	0.10	0.18	0.24	0.19
<b>Throughout the Station: Presenter(s)...</b>				
... gave equal attention to all participants	0.25	0.18	0.26	0.31
... kept nearly all participants focused on activities most of the time	0.23	0.22	0.22	0.20
... used appropriate language (clearly defining new terms when necessary)	0.14	0.14	0.14	0.15
... presented content information appropriate for participants' knowledge and ability	0.19	0.20	0.16	0.16
... provided clear instructions when necessary	0.42	0.45	0.48	0.45
... demonstrated enthusiastic/engaging behavior throughout	0.17	0.18	0.21	0.21
... was seen and heard by all participants nearly all the time	0.15	0.19	0.16	0.17
... used questions that allowed participants to voice what they already knew or just learned (i.e., recall questions)	0.31	0.29	0.50	0.35
... used questions that challenged participants to apply knowledge to new situations and/or made them think critically about an issue	0.19	0.20	0.41	0.34
... waited 3+ seconds after asking questions before calling on participants	0.76	0.24	0.76	0.57
... allowed participant questions to influence the direction of the learning experience	0.40	0.16	0.55	0.31
<b>By the End: Presenter(s)...</b>				
... described the relationship between the station objectives and the lives of participants (i.e., relate the topic to the audience)	0.18	0.32	0.40	0.31
... summarized the key points of the presentation	0.30	0.29	0.54	0.30

## Teaching Strategy Items

**Table 5:** Teaching Strategies Scores, across Stations (Linked and Not-Linked)

<b>TEACHING STRATEGIES</b>	<b>Linked</b>		<b>Not-Linked</b>	
	<b>Mean</b>	<b>St Dev</b>	<b>Mean</b>	<b>St Dev</b>
<b>Lecture</b> (Presenter delivered information to participants; includes visual aids and questions & answers)	0.08	0.14	0.29	0.17
<b>Demonstration</b> (Presenter used demonstrations, models, and props to illustrate concepts and processes)	0.10	0.18	0.29	0.15
<b>Discussion</b> (Participants shared ideas, thoughts, opinions, debates, etc., with each other and presenter)	0.16	0.13	0.24	0.13
<b>Guided Discovery</b> (Participants engaged in exploration outlined by presenter; includes games, role plays, simulations, structured experiments, etc.)	0.13	0.15	0.15	0.20
<b>Open Inquiry</b> (Participants determine the direction of investigation and learning by defining questions, methods, topic exploration, and interpretation of activity supported by presenter)	0.15	0.15	0.22	0.13

## Audience Engagement Items

**Table 6:** Audience Engagement Scores, across Stations (Linked and Not-Linked)

<b>AUDIENCE ENGAGEMENT</b>	<b>Linked</b>		<b>Not-Linked</b>	
	<b>Mean</b>	<b>St Dev</b>	<b>Mean</b>	<b>St Dev</b>
... listened attentively when expected	0.17	0.18	0.21	0.17
... participated fully when expected	0.20	0.13	0.16	0.18
... showed excitement and enthusiasm	0.26	0.26	0.31	0.16
... asked questions of the presenter	0.28	0.27	0.32	0.20

## Way-finding Items

**Table 7:** Way-finding, across Observation Dates (Linked and Not-Linked)

<b>WAY FINDING</b>	<b>Linked</b>	<b>Not-Linked</b>		<b>Total</b>	
	<b>5/17/08</b>	<b>Mean</b>	<b>St Dev</b>	<b>Mean</b>	<b>St Dev</b>
Front-desk or ticket desk announced/explained event	0.00	0.11	0.19	0.08	0.17
Event signs outside	0.00	0.11	0.19	0.08	0.17
Directional signs (arrows, pointers, etc.)	0.50	0.44	0.38	0.46	0.32
Station markers (#1, etc., with a name or symbol)	0.00	0.00	0.00	0.00	0.00
Site map (paper or brochure)	0.25	0.22	0.19	0.23	0.16
Site floor staff available to assist	0.00	0.07	0.12	0.05	0.10

**Table 8:** Presentation Scores, across Stations (Linked)

PRESENTATION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Mean	StDev
<b>Beginning: Presenter(s)...</b>																	
... welcomed participants positively	0.00	0.00	0.00	0.00	0.33	0.33	0.33	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.14
... introduced self clearly	0.00	0.00	0.50	0.50	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.17
... stated upcoming activities clearly	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.50	0.33	0.33	0.00	0.33	0.33	0.25	0.18	0.19	0.29
... asked questions that revealed participants' knowledge	0.50	0.75	0.00	0.00	0.00	0.00	0.50	0.00	0.33	0.33	0.33	0.75	0.67	0.50	0.39	0.29	0.29
... provided a clear advance organizer	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.25	0.10	0.18	0.18
<b>Throughout the Station: Presenter(s)...</b>																	
... gave equal attention to all participants	0.50	0.25	0.00	0.00	0.33	0.33	0.33	0.50	0.00	0.00	0.25	0.00	0.25	0.33	0.25	0.25	0.18
... kept nearly all participants focused on activities most of the time	0.50	0.25	0.00	0.00	0.67	0.33	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.25	0.23	0.22	0.22
... used appropriate language (clearly defining new terms when necessary)	0.25	0.00	0.25	0.25	0.00	0.00	0.33	0.25	0.00	0.00	0.00	0.00	0.25	0.25	0.14	0.14	0.14
... presented content information appropriate for participants' knowledge and ability	0.50	0.00	0.25	0.25	0.00	0.00	0.33	0.25	0.50	0.50	0.00	0.25	0.00	0.00	0.19	0.20	0.20
... provided clear instructions when necessary	0.50	0.50	0.00	0.00	1.00	0.67	0.00	0.00	0.67	0.00	0.00	0.00	1.25	0.00	0.42	0.45	0.45
... demonstrated enthusiastic/engaging behavior throughout	0.25	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.25	0.25	0.50	0.25	0.00	0.00	0.17	0.18	0.18
... was seen and heard by all participants nearly all the time	0.25	0.00	0.00	0.00	0.33	0.33	0.33	0.50	0.00	0.00	0.00	0.00	0.25	0.00	0.15	0.19	0.19
... used questions that allowed participants to voice what they already knew or just learned (i.e., recall questions)	0.25	0.50	0.25	0.25	0.33	0.00	0.00	0.00	0.33	0.33	0.50	0.00	0.25	1.00	0.31	0.29	0.29
... used questions that challenged participants to apply knowledge to new situations and/or made them think critically about an issue	0.25	0.25	0.50	0.50	0.33	0.00	0.00	0.00	0.00	0.00	0.50	0.25	0.00	0.00	0.19	0.20	0.20
... waited 3+ seconds after asking questions before calling on participants	1.00	1.00	1.00	1.00	0.67	0.67	0.25	0.25	0.75	0.75	0.75	0.75	0.50	1.00	0.76	0.24	0.24
... allowed participant questions to influence the direction of the learning experience	0.50	0.25	0.50	0.50	0.33	0.33	0.25	0.25	0.25	0.25	0.25	0.50	0.50	0.75	0.40	0.16	0.16
<b>By the End: Presenter(s)...</b>																	
... described the relationship between the station objectives and the lives of participants (i.e., relate the topic to the audience)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25	0.25	0.25	1.00	0.00	0.18	0.32	0.32
... summarized the key points of the presentation	0.00	0.50	0.25	0.25	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.75	0.75	0.50	0.30	0.29	0.29
<b>Mean</b>	0.29	0.28	0.19	0.19	0.28	0.25	0.17	0.17	0.25	0.25	0.24	0.21	0.33	0.28	0.30	0.29	0.29

Key:

- A. Aquatic Acoustics
- B. Build an Invertebrate
- C. Fish Detectives
- D. Fish Fetch
- E. Meet the Megafauna A and B
- F. Meet the Megafauna A - Bones, genetics
- G. Meet the Megafauna B - sounds
- H. Nifty Net Casting
- I. Restoring Puget Sound
- J. Something Fishy
- K. Talkin' Trash A - Beach debris, nets
- L. Talkin' Trash B - oil spill
- M. Tsunami Simulator
- N. Who Wants to be a Predator?
- O. Why do Salmon Need Trees?

**Table 9:** Presentation Scores, across Stations (Not-Linked)

PRESENTATION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Mean	StDev
<b>Beginning: Presenter(s)...</b>																	
... welcomed participants positively	0.33	0.00	0.56	0.09	0.75	0.33	0.00	0.00	0.33	0.56	0.25	0.80	0.33		0.22	0.33	0.26
... introduced self clearly	0.00	0.00	0.11	0.64	0.14	0.33	0.00	0.33	0.00	0.00	0.13	0.20	0.33		0.11	0.17	0.19
... stated upcoming activities clearly	0.63	0.33	0.67	0.36	0.57	0.33	0.33	1.00	0.33	0.44	0.75	0.40	0.67		0.22	0.50	0.22
... asked questions that revealed participants' knowledge	0.78	0.33	0.78	0.73	0.38	0.33	0.33	0.00	0.67	0.67	0.38	0.60	0.33		0.22	0.47	0.24
... provided a clear advance organizer	0.22	0.00	0.00	0.20	0.13	0.33	0.00	0.33	0.33	0.00	0.38	0.60	0.33		0.44	0.24	0.19
<b>Throughout the Station: Presenter(s)...</b>																	
... gave equal attention to all participants	0.00	0.33	0.56	0.00	0.89	0.00	0.00	0.67	0.00	0.33	0.13	0.00	0.67		0.11	0.26	0.31
... kept nearly all participants focused on activities most of the time	0.22	0.33	0.56	0.27	0.56	0.33	0.00	0.33	0.00	0.33	0.13	0.00	0.00		0.00	0.22	0.20
... used appropriate language (clearly defining new terms when necessary)	0.33	0.33	0.00	0.27	0.11	0.00	0.00	0.33	0.00	0.22	0.00	0.00	0.33		0.00	0.14	0.15
... presented content information appropriate for participants' knowledge and ability	0.22	0.33	0.11	0.36	0.25	0.00	0.00	0.33	0.33	0.29	0.00	0.00	0.00		0.00	0.16	0.16
... provided clear instructions when necessary	0.67	0.33	0.44	0.09	1.38	1.00	0.00	0.00	0.33	1.00	0.43	0.00	1.00		0.11	0.48	0.45
... demonstrated enthusiastic/engaging behavior throughout	0.33	0.00	0.44	0.00	0.67	0.00	0.33	0.00	0.33	0.33	0.25	0.20	0.00		0.00	0.21	0.21
... was seen and heard by all participants nearly all the time	0.00	0.33	0.22	0.36	0.50	0.00	0.00	0.00	0.33	0.22	0.13	0.00	0.00		0.11	0.16	0.17
... used questions that allowed participants to voice what they already knew or just learned (i.e., recall questions)	0.78	0.00	0.56	1.09	1.00	0.33	0.33	0.00	0.33	0.13	0.63	0.80	0.67		0.33	0.50	0.35
... used questions that challenged participants to apply knowledge to new situations and/or made them think critically about an issue	0.50	0.33	0.11	0.45	0.71	0.00	0.00	0.00	1.00	0.13	0.50	0.40	1.00		0.56	0.41	0.34
... waited 3+ seconds after asking questions before calling on participants	0.56	0.00	0.67	1.36	1.29	0.33	0.00	0.00	1.67	0.38	0.71	1.40	1.00		1.25	0.76	0.57
... allowed participant questions to influence the direction of the learning experience	0.56	0.33	0.50	0.82	0.44	0.00	1.00	0.67	0.33	0.50	0.25	1.00	0.33		1.00	0.55	0.31
<b>By the End: Presenter(s)...</b>																	
... described the relationship between the station objectives and the lives of participants (i.e., relate topic to the audience)	0.56	0.00	0.22	0.64	0.38	0.67	0.00	0.00	0.67	0.00	0.63	0.80	0.33		0.78	0.40	0.31
... summarized the key points of the presentation	0.44	0.67	0.44	1.00	0.50	0.33	1.00	0.33	0.67	0.00	0.86	0.20	0.33		0.78	0.54	0.30
<b>Mean</b>	0.40	0.22	0.39	0.49	0.59	0.26	0.19	0.24	0.43	0.31	0.36	0.41	0.43		0.35		

Key:

- A. Aquatic Acoustics
- B. Build an Invertebrate
- C. Fish Detectives
- D. Fish Fetch
- E. Meet the Megafauna A and B
- F. Meet the Megafauna A - Bones, genetics
- G. Meet the Megafauna B - sounds
- H. Nifty Net Casting
- I. Restoring Puget Sound
- J. Something Fishy
- K. Talkin' Trash A - Beach debris, nets
- L. Talkin' Trash B - oil spill
- M. Tsunami Simulator
- N. Who Wants to be a Predator?
- O. Why do Salmon Need Trees?

**Table 10:** Presentation Scores, across Observation Dates (Linked and Not-Linked)

PRESENTATION	Linked		Not-Linked			Total		
	5/17/08	5/15/08	5/16/08	5/18/08	Mean	St Dev	Mean	Std Dev
<b>Beginning: Presenter(s)...</b>								
... welcomed participants positively	0.18	0.39	0.53	0.18	0.36	0.17	0.32	0.17
... introduced self clearly	0.42	0.56	0.05	0.21	0.28	0.26	0.31	0.23
... stated upcoming activities clearly	0.59	0.72	0.95	0.93	0.87	0.12	0.80	0.17
... asked questions that revealed participants' knowledge	0.81	0.67	0.80	0.54	0.67	0.13	0.70	0.13
... provided a clear advance organizer	0.21	0.78	0.21	0.37	0.45	0.29	0.39	0.27
<b>Throughout the Station: Presenter(s)...</b>								
... gave equal attention to all participants	0.41	0.42	0.20	0.18	0.27	0.13	0.30	0.13
... kept nearly all participants focused on activities most of the time	0.33	0.47	0.38	0.29	0.38	0.09	0.37	0.08
... used appropriate language (clearly defining new terms when necessary)	0.19	0.11	0.13	0.21	0.15	0.06	0.16	0.05
... presented content information appropriate for participants' knowledge and ability	0.38	0.12	0.21	0.18	0.17	0.04	0.22	0.11
... provided clear instructions when necessary	0.34	0.39	0.38	0.52	0.43	0.08	0.41	0.08
... demonstrated enthusiastic/engaging behavior throughout	0.21	0.26	0.45	0.21	0.31	0.12	0.29	0.11
... was seen and heard by all participants nearly all the time	0.29	0.28	0.23	0.07	0.19	0.11	0.21	0.10
... used questions that allowed participants to voice what they already knew or just learned (i.e., recall questions)	0.73	0.71	1.00	0.68	0.79	0.18	0.78	0.15
... used questions that challenged participants to apply knowledge to new situations and/or made them think critically about an issue	0.59	0.88	0.92	0.36	0.72	0.31	0.69	0.27
... waited 3+ seconds after asking questions before calling on participants	1.36	1.40	1.31	0.69	1.13	0.38	1.19	0.33
... allowed participant questions to influence the direction of the learning experience	0.88	0.72	0.69	0.78	0.73	0.04	0.77	0.08
<b>By the End: Presenter(s)...</b>								
... described the relationship between the station objectives and the lives of participants (i.e., relate the topic to the audience)	0.33	0.94	0.63	0.74	0.77	0.16	0.66	0.25
... summarized the key points of the presentation	0.40	0.88	0.74	0.89	0.84	0.08	0.73	0.23
<b>Mean</b>	0.50	0.61	0.54	0.46				

Key:

A. Aquatic Acoustics  
 B. Build an Invertebrate  
 C. Fish Detectives

D. Fish Fetch  
 E. Meet the Megafauna A and B  
 F. Meet the Megafauna A - Bones, genetics

G. Meet the Megafauna B - sounds  
 H. Nifty Net Casting  
 I. Restoring Puget Sound

J. Something Fishy  
 K. Talkin' Trash A - Beach debris, nets  
 L. Talkin' Trash B - oil spill

**Table 11:** Teaching Strategies Scores, across Stations (Linked)

<b>TEACHING STRATEGIES</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>	<b>Mean</b>	<b>St Dev</b>
<b>Lecture</b> (Presenter delivered information to participants; includes visual aids and questions & answers)	0.00	0.00	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.08	0.14
<b>Demonstration</b> (Presenter used demonstrations, models, and props to illustrate concepts and processes)	0.00	0.00	0.00	0.00	0.33	0.33	0.00	0.25	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.10	0.18
<b>Discussion</b> (Participants shared ideas, thoughts, opinions, debates, etc., with each other and presenter)	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.16	0.13
<b>Guided Discovery</b> (Participants engaged in exploration outlined by presenter; includes games, role plays, simulations, structured experiments, etc.)	0.25	0.25	0.00	0.00	0.33	0.33	0.33	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.13	0.15
<b>Open Inquiry</b> (Participants determine the direction of investigation and learning by defining questions, methods, topic exploration, and interpretation of activity supported by presenter)	0.25	0.25	0.00	0.00	0.33	0.33	0.33	0.00	0.25	0.25	0.00	0.00	0.25	0.00	0.00	0.15	0.15
<b>Mean</b>	0.10	0.15	0.05	0.05	0.27	0.20	0.05	0.10	0.10	0.25	0.05	0.05	0.10	0.10	0.05		

**Table 12:** Teaching Strategies Scores, across Stations (Not-Linked)

<b>TEACHING STRATEGIES</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>	<b>Mean</b>	<b>St Dev</b>
<b>Lecture</b> (Presenter delivered information to participants; includes visual aids and questions & answers)	0.44	0.00	0.44	0.27	0.33	0.33	0.33	0.33	0.33	0.44	0.50	0.00	0.00	0.00	0.22	0.29	0.17
<b>Demonstration</b> (Presenter used demonstrations, models, and props to illustrate concepts and processes)	0.11	0.00	0.33	0.27	0.44	0.33	0.33	0.33	0.33	0.44	0.38	0.40	0.00	0.00	0.33	0.29	0.15
<b>Discussion</b> (Participants shared ideas, thoughts, opinions, debates, etc., with each other and presenter)	0.11	0.33	0.11	0.09	0.22	0.33	0.33	0.00	0.33	0.11	0.38	0.40	0.33	0.33	0.33	0.24	0.13
<b>Guided Discovery</b> (Participants engaged in exploration outlined by presenter; includes games, role plays, simulations, structured experiments, etc.)	0.22	0.00	0.44	0.00	0.44	0.33	0.00	0.00	0.00	0.22	0.50	0.00	0.00	0.00	0.00	0.15	0.20
<b>Open Inquiry</b> (Participants determine the direction of investigation and learning by defining questions, methods, topic exploration, and interpretation of activity supported by presenter)	0.11	0.33	0.33	0.00	0.22	0.33	0.33	0.33	0.33	0.22	0.13	0.00	0.33	0.11	0.22	0.22	0.13
<b>Mean</b>	0.20	0.13	0.33	0.13	0.33	0.33	0.27	0.20	0.27	0.29	0.38	0.16	0.13	0.13	0.20		

**Table 13:** Teaching Strategies Scores, across Observation Dates (Linked and Not-Linked)

TEACHING STRATEGIES	Linked		Not-Linked				Total	
	5/17/08	5/15/08	5/16/08	5/18/08	Mean	St Dev	Mean	St dev
<b>Lecture</b> (Presenter delivered information to participants; includes visual aids and questions & answers)	0.50	0.42	0.33	0.29	0.34	0.07	0.38	0.10
<b>Demonstration</b> (Presenter used demonstrations, models, and props to illustrate concepts and processes)	0.33	0.42	0.45	0.36	0.41	0.05	0.39	0.05
<b>Discussion</b> (Participants shared ideas, thoughts, opinions, debates, etc., with each other and presenter)	0.26	0.26	0.23	0.25	0.25	0.02	0.25	0.02
<b>Guided Discovery</b> (Participants engaged in exploration outlined by presenter; includes games, role plays, simulations, structured experiments, etc.)	0.33	0.21	0.35	0.39	0.32	0.10	0.32	0.08
<b>Open Inquiry</b> (Participants determine the direction of investigation and learning by defining questions, methods, topic exploration, and interpretation of activity supported by presenter)	0.14	0.16	0.18	0.29	0.21	0.07	0.19	0.06
<b>Mean</b>	<b>0.31</b>	<b>0.29</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>			

Key:

A. Aquatic Acoustics  
 B. Build an Invertebrate  
 C. Fish Detectives

D. Fish Fetch  
 E. Meet the Megafauna A and B  
 F. Meet the Megafauna A - Bones, genetics

G. Meet the Megafauna B - sounds  
 H. Nifty Net Casting  
 I. Restoring Puget Sound

J. Something Fishy  
 K. Talkin' Trash A - Beach debris, nets  
 L. Talkin' Trash B - oil spill

M. Tsunami Simulator  
 N. Who Wants to be a Predator?  
 O. Why do Salmon Need Trees?

**Table 14:** Audience Engagement Scores, across Stations (Linked)

AUDIENCE ENGAGEMENT	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Mean	St Dev
... listened attentively when expected	0.00	0.00	0.25	0.25	0.33	0.33	0.33	0.00	0.50	0.25	0.25	0.00	0.00	0.25	0.25	0.17	0.18
... participated fully when expected	0.25	0.00	0.00	0.00	0.33	0.33	0.33	0.25	0.25	0.25	0.25	0.25	0.25	0.00	0.00	0.20	0.13
... showed excitement and enthusiasm	0.25	0.00	0.50	0.50	0.67	0.67	0.67	0.25	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.26	0.26
... asked questions of the presenter	0.25	0.25	0.00	0.00	0.67	0.67	0.67	0.25	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.28	0.27
<b>Mean</b>	0.19	0.06	0.19	0.19	0.50	0.50	0.19	0.19	0.25	0.19	0.19	0.19	0.19	0.06	0.06		

**Table 15:** Audience Engagement Scores, across Stations (Not-Linked)

AUDIENCE ENGAGEMENT	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Mean	St Dev
... listened attentively when expected	0.11	0.00	0.44	0.27	0.44	0.00	0.00	0.33	0.33	0.44	0.25	0.20	0.00	0.00	0.11	0.21	0.17
... participated fully when expected	0.11	0.00	0.44	0.09	0.44	0.00	0.33	0.00	0.33	0.33	0.13	0.00	0.00	0.00	0.00	0.16	0.18
... showed excitement and enthusiasm	0.25	0.33	0.44	0.27	0.44	0.33	0.33	0.00	0.33	0.56	0.50	0.20	0.33	0.00	0.00	0.31	0.16
... asked questions of the presenter	0.11	0.33	0.56	0.45	0.67	0.33	0.33	0.33	0.00	0.44	0.43	0.40	0.00	0.00	0.11	0.32	0.20
<b>Mean</b>	0.15	0.17	0.47	0.27	0.50	0.17	0.25	0.17	0.25	0.44	0.33	0.20	0.08	0.06	0.06		

**Table 16:** Audience Engagement Scores, across Observation Dates (Linked and Not-Linked)

<b>AUDIENCE ENGAGEMENT</b>	<b>Linked</b>		<b>Not-Linked</b>			<b>Total</b>		
	<b>5/17/08</b>	<b>5/15/08</b>	<b>5/16/08</b>	<b>5/18/08</b>	<b>Mean</b>	<b>St Dev</b>	<b>Mean</b>	<b>St Dev</b>
... listened attentively when expected	0.31	0.42	0.48	0.07	0.32	0.22	0.32	0.18
... participated fully when expected	0.31	0.26	0.33	0.07	0.22	0.13	0.24	0.12
... showed excitement and enthusiasm	0.43	0.53	0.56	0.39	0.49	0.09	0.48	0.08
... asked questions of the presenter	0.74	0.79	0.62	0.79	0.73	0.10	0.73	0.08
<b>Mean</b>	<b>0.45</b>	<b>0.50</b>	<b>0.49</b>	<b>0.33</b>				

**Table 17:** Way-finding, across Observation Dates (Linked and Not-Linked)

<b>WAY FINDING</b>	<b>Linked</b>		<b>Not-Linked</b>			<b>Total</b>		
	<b>5/17/08</b>	<b>5/15/08</b>	<b>5/16/08</b>	<b>5/18/08</b>	<b>Mean</b>	<b>St Dev</b>	<b>Mean</b>	<b>St dev</b>
Front-desk or ticket desk announced/explained event	0.00	0.00	0.00	0.33	0.11	0.19	0.08	0.17
Event signs outside	0.00	0.33	0.00	0.00	0.11	0.19	0.08	0.17
Directional signs (arrows, pointers, etc.)	0.50	0.67	0.00	0.67	0.44	0.38	0.46	0.32
Station markers (#1, etc., with a name or symbol)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Site map (paper or brochure)	0.25	0.00	0.33	0.33	0.22	0.19	0.23	0.16
Site floor staff available to assist	0.00	0.00	0.20	0.00	0.07	0.12	0.05	0.10
<b>Mean</b>	<b>0.13</b>	<b>0.17</b>	<b>0.09</b>	<b>0.22</b>				



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Edgewater, MD

**Joe E. Heimlich, Ph.D.**

Extension Faculty  
The Ohio State University

**Cláudia Figueiredo, Ph.D.**

**Stephan P. Carlson, Ph.D.**

Professor  
Environmental Science Education  
University of Minnesota Extension

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