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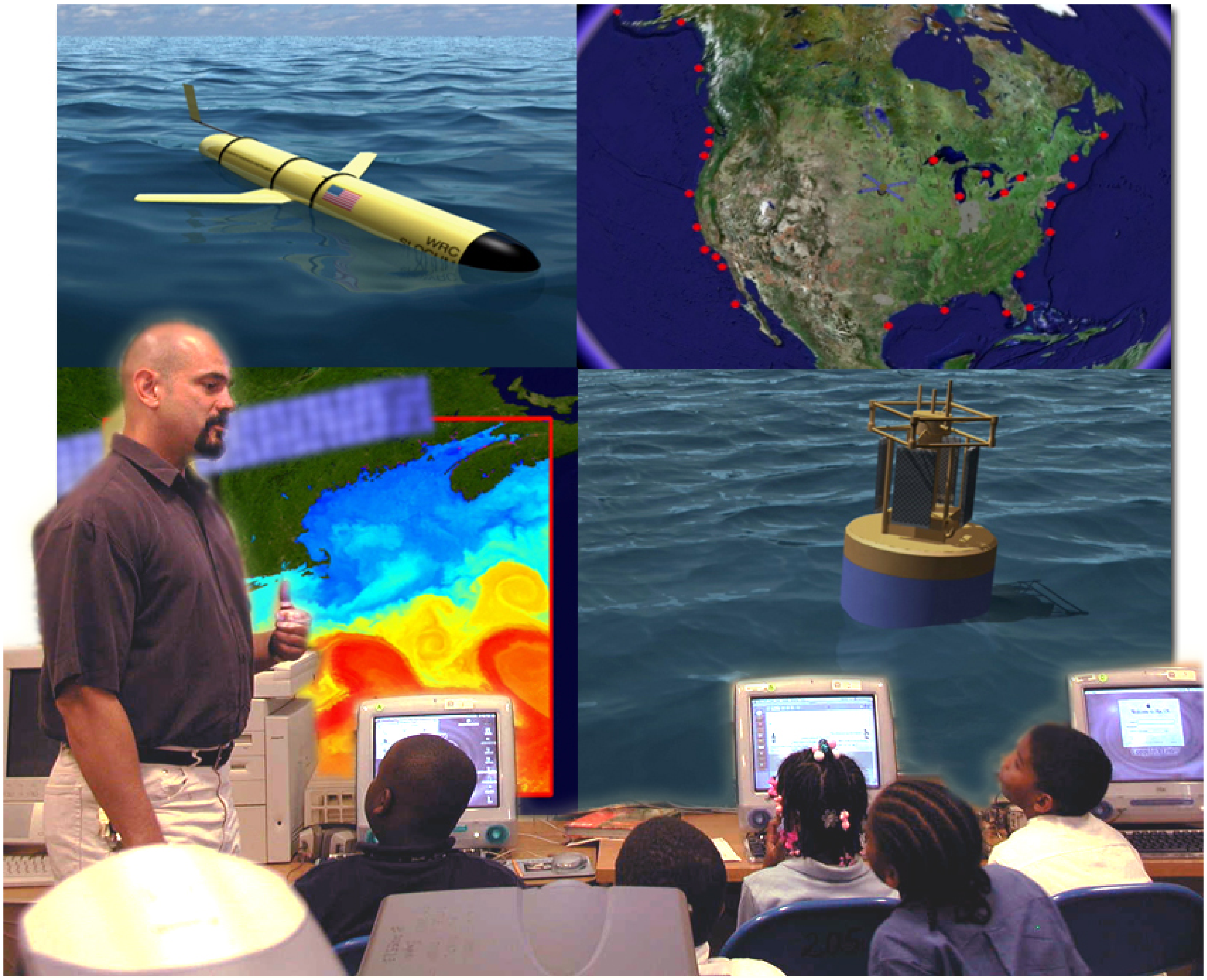

SWMP/IOOS Real-Time Data in K-12 Classrooms: A Front-end Evaluation

Final Report—Executive Summary
September 2006

by
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9/18/06
revised 11/1/06

This report was prepared for the NOAA/Estuarine Reserves Division
National Estuarine Research Reserve Association Cooperative Agreement (Grant # NA05NOS4191114)

Table of Contents ***page #***

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EXECUTIVE SUMMARY

This is a summary of the results and recommendations from a front-end evaluation project.
For all of this study's details and results, see the full report.

Study Overview

This front-end evaluation was designed to investigate the ways by which kindergarten through 12th-grade (K-12) teachers and students can use real-time data (RTD) and associated education products to understand and appreciate the role that the environment, in particular the ocean, plays in their lives.

For this project we defined real-time data as data that you can access as the data are being collected (or shortly thereafter) to study current conditions or events. (For some, this definition also applies to near-real-time data.) The interest in getting RTD into K-12 classrooms stems from the current national focus on the ocean and the changes occurring in ocean research. NOAA's NERRS (National Estuarine Research Reserve System) is uniquely positioned to support the use of real-time data by the education community. Through its water quality data stream (System-wide Monitoring Program or SWMP) and national network of educators, the NERRS will play an important role in NOAA's Ecosystem Goal Team and provide leadership in linking IOOS (Integrated Ocean Observing System) data to key user audiences.

This study focused on K-12 classrooms. We recognize that college & university teachers and students, coastal decision-makers, the general public and informal education institutions are all important audiences, but the goal here was to study one target group in depth, rather than studying many narrowly.

The vision for RTD use by the K-12 audience is to enable teachers to engage their students in exploring the ocean in real time right from their classrooms. The main question is: What do they need to do so? To answer that question NERRS (through the Jacques Cousteau NERR in New Jersey) collaborated with the National Marine Sanctuary Program, National Sea Grant College Program and the Centers for Ocean Science Excellence in Education (COSEE) to conduct this front-end evaluation.

The goals of this evaluation were to:

- identify the gap between SWMP/IOOS scientific data (current and projected) and the needs/capabilities of K-12 teachers and students to use those data, and
- to determine and recommend ways to bridge that gap via data visualization/ presentation and educational products/services.

The basis for this study's design was utilization-focused evaluation (Patton, 1997) and it employed a mix of traditional evaluation methods (interviews, focus groups and surveys) to gather qualitative and quantitative data from stakeholders and users (teachers). With these data we conducted a gap analysis (Weber, 1986) to answer the questions: Where are we now? and Where do we want to be? The results will aid NOAA/NERRS in designing and developing an education product that successfully addresses the gap between what stakeholders wish to accomplish and what teachers can use.

From January through July 2006, we gathered data from the education research community, SWMP/IOOS stakeholders and K-12 teachers from across the U.S. through the following methods:

- a review of peer-reviewed articles and published evaluation reports (literature review) on the use of environmental RTD in K-12 classrooms
- interviews and an online survey of stakeholders (that is, people with fiscal, decision-making or other significant influence) to determine the current status of SWMP/IOOS data and the vision for associated educational products
- teacher focus groups nationwide to determine needs and capabilities regarding RTD use
- prioritizing activity (prioritizing a list of 40 features for a RTD education product that resulted from the focus groups) with teachers and stakeholders at a spring 2006 follow-up meeting of the COSEE-Mid-Atlantic '05 teacher workshop and at the summer 2006 MBARI (Monterey Bay Aquarium Research Institute) EARTH teacher workshop.

We interviewed 11 stakeholders, mostly by telephone, with each interview lasting on average about an hour. For the online survey we sent an email to 60 people and received 27 responses (a response rate of 45%, which is higher than average for online surveys). For the prioritization activity, 16 stakeholders participated.

Ninety-two teachers representing 14 U.S. states, a range of grades (from elementary to high school) and a range of teaching experience with RTD (from no experience to weekly use) participated. We held 7 focus groups in 5 U.S. regions with 72 teachers from March through May 2006. For the prioritization activity, 25 teachers participated.

Study participants were a convenient sample selected by the local site coordinators following the criteria that teachers had to be using RTD with their students (although we actually got a range of RTD users). We chose this approach because we needed teachers familiar with using RTD to "concept test" an education product based on RTD. (In focus groups we found that teachers who were not using RTD were unable to provide feedback on what they needed). However, due to our selection criteria and sampling method, participants' views may not be representative of all U.S. teachers.

Discussion of Results: Literature Review

We reviewed more than 25 peer-reviewed articles and evaluation reports to answer the question: What resources/models/products/projects currently provide classroom teachers with real-time observatory data? Which ones have been proven (evaluated) to work? (The complete review is at http://marine.rutgers.edu/outreach/rtd/.) The key findings are:

- Lessons need to be flexible enough to adapt to user level, classroom time constraints and local phenomena, and be integrated into current teaching. Materials should be designed so that pieces can be removed and used by educators in other ways.

- Activities should encourage participation in multi-school communities (becoming a part of a larger community of science practitioners).

- Lessons should teach students why they are doing data collection and analysis, as well as what to do.

- Materials should be inquiry based, involve students in the full scientific process, and include hands-on activities.

- Lessons should be scaffolded so that at first there are more steps and guidance, but gradually they become more student-driven and open-ended.

- Visualization and modeling tools are essential to the development of RTD projects and they need to be specialized, refined or intermediary tools (different from those used by scientists) to support student learning.

- Teams that develop RTD lessons should be diverse and include expertise in science, technology, cognitive science, classroom teaching methods, and teacher professional development. Those partnerships should last long-term.

- Teachers are a critical link in the successful integration of RTD into the classroom curriculum, and so teacher preparedness, achieved through professional development, is essential.

Discussion of Results: Gap Analysis

During our gap analysis the main issues we explored based on the evaluation results were:

- target audience
- vision and goals
- content: data types/variables and sources
- product format & features
- barriers.

Target Audience

There seems to be general agreement between stakeholders and teachers regarding the target audiences for this project, and they are:

- middle-school students and teachers
- high-school students and teachers.

This study's results show a gap between stakeholders' views that high-school should be the primary target and teachers' views and other data that indicate that middle-school would be the better primary target, especially for NERRS. Although more high-school teachers attended the focus groups than middle-school teachers (56% vs. 43% respectively), in comparing the two groups' responses to the online survey we found that middle-school teachers were more likely to:

- have student use computers at school as part of their lessons
- have students use the Internet/websites at school as part of their lessons
- have students use real-time data (mostly student-collected data) as part of their lessons.

In addition, in the June 2003 report, *Inventory and Assessment of K-12 and Professional Teacher Development Programs in NERRS*, the most common audience was 6th to 8th grades (middle school) for both NERRS programs and teacher professional development. Thus there is already a wealth of experience among NERRS for working at the middle-school level.

A separate issue raised by a couple of stakeholders was how to accommodate under-served/ under-represented students, such as minorities, ESL students, students in schools with limited access to technology, etc. They didn't want these students overlooked when discussing the audience for RTD education product(s). Teachers also mentioned that some of their students had English language issues and that they had a range of ability levels in their classes. They did not, however, talk about any particular problems/issues with using RTD with diverse or special-needs students. Based on these results, we believe RTD lessons could work with all students and that products would have to be tailored to students' and teachers' needs. Based on the results of this study we cannot, however, answer the question of how to best meet those. That needs further study.

Vision & Goals

Interviewed stakeholders offered varied visions and goals on RTD in K-12 classrooms and for a RTD education product. From their statements there was no clear direction. Surveyed stakeholders were offered 11 goals (based on interviewee responses) and asked to choose what they thought should be the goal of education products based on RTD.

Their top choices were:

- connecting students with real-world science (92%)
- improving inquiry skills (92%)
- better understanding of estuarine/coastal ocean research (72%)
- better knowledge of the environment (72%).

When asked to prioritize by choosing a primary goal, their top choices were:

- connecting students to real-world science (28%)
- improving inquiry skills (24%)
- improving ocean literacy (20%).

In all focus group sessions teachers talked about why they use RTD in their teaching, why it is important despite the many obstacles they encounter. The most often mentioned reason was relevance—real-time data makes what happens in the classroom relevant to students' lives. It brings the real world into the classroom whether they're monitoring a schoolyard weather station, or testing and reporting on the water quality of a local pond, or tracking a hurricane. It also connects them to their future as citizens faced with questions requiring analysis in their roles as decision makers, voters, and possibly scientists. Connecting students to what's real was the main reason teachers used RTD in their lessons. This "real world" connection should be a key part of the vision and goals for education products based on RTD.

Content: The Data

Data Types

As part of our gap analysis, we asked stakeholders to indicate which RTD they thought teachers are most likely to use and we asked teachers which RTD they actually use. [Note: The list offered to both was largely based on the provisional IOOS core variables, pg. 20 in *First U.S. Integrated Ocean Observing System (IOOS) Development Plan*]. The table below shows the rankings of stakeholders' views on what teachers would use compared to what teachers actually use (based on percentage and sorted by teacher use).

Data Types	*Stakeholders Ranking: Teachers Likely to Use*	*Teachers Ranking: What Teachers Use*
temperature: water	1	1
temperature: air	3	2
pH	11	3
salinity	2	4
dissolved oxygen (DO)	4	5
currents	9	6
water quality	7	7
algal blooms	10	7
animal tagging/tracking	5	8
video/live camera	7	8
zooplankton species	13	8
waves	14	9
ocean color	18	10
turbidity (clarity/cloudiness)	8	11
nutrients	9	11
fish species & abundance	6	14
river discharge	10	15

Some of the rankings of data types closely match, but there are also some clear differences between teachers' use and stakeholders' views. The design/development of a RTD education product should, at least initially, be based on the data types that teachers use, which will make their use of the product more likely.

Data Sources

An issue encounter during this study that surprised us was that of student-collected vs. scientist/observatory-collected data. On the teacher pre-workshop surveys, 61% of teachers said they use RTD from the Internet and 52% use student-collected RTD (these are tallies of responses to an open-ended question about RTD use in the classroom). When comparing middle-school teacher responses to those of high-school teachers, more middle-school teachers use student-collected data than Internet data (61% vs. 57% respectively), where the reverse was true for high-school teachers (64% Internet data vs. 45% student-collected data).

In all of the focus groups, teachers talked about having their students collect their own data, mostly weather data or water-quality data. For those teachers this introduced students to the concept of data (unfamiliar to many at the middle-school level), got them involved in something hands-on, connected them to their local environment and in some cases to the community, and engaged them in science as a process. Several teachers expressed that student-collected data combined real-time and relevance.

Another data-source question raised during this study was the issue of local data versus national or other data, which was discussed in five of the seven focus groups. Middle-school teachers, in particular, felt it was important for students to understand first what data are, then become familiar with and understand local data. With that foundation, students could then use Internet-based local or national data for baseline or cross-site comparisons, for understanding broader systemwide concepts and issues, and/or for investigating issues that they can't investigate locally.

If NERRS is to focus on the middle-school audience initially, it's in the perfect position to provide teachers and students with opportunities for collecting data locally as well as offering local and national data sets for comparison. Whatever data types/streams or data source(s) become the basis of a RTD education product, it was clear from teachers' conversations with us that the data be relevant to their students, either to their lives (personal or virtual lives) or to the communities in which they live.

Product Format & Features

Stakeholders and teachers offered many of the same suggestions for the features of an idea RTD education product. Based on our conversations during this study we developed a list of nearly 40 features consistently mentioned by both groups *(see the full report for the complete list)*. During two prioritization sessions with stakeholders and teachers (one at a COSEE-Mid-Atlantic teacher meeting and the other at an MBARI EARTH summer teacher workshop), we were able to develop an "essentials" list.

The top features chosen by stakeholders were (not in any hierarchical order and presented as worded for the prioritization activity):

- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- inquiry-based lessons/activities for students
- lesson plans for teaching science concepts with real-time data
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected
- online [web] access to data sets
- real-time data projects for students
- stories or case studies that show how scientists use real-time data.

The top features common to both middle- and high-school teachers were (not in any hierarchical order):

- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- lesson plans for teaching science concepts with real-time data
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected
- tips on how to get started using real-time data in classroom with students.

Note: Features chosen differed depending on the grade level (for details see the full report).

For the most part, top features chosen by teachers matched those chosen by stakeholders. Because these choices were in the abstract, that is, based on a list rather than a real product, we asked focus group teachers to review two RTD websites (Eyes on the Bay and the CDMO NERRS data site) as models and provide feedback regarding what worked and what didn't about each. *(Note: this review occurred from March through May 2006 and so teachers' comments regarding those websites are for that time period and do not reflect any recent upgrades/changes.)*

Neither website met all their needs, although the Eyes on the Bay website was more positively reviewed as being closer to what they were looking for than the CDMO website. Generally, the features that met teachers' needs/desires were:

- page layouts that were simple, not too cluttered, with few words
- lots of visually based explanations (illustrations, pictures, graphics) and data visualizations, but simple in design
- local data sets (viewed as relevant) that could also be compared to places nationwide
- good easy-to-access explanations of content, parameters and terms
- intuitive navigation in and out
- data that are easy to get to—just a couple of clicks
- ease, flexibility when comparing data parameters
- easy to download data to Excel
- access to tabular data as well as data visualizations.

Design of the RTD education product should incorporate these features and those from the prioritization list at a minimum.

In all focus group discussions teachers talked about their limited time to teach all that's required and the limited time of a class period. To help them better manage their time they requested simplicity in design, limited text and lots of visuals (for quick absorption of information), quick and easy access to data, and lesson plans to teach concepts and/or interpret the data. The majority of teachers were fine with an Internet-based product as long as they could download data for teaching if they couldn't access the data when needed or for students to be able to manipulate. Very few teachers requested that RTD be provided on a CD or in print materials.

There were mixed views regarding the target (and therefore the design) of the online education product—should it be designed for teachers or for students? A few teachers wanted to be able to send their students directly to the site; others did not. Teachers offered no clear guidance on this issue. It seems to be a personal preference and/or depend on students' abilities.

An issue that was not available on either website but which came up in the focus group discussions was the need for different entry points for different levels of learners—from introductory (what is data?) to advanced (how-to use of data and what they mean). These multiple levels were appropriate for teachers and students. Teachers requested two to three entry levels, clearly identified as such.

During five of the focus groups teachers talked about connecting students with scientists. They were mostly interested in getting answers to questions, especially regarding what the data mean. However, during the prioritization sessions, this was not among the features in the "essential" category.

Some stakeholders and teachers mentioned the importance of viewing a RTD education product as part of a whole program that includes, ideally, all of the following:

- data collection at NERRS or other sites local to schools
- data use in the classroom (the RTD education product)
- training of classroom teachers: pre-service training, in-services, ongoing support
- training of NERRS Education Coordinators (ECs) on the use of RTD in NERRS education programs and on working with classroom teachers to help them integrate RTD into their teaching. *Note: training for ECs in teacher professional development was a recommendation in the June 2003 Inventory report cited earlier.*

Barriers & Challenges

Both stakeholders and teachers held similar views on the most common barriers and challenges. The primary barriers expressed by stakeholders were:

- funding/costs
- time
- developing an effective product and presenting data so that they're useful
- teachers' abilities and available time
- student access to technology
- testing/standards
- RTD viewed as an add-on, not integrated
- no clear vision for this product.

Teachers talked about all of these same issues. In almost all of the seven focus groups teachers mentioned testing and standards, in particular state standards. Most teachers agreed that lessons/activities aligned with national standards are not helpful; teachers need some way (keys, tables, etc.) to know how lessons/activities meet their particular state standards.

Further results from this study illustrated that this issue of standards/testing is actually the greatest barrier to a RTD education product. From our "Where do RTD fit?" activity during the focus group sessions, teachers showed us the disconnect between the potential for RTD in exciting students and teachers and connecting them to the real world vs. the reality of today's K-12 teaching environment with state standards and high-stakes testing.

On the RTD lesson planning/teaching process maps teachers indicated overwhelmingly that RTD must fit with (listed hierarchically):

- student interest (indicated on the map by 96%)

- science inquiry (94%)
- current events and science concepts (both 92%)
- student skills/science skills (88%)
- math skills (81%).

RTD did not fit as well with

- state standards (indicated on the map with 53%)
- curriculum & textbooks (43%)
- state tests (22%).

These results were for RTD that teachers are currently using. When we asked them to map SWMP/IOOS data, they fared even worse on those three items:

- state standards (indicated on the map with 43%)
- curriculum & textbooks (33%)
- state tests (15%).

And although teachers are acutely aware of standards and testing, many of the ones we talked to were passionate about using RTD to connect students with the world around them and so used creative ways to align the use of RTD with their standards/testing-based teaching. Given the realities of high-stakes testing (National Research Council, 1999), any RTD product needs to be designed to support what teachers currently have to teach/test and be integrated into what they do instead of as an add-on. In addition, if NOAA scientists and educators view RTD as the future for science, there needs to be work on the political front with science education reform to make changes in what teachers are required to teach/test and how they teach so that what they do matches how science is conducted.

Recommendations

Our recommendations are based on our results and are supported by the literature review.

Target Audience

- The K-12 target audience for RTD education product(s) should be middle-school and high-school students and teachers, and if prioritizing between those two, the first priority should be middle-school students and teachers.
- We believe RTD lessons could work with all students, including those under-served/under-represented, such as minorities, ESL students, students in schools with limited access to technology, etc. However, this study cannot answer the question of how to best meet the needs of these students and their teachers. That needs more study.

Vision & Goals

- RTD brings the real world into the classroom and it is the main reason teachers use RTD in their lessons. This "real world" connection should be a key part of the vision and goals for education products based on RTD.

The Content: Data

- The design/development of a RTD education product should, at least initially, be based on the data types that teachers currently use, which will make their use of the product more likely. The top ones teachers currently use are: temperature (air & water), pH, salinity, dissolved oxygen and currents.
- Student-collected data was an important part of RTD lessons for both middle-school and high-school classes, but more so for middle school. If data are provided, teachers are mostly interested in local data sets. Whatever data or sources are the bases of a RTD education product, it was clear from teachers' conversations that the data must be relevant to their students.

Product Format & Features

- The design of a RTD education product should incorporate these features at a minimum:
  - page layouts that are simple, not too cluttered, with few words
  - intuitive navigation in and out
  - data that are easy to get to—just a couple of clicks
  - lots of visually based explanations (illustrations, pictures, graphics) and data visualizations, but simple in design
  - good easy-to-access explanations of content, parameters and terms
  - map interface so users can find where real-time data are collected
  - lesson plans for teaching science concepts with real-time data
  - local data sets that could also be compared to places nationwide
  - data visualization tools (ability to graph, map and chart data)
  - ease, flexibility when comparing data parameters
  - access to tabular data as well as data visualizations
  - easy download to Excel or other spreadsheet
  - tips on how to get started using real-time data in classroom with students
  - different entry points for different levels of learners—from introductory to advanced.
- Most teachers were fine with an Internet-based product as long as they could download data to Excel. Very few teachers requested that RTD be provided on a CD or in print materials.
- There were mixed views regarding audience use of an online education product—should it be for teachers or for students? Teachers offered no clear guidance on this issue.
- This product should be part of a whole program that includes, ideally, all of the following:
  - data collection at NERRS or other sites local to schools
  - data use in the classroom (the RTD education product)
  - training of classroom teachers: pre-service training, in-services, ongoing support
  - training of NERRS Education Coordinators (ECs) on the use of RTD in NERRS education programs and on working with classroom teachers to help them integrate RTD into their teaching.

Barriers & Challenges

- The greatest barrier to this product for teachers is the disconnect between the potential for RTD in exciting/connecting students to the real world and the reality of today's K-12 teaching environment with state standards and high-stakes testing. Any RTD product needs to be designed to support what teachers currently have to teach/test and be integrated into what they do instead of as an add-on.
- if NOAA scientists and educators view RTD as the future for science, there needs to be work on the political front with science education reform to make changes in what teachers are required to teach/test and how they teach so that what they do matches how science is conducted.

SWMP/IOOS Real-Time Data in K-12 Classrooms:
A Front-end Evaluation

EVALUATION REPORT

Overview

This evaluation project, originally titled, "Assessing Capacity and Needs for Integrating IOOS into K-12 Classrooms," is a front-end study designed to investigate the ways by which kindergarten through 12th-grade (K-12) teachers and students can use real-time data (RTD) and associated education products to understand and appreciate the role that the environment, in particular the ocean, plays in their lives..

For this project we defined real-time data as data that you can access as the data are being collected (or shortly thereafter) to study current conditions or events. (For some, this definition also applies to near-real-time data.) The interest in getting RTD into K-12 classrooms stems from the current national focus on the ocean and the changes occurring in ocean research. NOAA's NERRS (National Estuarine Research Reserve System) is uniquely positioned to support the use of real-time data by the education community. Through its water quality data stream (System-wide Monitoring Program or SWMP) and national network of educators, the NERRS will play an important role in NOAA's Ecosystem Goal Team and provide leadership in linking IOOS (Integrated Ocean Observing System) data to key user audiences.

This study focused on K-12 classrooms. We recognize that college & university teachers and students, coastal decision-makers, the general public and informal education institutions are all important audiences, but the goal here was to study one target group in depth, rather than studying many narrowly.

The vision for RTD use by the K-12 audience is to enable teachers to engage their students in exploring the ocean in real time right from their classrooms. The main question is: What do they need to do so? To answer that question NERRS (through the Jacques Cousteau NERR in New Jersey) collaborated with the National Marine Sanctuary Program, National Sea Grant College Program and the Centers for Ocean Science Excellence in Education (COSEE) to conduct this front-end evaluation.

Evaluation Goals & Objectives

The goals of this front-end evaluation were to:

- identify the gap between SWMP/IOOS scientific data (current and projected) and the needs/capabilities of K-12 teachers and students to use those data, and
- to determine and recommend ways to bridge that gap via data visualization/ presentation and educational products/services.

The basis for this study's design was utilization-focused evaluation (Patton, 1997) and it employed a mix of traditional evaluation methods (interviews, focus groups and surveys) to gather qualitative and quantitative data from stakeholders and users (teachers). With these data we conducted a gap analysis (Weber, 1986) to answer the questions: Where are we now? and Where do we want to be? The results will aid NOAA/NERRS in designing and developing an education product that successfully addresses the gap between what stakeholders wish to accomplish and what teachers can use.

Our tasks were to:

1. Assess current capacity & status: What data resources and formats are currently available?
2. Identify the ideal: What do stakeholders (NOAA, NERRS, IOOS, COSEEs, Sea Grant, etc.) view as the ideal uses of SWMP/IOOS data?
3. Determine needs: What data can K-12 teachers use and what formats/products are they likely to use?
4. Analyze the gap(s): What's the gap between the ideal and the needs/capabilities, and what's needed to bridge that gap?

Evaluation Questions/Issues

The questions/issues this evaluation addressed were:

Objective 1

- What SWMP/IOOS data streams/data types are available or will be available in the near future?
- What resources/models/products/projects currently provide classroom teachers with real-time observatory data? Which resources have been proven (evaluated) to work?

Objective 2

What is the stakeholders' vision for the use of SWMP/IOOS data?

- Who are the users they want to reach?
- What are their desired goals/outcomes?
- What would they like to provide users?
- What do they think the users need/want/would use?
- What do they think would facilitate use? What would prevent use?
- What's out there now that they think works?

Objective 3

What's happening currently with potential users? What's their current use, needs, capabilities for SWMP/IOOS data?

- What's out there now that they're currently using and what's working or not working?
- What are their data visualization/formatting/presentation needs, based on what works and what doesn't?
- What are their educational products needs (lesson plans, etc.) and what are their formatting preferences for such products?
- How/where would these data fit into the curriculum (oceans, atmosphere, climate, humans & environment)?
- What enables them and what prevents them from using such data?

Objective 4

Where are the gaps between data offerings and what teachers can/would use?
And, what might bridge those gaps?

- data types/topics, data format
- technology access
- teacher skills, student skills
- lesson plans
- curriculum fit, standards/testing
- time
- perception of usefulness.

Methods

From January through July 2006, we gathered data from the education research community, SWMP/IOOS stakeholders (n = 54) and K-12 teachers (n = 92) from across the U.S. through the following methods:

- a review of peer-reviewed articles and published evaluation reports (literature review) on the use of environmental RTD in K-12 classrooms
- interviews and an online survey of stakeholders (that is, people with fiscal, decision-making or other significant influence) to determine the current status of SWMP/IOOS data and the vision for associated educational products
- teacher focus groups nationwide to determine needs and capabilities regarding RTD use
- prioritizing activity with teachers and stakeholders (prioritizing a list of 40 features for a RTD education product that resulted from the focus group discussions).

Literature Review

We reviewed and summarized more than 25 peer-reviewed articles and published evaluation reports focused on the use of real-time environmental data in K-12 classroom.

Stakeholder Interviews & Survey

During the spring of 2006 we conducted interviews and an online survey of stakeholders (as identified by NOAA), that is, people with fiscal, decision-making or other significant influence on the development of education products/programs that make use of SWMP/IOOS data for K-12 audiences. We interviewed 11 people, mostly by telephone, and each interview lasted on average about an hour.

The online survey consisted of 24 questions. It was launched in March 27, 2006 with an email sent to 60 people. Over a period of three weeks, we sent 2 reminders and closed the survey on April 15, 2006, with 27 responses (a response rate of 45%, which is higher than average for online surveys).

Teacher Focus Group Sessions

For the focus group sessions we worked with NERRS and COSEE sites nationwide. Each site invited 10 – 15 teachers who teach using RTD (*see our definition on page 1*). We didn't restrict use to certain kinds of RTD or to specific grade levels.

We conducted seven focus group sessions in five U.S. regions:

- South/Southeast: Weeks Bay NERR, Alabama
- Northern/Central California: Elkhorn Slough NERR/San Francisco Bay NERR
- Southern California: COSEE-West, Los Angeles
- New England: Waquoit Bay NERR, Massachusetts
- Mid-Atlantic: Jacques Cousteau NERR, New Jersey

Teachers who participated represented a range of grades (from elementary to high school) and a range of teaching experience with RTD (from no experience to weekly use). Study participants were a convenient sample selected by the local site coordinators following the criteria that teachers had to be using RTD with their students (although we actually got a range of RTD users). We chose this approach because we needed teachers familiar with using RTD to "concept test" an education product based on RTD. (In focus groups we found that teachers who were not using RTD were unable to provide feedback on what they needed). However, due to our selection criteria and sampling method, participants' views may not be representative of all U.S. teachers.

Each focus group session was offered on a Saturday morning or afternoon and lasted 2.5 to 3 hours following this agenda:

- Introductions: Facilitators, teachers, session goals and definition of RTD (20 minutes)
- Teachers' Current RTD Use (30 minutes)
  - Group Discussion: What data, where from, where it fits in curriculum, why do they use the data/sources they use?
- Where Do RTD Fit? (10 minutes)
  - Individual Exercise: On a blank sheet of paper answer this question... At what stage(s) of your lesson planning & teaching process do you use RTD? Where do RTD fit?
  - Individual Exercise: Using the provided "map" of lesson planning/teaching elements, show us where the RTD you use fit (use colored pen to write RTD in relevant bubbles)
- SWMP/IOOS RTD Overview PowerPoint Presentation (15 minutes)
- Where do SWMP/IOOS RTD Fit? (20 minutes)
  - Individual Exercise: Using another provided "map" of lesson planning/teaching elements, show us where SWMP/IOOS RTD fit (use same colored pens)
- RTD Websites Review (40 minutes)
  - Individual or small groups review CDMO SWMP website & Eyes on the Bay website as models of RTD education products (via a feedback form)
- The Ideal RTD Ed Product (30 minutes)
  - Group Discussion: Based on teachers' experiences with RTD and the two websites, what features/formats would create the ideal RTD ed product for teachers?
- Closure & Thank yous.

Teacher Prioritizing Sessions

Based on focus group discussions we developed a list of approximately 40 features that teachers had requested for a RTD education product. Because we thought it was important to offer a prioritization of this long list of features, we decided to take advantage of teachers and stakeholders participating in an April 2006 follow-up meeting of the COSEE-Mid-Atlantic summer '05 teacher workshop and the MBARI (Monterey Bay Aquarium Research Institute) EARTH summer workshop held in July 2006. Twenty-five teachers representing at least 14 U.S. states participated, along with sixteen stakeholders (workshop scientists and educators).

During an hour-long session at each of the two workshops we gave small groups (teachers in grade-level groups and stakeholders in separate groups) an envelope containing the 40 features and asked them to prioritize by writing a 1, 2 or 3 on each feature, with 1 = essential, 2 = nice to have, and 3 = not necessary.

Timeline

What follows is a projected timeline for this project.

Timing Task	Oct. - Dec. 2005	Nov. - Dec. 2005	Jan. & Feb. 2006	Mar. - May 2006	May - Sept. 2006
start project	• finalize the evaluation plan • conduct literature review				
data collection from stakeholders	• identify key stakeholders • set up interview dates	• conduct interviews • conduct online survey	• send thank yous		
data collection from teachers (pre-workshop surveys; focus groups; RTD Fit map; websites review; prioritizing activity)		• select host sites • set up meeting dates	• develop focus group protocols (all) • select teachers and invite to participate	• coordinate with host sites • conduct focus groups at host sites • ask teachers to prioritize product features	• send thank yous to hosts and teachers
report findings				• begin analyzing data	• analyze data • write and deliver report

Data Tallying & Analysis

Responses to interview/focus group questions were mostly qualitative and open-ended. For analysis we summarized, categorized, then tallied to determine trends. The top responses are reported in the main report as the frequency and percentage by category. We've included all the open-ended responses in the appendices.

Survey and feedback instruments used a mix of questions to collect qualitative and quantitative data. Responses to qualitative questions were categorized, then tallied. All responses were reported as the frequency and percentage by category. Responses to quantitative questions (such as rating scales) were tallied and are reported here as frequencies and averages.

What follows are the evaluation results.

Results

Literature Review

Education & Outreach staff at the Institute of Marine & Coastal Sciences at Rutgers University conducted a review of published literature focused on the use of real-time environmental data in K-12 classroom. The literature review was designed to address Objective 1, specifically to answer the question:

- What resources/models/products/projects currently provide classroom teachers with real-time observatory data? Which resources have been proven (evaluated) to work?

We chose to include peer-reviewed literature and evaluation reports (project documentation) from projects and programs. Overall we found there are a number of government-funded (NSF, NOAA, NASA) projects that have focused on the use of environmental real-time data in K-12 formal education curriculum. These programs include the Global Learning and Observations to Benefit the Environment (GLOBE) program, Forest Watch, Global Thinking Project, Collaborative Visualization (CoVis), World Watchers, and JASON. Some research has been conducted, mostly in the form of case study documentation, to assess the success of these programs in the formal K-12 enterprise. Most of these projects were designed to 1) increase student scientific understanding of the Earth, 2) increase environmental awareness, and 3) help students reach higher standards in science and math by doing real (authentic) science using a collaborative inquiry based learning experience. Many of these projects use technology to facilitate authentic science practice in the classroom. A number of the projects (GLOBE, Global Thinking Project, World Watchers, and CoVis in particular) focused on students constructing meaning from their experiences through participation in activities that closely resemble those of real scientists (including investigating real science problems, collaborating between individuals within classrooms, and among geographically remote classrooms). The students were given shared goals, data, and knowledge through questioning, data analysis, and discussion of results. The thought was that technology enhanced projects are "unique and compelling" —i.e., beyond word processing and telecommunication but constructing knowledge from graphs, tables, and maps and interpreting and communicating that knowledge to student-teacher-scientist peers. Each project attempted to develop pathways by which students could participate in the scientific process and understand the nature of science from their experiences.

A complete review of more then 25 published articles/reports can be found in Appendix 1 or online at http://marine.rutgers.edu/outreach/rtd/.

Overall Benefits to Using Environmental RTD in K-12 Classrooms

We identified three key themes in the literature that describe the overall benefits of using environmental RTD specifically in grades 4-12:

- ***Students gain a deeper understanding of science (and math), especially when the lessons are inquiry based.*** Results from the Global Thinking Project (Dunkerly-Colb & Hassard 1997) indicate that students achieved a greater understanding of the environment through constructivist learning experiences. Students from Georgia, U.S.A. and Russia participated in a variety of self-directed learning experiences involving data collection, analysis, and the use of technology to communicate results and exchange ideas. Hotaling (2005) reported real-time data can be successfully implemented in classroom settings, and it provides authentic, engaging, and meaningful learning experiences.

- ***Students feel more engaged with lessons when the experience is authentic and has real links / value.*** The JASON (Moss 2003), Forest Watch (Moss et al 1998), and GLOBE (Means et al 1996; Means et al 1997; Center for Technology in Learning 2005) programs all report that technology and involvement in real world science appeals to students and give them a sense that what they are doing has value.

- ***Students learn new science and math-oriented skills***. Lauten & Lauten (1998) argue that environmental data analysis can be successfully implemented in middle school and early high school classroom to meet mathematics content standards (algebra and geometry). In this study, researchers were able to demonstrate mathematic competencies through the *Earth Day: Forest Watch* program, in which students collect and assess data about the health of white pine forest stands, and then compare their results to data given by the Landsat Thematic Mapper (TM) for their local area. A three year evaluation of the Sky Math program (University Corporation for Atmospheric Research 1997) determined that students were effectively learning mathematics and science concepts using the Sky Math module, which integrated real-time weather data into an algebra based curriculum.

Relevance of RTD projects to School Science/Math Curriculum
Given a climate of high stakes testing with federal mandates such as "No Child Left Behind" and increasing importance on the National Science Education Standards (NSES), how likely is it that teachers can/will use authentic RTD projects in their science curriculum? The Boreal Forest Watch was designed in partnership with the Saskatchewan Education CORE curriculum, which made it functionally feasible and even appealing for the teachers to institute (Spencer et al 1998). Teachers are presented with many choices of selecting and using data collection technology with their students (Krueger & Rawls 1998). Overall, educators are encouraged to use materials that are developmentally appropriate and focused on the educational needs of their students (see figure 1: Relevant technology standards for grade K-12).

> The NSES refer to technology as *exciting tools which allow students to conduct inquiry and understand science.*
>
> The appropriate use of technology is recommended:
>
> - **Grades K-4** "Employ simple equipment and tools to gather data and extend the senses"
> - **Grades 5-8** "Use appropriate tools and techniques to gather, analyze, and interpret data"
> - **Grades 9-12** "Use technology and mathematics to improve investigations and communications".

Curriculum Design Lessons Learned
The use of real-time environmental data in the classroom is in its infancy. Most of the published work on this topic is qualitative and descriptive in nature (i.e., mostly case studies without controls). Given these constraints, the authors provide the following advice on the development of effective lessons using environmental RTD:

- ***Develop lessons/applications that are flexible enough to adapt to level and classroom time constraints, local phenomena and be integrated into current teaching. Design materials so that pieces can be removed and used by educators in other ways.*** Wormstead et al (2002) provides this general advice based on experience with the GLOBE program: 1) Introductory-level background information should be provided but kept separate from data collection information; 2) Include a student-centered section; 3) Organize materials in a clear, easy-to-follow, graphical layout; 4) Provide consistent formats for lessons, in a step-by-step format,

5) include hands-on and inquiry-based lessons whenever possible (include outdoor lessons whenever relevant), and 6) provide strong support for teachers, including follow-up workshops. Edelson (2005) recommended the development of projects that focus on local phenomena and the use of technology to facilitate authentic science practices in the classroom.

- ***Encourage conduct of activities in multi-school communities (becoming a part of a larger community of science practitioners).*** Several authors recommend providing a "network" or "community of practice" for communication and even collaboration among teachers, other schools, other institutions, scientists, etc. This practice would help support the integration of RTD activities into the curriculum.

- ***Lessons should teach students why they are doing data collection and analysis (integrate conceptual understanding).*** RTD project designers are encouraged to place equal value on the content and the scientific validity of student-collected data. The unique goal of using RTD in the classroom is to demonstrate and communicate the nature of science and scientific inquiry. Many of the projects (most notable the JASON project) reported that teachers did not take full advantage of the technology tools and focused on content translation instead of the process of scientific inquiry. The authors recommend that teachers regularly ask students to stop and think, conceptually, about their learning and what they are doing. This notion of using RTD to support inquiry has not been fully realized in most of the projects reviewed.

- ***Develop materials that are inquiry-based, that involve students in the full scientific process, and include hands-on activities.*** Steps of lessons must be open enough to engage students in inquiry without being so broad that students can easily become lost. Every effort should be made to explain the big picture "why" of the proposed activity (Edelson et al 2002; Moss 2003). Numerous studies concluded that students understood the "that" and "how" of the concept introduced in the unit, or the technique/tool associated with the data collection, but were missing the "why" of the concept or purpose of the RTD project. A strong recommendation is made to design the curriculum to fully explain the "why," of the lesson.

- ***Lessons should be scaffolded so that at first there are more steps and guidance, but gradually they become more student-driven and open-ended.*** Learning occurs when students investigate open questions about which they are genuinely concerned using methods that parallel those of scientists. It is critical to identify student prior knowledge and misconceptions when constructing lessons/materials. Results from the highly acclaimed Web-based Inquiry Science Environment or WISE program suggest a "Learning-for-Use" design framework for RTD applications (Linn et al 2003).

  The recommended framework, which is a three-step process, must proceed in order but can be cycled through numerous times and/or in various ways for each learning objective: 1) *Motivation*, which can be achieved through the creation of task demand or eliciting curiosity; 2) *Knowledge construction*, which can be achieved through direct experiences, indirect experiences, modeling, instruction, or explanation; 3) *Knowledge organization*, which can be achieved through practice (using components of understanding in another context), application (applying understanding in context), or reflection.

  The WISE research (Linn et al 2003) suggests that the science doesn't necessarily need to be "simplified." WISE developers often offer very detailed steps for the first inquiry investigation, and then less detailed steps for subsequent investigations. The authors caution not to over extend the knowledge demands of the task in the project, being careful to make sure the concepts are developmentally appropriate for the target audience of the project (Edelson et al 2002).

- ***Development teams should be diverse, including expertise in science, technology, cognitive science, classroom teaching methods, and teacher professional development, and partnerships should last long-term.*** Many of the projects were focused on supporting and creating student-teacher–scientist partnerships (STSP) to improve understanding of scientific inquiry and the nature of science. The scientist is seen as a mentor for students and teachers and a learner of teacher/student needs. Results of long-term studies on the JASON project indicate that although student-scientist research collaborations were found to be feasible and produce results reliable enough for professional quality data, there was not a positive change in students' conceptions of the nature of science. Students had uninformed notions of scientific questioning, viewed data collection as only following prescribed steps and ultimately repetitive, and had little experience with data analysis or the communication of scientific findings (Moss et al 1998). The authors concluded from their experiences with this study that the design of the STSP must include: 1) sufficient exposure to posing questions, data analysis, and communication of results and 2) a strong sense of partnership (students communicating with scientists directly in the generation of research questions). Successful STSPs must encourage students' conceptions of science to include scientists engaging in experiments and natural observation. The projects must go beyond a content focus and embrace science teaching and learning as portrayed in NSES and AAAS benchmarks. The STSP model if successful must be viewed as complementary and even beneficial to testing initiatives. which are driving the choice of curricular programs.

Technology: Development of Data Visualization Tools

Visualization and modeling tools are essential to the development of RTD projects in a curricular context. The Center for Innovative Learning Technologies (CILT), founded in October 1997 with a grant from the National Science Foundation (NSF), was designed to stimulate the development and study of important, technology-enabled solutions to critical problems in K-14 science, technology, engineering, and mathematics (STEM) learning. The CoVis (specifically Wordwatcher project) in particular has been thoughtful about the role of technology in student learning from RTD and the impact/benefits to STSP (Edelson 2005). Perhaps the most important finding/outcome of his work has been documenting the necessity of what he calls "bridging functions." These intermediary tools or visualizations are necessary to help students grasp concepts that are more than one step away from their usual frame of reference (i.e., first presenting colors on a map as numbers to get students to understand that the colors represent amounts and not just ink). This finding underscores the need for specialized, refined or intermediary tools (different from those used by scientists) to be developed to support student learning with environmental RTD.

Edelson (2005) points out the importance of building scientific expert or tacit knowledge into student data visualization tools' interfaces. Tacit knowledge should be embedded into the tool's interface (i.e., such as geographical visualizations and graphical interfaces to link students to data, as opposed to text). He notes that scientists can more efficiently interpret data because of their tacit knowledge. However, a less experienced student-teacher audience will need "bridging functions" to assist them in building necessary skills for interpreting data. Other data visualization tips include:

> ***Tacit Knowledge*** *is that which cannot be codified, but can only be transmitted via training or gained through experience. Tacit knowledge has been described as "know-how" (as opposed to "know-what" [facts] and "know-why" [science]). It involves learning and skill. The simplest example of tacit knowledge is riding a bike or swimming — it doesn't happen by reading a textbook, but only through personal experimentation, observation, and/or the guidance of an instructor.*

- Keep only the most important and useful functions of the scientific tool, so as not to overwhelm students with too much complexity.
- Automate or remove tasks which will have little pedagogical value (i.e., the time researchers spend reformatting data).
- Supply data libraries that support investigations into students' topic of choice (to help motivate them).

Technology: Development of Communication Tools
The authors encourage forms of electronic communication, between scientists, teachers and students to form a community of learners, thus blurring traditional roles between the partners (Edelson 2005; Dunkerly-Colb & Hassard 1997; Center for Technology in Learning 2005).
Lin el al (2003) produced evidence that having the teacher initiate a class discussion about the students' findings and then encouraging them to post them to an on-line discussion board involved much more student participation (90%) than a classroom discussion alone typically does (15%).

Implementation of RTD: Teacher Training/Classroom Support
Overall, the authors agree that teachers are a critical link in the successful integration of environmental RTD into the classroom curriculum. All of the studies agreed that teacher preparedness, achieved through professional development, is essential. Professional development should teach specific curriculum in context, and should be considered a long-term commitment, extending over the course of the time that the curriculum is being implemented.

Developers of environmental RTD materials should be aware that teachers are constrained by time when determining what/how to teach new/innovative materials. In studies related to the JASON program, teachers did not stray from what was modeled/presented in professional development training (Moss et al 1998). Yepes-Baraya (2000) advocates for the increase in use of collaborative projects (seen as painless way to introduce more teachers to the use of technology in the classroom).

The authors agree that strengthening mentoring and support among trained teachers and a cadre of turnkey mentees is a cost-effective method by which to build a community of users. as is involving school administration and technology staff as much as possible—fully integrating them into training models. Developers should employ effective practices (see Appendix 18) when designing professional development programs/experiences for teachers.

Stakeholders' Views

The stakeholders' interviews and online survey were designed to address part of Objective 1 and all of Objective 2, specifically to answer these questions:

- What is stakeholders' vision for the use of SWMP/IOOS data by K-12 teachers?
- What SWMP/IOOS data streams/data types are available or will be available in the near future?

We conducted telephone interviews of 11 stakeholders and launched an online survey, receiving 27 responses (out of 60 emailed requests), a return rate of 45%. Because many of the questions of the two groups overlapped, we are reporting the responses of both in this section.

The stakeholders we interviewed and surveyed had fiscal, decision-making or other significant influence on the development and implementation of national education products/programs dealing with real-time data (RTD). Individual comments are confidential and not attributed to any particular respondent, however, in acknowledgment of their contributions to this study, you'll find the list of interviewed stakeholders and affiliations in the Acknowledgments section.

We did not collect names from online survey respondents (and so can't acknowledge them), however they represented these organizations:

Online #2. For which agency/group do you currently work? (check one)

Response Choices	*Frequency* *n = 27*	%
NOAA National Estuarine Research Reserves	20	74%
NOAA National Marine Sanctuaries	1	4%
NOAA National Ocean Service	1	4%
NOAA National Weather Service	1	4%
NOAA Office of Education	1	4%
IOOS	1	4%
Other *(please specify)* NOAA OAR, ESR/LPSD Marine & Aviation Operations	2	7%

and held these positions:

Online #1. What is your current job position? (check all that apply)

Response Choices	*Frequency* *n = 27*	%
educator	17	63%
coordinator	14	52%
program manager	6	22%
director/administrator/manager	2	7%
researcher/scientist	1	4%
other *(please specify)*	0	0%

Note: This multiple-choice question allowed respondents to choose more than one response, and so the total equals more than 100%.

We asked stakeholders if they were familiar with SWMP and/or IOOS. During the interview if someone was not familiar with both, the interviewer offered a brief explanation. For the survey the information was provided in the solicitation email and at the beginning of the online survey. Most everyone we contacted was familiar with SWMP and IOOS and the work currently underway regarding IOOS and the integration of SWMP.

Online #3. Are you familiar with SWMP (System-wide Monitoring Program) and/or IOOS (Integrated Ocean Observing System)? (check one)

Response Choices	*Frequency n = 27*	*%*
yes, familiar with both SWMP & IOOS	20	80%
yes, familiar with SWMP	2	8%
yes, familiar with IOOS	2	8%
no, not familiar with either	1	4%
no answer	2	—

<u>Vision</u>

To gain an understanding of stakeholders' vision for the use of SWMP/IOOS real-time data in K-12 classrooms we asked a general, open-ended question during both the interview and survey of their vision on the use of SWMP/IOOS data in K-12 classrooms.

Interview Question: Let's start with a description of your vision/thoughts about the integration of SWMP & IOOS data (or, if not familiar with SWMP/IOOS, then real-time data) and their use by K-12 classroom teachers.

Interviewees responded that SWMP and IOOS are interdependent and that the integration of SWMP into IOOS will offer a complete picture of coastal and ocean systems. Several took the point of view of users and offered that users won't perceive a separation and so it is not useful to make a distinction between the two.

All of the interviewees agreed on the need for a vision for this effort, but there was no clear agreement on what that vision should be.

The positive visions expressed included

- teaching about land/water interactions, interdependent systems
- showing/comparing different estuarine systems around the country
- showing human impacts on such systems
- connecting teachers and students to real world issues and the practice of science
- adding relevancy and richness to curriculum
- introducing teachers to observing systems
- adding inquiry and critical thinking to science lessons
- hooking, exciting, engaging students and teachers.

Most were cautiously optimistic regarding RTD as an educational tool. Concerns raised included:

- questions about how RTD would fit with school curriculum: is this something that supplements and enriches it, or changes the way science is taught in the schools
- RTD may not fit with currently curriculum standards and "high-stakes" testing
- teachers' access to technology and abilities to use RTD

- providing teachers data in forms they can understand and use with students (data translation and visualization)
- what's the hook that's going to engage students and teachers
- how does RTD address the needs of minority/underserved students.

A few thought that educators were getting ahead of themselves in terms of planning RTD products before scientists have decided what RTD would be available and in what forms; however, others felt strongly that now is the time to be planning such products so that they will be useful in the end to the education community. Almost everyone viewed this as a long-term (10+ year) process.

Online survey respondents had similar views.

Online #4. Because you stated that you're familiar with SWMP and/or IOOS, please tell us your thoughts regarding their integration and use in K-12 classrooms.

Responses	*Frequency n = 18*	*%*
great potential	5	28%
need to translate for classroom use	5	28%
can connect education with local issues	4	22%
help teach about estuaries	3	17%

Note: This was an open-ended question and many respondents offered more than one response. Only the top responses are reported here and the total may equal more than 100%. See Appendix 11 for all the responses to this question.

On the online survey we asked NERRS educators (those selecting yes to online question #5, n = 19) very specific questions about the use of these data in NERRS education programs. These questions were designed to help us form recommendations on the incorporation of real-time data in NERRS programs.

Online #6. Do you use SWMP or other real-time data (RTD) in any of your current NERRS' education programs?

Response Choices	*Frequency n = 19*	*%*
yes	11	58%
no	8	42%
not sure	0	0%

Online #7. Do you foresee using SWMP or other real-time data (RTD) as part of your NERRS education programs in the future?

Response Choices	*Frequency n = 19*	*%*
yes	17	89.5%
no	0	0%
not sure	2	10.5%

Online #8. Do you think RTD should play a key role in NERRS education/outreach efforts?

Response Choices	*Frequency n = 19*	*%*
yes, definitely	7	37%
probably	6	32%
not sure	5	26%
probably not	1	5%
no, definitely not	0	0%

Audience

The focus of this study was on the K-12 audience, even though we know college & university teachers and students, informal education institutions and the general public are all potential audiences. We asked stakeholders to tell us who within the K-12 community they thought of as the primary audience.

Interview Question: Who do you think is the primary K-12 audience for SWMP/IOOS data (RTD) & ed products?

To this question, interviewees responded that in terms of students, the primary audience was middle school and high school, but that might go as low as 4th or 5th grade. They emphasized that whatever was developed needed to fit with curriculum and standards and be developmentally appropriate. The other major audience was teachers, both pre-service and current teachers.

Online #9. Who do you think should be the primary K-12 audiences for NOAA education products based on real-time data (RTD)? (check all that should be included)

Response Choices	*Frequency n = 27*	*%*
K to 3	1	4%
4	3	12%
5	8	32%
6	14	56%
7	17	68%
8	19	76%
9	23	92%
10 to 12	24	96%
other *(please specify)* *community colleges & universities* *any grade working with graphs; homeschoolers; public at large; informal ed groups*	8 6 1 each	32%
skipped / no answer	2	—

Note: This multiple-choice question invited respondents to check more than one response, and so the total is more than 100%.

Most everyone was in agreement that the target audience should be high-school and middle-school students and their teachers.

Enhancing Classroom Practice

Interview Question: Ideally, what do you think SWMP/IOOS data (RTD) and resulting ed products could offer K-12 classroom teachers? How could they impact/enhance classroom practice?

To this question, most interviewees talked about the great potential and opportunities for students. RTD could support hands-on, project-based, inquiry learning. It could add not only relevance and excitement to lessons, but also enhance critical thinking and move learning away from memorization. The collection of RTD would give students a better understanding of local habitats and connect them to local issues. This tool could assist with improving science literacy, as well as improving math, technology, even reading skills.

Several people talked about the possibility that RTD could change how science is taught in K-12 classrooms in ways that would support inquiry-based teaching. Again, however, the main concern was the competency of teachers, their abilities technically and scientifically to use this new tool.

Long-term Goal

Interview Question: What do you see as the ultimate long-term goal/end point for teachers & students using RTD data in the classroom?

Interviewees offered a variety of goals for this project, and there was no consensus on a single direction. Goals included (offered here in no particular order):

- a better understanding of the environment (ocean, estuarine, local) and the interconnectedness of systems
- strengthening science education
- getting more ocean science into the classroom
- fostering an emotional attachment to the environment through the study of it
- understanding how daily lives/human choices impact the watershed/coastal communities
- understanding data and math and integrating the two into real-world applications
- learning to synthesize information to make better decisions
- engage students in/support them in problem solving, critical thinking, scientific process
- show how science is done
- understanding ocean data so that eventually they can access it they way they do weather data
- exposing them to career potentials.

Based on the interview responses, we developed a list of 11 goals for those taking the online survey. We asked them two questions: first, to indicate all the goals that they thought a RTD education product should meet, then asked them to indicate the "primary goal" for such a product.

Online #10. What do you think should be the goals of NOAA K-12 education products based on RTD? (check all that apply)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	*%*
connecting students with real-world science	23	92%
improving inquiry skills	23	92%
better understanding of estuarine/coastal ocean research	18	72%
better knowledge of the environment	18	72%
improving ocean literacy	16	64%
better science education	15	60%
greater understanding of the ocean/atmosphere interface	14	56%
better stewards of the environment	12	48%
greater awareness of science career paths/choices	12	48%
better math education	10	40%
preparing students to be scientists	9	36%
other *(please specify)* *increased knowledge of estuarine processes* *students should gain experience with technology used to measure parameters and analyze data*	2	8%
skipped/no answer	2	—

Note: This multiple-choice question invited respondents to check more than one response, and so the total equals more than 100%.

Online #11. What do you think should be the primary goal of NOAA K-12 education products based on RTD? (check one)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	*%*
connecting students to real-world science	7	28%
improving inquiry skills	6	24%
improving ocean literacy	5	20%
better stewards of the environment	3	12%
better knowledge of the environment	1	4%
better science education	1	4%
greater understanding of the ocean/atmosphere interface	1	4%
better understanding of estuarine/coastal ocean research	1	4%
better math education	0	0%
greater awareness of science career paths/choices	0	0%
preparing students to be scientists	0	0%
other *(please specify)*	0	0%
skipped/no answer	2	—

Connecting students to real-world science and improving inquiry skills were the top choices.

Ed Product Features

Interview Question: What might those ed products look like/feature/offer?

We asked stakeholders about the features and formats for a RTD education product. Everyone generally agreed that the product must work for teachers first and must provide them with what they need to work with their students.

In our review of the results of our interviews we saw that RTD education product features/ formats could be organized into four main categories:

- the source(s) of data: student-collected and/or provided data (i.e., scientist or observing system-collected), local and/or national data
- if provided data, then data format: raw data sets, QAQC data sets, historical/archived data sets, data translation, visualization and interpretation, and ability to manipulate
- in addition to data, the ed product components: lesson plans, data-collecting kits, Internet-based data, non-Internet-based data, stories, events or other context for the data, interactive visuals, games & challenges
- the training of teachers: pre-service training, in-services, ongoing support.

A few interviewees thought it was important for students to collect their own data to help them understand what data are and to connect them to their local communities. Some suggested that having student collect data would enable them to better understand data from scientists and/or observing systems. Student-collected data seemed to be more important among online respondents. And the sharing of data with other students and scientists (as is common in GLOBE and other RTD education programs) received mixed reviews by online respondents (we didn't ask this of interviewees). Most interviewees' comments focused on students' use of observing system data.

Online #12. Do you think K-12 students collecting data in the field is an important part of understanding RTD?

Response Choices	*Frequency n = 27*	%
yes, definitely	11	44%
probably	11	44%
not sure	0	0%
probably not	3	12%
no, definitely not	0	0%
skipped/no answer	2	—

Online #13. Do you think K-12 students sharing their field data with other students is an important part of understanding RTD?

Response Choices	*Frequency n = 27*	%
yes, definitely	5	20%
probably	10	40%
not sure	5	20%
probably not	4	16%
no, definitely not	1	4%
skipped/no answer	2	—

Online #14. Do you think K-12 students contributing their field data to scientists' data is an important part of understanding RTD?

Response Choices	*Frequency n = 27*	%
yes, definitely	3	12%
probably	4	16%
not sure	5	20%
probably not	12	48%
no, definitely not	1	4%
skipped/no answer	2	—

Online responses generally expressed the same views on features and formats as did interviewees. There was general agreement that teachers needed more than just data sets—the data need to be translated from data tables to some visual form that offers context so teachers and students understand what the data mean. Stakeholder interviewees have different views on how little or how much translation and visualization would be necessary, and how much of that work students could/should be able to do.

In addition to the RTD, an education product would likely offer lesson plans to aid teachers with using the data. About half the interviewees expressed the desire for non-Internet-based lessons and data sets, in particular for teachers and students with limited access to technology. If the data are to be student-collected, there was a question about access to equipment to do so and if that should be provided.

Online #15. Which data formats would be most useful to K-12 teachers? (check all that apply)
Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	%
packaged lessons/lesson plans with RTD	24	96%
data visualizations (maps, graphs, etc.)	23	92%
comparable data (different parameters)	20	80%
comparable data (different sites)	20	80%
quality assured/controlled (QAQC) data streams	9	36%
raw data streams	2	8%
other *(please specify)* *workshops/training on how to use data and lessons is most important* *Unknown* *Step by step instructions for accessing, formatting and using data and a resource person to contact with questions* *packaged lesson plans only as introductory materials to build skills necessary to use the 'real' data* *I espouse a mixed approach because you have to get teachers up to speed, so comparable data and visualizations are handy, however the ultimate goal is to get students armpit deep in the data* *all of the above, but it depends so much on field of study*	6	24%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total equals more than 100%.

Online #17. What do you think should be the essential features of NOAA K-12 education products based on RTD? (check all that apply)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	*%*
lesson plans for teaching science concepts with RTD	23	92%
packaged lessons/lesson plans	22	88%
alignment to state/national standards	22	88%
lesson plans for teaching the science process with RTD	18	72%
lesson plans for teaching math skills with RTD	17	68%
maps to show where RTD is being collected	17	68%
information on the technology, that is, how data are collected	15	60%
quality assured/controlled (QAQC) data streams	12	48%
assessments for use with lessons	12	48%
info on scientists who use RTD in their research	11	44%
assessments tied to state tests	9	36%
raw data streams	5	20%
other *(please specify)* *don't know/unknown* *Adaptability to different fields of study - math, science, policy* *Simplified or partial data sets* *workshops/training on how to use RTD*	4	16%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total is more than 100%.

Several interviewees suggested offering data in context, in particular stories or spectacular events as the hook to get students interested in data. A few suggested designing this education product to make the use of the latest technologies (iPods, Blackberry, etc.) and to use the techniques of game and entertainment designers to attract students' interest.

Online #18. What do you think would be the best format(s) for NOAA K-12 education products based on RTD? (check all that apply)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	*%*
web-based/websites	22	88%
media, such as CDs or DVDs	18	72%
hands-on kits	17	68%
print materials/packets	14	56%
supplemental materials aligned with textbooks	11	44%
mobile devices, such as PDAs, cell phones, etc.	1	4%
other *(please specify)* *don't know* *above depends on lowest common denominator needs/capabilities of K-12 teachers* *workshops/training on how to use RTD and create a 'train the trainer' scenario where teachers train other teachers*	3	12%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total is more than 100%.

There was general consensus that whatever is developed, there needs to be a strong and ongoing teacher training/professional development component on the meaning of RTD and how to teach with it. All agreed that whatever was designed needed to work for teachers and that the product(s) are developed to help teachers do what they already do, not be an add-on or supplement to all that teachers have to do.

As part of our gap analysis between stakeholders' views and teachers' views, we asked both groups about the data used in K-12 classrooms. For stakeholders this question was asked only of online respondents. We developed a list of 27 "data streams" largely based on the provisional IOOS core variables [from page 20 of the *First U.S. Integrated Ocean Observing System (IOOS) Development Plan*] available at http://www.ocean.us/ documents/docs/IOOSDevPlan_low-res.pdf. We asked stakeholders to indicated which data they thought teachers are most likely to use.

Online #16. Which real-time data streams do you think teachers are most likely to use? (check all that apply)

Response Choices	*Frequency n = 27*	%
temperature: water	22	88%
salinity	20	80%
temperature: air	19	76%
dissolved oxygen (DO)	18	72%
animal tagging/tracking	17	68%
fish species & abundance	16	64%
video/live camera	15	60%
water quality	15	60%
turbidity (clarity/cloudiness)	14	56%
currents	13	52%
nutrients	13	52%
algal blooms	12	48%
river discharge	12	48%
pH	11	44%
water depth	11	44%
zooplankton species	9	36%
waves	8	32%
water contaminants	7	28%
water level	7	28%
bathymetry/topography	6	24%
seafood contaminants	6	24%
wind vector	4	16%
ocean color	3	12%
ice concentration	2	8%
vector currents	2	8%
directional wave spectra	1	4%
optical properties	1	4%
other *(please specify)*	3	12%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total equals more than 100%.

Currently Available Ed Products

To provide those who will be developing this education product with models of RTD environmental education products, we asked stakeholders for examples.

Interview Question: Are you aware of any current (or in the works) education products (by NOAA or others) that fit your vision for the SWMP/IOOS (RTD) ed product(s)?

Online #22. What are the best K-12 education products based on RTD that you know are currently available?

All of the interviewees had one or more products to suggest. Sixty percent of the online respondents stated they didn't know of any. Suggestions from both groups included GLOBE, COOLClassroom, NMEA BRIDGE, MBARI EARTH, Eyes on the Bay, Phytopia, NERRS SWMP data, Gulf Stream Voyage and various weather sites. However, there were many more suggestions from stakeholders (and later from teachers).

Rather than list all of the suggestions in this report, we've developed a website with an annotated list of the currently available RTD online resources. You can find that list at: http://marine.rutgers.edu/outreach/rtd/.

Barriers to RTD Use

All projects have barriers that must be understood and dealt with. To anticipate these we asked stakeholders' for their views.

Interview Question: What do you think will be the barriers to developing SWMP/IOOS data (RTD) & ed products? And, to K-12 use of these data & ed products?

The main barriers suggested by interviewees (offered in order of the number of responses, in parenthesis) are:

- funding/costs (4)
- developing an effective product (4)
- teachers' abilities and available time (3)
- student access to technology (3)
- testing (3)
- RTD viewed as an activity, an add-on, not integrated (3)
- no clear vision for this product (3)
- competition for teachers' attention (2)
- data availability/accessibility (2)
- political issues (within the OOS community & within school systems) (2)

One person each mentioned: issues of accessibility and relevance to all students, NERRS' educators' time & skills, and internal communication challenges.

We asked survey respondents this question and a question on how to overcome the barriers to getting RTD into classrooms. Their rankings of barriers were a bit different than those of interviewees. Their solutions matched earlier comments about developing easy-to-use materials and training teachers on how to use them. The online survey responses are on the following page.

Online #20. What are the greatest barriers to getting RTD into K-12 classrooms? (check all that apply)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	%
time	15	60%
awareness that the data exist	15	60%
state/national testing	14	56%
K-12 teacher abilities	13	52%
format/presentation of data	13	52%
teacher interest	13	52%
funding	9	36%
access to computers/Internet	9	36%
state standards	5	20%
student abilities	5	20%
availability of data	4	16%
student interest	3	12%
other *(please specify)* *don't know* *no ecology state standards* *Need for teacher training specifically on how to obtain and use data in classes* *How to use the data so that it is meaningful*	4	16%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total is more than 100%.

Online #21. What are the best ways to overcome the barriers you checked above? (check all that apply)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	%
easy-to-use RTD lesson plans	20	80%
in-service teacher training/professional development	18	72%
better promotion & awareness that RTD is available	15	60%
data visualization/formatting for education use	15	60%
consistent data availability	9	36%
pre-service teacher training	8	32%
national ocean literacy standards	8	32%
systemwide science education reform	8	32%
greater data availability	8	32%
greater accessibility to computers/Internet in schools	5	20%
other *(please specify)* *don't know* *state standards* *you can't make a teacher do this, they have to be personally interested for themselves or the ed value*	3	12%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total is more than 100%.

Dissemination of Ed Product(s)

Reaching teachers with such a product is of course important and so we asked stakeholders for their thoughts on the dissemination of a RTD education product.

Interview Question: What are your thoughts about how to disseminate these ed products, that is, how do you get them to teachers and in what format(s)?

There was general agreement that dissemination should be well planned and comprehensive. Several mentioned that this is not just a product, but also a program that needs professional production and support. Most everyone suggested using all avenues at NOAA's disposal, including working with teachers directly through professional development sessions and local and national conferences/meetings (NSTA, NMEA, etc.) and working with partners (NSF, Sea Grant, COSEEs, NASA, ORION, the regional OOS, universities, informal education sites, etc.).

There was general agreement that the main access be through the Internet, but also be made available as CDs and in print. One person suggested working with a textbook publisher and another suggesting working with TV/radio/Internet programs to make teachers and students aware of what's available. One person suggested looking at dissemination to multicultural audiences via community groups.

Several people offered that the product and its dissemination be measured/evaluated so it could be improved and so that its impact (assuming positive) could be promoted. Online respondents generally agreed and their percentages offer some prioritization.

Online #19. What do you think are the best ways to reach K-12 teachers with education products based on RTD? (check all that apply)

Note: For this question responses were presented in random order to each respondent to address the issue of reading order bias, that is, respondents selecting responses occurring at the top of the list.

Response Choices	*Frequency n = 27*	*%*
in-service training	19	76%
package for easy use	18	72%
conference presentations/workshops	17	68%
align with state standards	17	68%
tie to local issues/events	16	64%
show they make learning interesting/engaging for students	16	64%
integrate with state curriculum/textbooks	13	52%
tie to current events	12	48%
pre-service training	11	44%
show they improve student test scores	11	44%
other *(please specify)* *Offer graduate credit and stipend for training and require follow up where teachers report on using RTD* *Align with National Science Ed Standards*	2	8%
skipped/no answer	2	—

Note: This multiple-choice question invited more than one response, and so the total is more than 100%.

Want to Know

At the end of the interview and the online survey we asked stakeholders about their interests regarding a front-end evaluation of K-12 teachers' needs.

Interview Question: Based on what you know about this assessment, what decisions do you hope to/want to be able to make using the results from this assessment project? Any particular questions/issues that you'd like answered?

Online #23. What would you like to know about how K-12 teachers use RTD in their classrooms?

The comments raised by the two questions above are for the most part handled by the remainder of this report. Those that are not answered in this report are listed in the Next Questions section. You can find all the comments to #23 in Appendix 12.

Other Comments

We asked stakeholders if they had any additional comments, anything they hadn't discussion that they'd like to say.

Interview Question: Before we end this interview, do you have any other thoughts/comments about SWMP/IOOS data (RTD), ed products or this assessment that you'd like to mention that we haven't addressed yet?

Most of the interviewees covered issues that they (or someone else) had mentioned previously. Several people mentioned the need to document what it takes to get RTD into classrooms (time, resources and effective lessons) and make those data relevant, then share that information broadly. One person was not convinced that RTD was an effective teaching tool.

A couple of people had questions about students and what they can handle—what's relevant, what's grade/age appropriate, what's technically feasible?

Several people were concerned about the exclusion of general public and informal educators from this study. (The evaluator explained that the resources didn't allow a study of all potential audiences for SWMP/IOOS data.)

One person wanted to know how to make coastal (ocean and estuary) data as relevant as weather data in people's lives. Another wanted to know which data would be part of this project—which ones would be relevant? There was also a question about this being a national program or a regional program and how to marry those two.

A couple of interviewees recognized the current "window of opportunity" for the NOAA education community to promote coastal (ocean and estuarine) RTD in K-12 education given the current national focus on the oceans and development of ocean observing systems nationwide. And one or two people were resigned to the fact that is a long-term effort that can only have the impact imagined with sustainable support, which is never guaranteed.

Online #24. Do you have any other comments/feedback about the use of RTD in K-12 classrooms?

See all of the online comments in Appendix 13.

Teachers' Views (Focus Groups)

The teacher focus group sessions were designed to address Objective 3, specifically to answer these questions:

- What's happening currently with potential users? What's their current use, needs, capabilities for SWMP/IOOS data?
- What's out there now that they're currently using and what's working or not working?
- What are their data visualization/formatting/presentation needs, based on what works and what doesn't?
- What are their educational products needs (lesson plans, etc.) and what are their formatting preferences for such products?
- How/where would these data fit into the curriculum (oceans, atmosphere, climate, humans & environment)?
- What enables them and what prevents them from using such data?

We held 7 focus groups at 5 locations nationwide during March, April and May 2006. A total of 72 teachers participated in focus groups. The sessions are listed below in order of date held.

Site	Location	Date	teacher #
Jacques Cousteau NERR *(pilot)*	Tuckerton, NJ	March 4, 2006	7
Weeks Bay NERR	Fairhope, AL	March 11	8
Elkhorn Slough NERR	Moss Landing, CA	April 8	8
COSEE-West, UCLA	Los Angeles, CA	April 22, 2006	15
Waquoit Bay NERR	Bourne, MA	May 13, 2006 a.m. & p.m.	13 9
Jacques Cousteau NERR	Tuckerton, NJ	May 20, 2006	12

We are reporting pre-workshop survey results below for 70 of 77 teachers. We had 2 non-classroom teachers attended focus groups, plus 5 teachers who completed a pre-workshop survey but did not attend a focus group. We have not include those responses in this analysis.

We are reporting results from all teachers and by two grade levels: middle school and high school. In some cases both middle school and high school include grade 9. If a teacher taught only grade 9 or grade 9 and below, we included those responses in middle school. If a teacher taught grade 9 and above, we included those responses in high school. We decided not to separately report elementary-school teachers' responses because we had very few of them (5 or fewer) and those who were all taught 6th grade as well, and so we included their responses in the middle-school category. The teachers participating in the focus groups were selected by the local site coordinators following the criteria that they teachers had to be using RTD in the classroom with their students (although a review of our pre-workshop surveys showed that the RTD experience of focus group participants ranged from none to weekly use).

<u>Pre-Meeting Online Survey Results</u>

Approximately two weeks before each focus group session, we asked teachers (via email) to complete an online pre-workshop survey. Those data were used to familiarize us with the participants and to gather information on their use of RTD in their classrooms. What follows are the results of the pre-workshop survey. *n = 70 unless otherwise noted*

1 & 2. Your name, and 5, 6, 7 & 8. Your school, school district, city & state
See Acknowledgments
3 & 4. Contact information: Not included in this report to ensure confidentiality & privacy

9. School setting (check one)

Response Choices	*Frequency*	*%*
rural	10	14%
suburban	43	61%
urban	17	24%

10. What is the racial/ethnic mix of students at your school? (approximations okay)

Response Summary	*Frequency*	*%*
mostly White (60%+)	40	57%
mixed population (nearly equal mixes of two or more ethnic/racial groups)	12	17%
mostly Hispanic (45%+)	11	16%
mostly Black/African American (50%+)	4	6%
no answer	3	4%

11. Which grade/grades are you teaching this year (2005-2006)? (check all that apply)

Response Summary	*Frequency n = 72*	*%*
Primary (K – 2)	0	0%
Elementary (3 – 5)	4	6%
Middle School (6-9)	31	43%
High School (9-12)	40	56%
Other	2	3%

Note: This multiple-choice question invited multiple responses, and so the total equals more than 100%.

12. Which subject/subjects are you teaching this year (2005-2006)?

Responses	*Frequency*	*%*
life science/biology/zoology	31	20%
science	23	15%
marine bio/oceanography	17	11%
math	10	6%
physical sci/physics	10	6%
environ sci/field study	9	6%
earth sci/geo sci	7	5%
computers/tech	6	4%
chemistry	6	4%
human bio/health	4	3%
botany/horticulture	2	1%
science research	1	1%
forensic sci	1	1%
honors/AP classes	18	12%
other than science (including English, language arts, physical ed, social science, art, regional planning)	10	6%

Note: This was an open-ended question and many respondents offered more than one response. Only the top responses are reported here and the total may equal more than 100%.

13. How many years have you been teaching?

Response Summary	*Frequency*	*%*
first year	2	3%
2	4	6%
3 to 5	10	14%
6 to 10	20	29%
11 to 15	9	13%
16 to 20	8	11%
21 to 25	6	9%
26 to 30	4	6%
30+	6	9%
no answer	1	1%

14. What is your training/schooling in the sciences? (check all that apply)

Response Choices	*Frequency*	*%*
None	1	1%
Inservice/professional development workshops	38	53%
Teaching credential with science emphasis	34	49%
BA/BS in a science field	47	67%
MA/MS in a science field	27	39%
PhD in a science field	0	0%
Other *(please specify)* *mostly additional details regarding education or work-related training*	15	21%

Note: This multiple-choice question invited more than one response, and so the total equals more than 100%.

15. What is your training/schooling in computer & technology use? (check all that apply)

Response Choices	*Frequency*	*%*
None	2	3%
Self-taught	62	89%
Inservice/professional development workshops	57	81%
College course(s)	36	51%
Teaching credential with computer/tech emphasis	6	9%
BA/BS in a computer/technology-related field	0	0%
MA/MS in a computer/technology-related field	0	0%
PhD in a computer/technology-related field	0	0%
Other *(please specify)* *mostly online courses and work experience as a programmer, engineer, etc.*	8	11%

Note: This multiple-choice question invited more than one response, and so the total equals more than 100%.

16 & 17. What's the computer set up at school? & How many computers in each?

Most teachers had a computer in the classroom, but not all. Middle school and high school had equal access to computers. And middle-school teachers used them slightly more than high-school teachers. Middle-school teachers also used the Internet more regularly. Home use for assignments was generally not a part of school lessons.

Responses	*Frequency*	%	*# Range*	*Avg.*
Computers in my classroom	61	87%	1 to 30	5
Computer(s) in a computer lab	64	91%	8 to 90	27
Computer(s) in the library/media center	48	69%	2 to 40	18
Other *(please specify)* *portable carts* *other labs*	10	14%	8 to 27	17

By grade: Middle School (6 to 9)

Responses	*Frequency*	%	*# Range*	*Avg.*
Computers in my classroom	27	33%	1 to 30	4
Computer(s) in a computer lab	30	36%	12 to 60	27
Computer(s) in the library/media center	20	24%	2 to 40	16
Portable cart	5	6%	12 to 24	17
Other *(please specify)*	1	1%	—	—

By grade: High School (9 to 12)

Responses	*Frequency*	%	*# Range*	*Avg.*
Computers in my classroom	35	34%	1 to 29	6
Computer(s) in a computer lab	35	34%	6 to 90	26
Computer(s) in the library/media center	28	27%	2 to 40	20
Portable cart	2	2%	8 to 25	17
Other *(please specify)*	2	2%	—	—

18. How regularly do you have your students use computers at school as part of their lessons? (check one)

Response Choices	*Frequency*	%
never	0	0%
rarely	7	10%
sometimes	19	27%
often (monthly)	23	33%
regularly (weekly)	21	30%

By grades

Response Choices	*Mid School Frequency n = 31*	%	*Hi School Frequency n = 40*	%
never	0	0%	0	0%
rarely	3	10%	4	10%
sometimes	8	26%	12	30%
often (monthly)	10	32%	13	33%
regularly (weekly)	10	32%	11	28%

19. How regularly do you have your students use the Internet/websites at school as part of their lessons? (check one)

Response Choices	*Frequency*	*%*
never	0	0%
rarely	8	11%
sometimes	19	27%
often (monthly)	25	36%
regularly (weekly)	18	26%

By grades

Response Choices	*Mid School Frequency n = 31*	*%*	*Hi School Frequency n = 40*	*%*
never	0	0%	0	0%
rarely	3	10%	5	13%
sometimes	8	26%	11	28%
often (monthly)	10	32%	15	38%
regularly (weekly)	10	32%	9	23%

20. How regularly do you have your students use the Internet/websites at home as part of their lessons? (check one)

Response Choices	*Frequency*	*%*
never	4	6%
rarely	10	14%
sometimes	23	33%
often (monthly)	18	26%
regularly (weekly)	15	21%

By grades

Response Choices	*Mid School Frequency n = 31*	*%*	*Hi School Frequency n = 40*	*%*
never	2	6%	2	5%
rarely	3	10%	7	18%
sometimes	12	39%	11	28%
often (monthly)	9	29%	9	23%
regularly (weekly)	5	16%	11	28%

*21. How regularly do you have your students use real-time (or near-real-time) data** as part of their lessons? (check one) **Note: We're defining real-time (or near-real-time) data as data that you can access as the data are being collected, or shortly thereafter, to study current conditions or events.*

Response Choices	*Frequency*	*%*
never	16	23%
rarely	16	23%
sometimes	22	31%
often (monthly)	9	13%
regularly (weekly)	7	10%

By grades

Response Choices	*Mid School Frequency n = 31*	%	*Hi School Frequency n = 40*	%
never	5	16%	11	28%
rarely	10	32%	6	15%
sometimes	5	16%	18	45%
often (monthly)	8	26%	1	3%
regularly (weekly)	3	10%	4	10%

22. *If you have used real-time/near-real-time data in your teaching, please tell us what kind of data and from which sources?*

Responses	*Frequency n = 44*	%
data from Internet sources	27	61%
student-collected data	23	52%
weather data	16	36%
NOAA data sources	8	18%
earthquake/seismic/USGS data	5	11%
COOLClassroom	5	11%
data on gases (DO, CO2)	5	11%
water quality data	4	9%
classroom labs/experiments	4	9%
local pond study	3	7%
data for science fair projects or research	3	7%
NASA data	3	7%
water temperature studies	3	7%

Note: This was an open-ended question and many respondents offered more than one response. Only the top responses are reported here and the total may equal more than 100%. See Appendix 10 for all the data sources described by teachers here and in focus group sessions.

By grades

Responses	*Mid School Frequency n = 23*	%	*Hi School Frequency n = 22*	%
data from Internet sources	13	57%	14	64%
student-collected data	14	61%	10	45%
weather data	11	48%	5	23%
NOAA data	2	9%	6	27%
earthquake/seismic/USGS data	4	17%	1	5%
COOLClassroom	4	17%	1	5%
local pond study	3	13%	0	0%
water temperature studies	3	13%	0	0%
data for science fair projects or research	3	13%	0	0%
data on gases (DO, CO2)	2	9%	3	14%
classroom labs/experiments	1	4%	3	14%
NASA data	0	0%	3	14%
water quality data	2	9%	2	9%

23. With which of these real-time/near-real-time data streams are you familiar? (check all that apply)

Response Choices	*Frequency*	%
temperature: water	49	67%
temperature: air	42	60%
pH	36	51%
salinity	33	47%
dissolved oxygen (DO)	33	47%
currents	27	39%
animal tagging/tracking*	19	34%
turbidity (clarity/cloudiness)	23	33%
algal blooms	23	33%
water depth	20	29%
water quality	19	27%
video/live camera*	15	27%
fish species & abundance	16	23%
zooplankton species	15	21%
waves	15	21%
wind vector	14	20%
water level/sea level**	12	17%
nutrients	12	17%
bathymetry/topography	12	17%
ocean color	11	16%
vector currents	9	13%
water contaminants	6	9%
river discharge	6	9%
optical properties	6	9%
directional wave spectra	3	4%
ice concentration	2	3%
seafood contaminants	1	1%
other	18	26%

Note: This multiple-choice question invited respondents to check more than one response, and so the total equals more than 100%.

Note: The list on the survey is largely based on the provisional IOOS core variables [from page 20 of the First U.S. Integrated Ocean Observing System (IOOS) Development Plan] available at http://www.ocean.us/documents/docs/IOOSDevPlan_low-res.pdf.

24. *Which of these real-time/near-real-time data streams have you used in your teaching? (check all that apply)*

Response Choices	*Frequency*	%
temperature: water	32	46%
temperature: air	30	43%
pH	25	36%
salinity	22	31%
dissolved oxygen	16	23%
currents	16	23%
algal blooms	13	19%
water quality	12	17%
zooplankton species	10	14%
waves	9	13%
ocean color	9	13%
video/live camera*	8	11%
turbidity	8	11%
nutrients	8	11%
bathymetry/topography	8	11%
animal tag/tracking*	8	11%
wind vector	7	10%
water depth	7	10%
water/sea level**	6	9%
water contaminants	5	7%
vector currents	5	7%
fish species & abundance	5	7%
river discharge	3	4%
optical properties	3	4%
seafood contaminants	2	3%
ice concentration	2	3%
directional wave spectra	2	3%
none	9	13%
other	10	14%

Note: This multiple-choice question invited respondents to check more than one response, and so the total equals more than 100%.

Note: The list on the survey is largely based on the provisional IOOS core variables [from page 20 of the First U.S. Integrated Ocean Observing System (IOOS) Development Plan] available at http://www.ocean.us/documents/docs/IOOSDevPlan_low-res.pdf.

By grades

Response Choices	*Mid School Frequency n = 23*	*%*	*Hi School Frequency n = 22*	*%*
temperature: air	17	55%	13	33%
temperature: water	17	55%	15	38%
pH	11	35%	14	35%
currents	8	26%	8	20%
dissolved oxygen	8	26%	8	20%
water quality	7	23%	5	13%
animal tag/tracking*	5	16%	3	8%
salinity	5	16%	17	43%
zooplankton species	4	13%	6	15%
turbidity	4	13%	4	10%
ocean color	4	13%	5	13%
algal blooms	4	13%	10	25%
wind vector	3	10%	4	10%
nutrients	3	10%	5	13%
video/live camera*	3	10%	5	13%
water contaminants	3	10%	2	5%
water depth	3	10%	4	10%
waves	3	10%	6	15%
optical properties	2	6%	1	3%
bathymetry/topography	2	6%	6	15%
seafood contaminants	2	6%	0	0%
river discharge	2	6%	1	3%
fish species & abundance	2	6%	3	8%
vector currents	2	6%	3	8%
water/sea level**	2	6%	4	10%
ice concentration	1	3%	1	3%
directional wave spectra	0	0%	2	5%
none	3	10%	6	15%
other *(please specify)*	3	10%	7	18%

Note: These data are sorted based on descending order of middle-school teachers' responses.

Focus Group Discussion: Current RTD Use

At the beginning of each focus group session, we asked teachers to tell us about the real-time data they were currently using with their students. Teachers described much of the same types and sources of data as in their pre-workshop surveys.

In all seven focus group sessions one or more teachers talked about weather data, either daily weather patterns or tracking events, such as hurricanes. All obtained at least some data from a local or national weather channel, newspaper or Internet sources (Weather.com, Weather Bug, NOAA, etc.). Four of the seven groups discussed students collecting data and monitoring weather via the school weather station/sensors.

In six of the seven groups one or more teachers talked about collecting water-quality data. In all cases these data were student collected and analyzed. These included measuring dissolved oxygen (DO), pH and/or nitrites. Several teachers discussed local pond studies in which they've engaged their students. In three groups teachers mentioned students collecting and analyzing salinity. In five of the seven groups teachers talked about students collecting data on local organisms (sand crabs, insects, fish and/or plankton).

For the teachers who had their students collecting data, this was an important way of introducing their students to the concept of data (unfamiliar to many at the middle-school level), got them engaged because it was something hands-on and became something personal, connected them to their local environment and in some cases to the community, and engaged them in science as a process.

Other data types/sources mentioned by a few teachers included: air temperature (as part of weather studies and GLOBE network projects), sea surface temperature (from satellites and ocean buoys), currents & tides, earthquakes (primarily USGS data). One teacher has her students track sea turtles via the Internet. We received so many suggestions that rather than list all of them in this report, we've developed an annotated list of the currently available RTD online resources and posted it online at http://marine.rutgers.edu/outreach/rtd/.

During this discussion teachers also talked about the challenges they face when using RTD with their students. During three of the seven sessions the main challenges were technological: teachers did not have access to enough computers for student work, had no or limited Internet access, and/or had computers that purposely were not fully functional (inoperable sound cards, restrictions on downloading software, site blockers to protect students, etc.). Teachers also discussed their problems with unpredictable/unreliable websites, especially during limited, scheduled lab time. If all students try to enter a site at once, students experience slowdowns due to bottlenecks (either on the school's side or the website side) and become easily frustrated. If a site is down during a scheduled lab time, the lesson is lost. And because most teachers work on tight time schedules their students have little or no time for exploration in labs (or in the field).

During all seven sessions teachers talked about the importance of the data being relevant to students' lives and experiences. Some were concerned that online data would be too abstract for their students, and teachers didn't necessarily have the time to make the relevant connections. Those teachers who have students collecting data felt that student-collected data combined real-time and relevance.

In all of the focus groups teacher discussed the need to have materials that are appropriate for their students. In three focus groups teachers specifically requested materials for students with limited reading skills and/or limited English language proficiency.

In only one group did a teacher mention the reluctance of teachers to use a new technology or teach in a different way. That seemed to be less of a concern that the issues of time and technology access/management.

In all seven of the groups teachers talked about why they use RTD in their teaching, why it is important to them despite the many obstacles they encounter. (All groups responded to this issue even though this question was asked specifically of only three of the seven groups). The most often mentioned reason for using RTD was relevance—real-time data makes what happens in the classroom relevant to students' lives. It brings the real world into the classroom whether they're monitoring a schoolyard weather station, or testing and reporting on the water quality of a local pond, or tracking a hurricane. It also connects them to their future as citizens faced with questions that need analysis in their roles as decision makers, voters, and possibly scientists. Connecting students to what's real was the reason teachers use RTD in their lessons.

In five of the seven groups teachers addressed the issue of local versus national data. Several teachers (in particular middle-school teachers) felt it was important for students to understand data first, then become familiar with and understand local data. With that foundation, students could then use Internet-based local or national data for baseline or cross-site comparisons, for understanding broader systemwide concepts and issues, and/or for investigating issues that they can't investigate locally.

Focus Group Activities: Where Do RTD Fit?

To learn where real-time data fit into the lesson planning and teaching process, we asked teachers in every focus group to participate in three activities. First, we asked them to write a brief (one-page) essay answering the question: At what stage(s) of your lesson planning & teaching process do your use RTD? Where do RTD fit?

Next, we asked teachers to use a "graphic organizer" (See Appendix 7) to map out for us where RTD (as they're currently using them) fit into their teaching by writing RTD in/on the bubbles on a provided sheet (for the few not currently using RTD, we asked them where such data would likely fit). Then we showed them a brief PowerPoint presentation (see Appendix 8) defining and discussing what's happening with SWMP/IOOS data. After the PowerPoint presentation, we asked teachers to again use the graphic organizer, providing a second sheet, to show us where SWMP/IOOS data would fit into their lesson planning/teaching process. Those results are reported on the next page.

Essay Results

We analyzed the essays by categorizing teachers comments (i.e., I start with RTD then develop a lesson, or I start with a unit concept then look for RTD to support it, etc.), then tallied the number of times each category arose in the entire set of essays. Those results are reported below.

The majority of teachers (45%) said they start their teaching process with a unit or a concept that they need to teach, then look for RTD to support their teaching, to illustrated the concept to their students. High-school teachers were more likely to take this approach than middle-school teachers (48% vs. 39% respectively).

The next category with the greatest responses was an “it-all-depends” category. In their essays teachers described using real-time data in various stages of the teaching process depending on the topic, the goals of the unit/lessons, students’ needs and the RTD. Overall 15% of teachers said they had used RTD at the beginning of a lesson to “hook” students, in the middle to illustrate concepts and at the end as a culmination piece, to bring home main point of a lesson. High-school and middle-school teachers were nearly the same in describing this approach (19% and 17% respectively).

Using RTD primarily at the end of the teaching process was mentioned by 14% of teachers to help students apply what they had learned from lectures or the textbook. Middle-school teachers were much more likely to use this approach than high-school teachers (23% vs. 7% respectively). About 6% (mostly high-school teachers) mentioned having students analyze data as part of a unit assessment.

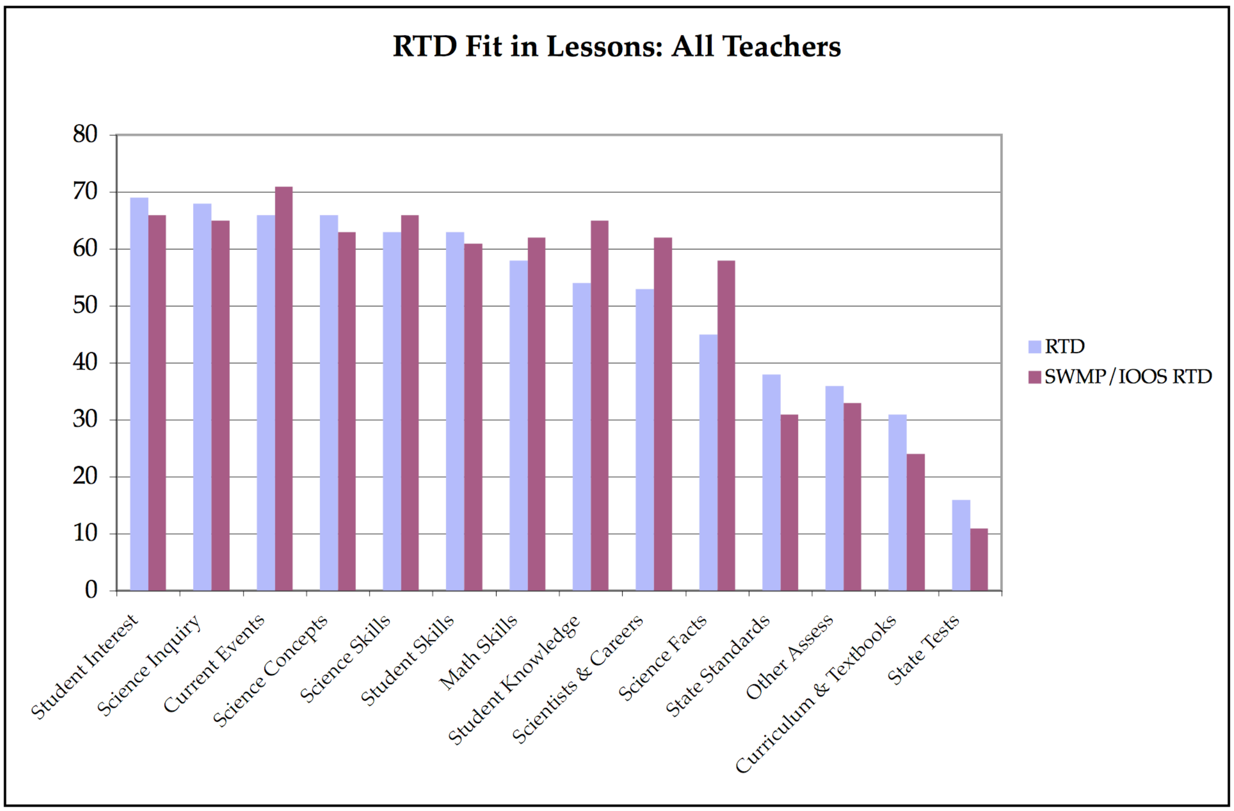
In 10% of the essays, mostly those of middle-school teachers (16% vs. 5%), they wrote about RTD in student inquiry/research projects. These two categories appeared in 8% of the essays: starting with RTD and relevance of RTD. For starting with RTD, high-school teachers mostly (12% vs. 3%) use that approach to engage their students at the beginning of a lesson. The use of RTD to bring the “real” world or science into the classroom was mentioned mostly by middle-school teachers (13% vs. 5%).

About 7% (mostly middle-school teachers) wrote about using RTD to teach skills, primarily graphing or learning to collect data. On the essays only three teachers mentioned considering state standards, and only one mentioned starting with the state standards.

Graphic Organizer (Mapping) Results

These tallies show the percentage of teachers who wrote RTD on/in the bubbles of the graphic organizer (Appendix 7) to show where the RTD they’re currently using fit in their teaching (the first mapping activity) and where SWMP/IOOS RTD would likely fit in their teaching (the second mapping activity after the PowerPoint presentation). The tables and graphs follow on the next few pages.

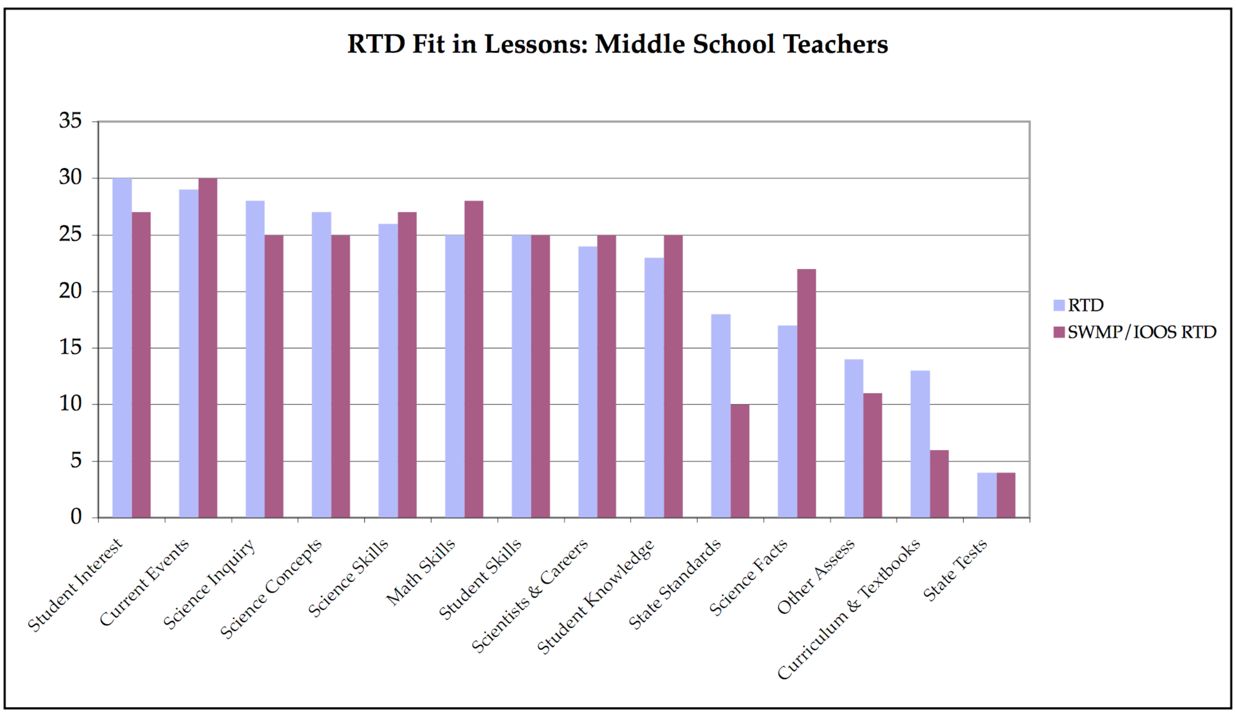
Response Choices	*Current RTD Fit Frequency*	*%*	*SWMP/IOOS RTD fit Frequency*	*%*
student interest	69	96%	66	92%
science inquiry	68	94%	65	90%
current events	66	92%	71	99%
science concepts	66	92%	63	88%
science skills	63	88%	66	92%
student skills	63	88%	61	85%
math skills	58	81%	62	86%
student knowledge	54	75%	65	90%
scientists & careers	53	74%	62	86%
science facts	45	63%	58	81%
state standards	38	53%	31	43%
other assessment	36	50%	33	46%
curriculum & textbooks	31	43%	24	33%
state tests	16	22%	11	15%



The next two pages show the break out of these data by grade levels.

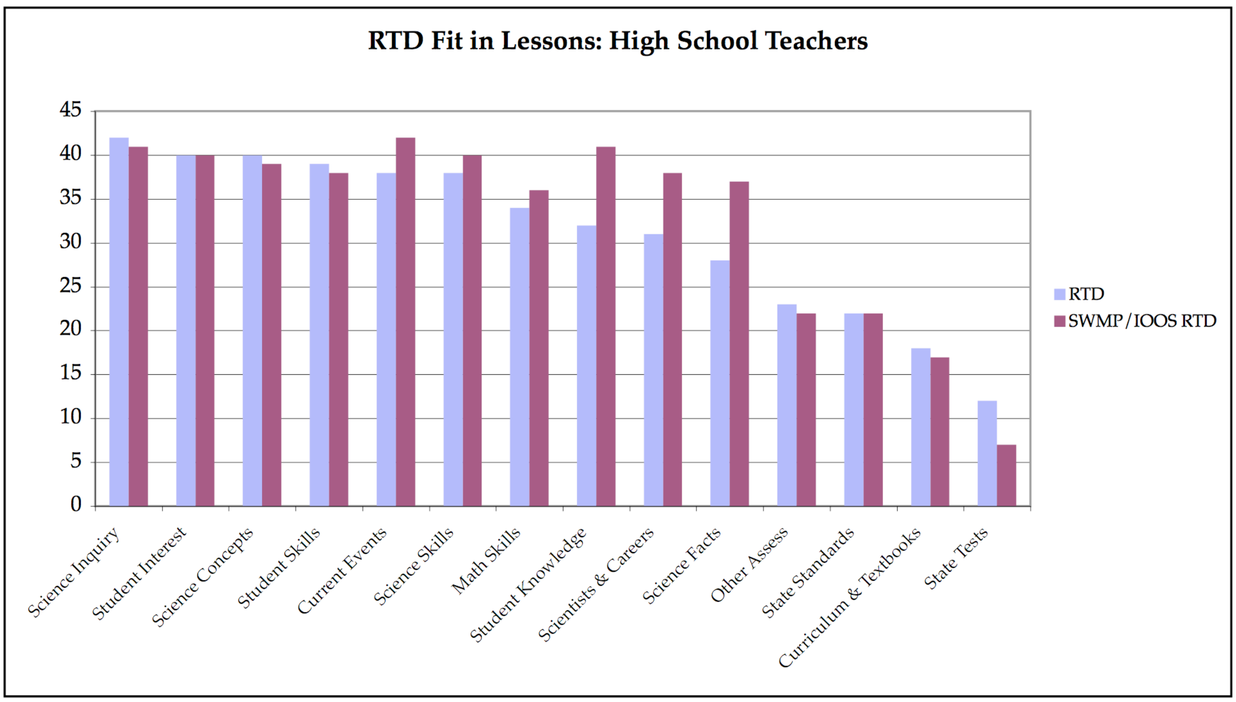
By grades: Middle School

Middle School Teachers' Response Choices	*Current RTD Fit Frequency*	*%*	*SWMP/IOOS RTD fit Frequency*	*%*
student interest	30	100%	27	90%
current events	29	97%	30	100%
science inquiry	28	93%	25	83%
science concepts	27	90%	25	83%
science skills	26	87%	27	90%
math skills	25	83%	28	93%
student skills	25	83%	25	83%
scientists & careers	24	80%	25	83%
student knowledge	23	77%	25	83%
state standards	18	60%	10	33%
science facts	17	57%	22	73%
other assessment	14	47%	11	37%
curriculum & textbooks	13	43%	6	20%
state tests	4	13%	4	13%



By grades: High School

High School Teachers' Response Choices	*Current RTD Fit Frequency*	*%*	*SWMP/IOOS RTD fit Frequency*	*%*
science inquiry	42	98%	41	95%
student interest	40	93%	40	93%
science concepts	40	93%	39	91%
student skills	39	91%	38	88%
current events	38	88%	42	98%
science skills	38	88%	40	93%
math skills	34	79%	36	84%
student knowledge	32	74%	41	95%
scientists & careers	31	72%	38	88%
science facts	28	65%	37	86%
other assessment	23	53%	22	51%
state standards	22	51%	22	51%
curriculum & textbooks	18	42%	17	40%
state tests	12	28%	7	16%



Focus Group Activity: Review of RTD Websites

Because we wanted the discussions to be concrete rather than abstract, we chose two websites that present RTD to the public in different ways to serve as "models" of online education products for teachers to review. The websites were NOAA's Centralized Data Management Office (CDMO) with SWMP data and Maryland Department of Natural Resources Eyes on the Bay website with Chesapeake Bay data. *(Note: this review occurred from March to May 2006 and so teachers' comments regarding are for that time period and do not reflect any recent website upgrades.)*

We divided each focus group into two and asked half the group to review the CDMO site and half to review the Eyes on the Bay site for approximately 20 minutes. After 15 minutes we reminded them that they would be switching sites in 5 minutes and asked them to complete a feedback form (see Appendix 9) on the website they were reviewing. At the end of 20 minutes we asked them to switch websites, and follow the same timing and procedure for the second review. Teachers could work alone or in groups on this activity, but each were to complete a feedback form on the websites they viewed.

Note: This activity was designed primarily to prime teachers for our wrap-up discussion on their needs and the best features for a RTD education product. The activity was not designed as a formative evaluation of either website. Twenty minutes is not an adequate amount of time for a teacher to review all of the features that a website has to offer. The use of the websites served our purpose, which was to stimulate discussion. We've included all the website feedback responses here for those responsible for these websites in case they wish to investigate further some of the issues raised by the teachers.

Most teachers were unfamiliar with these websites. It was easier for them to find data on the Eyes on the Bay website. Middleschool teachers had a slightly easier time than high-school teachers. Both groups had navigation issues, more with the CDMO site than Eyes on the Bay.

1. *Have you ever visited this website before or used it in your teaching? (check one)*

Response Choices	*All Frequency n = 140*	*%*	*CDMO Frequency n = 70*	*%*	*EoBay Frequency n = 70*	*%*
yes, have visited	5	4%	3	4%	2	3%
yes, have used it	1	1%	1	1%	0	0%
no, neither	129	92%	63	90%	66	94%
not sure	0	0%	0	0%	0	0%
no answer	5	4%	3	4%	2	3%

2. *How easy was it for you to find the real-time (near-real-time) data on this site? (circle a number from 1 = not easy to 7 = very easy)*

Response Choices	*All Frequency n = 136*	*%*	*CDMO Frequency n = 68*	*%*	*EoBay Frequency n = 68*	*%*
1 = not easy	7	5%	7	10%	0	0%
2	9	7%	8	12%	1	1%
3	4	3%	4	6%	0	0%
4	17	13%	12	18%	5	7%
5	18	13%	11	16%	7	10%
6	19	14%	8	12%	11	16%
7 = very easy	62	46%	18	26%	44	65%
average		*5.5*		*4.6*		*6.3*

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 39*	*%*
1 = not easy	1	3%	6	15%
2	3	10%	5	13%
3	3	10%	1	3%
4	5	17%	8	21%
5	4	14%	7	18%
6	3	10%	5	13%
7 = very easy	10	34%	7	18%
average		*5.1*		*4.3*

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 28*	*%*	*Hi School Frequency n = 40*	*%*
1 = not easy	0	0%	0	0%
2	1	4%	0	0%
3	0	0%	0	0%
4	3	11%	2	5%
5	1	4%	6	15%
6	5	18%	7	18%
7 = very easy	18	64%	25	63%
average		*6.2*		*6.4*

3. Rate each of these usability issues for this website. (circle one choice for each issue)

Issue: From the beginning, I knew where to go to find what I was looking for.	*All Frequency n = 137*	*%*	*CDMO Frequency n = 68*	*%*	*EoBay Frequency n = 69*	*%*
0 = never/not at all	6	4%	5	7%	1	1%
1 = sometimes	43	31%	27	40%	16	23%
2 = most of the time	60	44%	28	41%	32	46%
3 = always	28	20%	8	12%	20	29%
na = doesn't apply	0	0%	0	0%	0	0%

By grades for CDMO (SWMP data)

Issue: From the beginning, I knew where to go to find what I was looking for.	*Mid School Frequency n = 28*	*%*	*Hi School Frequency n = 39*	*%*
0 = never/not at all	2	7%	3	8%
1 = sometimes	10	36%	18	46%
2 = most of the time	12	43%	14	36%
3 = always	4	14%	4	10%
na = doesn't apply	0	0%	0	0%

By grades for Eyes on the Bay

Issue: From the beginning, I knew where to go to find what I was looking for.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 40*	*%*
0 = never/not at all	0	0%	1	3%
1 = sometimes	7	24%	10	25%
2 = most of the time	11	38%	19	48%
3 = always	11	38%	10	25%
na = doesn't apply	0	0%	0	0%

Issue: I knew where I was as I moved through the site.	*All Frequency n = 137*	*%*	*CDMO Frequency n = 67*	*%*	*EoBay Frequency n = 70*	*%*
0 = never/not at all	5	4%	4	6%	1	1%
1 = sometimes	41	30%	27	40%	14	20%
2 = most of the time	57	42%	25	37%	32	46%
3 = always	34	25%	11	16%	23	33%
na = doesn't apply	0	0%	0	0%	0	0%

By grades for CDMO (SWMP data)

Issue: I knew where I was as I moved through the site.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 38*	*%*
0 = never/not at all	3	10%	1	3%
1 = sometimes	12	41%	17	45%
2 = most of the time	9	31%	14	37%
3 = always	5	17%	6	16%
na = doesn't apply	0	0%	0	0%

By grades for Eyes on the Bay

Issue: I knew where I was as I moved through the site.	*Mid School Frequency n = 30*	*%*	*Hi School Frequency n = 40*	*%*
0 = never/not at all	0	0%	1	3%
1 = sometimes	10	33%	4	10%
2 = most of the time	10	33%	21	53%
3 = always	10	33%	14	35%
na = doesn't apply	0	0%	0	0%

Issue: I found what I was looking for.	*All Frequency n = 137*	*%*	*CDMO Frequency n = 70*	*%*	*EoBay Frequency n = 69*	*%*
0 = never/not at all	9	6%	9	13%	0	0%
1 = sometimes	27	19%	20	29%	7	10%
2 = most of the time	57	41%	31	44%	26	38%
3 = always	45	32%	10	14%	35	51%
na = doesn't apply	1	1%	0	0%	1	1%

By grades for CDMO (SWMP data)

Issue: I found what I was looking for.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
0 = never/not at all	1	3%	8	20%
1 = sometimes	10	34%	12	29%
2 = most of the time	16	55%	14	34%
3 = always	2	7%	7	17%
na = doesn't apply	0	0%	0	0%

By grades for Eyes on the Bay

Issue: I found what I was looking for.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 39*	*%*
0 = never/not at all	0	0%	0	0%
1 = sometimes	3	10%	4	10%
2 = most of the time	11	38%	14	36%
3 = always	15	52%	20	51%
na = doesn't apply	0	0%	1	3%

Issue: The information was clear, easy to read.	*All Frequency n = 137*	*%*	*CDMO Frequency n = 69*	*%*	*EoBay Frequency n = 68*	*%*
0 = never/not at all	6	4%	6	9%	0	0%
1 = sometimes	25	18%	23	33%	2	3%
2 = most of the time	52	38%	25	36%	27	40%
3 = always	54	39%	15	22%	39	57%
na = doesn't apply	0	0%	0	0%	0	0%

By grades for CDMO (SWMP data)

Issue: The information was clear, easy to read.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 40*	*%*
0 = never/not at all	0	0%	6	15%
1 = sometimes	13	45%	12	30%
2 = most of the time	9	31%	15	38%
3 = always	7	24%	7	18%
na = doesn't apply	0	0%	0	0%

By grades for Eyes on the Bay

Issue: The information was clear, easy to read.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 39*	*%*
0 = never/not at all	0	0%	0	0%
1 = sometimes	0	0%	2	5%
2 = most of the time	11	38%	15	38%
3 = always	18	62%	22	56%
na = doesn't apply	0	0%	0	0%

Issue: I understood what kind of real data was available on this site.	*All Frequency n = 138*	*%*	*CDMO Frequency n = 70*	*%*	*EoBay Frequency n = 68*	*%*
0 = never/not at all	4	3%	4	6%	0	0%
1 = sometimes	24	17%	15	21%	9	13%
2 = most of the time	56	41%	34	49%	22	32%
3 = always	54	39%	17	24%	37	54%
na = doesn't apply	0	0%	0	0%	0	0%

By grades for CDMO (SWMP data)

Issue: I understood what kind of real data was available on this site.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
0 = never/not at all	1	3%	3	7%
1 = sometimes	7	24%	8	20%
2 = most of the time	13	45%	22	54%
3 = always	8	28%	8	20%
na = doesn't apply	0	0%	0	0%

By grades for Eyes on the Bay

Issue: I understood what kind of real data was available on this site.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 39*	*%*
0 = never/not at all	0	0%	0	0%
1 = sometimes	2	7%	8	21%
2 = most of the time	7	24%	13	33%
3 = always	20	69%	18	46%
na = doesn't apply	0	0%	0	0%

Issue: The data were presented in ways that I understood.	*All Frequency n = 127*	*%*	*CDMO Frequency n = 64*	*%*	*EoBay Frequency n = 63*	*%*
0 = never/not at all	3	2%	3	5%	0	0%
1 = sometimes	14	11%	13	20%	1	2%
2 = most of the time	50	39%	29	45%	21	33%
3 = always	60	47%	19	30%	41	65%
na = doesn't apply	0	0%	0	0%	0	0%
question not on pilot survey	12	—	6	—	6	—

By grades for CDMO (SWMP data)

Issue: The data were presented in ways that I understood.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 38*	*%*
0 = never/not at all	0	0%	3	8%
1 = sometimes	7	27%	6	16%
2 = most of the time	14	54%	15	39%
3 = always	5	19%	14	37%
na = doesn't apply	0	0%	0	0%
question not on pilot survey	3	—	3	—

By grades for Eyes on the Bay

Issue: The data were presented in ways that I understood.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 37*	*%*
0 = never/not at all	0	0%	0	0%
1 = sometimes	1	4%	0	0%
2 = most of the time	5	19%	15	41%
3 = always	20	77%	22	59%
na = doesn't apply	0	0%	0	0%
question not on pilot survey	3	—	3	—

Issue: The data were presented in ways that I could use.	*All Frequency n = 124*	*%*	*CDMO Frequency n = 64*	*%*	*EoBay Frequency n = 60*	*%*
0 = never/not at all	6	5%	6	9%	0	0%
1 = sometimes	29	23%	23	36%	6	10%
2 = most of the time	40	32%	18	28%	22	37%
3 = always	48	39%	16	25%	32	53%
na = doesn't apply	1	1%	1	2%	0	0%
question not on pilot survey	12	—	6	—	6	—

By grades for CDMO (SWMP data)

Issue: The data were presented in ways that I could use.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 38*	*%*
0 = never/not at all	3	12%	3	8%
1 = sometimes	12	46%	11	29%
2 = most of the time	7	27%	11	29%
3 = always	4	15%	12	32%
na = doesn't apply	0	0%	1	3%
question not on pilot survey	3	—	3	—

By grades for Eyes on the Bay

Issue: The data were presented in ways that I could use.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 34*	*%*
0 = never/not at all	0	0%	0	0%
1 = sometimes	2	8%	3	9%
2 = most of the time	8	31%	14	41%
3 = always	16	62%	17	50%
na = doesn't apply	0	0%	0	0%
question not on pilot survey	3	—	3	—

Issue: The site presented the information I needed to understand the data.	*All Frequency n = 123*	*%*	*CDMO Frequency n = 63*	*%*	*EoBay Frequency n = 60*	*%*
0 = never/not at all	4	3%	4	6%	0	0%
1 = sometimes	21	17%	17	27%	4	7%
2 = most of the time	44	36%	27	43%	17	28%
3 = always	54	44%	15	24%	39	65%
na = doesn't apply	0	0%	0	0%	0	0%
question not on pilot survey	12	—	6	—	6	—

By grades for CDMO (SWMP data)

Issue: The site presented the information I needed to understand the data.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 37*	*%*
0 = never/not at all	2	8%	2	5%
1 = sometimes	10	38%	9	24%
2 = most of the time	9	35%	17	46%
3 = always	5	19%	9	24%
na = doesn't apply	0	0%	0	0%
question not on pilot survey	3	—	3	—

By grades for Eyes on the Bay

Issue: The site presented the information I needed to understand the data.	*Mid School Frequency n = 25*	*%*	*Hi School Frequency n = 35*	*%*
0 = never/not at all	0	0%	0	0%
1 = sometimes	1	4%	2	6%
2 = most of the time	5	20%	12	34%
3 = always	19	76%	21	60%
na = doesn't apply	0	0%	0	0%
question not on pilot survey	3	—	3	—

Issue: I felt frustrated using the site.	*All Frequency n = 137*	*%*	*CDMO Frequency n = 70*	*%*	*EoBay Frequency n = 67*	*%*
0 = never/not at all	59	43%	16	23%	43	64%
1 = sometimes	56	41%	36	51%	20	30%
2 = most of the time	14	10%	13	19%	1	1%
3 = always	5	4%	4	6%	1	1%
na = doesn't apply	3	2%	1	1%	2	3%

By grades for CDMO (SWMP data)

Issue: I felt frustrated using the site.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
0 = never/not at all	3	10%	12	29%
1 = sometimes	21	72%	17	41%
2 = most of the time	5	17%	8	20%
3 = always	0	0%	3	7%
na = doesn't apply	0	0%	1	2%

By grades for Eyes on the Bay

Issue: I felt frustrated using the site.	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 38*	*%*
0 = never/not at all	19	66%	24	63%
1 = sometimes	9	31%	10	26%
2 = most of the time	0	0%	1	3%
3 = always	0	0%	1	3%
na = doesn't apply	1	3%	2	5%

Issue: I was overwhelmed by the data on this site.	*All Frequency n = 123*	*%*	*CDMO Frequency n = 62*	*%*	*EoBay Frequency n = 61*	*%*
0 = never/not at all	80	65%	40	65%	40	66%
1 = sometimes	30	24%	15	24%	15	25%
2 = most of the time	6	5%	4	6%	2	3%
3 = always	4	3%	1	2%	3	5%
na = doesn't apply	3	2%	2	3%	1	2%
question not on pilot survey	12	—	6	—	6	—

By grades for CDMO (SWMP data)

Issue: I was overwhelmed by the data on this site.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 36*	*%*
0 = never/not at all	13	50%	28	78%
1 = sometimes	11	42%	4	11%
2 = most of the time	2	8%	2	6%
3 = always	0	0%	0	0%
na = doesn't apply	0	0%	2	6%
question not on pilot survey	3	—	3	—

By grades for Eyes on the Bay

Issue: I was overwhelmed by the data on this site.	*Mid School Frequency n = 26*	*%*	*Hi School Frequency n = 35*	*%*
0 = never/not at all	17	65%	23	66%
1 = sometimes	9	35%	6	17%
2 = most of the time	0	0%	2	6%
3 = always	0	0%	3	9%
na = doesn't apply	0	0%	1	3%
question not on pilot survey	3	—	3	—

4. Thinking about how you use real-time data in your teaching, how useful would this website be to you? (circle a number from 1 = not useful to 7 = extremely useful)

Response Choices	*All Frequency n = 139*	*%*	*CDMO Frequency n = 69*	*%*	*EoBay Frequency n = 70*	*%*
1 = not useful	12	9%	9	13%	3	4%
2	10	7%	8	12%	2	3%
3	11	8%	5	7%	6	9%
4	15	11%	8	12%	7	10%
5	24	17%	14	20%	10	14%
6	28	20%	12	17%	16	23%
7 = extremely useful	39	28%	13	19%	26	37%
average		*4.9*		*4.4*		*5.4*

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 28*	*%*	*Hi School Frequency n = 41*	*%*
1 = not easy	2	7%	7	17%
2	4	14%	4	10%
3	4	14%	1	2%
4	7	25%	2	5%
5	4	14%	11	27%
6	5	18%	6	15%
7 = very easy	2	7%	10	24%
average		*4.1*		*4.5*

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 30*	*%*	*Hi School Frequency n = 40*	*%*
1 = not easy	2	7%	2	5%
2	1	3%	1	3%
3	2	7%	4	10%
4	2	7%	4	10%
5	6	20%	4	10%
6	5	17%	12	30%
7 = very easy	12	40%	13	33%
average		*5.5*		*5.4*

5. How does this website compare to other real-time (near-real-time) data sites that you've used? (circle a number from 1 to 7)

Response Choices	*All Frequency n = 117*	*%*	*CDMO Frequency n = 60*	*%*	*EoBay Frequency n = 57*	*%*
1 = not nearly as good	8	7%	8	13%	0	0%
2	9	8%	9	15%	0	0%
3	8	7%	5	8%	3	5%
4	14	12%	7	12%	7	12%
5	26	22%	15	25%	11	19%
6	31	26%	10	17%	21	37%
7 = much better than others	21	18%	6	10%	15	26%
average		*4.9*		*4.1*		*5.7*

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 24*	*%*	*Hi School Frequency n = 36*	*%*
1 = not easy	4	17%	4	11%
2	3	13%	6	17%
3	3	13%	2	6%
4	3	13%	5	14%
5	7	29%	7	19%
6	4	17%	6	17%
7 = very easy	0	0%	6	17%
average		*4.0*		*4.0*

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 39*	*%*
1 = not easy	0	0%	0	0%
2	0	0%	0	0%
3	0	0%	3	10%
4	2	8%	5	16%
5	5	20%	4	13%
6	11	44%	10	32%
7 = very easy	7	28%	9	29%
average		*5.9*		*5.5*

6. Was the website's real-time (near-real-time) data presented in a way that you could use with your students? (check one)

Response Choices	*All Frequency n = 136*	*%*	*CDMO Frequency n = 68*	*%*	*EoBay Frequency n = 68*	*%*
definitely	58	43%	18	26%	40	59%
probably	47	35%	25	37%	22	32%
not sure	22	16%	17	25%	5	7%
no	8	6%	8	12%	0	0%
no answer	1	1%	0	0%	1	1%

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
definitely	3	10%	15	37%
probably	12	41%	15	37%
not sure	11	38%	6	15%
no	3	10%	5	12%
no answer	0	0%	0	0%

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 30*	*%*	*Hi School Frequency n = 40*	*%*
definitely	17	57%	24	60%
probably	10	33%	12	30%
not sure	2	7%	3	8%
no	0	0%	0	0%
no answer	1	3%	1	3%

6b. Please explain your response above.

Responses: Positive	*All Frequency n = 129*	*%*	*CDMO Frequency n = 65*	*%*	*EoBay Frequency n = 64*	*%*
is student appropriate	15	12%	3	5%	12	19%
graphs and/or tables were useful	16	12%	5	8%	11	17%
visual/graphic format was good	11	9%	3	5%	8	13%
there's a lot here/great potential	9	7%	5	8%	4	6%
navigation was easy	9	7%	2	3%	7	11%
other: see Appendix 14 for all responses						

Responses: Negative	*All Frequency*	*%*	*CDMO Frequency*	*%*	*EoBay Frequency*	*%*
is not student appropriate	15	12%	12	18%	3	5%
too difficult for students to work w/ data	9	7%	6	9%	3	5%
hard to find the data	7	5%	7	11%	0	0%
needs to have local area data	7	5%	2	3%	5	8%
overwhelming/ too complex	7	5%	4	6%	3	5%
other: see Appendix 14 for all responses						

Note: This was an open-ended question and many respondents offered more than one response. Only the top responses are reported here and the total may equal more than 100%.

7. What parts/aspects of this website would be <u>most useful</u> to you and why?

Responses	*All Frequency n = 133*	*%*	*CDMO Frequency n = 67*	*%*	*EoBay Frequency n = 66*	*%*
interactive (place & data map)	20	15%	2	3%	18	27%
graphs, ability to compare	17	13%	11	16%	6	9%
real data	15	11%	5	7%	10	15%
lesson plans	14	11%	4	6%	10	15%
student appropriate	14	11%	6	9%	8	12%
good definition of terms & parameters	14	11%	4	6%	10	15%
other: see Appendix 15 for all responses						

Note: This was an open-ended question and many respondents offered more than one response. Only the top responses are reported here and the total may equal more than 100%.

8. *If you were confused or frustrated at any time using the website, please tell us what happened.*

Responses	*All Frequency n = 101*	*%*	*CDMO Frequency n = 57*	*%*	*EoBay Frequency n = 44*	*%*
yes, ran into some problems	82	81%	55	96%	27	61%
navigation issues	20	20%	15	26%	5	11%
no, didn't really have any problems	16	16%	2	4%	14	32%
overwhelming, too much at first	10	10%	1	2%	9	20%
would take lots of time to learn site/ prep for students	10	10%	5	9%	5	11%
locating the RTD	9	9%	9	16%	0	0%
other: see Appendix 16 for all responses						

Note: This was an open-ended question and many respondents offered more than one response. Only the top responses are reported here and the total may equal more than 100%.

9. *Would you use this website in your teaching?* (check one)

Response Choices	*All Frequency n = 136*	*%*	*CDMO Frequency n = 68*	*%*	*EoBay Frequency n = 68*	*%*
definitely	43	32%	15	22%	28	41%
probably	47	35%	21	31%	26	38%
not sure	30	22%	21	31%	9	13%
no	16	12%	11	16%	5	7%

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
definitely	5	17%	10	24%
probably	6	21%	17	41%
not sure	16	55%	5	12%
no	2	7%	9	22%

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 30*	*%*	*Hi School Frequency n = 40*	*%*
definitely	13	43%	15	38%
probably	12	40%	15	38%
not sure	4	13%	6	15%
no	1	3%	4	10%

10. Would you have your students use this website? (check one)

Response Choices	*All Frequency n = 136*	*%*	*CDMO Frequency n = 68*	*%*	*EoBay Frequency n = 68*	*%*
definitely	40	29%	13	19%	27	40%
probably	47	35%	22	32%	25	37%
not sure	33	24%	21	31%	12	18%
no	15	11%	12	18%	3	4%
no answer	1	1%	0	0%	1	1%

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
definitely	2	7%	11	27%
probably	8	28%	16	39%
not sure	16	55%	5	12%
no	3	10%	9	22%
no answer	0	0%	0	0%

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 30*	*%*	*Hi School Frequency n = 40*	*%*
definitely	12	40%	15	38%
probably	11	37%	15	38%
not sure	6	20%	7	18%
no	1	3%	2	5%
no answer	0	0%	1	3%

11. Would you recommend this website to another teacher to use? (check one)

Response Choices	*All Frequency n = 136*	*%*	*CDMO Frequency n = 68*	*%*	*EoBay Frequency n = 68*	*%*
definitely	60	44%	22	32%	38	56%
probably	45	33%	22	32%	23	34%
not sure	19	14%	12	18%	7	10%
no	11	8%	11	16%	0	0%
no answer	1	1%	1	1%	0	0%

By grades for CDMO (SWMP data)

Response Choices	*Mid School Frequency n = 29*	*%*	*Hi School Frequency n = 41*	*%*
definitely	7	24%	16	39%
probably	10	34%	13	32%
not sure	8	28%	4	10%
no	3	10%	8	20%
no answer	1	3%	0	0%

By grades for Eyes on the Bay

Response Choices	*Mid School Frequency n = 30*	*%*	*Hi School Frequency n = 40*	*%*
definitely	16	53%	22	55%
probably	12	40%	13	33%
not sure	2	7%	5	13%
no	0	0%	0	0%
no answer	0	0%	0	0%

12. *Do you have suggestions on how to improve the presentation of this website's data to make it more useful to you and your students?*
    See Appendix 17 for all of the teachers' responses.

Focus Group Discussion: Ideal RTD Ed Product

Since just before this discussion teachers has viewed the CDMO (SWMP data) website and Eyes on the Bay website, we asked them to talk about their needs/desires for a RTD education product using those two websites (and others they knew of) as examples. Neither of the two websites met all their needs. Both had some positive and negative features (as seen in detail from the feedback results above).

Generally, what met their needs/desires on the CDMO website were:

- page layouts were simple
- text was limited, not too much for students
- lots of visuals
- local, relevant data sets could also be compared to places nationwide
- good explanations of content, parameters and terms.

Generally, what met their needs/desires on the Eyes on the Bay website were:

- data was easy to get to—just a couple of clicks, navigation was "intuitive"
- ease, flexibility when comparing data
- easy to download data to Excel
- could get access to raw data
- very relevant for those on the Chesapeake Bay.

In all seven of the focus group sessions teachers discussed the need for simplicity in design especially for an online RTD education product—quick and easy access to data, few clicks to accomplish tasks, clear & intuitive navigation, limited text and a lot of visuals. These design features will aid teachers and students in getting the most from the product given teachers' needs to cover a lot of content over the course of the school year and limited time.

During most of the focus group discussions (six out of the seven) teachers asked for lesson plans at all levels/abilities that incorporate the use of RTD to teach required concepts. Teachers will change and adapt them, but the provision of lessons will help save them time. Most teacher groups also requested downloadable data (into Excel or other spreadsheet) for processing by teachers to tailor lessons to students, for backup in case a website is unavailable during lab sessions, and for manipulation by students. A few requested a CD with data, but many felt that would be unnecessary if the data were downloadable.

During most focus group sessions teachers discussed the need for a product that allows different entry points for different levels of learners—from introductory (what is data?) to advanced (how to use of data and what they mean). And that these multiple levels were appropriate for teachers and students. Several teachers in our focus groups did not currently use RTD and had questions on how to get started. Other teachers who had been teaching many years with RTD were not necessarily familiar with the latest technology or data parameters. And within a single class student abilities can vary greatly. There definitely was a need for two to three entry levels, clearly identified as such. Some suggested using grade levels, but for others that was an issue if they had older students (high school) entering a lower grade level (middle school) due to lack of experience or abilities. It was suggested that another means of identifying levels be used. It was also suggested that there be plenty of step-by-step guidance/aids at all levels so no one gets lost or frustrated.

During most of the focus groups teachers talked about the importance of visuals to help students orient and understand. Maps were touted as useful during six of seven focus groups. That way students know where the data are from and they can compare local data to data from other places around the country. The ability to overlay data on the same graph to compare two or more parameters was mentioned by four of seven groups. In three of the focus groups teachers said they liked CDMO's pictures of the instruments used to gather data and the gauges used to show data.

During five of the focus groups teachers talked about connecting students with scientists. They were mostly interested in getting answers to questions, especially regarding what the data mean. A few also wanted students to understand from scientists how to do science. This desire for students to understand science was also raised in five focus groups when teachers talked about the ability of students to compare their data to other students' data and/or to scientist-collected data sets. They felt this would enable students to see greater value of what they were doing.

In almost all of the seven focus groups teachers mentioned testing and standards, in particular state standards. Most teachers agreed that lessons/activities aligned with national standards are not helpful; teachers need someway (keys, tables, etc.) to know how lessons/activities meet their particular state standards. And although they're acutely aware of standards and testing, many of teachers we talked to were passionate about using RTD to connect students with the world around them and so used creative ways to align the use of RTD with their standards/testing-based teaching.

There were mixed views regarding audience use of an online ed product—should it be for teachers or for students. A few teachers wanted to be able to send their students to the site; others did not. Teachers offered no clear guidance on this issue.

There were numerous other requests from teachers. Based on teachers' surveys and focus groups we developed a list of nearly 40 requested features for a RTD education product. They are (alphabetically listed and presented as worded for the prioritization activity):

- ability for teachers who have used the lessons to post/upload their adaptations or feedback on the lessons
- ability to share student-collected data with other students
- ability to share student-collected data with scientists
- access to the same raw data sets that research scientists use
- assessments for testing student learning of content/skills
- assessments tied to state/national tests
- background information on how scientists use real-time data sets
- bilingual/multi-lingual student information/worksheets
- data comparison tools (ability to compare data from different places over time)
- data comparison tools (ability to compare multiple data parameters for different places over time)
- data comparison tools (ability to compare multiple data parameters over time)
- data sets on CDs
- data sets that have been quality assured/controlled (QAQC) before you gain access
- data visualization tools (ability to graph multiple data sets on a single visual)
- data visualization tools (ability to graph, map, chart data sets)
- email access to research scientists (to answer questions)
- email access to science educators (to answer questions)
- information & visuals showing the technology (how data are collected)
- inquiry-based lessons/activities for students
- international data sets
- kits with equipment so students can collect real data
- lesson plans for teaching math & graphing skills with real-time data
- lesson plans for teaching science concepts with real-time data
- lesson plans for teaching science process (how to do science using real-time data)
- local data sets
- map interface so you can find where the real-time data are being collected
- national data sets
- online access to data sets
- online conversations with research scientists
- online talks/lectures by research scientists
- other background information, specify:
- real-time data projects for students
- research scientists' profiles (their research interests, education background, etc.)
- several different entry levels (from beginner for teachers/students new to real-time data to advanced for those who know how to use real-time data)
- stories or case studies on how scientists use real-time data
- student worksheet templates that teachers can change to meet particular needs
- table or other document showing lessons' alignment to state/national standards
- tips on how to get started using real-time data in classroom with students
- webquest to orient new users (teachers or students) to the website with online data

Prioritization of RTD Education Product Features

Based on teacher focus groups we developed a list of approximately 40 features that teachers had requested for a RTD education product. The list was long and we needed help prioritizing those features. We decided to take advantage of a follow-up meeting of COSEE-MA summer '05 trained teachers in April 2006 and of MBARI EARTH teachers in July 2006. These teachers represent 14 U.S. states, a range of experiences with RTD and teach in a range of grades. During the two meetings we gave teachers envelopes containing the features listed on page 56 and asked them to prioritize by writing a 1, 2 or 3 on each feature: 1 = essential, 2 = nice to have, and 3 = not necessary. Below are the prioritization results by grade. *(Note: the list items are presented as worded for this activity.)*

Elementary School Teachers' Top List (all rated as 1; there's no hierarchy to this list)

- ability to share student-collected data with other students
- assessments [student assessments] for lesson content/skills
- background information on how real-time data sets are used by scientists
- data visualization tools (ability to graph, map, chart data)
- information & visuals showing the technology (how data are collected)
- inquiry-based lessons/activities for students
- lesson plans for teaching math & graphing skills with real-time data
- lesson plans for teaching science concepts with real-time data
- lesson plans for teaching science process (how to do science using real-time data)
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected [locally and/or nationally]
- real-time data projects for students
- several different entry levels (from beginner for teachers/students new to real-time data to advanced for those who know how to use real-time data)
- stories or case studies that show how scientists use real-time data
- student worksheet templates that teachers can change to meet particular needs
- table or other document showing alignment to state/national standards
- tips on how to get started using real-time data in classroom with students

Middle School Teachers' Top List (all rated as 1; there's no hierarchy to this list)

- ability for teachers who have used the lessons to post/upload their adaptations or feedback on the lessons
- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- lesson plans for teaching science concepts with real-time data
- lesson plans for teaching science process (how to do science using real-time data)
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected [locally and/or nationally]
- several different entry levels (from beginner for teachers/students new to real-time data to advanced for those who know how to use real-time data)
- tips on how to get started using real-time data in classroom with students
- webquest to orient new users (teachers or students) to the website with online data

High School Teachers' Top List (all rated as 1; there's no hierarchy to this list)

- data visualization tools (ability to graph multiple data sets on a single visual)
- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- inquiry-based lessons/activities for students
- lesson plans for teaching science concepts with real-time data
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected [locally and/or nationally]
- online [web] access to data sets
- real-time data projects for students
- tips on how to get started using real-time data in classroom with students

College Teachers' Top List (all rated as 1; there's no hierarchy to this list)

- ability to share student-collected data with other students
- background information on how real-time data sets are used by scientists
- data comparison tools (ability to compare data from different places over time)
- data comparison tools (ability to compare multiple data parameters for different places over time)
- data comparison tools (ability to compare multiple/different data parameters over time)
- data visualization tools (ability to graph multiple data sets on a single visual)
- data visualization tools (ability to graph, map, chart data)
- information & visuals showing the technology (how data are collected)
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected [locally and/or nationally]
- national data sets
- online [web] access to data sets
- webquest to orient new users (teachers or students) to the website with online data

Stakeholder Prioritization

During these to meetings, we also took advantage of the stakeholders present and asked them to prioritize the same list of features from their perspective—what should a RTD education product feature. Here's their top list.

Stakeholders' Top List (all rated as 1; there's no hierarchy to this list)

- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- inquiry-based lessons/activities for students
- lesson plans for teaching science concepts with real-time data
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected [locally and/or nationally]
- online [web] access to data sets
- real-time data projects for students
- stories or case studies that show how scientists use real-time data

Discussion of Results: Literature Review

We reviewed more than 25 peer-reviewed articles and evaluation reports to answer the question: What resources/models/products/projects currently provide classroom teachers with real-time observatory data? Which ones have been proven (evaluated) to work? The complete review is at http://marine.rutgers.edu/outreach/rtd/.

The key findings were:

- Lessons need to be flexible enough to adapt to user level, classroom time constraints and local phenomena, and be integrated into current teaching. Materials should be designed so that pieces can be removed and used by educators in other ways.
- Activities should encourage participation in multi-school communities (becoming a part of a larger community of science practitioners).
- Lessons should teach students why they are doing data collection and analysis, as well as what to do.
- Materials should be inquiry based, involve students in the full scientific process, and include hands-on activities.
- Lessons should be scaffolded so that at first there are more steps and guidance, but gradually they become more student-driven and open-ended.
- Visualization and modeling tools are essential to the development of RTD projects and they need to be specialized, refined or intermediary tools (different from those used by scientists) to support student learning.
- Teams that develop RTD lessons should be diverse and include expertise in science, technology, cognitive science, classroom teaching methods, and teacher professional development. Those partnerships should last long-term.
- Teachers are a critical link in the successful integration of RTD into the classroom curriculum, and so teacher preparedness, achieved through professional development, is essential.

Discussion of Results: Gap Analysis

The goals of this front-end evaluation were to:

- identify the gap between SWMP/IOOS scientific data (current and projected) and the needs/capabilities of K-12 teachers and students to use those data, and
- to determine and recommend ways to bridge that gap via data visualization/ presentation and educational products/services.

The discussion in this section covers the first goal above (the Recommendations section that follows covers the second goal). A gap analysis (Weber, 1986) answers the questions: Where are we now? and Where do we want to be? Identifying any gaps will aid NOAA/NERRS in designing and developing an education product that successfully bridges what stakeholders wish to accomplish and what teachers can use. Analyzing the results from stakeholders and teachers have enabled us to identify the gap between the two views.

The main gap issues we explored using the results of this front-end evaluation are:

- target audience
- vision and goals
- content: data types/variables and sources
- product format & features
- barriers

Target Audience

There seems to be general agreement between stakeholders and teachers regarding the target audiences for this project, and they are:

- middle-school students and teachers
- high-school students and teachers.

(Reminder: This evaluation focused on K-12 classrooms. We recognize that college & university teachers and students, coastal decision-makers, the general public and informal education institutions are important audiences, but the goal here was to study one target group in depth, rather than studying many narrowly.)

The K-12 audience not included on this list is primary and elementary school students and teachers. This exclusion is not to suggest that younger students could not understand or their teachers could not teach using real-time data. We know they can and some teachers do. However, the types of data that would be made available through most ocean observing systems are less age/grade appropriate at this education level and students at this level are just learning the skills necessary to understand RTD. Given the limited resources of any project, it is important to focus and both stakeholders and teachers were focused on middle-school and high-school students for a RTD education product.

This study's results show a gap between stakeholders' views that high-school should be the primary target and teachers' and other data that indicate that middle-school would be the better primary target, especially for NERRS.

On the online survey, over 90% of respondents stated that high school (grades 9 – 12) should be the primary audience, whereas 56 to 76% stated middle school (6 – 8) should be the primary audience.

And although more high-school teachers attended the focus groups than middle-school teachers (56% vs. 43% respectively), in comparing the two groups' responses to the online survey we found that middle-school teachers were more likely to:

- have student use computers at school as part of their lessons
- have students use the Internet/websites at school as part of their lessons
- have students use real-time data (mostly student-collected data) as part of their lessons.

In addition, in the June 2003 report, *Inventory and Assessment of K-12 and Professional Teacher Development Programs in NERRS*, the most common audience was 6^{th} to 8^{th} grades (middle school) for both NERRS programs and teacher professional development. Thus there is already a wealth of experience among NERRS for working at the middle-school level.

A separate issue raised by a couple of stakeholders was how to accommodate under-served/under-represented students, such as minorities, ESL students, students in schools with limited access to technology, etc. They didn't want these students overlooked when discussing the audience for RTD education product(s).

Although the teachers who participated in our focus groups were for the most part White (we did not collect data on their race/ethnicity), their student populations were diverse: 57% taught in schools with mostly (60%+) White students, 17% in schools with nearly equal mixes of two or more ethnic/racial groups, 16% in schools with mostly (45%+) Hispanic students and 6% in schools with mostly (50%+) Black/African-American students.

During three of the focus group discussions teachers mentioned that some of their students had English language issues. In most groups teachers mentioned that they had a range of ability levels in their classes (we didn't ask specifically for those data). No one talked about any particular problems/issues with using RTD with diverse or special-needs students. Some stated that the act of collecting data actually helped these students, although equipment and computer availability was a resource issue for some schools. Based on these results, we believe RTD lessons could work with all students.

When we asked teachers to prioritize the features they would need in a RTD education product, features that would be especially useful for teachers working with diverse or special-needs students, such as Spanish-language worksheets or data-collecting kits, rated low on the list. Based on the results of this study we cannot answer the question of how to best meet the needs of these students and their teachers. That needs more study.

Vision & Goals

Interviewed stakeholders offered varied visions and goals on RTD in K-12 classrooms and for a RTD education product. From their statements there was no clear direction. Surveyed stakeholders were offered 11 goals (based on interviewee responses) and asked to choose what they thought should be the goal of education products based on RTD. Their top choices were:

- connecting students with real-world science (92%)
- improving inquiry skills (92%)
- better understanding of estuarine/coastal ocean research (72%)
- better knowledge of the environment (72%).

When asked to prioritize by choosing a primary goal, their top choices were:

- connecting students to real-world science (28%)
- improving inquiry skills (24%)
- improving ocean literacy (20%).

In all seven of the groups teachers talked about why they use RTD in their teaching, why it is important to them despite the many obstacles they encounter. The most often mentioned reason for using RTD was relevance—real-time data makes what happens in the classroom relevant to students' lives. It brings the real world into the classroom whether they're monitoring a schoolyard weather station, or testing and reporting on the water quality of a local pond, or tracking a hurricane. It also connects them to their future as citizens faced with questions requiring analysis in their roles as decision makers, voters, and possibly scientists. Connecting students to what's real was the main reason teachers use RTD in their lessons.

This "real world" connection chosen by stakeholders and as expressed by teachers should be a key part of the vision and goals for education products based on RTD.

Content: The Data

<u>Data Types</u>

As part of our gap analysis between stakeholders' views and teachers' views, we asked both groups about RTD data use in K-12 classrooms. For stakeholders this question was asked only of online respondents. We developed a list of 27 "data streams," largely based on the provisional IOOS core variables [pg. 20 in *First U.S. Integrated Ocean Observing System (IOOS) Development Plan*] available at http://www.ocean.us/documents/docs/IOOSDevPlan_low-res.pdf.

We asked stakeholders to indicate which data types they thought teachers are most likely to use and we asked teachers which data types they actually use. The table below compares rankings stakeholders views on what teachers would use compared to what teachers actually use (based on percentage and sorted by teacher use).

Data Types	*Stakeholders Ranking: Teachers Likely to Use*	*Teachers Ranking: What Teachers Use*
temperature: water	1	1
temperature: air	3	2
pH	11	3
salinity	2	4
dissolved oxygen (DO)	4	5
currents	9	6
water quality	7	7
algal blooms	10	7
animal tagging/tracking	5	8
video/live camera	7	8
zooplankton species	13	8
waves	14	9
ocean color	18	10
turbidity (clarity/cloudiness)	8	11
nutrients	9	11
fish species & abundance	6	14
river discharge	10	15

Some of the rankings of data types closely match, but there are also some clear differences between teachers' use are stakeholders' views. The design/development of a RTD education product should, at least initially, be based on the data types that teachers use, which will make their use of the product more likely.

<u>Data Sources</u>

An issue encounter during this study that surprised us was that of student-collected vs. scientist/observatory-collected data. On the teacher pre-workshop surveys, 61% of teachers said they use RTD from the Internet and 52% use student-collected RTD (these are tallies of responses to an open-ended question about RTD use in the classroom). When comparing middle-school teacher responses to those of high-school teachers, more middle-school teachers use student-collected data than Internet data (61% vs. 57% respectively), where the reverse was true for high-school teachers (64% Internet data vs. 45% student-collected data).

In all of the focus groups, teachers talked about having their students collect their own data, mostly weather data or water-quality data. For those teachers this introduced students to the concept of data (unfamiliar to many at the middle-school level), got them involved in something hands-on, connected them to their local environment and in some cases to the community, and engaged them in science as a process. Several teachers expressed that student-collected data combined real-time and relevance.

Another data-source question raised during this study was the issue of local data versus national or other data, which was discussed in five of the seven focus groups. Middle-school teachers, in particular, felt it was important for students to understand first what data are, then become familiar with and understand local data. With that foundation, students could then use Internet-based local or national data for baseline or cross-site comparisons, for understanding broader systemwide concepts and issues, and/or for investigating issues that they can't investigate locally.

If NERRS is to focus on the middle-school audience initially, it's in the perfect position to provide teachers and students with opportunities for collecting data locally as well as offering local and national data sets for comparison. Whatever data types/streams or data source(s) become the basis of a RTD education product, it was clear from teachers' conversations with us that the data be relevant to their students, either to their lives (personal or virtual lives) or the communities in which they live.

Product Format & Features

Stakeholders and teachers offered many of the same suggestions for the features of an idea RTD education product. Based on our conversations during this study we developed a list of nearly 40 features consistently mentioned by both groups *(see the full report for the complete list)*. During two prioritization sessions with stakeholders and teachers (one at a COSEE-Mid-Atlantic teacher meeting and the other at an MBARI EARTH summer teacher workshop), we were able to develop an "essentials" list.

The top features chosen by stakeholders were (not in any hierarchical order and presented as worded for the prioritization activity):

- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- inquiry-based lessons/activities for students
- lesson plans for teaching science concepts with real-time data
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected
- online [web] access to data sets
- real-time data projects for students
- stories or case studies that show how scientists use real-time data.

The top features common to both middle- and high-school teachers were (not in any hierarchical order):

- data visualization tools (ability to graph, map, chart data)
- downloadable to Excel or other spreadsheet
- lesson plans for teaching science concepts with real-time data
- local [locally relevant] data sets
- map interface so you can find where real-time data is collected
- tips on how to get started using real-time data in classroom with students.

Note: Features chosen differed somewhat depending on the grade level (see pages 57 & 58 for lists by grade level from elementary school through college).

For the most part, top features chosen by teachers matched those chosen by stakeholders. Because these choices were in the abstract, that is, based on a list rather than a real product, we asked focus group teachers to review two RTD websites as models and provide feedback regarding what worked and what didn't about each.

Neither website met all their needs, although the Eyes on the Bay website was more positively reviewed as being closer to what they were looking for than the CDMO website. Generally, the features that met their needs/desires were:

- page layouts that were simple, not too cluttered, with few words
- lots of visually based explanations (illustrations, pictures, graphics) and data visualizations, but simple in design
- local data sets (viewed as relevant) that could also be compared to places nationwide
- good easy-to-access explanations of content, parameters and terms
- intuitive navigation in and out
- data that's easy to get to—just a couple of clicks
- ease, flexibility when comparing data parameters
- easy to download data to Excel
- access to tabular data as well as data visualizations.

Design of the RTD education product should incorporate these features and those from the prioritization list at a minimum.

In all focus group discussions teachers talked about their limited time to teach all that's required and the limited time of a class period. To help them better manage their time they requested simplicity in design, limited text and lots of visuals (for quick absorption of information), quick and easy access to data, and lesson plans to teach concepts and/or interpret the data. The majority of teachers were fine with an Internet-based product as long as they could download data for teaching if they couldn't access the data when needed or for students to be able to manipulate. Very few teachers requested that RTD be provided on a CD or in print materials.

There were mixed views regarding the target (and therefore the design) of the online education product—should it be designed for teachers or for students? A few teachers wanted to be able to send their students directly to the site; others did not. Teachers offered no clear guidance on this issue. It seems to be a personal preference and/or depend on students' abilities.

An issue that was not available on either website but which came up in the focus group discussions was the need for different entry points for different levels of learners—from introductory (what is data?) to advanced (how to use of data and what they mean). These multiple levels were appropriate for teachers and students. Teachers requested two to three entry levels, clearly identified as such.

During five of the focus groups teachers talked about connecting students with scientists. They were mostly interested in getting answers to questions, especially regarding what the data mean. However, during the prioritization sessions, this was not among the features in the "essential" category.

During the stakeholder interviews and online survey, several people mentioned the importance of viewing this product as part of a whole program that includes, ideally, all of the following:

- data collection at NERRS or other sites local to schools
- data use in the classroom (the RTD education product)
- training of classroom teachers: pre-service training, in-services, ongoing support
- training of NERRS Education Coordinators (ECs) on the use of RTD in NERRS education programs and on working with classroom teachers to help them integrate RTD into their teaching. *Note: training for ECs in teacher professional development was a recommendation in the June 2003 Inventory report cited earlier.*

Barriers & Challenges

Both stakeholders and teachers held similar views on the most common barriers and challenges. The primary barriers expressed by stakeholders were:

- funding/costs
- time
- developing an effective product and presenting data so that they're useful
- teachers' abilities and available time
- student access to technology
- testing/standards
- RTD viewed as an add-on, not integrated
- no clear vision for this product

In almost all of the seven focus groups teachers mentioned testing and standards, in particular state standards. Most teachers agreed that lessons/activities aligned with national standards are not helpful; teachers need someway (keys, tables, etc.) to know how lessons/activities meet their particular state standards.

Further results from this study illustrated that this issue of standards/testing is actually the greatest barrier to a RTD education product. From our "Where do RTD fit?" activity during the focus group sessions, teachers showed us the disconnect between the potential for RTD in exciting students and teachers and connecting them to the real world vs. the reality of today's K-12 teaching environment with state standards and high-stakes testing.

On the RTD lesson planning/teaching process maps teachers indicated overwhelmingly that RTD must fit with (listed hierarchically):

- student interest (indicated on the map by 96%)
- science inquiry (94%)
- current events and science concepts (both 92%)
- student skills/science skills (88%)
- math skills (81%).

RTD did not fit as well with

- state standards (indicated on the map with 53%)
- curriculum & textbooks (43%)
- state tests (22%).

These results were for RTD that teachers are currently using. When we asked them to map SWMP/IOOS data, they fared even worse on those three items:

- state standards (indicated on the map with 43%)
- curriculum & textbooks (33%)
- state tests (15%).

And although teachers are acutely aware of standards and testing, many of the ones we talked to were passionate about using RTD to connect students with the world around them and so used creative ways to align the use of RTD with their standards/testing-based teaching.

Given the realities of high-stakes testing (National Research Council, 1999), any RTD product needs to be designed to support what teachers currently have to teach/test and be integrated into what they do instead of as an add-on. In addition, if NOAA scientists and educators view RTD as the future for science, there needs to be work on the political front with science education reform to make changes in what teachers are required to teach/test and how they teach so what they do matches how science is conducted.

Recommendations

Our recommendations are based on our results and are supported by the literature review.

Target Audience

- The K-12 target audience for RTD education product(s) should be middle-school and high-school students and teachers, and if prioritizing between those two, the first priority should be middle-school students and teachers.
- We believe RTD lessons could work with all students, including those under-served/under-represented, such as minorities, ESL students, students in schools with limited access to technology, etc. However, this study cannot answer the question of how to best meet the needs of these students and their teachers. That needs more study.

Vision & Goals

- RTD brings the real world into the classroom and it is the main reason teachers use RTD in their lessons. This "real world" connection should be a key part of the vision and goals for education products based on RTD.

The Content: Data

- The design/development of a RTD education product should, at least initially, be based on the data types that teachers currently use, which will make their use of the product more likely. The top ones teachers currently use are: temperature (air & water), pH, salinity, dissolved oxygen and currents.
- Student-collected data was an important part of RTD lessons for both middle-school and high-school classes, but more so for middle school. If data are provided, teachers are mostly interested in local data sets. Whatever data or sources are the bases of a RTD education product, it was clear from teachers' conversations that the data must be relevant to their students.

Product Format & Features

- The design of a RTD education product should incorporate these features at a minimum:
    - page layouts that are simple, not too cluttered, with few words
    - intuitive navigation in and out
    - data that are easy to get to—just a couple of clicks
    - lots of visually based explanations (illustrations, pictures, graphics) and data visualizations, but simple in design
    - good easy-to-access explanations of content, parameters and terms
    - map interface so users can find where real-time data are collected
    - lesson plans for teaching science concepts with real-time data
    - local data sets that could also be compared to places nationwide
    - data visualization tools (ability to graph, map and chart data)
    - ease, flexibility when comparing data parameters
    - access to tabular data as well as data visualizations
    - easy download to Excel or other spreadsheet
    - tips on how to get started using real-time data in classroom with students
    - different entry points for different levels of learners—from introductory to advanced.

- Most teachers were fine with an Internet-based product as long as they could download data to Excel. Very few teachers requested that RTD be provided on a CD or in print materials.
- There were mixed views regarding audience use of an online education product—should it be for teachers or for students? Teachers offered no clear guidance on this issue.
- View this product as part of a whole program that includes, ideally, all of the following:
  - data collection at NERRS or other sites local to schools
  - data use in the classroom (the RTD education product)
  - training of classroom teachers: pre-service training, in-services, ongoing support
  - training of NERRS Education Coordinators (ECs) on the use of RTD in NERRS education programs and on working with classroom teachers to help them integrate RTD into their teaching.

Barriers & Challenges

- The greatest barrier to this product for teachers is the disconnect between the potential for RTD in exciting/connecting students to the real world and the reality of today's K-12 teaching environment with state standards and high-stakes testing. Any RTD product needs to be designed to support what teachers currently have to teach/test and be integrated into what they do instead of as an add-on.
- if NOAA scientists and educators view RTD as the future for science, there needs to be work on the political front with science education reform to make changes in what teachers are required to teach/test and how they teach so that what they do matches how science is conducted.

Next Questions

As part of the stakeholders' questions we asked what they would like to know about how K-12 teachers' use RTD in their classrooms and what questions they would like this evaluation project to answer. Below are the questions posed at the start of this project that we believe this evaluation report addresses in whole or to a large degree.

Front-end/Needs Assessment Questions Addressed

I would like someone to gather a variety of successful examples
What are the best products and tools using RTD for teachers?
How frequently do they use this? Would they want to use it more and if so what would they need to make that happen?
Relevance to classroom curriculum - how does access to RTD support classroom activities?
The ease with which near real-time data are used, the frequency that the data is used, the top 5 data that are used for water quality discussions (e.g., dissolved oxygen, PAR, satellite color information, etc). What's missing for the teacher's information/support?
What parameters do they target? What parameters would they like to see that aren't widely available?
What they use, what they prefer, what works best and what kind of feedback they get from students.
What they find useful? What their students find interesting?
How the fit it in state and national standards and testing?
What they're currently using and where it comes from if they could pick any RTD, what would be most utilized in their classroom?
Why are some teachers able to use the data but not others? Who is more likely to use the data middle school teachers or high school teachers? Private school or public? The informal feedback I get from teachers is that high school classes are so test oriented that the teachers don't have the freedom to do this kind of teaching. I would like to know if that is true.

Below are some of the questions that still need consideration as NOAA continues to develop RTD education products.

Additional Front-end/Needs Assessment Questions

How does this relate to other curriculum and field trip opportunities?
If science teachers are the only ones using RTD in their classrooms. Exactly how much of their classroom teaching is dedicated to state test topics.
How NOAA can be more supportive to teacher needs--greater communication between teachers/scientists.
I'm not aware of use in my area so local uses etc.
Offer an in-service training associated with an annual NERRS Education Coordinator's meeting. Who, what, where, how is it [RTD] being done.

Formative Evaluation Questions

How are they getting the students engaged with the material?
It is crucial to know whether exercises will be teacher led with whole class or used by students with no direct supervision.
Teacher focus group would be very valuable, however the best data would come AFTER they tried to use the material in the classroom. It's one thing to brainstorm while well caffeinated, and another to implement in a classroom with 26 students.
What training and support would be required to motivate a teacher to use RTD?

Summative Evaluation Questions

Are the students really understanding the significance of the data?
Impacts on learning? Anecdotes on how RTD changed lessons or students' enjoyment of curricula.
Usefulness of RTD as a tool for applying real data to lessons?
Can students relate to RTD? Does it help them to understand the scientific process better? Does use of RTD help students to better understand the interdisciplinary nature of different classroom disciplines (i.e., physics, mathematics, biology etc.)?

Acknowledgments

We would like to offer a heartfelt thanks to Atziri Ibanez at NOAA/National Estuarine Research Reserve for engaging us in this project, the NEERS and COSEE contacts at our workshop sites, as well as the stakeholders and teachers who offered their valuable time and thoughtful remarks. Everyone is listed below in acknowledgment of their contributions. Our apologies for any errors in names or the omission of contributors.

The evaluator would especially like to acknowledge our continuing successful collaborations with the dedicated Rutgers IMCS staff, in particular Janice McDonnell, my co-collaborator on this project. In addition we received gracious support from Rutgers team members Madeline Gazzale, Corinne Dalelio, Sage Lichtenwalner and Jeff Marshall. Word Craft associates who contributed to this evaluation include Steve Downey, Jon Deuel and Linda Hagelin.

We're grateful for everyone's assistance.

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Mike DeLuca, Rutgers Institute of Marine & Coastal Sciences & Jacques Cousteau NERR
Atziri Ibanez, NOAA, National Estuarine Research Reserves
Louisa Koch, NOAA Office of Education
Michiko Martin, NOAA National Marine Sanctuaries
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Focus Group Site Contacts/Coordinators

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Pat Harcourt, Waquoit Bay NERR
Kenton Parker, Elkhorn Slough NERR
Margaret Sedlecky, Weeks Bay NERR

Focus Group Teachers ***(by regions)***

Weeks Bay NERR, Alabama, Focus Group

Megan Anderson	Fairhope High School
Anita Bryan	Murphy High School
Stephanie Hannon	Fairhope High School
Jennifer Janey	Robertsdale High School
Janie Lloyd	Robertsdale High School
Brenda McMillian	LeFlore High School
Paula Peterson	Murphy High School
Tim Pimper	Perdido Jr. High School
Jerry Wouters	Mary Montgomery High School

Elkhorn Slough NERR/San Francisco Bay NERR, Northern/Central California, Focus Group

Matthew Binder	North Monterey County
Jamie Dickinson	San Carlos School
Trent Hatfield	Brandon High School
Alex Hobsteen	Los Arboles Middle School
Lucila Molina	Gilroy High School
Robert Quinonez	CSU Monterey Bay
Benjamin Slyder	North Monterey County
Darrell Steely	Pacific Collegiate School

COSEE-West, Southern California, Focus Group

John Cary	Malibu High School
Marlene Everlingham	RCD SMM Naturalist
Afrodita Fuentes	Belmont High School
Jean Gasca	Avneah Academy
Cliff Gerstman	Junipero Serra High School
John (Gary) Goodeliunas	El Camino Real High School
Renee Klein	Animo Venice Charter HS
Charles Lee	Beverly Hills High School
Tracy Levin	John Adams Middle School
Ron Ozuna	Roosevelt High School
Urlette Reyes	King Drew Medical Magnet
Tom Russell	Dana Middle School
Luis Sandoval	Marco Antonio Firebaugh HS
Larry Simonsen	Hollenbeck Magnet Middle School
Brigitte Steinmetz	John Adams Middle School

Waquoit Bay NERR, Massachusetts, Focus Groups

Laurie Bianchi	Whitman Hanson High School
Margaret Brumstead	Dartmouth High School
Sheila Carotenuto	Quashnet School
Jen Ceven	Ralph Butler School, Avon
Deb Dakin	Scituate High School
Andy Dannenberg	Newton High School
Amelia Dolan	Hanover Middle school
Tom Eldridge	N. Quincy High School
Bob Heller	Lawrence Junior High School
Bruce Kamerer	McKay School, Boston
Jacob Kasper	Cohen Hillel Academy
David Lemee	Bourne Middle School
Linda McIntosh	Dana Hall High School
JoAnn Merchant	Canton High School
Gil Newton	Sandwich High School
Lynn Parks	Lawrence Junior High School
Sandra Pierson	O'Bryant High School
Katie Roberts	Hingham Middle School
Zach Snow	Newton High School
Gail Stone	Horace Mann Charter School
Eve Vidito	St. Francis Xavier School
Ginger Winslow	Derby Academy

Jacques Cousteau NERR, New Jersey, Focus Groups

Eileen Bendixsen	Hazlet Middle School
Loris Chen	Eisenhower Middle School
Jamie Corbett	Howell Memorial Middle School
Laura Crosby-Dunbar	Sea Girt Elementary School
Lily Curran	Howell Public Schools
Clif Daniels	Kingsway Middle School
Mary Jane Davis	Red Bank Catholic High School
Christine Girtain	Tom River HS South
Denise Glenn	Thomas Jefferson School
Karen Harrison	Bordentown Regional High School
Missy Holzer	Chatham High School
Phil Levy	Lacy Township
Peter Martyniuk	Glen Meadow Middle School
John Moore	Burlington County Institute of Tech Medford Campus
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Sue Pena	Lacy Township
Wanda Power	Ridgewood High School
Kathy Snyder	Zion Lutheran School
Nicole Woolley	Howell Middle School South

Prioritization Activity Participants

Teachers

COSEE-Mid-Atlantic Workshop

Marcia Berger	Morris Hills High School, NJ
Laura Crosby	Sea Girt Elementary School, NJ
Clif Daniels	Kingsway Regional High School, NJ
Rob Honer	Colonel Richardson High School, MD
Stacy Markowitz	Roberto W. Clemente Middle School, MD
Lori Martin	Bethel High School, VA
Kelli McDonald	Herbert Hoover Middle School, NJ
Dorothy Pesce	Triadelphia Ridge Elementary School, MD
Donna Reinhart	Cheltenham Township Public School, PA

MBARI EARTH Workshop

Lisa Adams	Georgia Institute of Technology, GA
Megan Anderton	Fairhope High School, AL
Esat Atikkan	Montgomery College, MD
Eileen Bendixsen	Hazlet Middle School, NJ
John Cary	Malibu High School, CA
Stephen Coleman	Monument School, WA
Stephany Hannon	Fairhope High School, AL
Becky Kapley	Community College, OH
(Joseph) Damian Kellogg	Trenton Central High School, NJ
Devon Lee	Theodore Roosevelt High School, TX
Katie Lodes	St. Joseph's Academy, MO
Jennifer Magnusson	Geneva Elementary School, WA
Sam Roman	Empire CompuTech Center, OH
Miriam Sutton	Newport Middle School, NC
Joanne Vanderhorst	Junipero Serra, CA
Kevin Vincent	Basehor-Linwood High School, KS

Stakeholders

COSEE-Mid-Atlantic Workshop

Deidre Gibson	COSEE-Mid-Atlantic, Hampton University
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Laura Murray	COSEE-Mid-Atlantic, University of Maryland
Lenny Pace	COSEE-Mid-Atlantic

MBARI EARTH Workshop

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Amy Cline	Coastal Ocean Observation & Analysis, NH
Kate Greganti	SEACOOS, SC
Linda Hagelin	Monterey Bay Aquarium, CA
Liesl Hotaling	Stevens Institute CIESE/COSEE-Mid-Atlantic, NJ
Abby Manahan	Bigelow, ME
George Matsumoto	MBARI, CA
Chris Petrone	BRIDGE/NMEA, VA
Erika Heine Raymond	Ocean Research and Conservation Association, FL
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Appendices

Appendix 1
Literature Review

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
5-18 year old students in 58 participating countries on 5 continents	• Global Learning and Observations to Benefit the Environment (GLOBE) is an international environmental education program designed to increase student scientific understanding of the Earth, increase environmental awareness, and help students reach higher standards in science and math by doing real science using a collaborative inquiry based learning experience. • The study focused on determining if student collected data are accurate enough to support rigorous scientific investigations.	• The Education Team on Data Validation and Accuracy Assessment collaborated with teachers and students to 1) design and test pre-protocol learning activities, 2) test the protocols designed to guide the collection and analysis of data and 3) implement the learning activities and protocols to determine the relative accuracy of student verses scientist collected land cover data. • They developed an error matrix to determine the accuracy of land cover maps generated by students compared to professionals.	• Student-scientist research collaborations are feasible and can produce results reliable enough for professional quality data (The study found overall accuracy was 67% when comparing student data to reference data). • To obtain good results in the field extensive pre-protocol training is needed. This requires significant time investment and training. • Scheduling field sampling can be challenging given the school academic calendar.	Becker et al., 1998
High school students and teachers	• Ten schools (100 students) in Georgia, U.S.A and Russia participated in an exchange program where they participated in environmental research activities in Russian and American communities and lived in the context of each others culture. • Students participated in the Global Thinking Project where they 1) worked with their teachers to construct ideas about environmental topics, 2) got involved in two episodes of problem identification, data collection and analysis and 3) participated in two "Global Environmental Summits in Moscow and Atlanta. • Development of a "citizen	• Case study/documentation of the project of the network science approach where students are allowed to construct meaning from their experiences and participate in activities that closely resemble those of real scientists (including investigating real science problems, collaborating between individuals within classrooms, and among geographically remote classrooms, shared goals, data, and knowledge through questioning, data analysis, and discussion of results and finally technology enhanced projects that are unique and compelling – i.e. Beyond word processing and telecommunication but constructing graphs, tables, and	• The authors report that both students and teachers achieved greater understanding of the environment and of a different culture. • Constructivist learning environments are conducive to student understanding by the open/self directed nature of the learning experience.	Dunkerly-Colb & Hassard, 1997

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
	scientists" among teachers and students who participated.	maps.)		
High School students and teachers	• This paper is a review of projects that engages the use of technology to facilitate authentic scientific practice in classrooms. • The author most notably focuses on the CoVis project funded by NSF in 1993.	• Case Study/documentation of the best practices associated with achieving science learning through the adaptation of scientific practice • The author lists a series of characteristics of authentic practice based on the evaluation results of numerous authentic projects.	• Learning occurs when students investigate open questions about which they are genuinely concerned using methods that parallel those of scientists. • The CoVis project successfully focused on two types of technology tools for students: 1) scientific visualization tools and 2) communication and collaboration tools. • CoVis and other data vis projects presented teachers with a set of resources and technologies as opposed to a fixed curriculum. Teachers were encouraged to set a project cycle (anywhere from 2 days to a half a year) based on their needs and student needs. • Teachers are the richest source of expertise – focus teacher development activities around the establishment of a community of teachers for the exchange of ideas, experiences, and strategies. • Two important themes among projects that use technology to facilitate authentic science practices in the classroom – 1) focus on local phenomena and 2) encourage conduct of activities in multi-school communities (becoming a part of a larger community of science practitioners)	Edelson, 1997
The CoVis development team	• Learning through Collaborative Visualization, or CoVis, a project which engages students with real world scientific visualization tools, and collaborations with real world scientists, in order to develop scientific knowledge	• Case study/documentation of the history (since 1992) of the development of CoVis, the problems that arose, and the subsequent handling of those problems by the CoVis development team • Lessons learned and best practices	• Tacit expert knowledge should be embedded into the tool's interface (i.e. geographical visualizations and graphical interfaces to link students to data, as opposed to text) • Keep only the most important and useful functions of the scientific tool, so as not to overwhelm students with too much complexity • Automate or make unnecessary tasks which will have little pedagogical value (i.e. the time researchers spend	Edelson, 2005

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
			reformatting data) • Add "bridging functions" where necessary to help students grasp concepts that are more than one step away from their usual frame of reference (i.e. first presenting colors on a map as numbers to get students to understand that the colors represent amounts and not just ink) • To avoid being too open-ended, include inquiry-support software tools that facilitate structure and planning, recording and monitoring • Supply data libraries that support investigations into students' topic of choice (to help motivate them) • The "Learning-for-Use" design framework includes three steps that must be met (which must go in order but can be cycled through numerous times and/or in various ways for each learning objective): 1) *motivation*, which can be achieved through the creation of task demand or eliciting curiosity, 2) *knowledge construction*, which can be achieved through direct experiences, indirect experiences, modeling, instruction, explanation, or sense-making and 3) *knowledge organization*, which can be achieved through practice (using components of understanding in another context), application (applying understanding in context), or reflection • Units should be scenario-based and inquiry • Teacher preparedness, achieved through professional development, is necessary • Professional development should teach specific curriculum in context, and extend over the course of the time that the curriculum is being implemented • Development teams should be diverse, including expertise in science,	

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
			technology, cognitive science, classroom teaching methods, and teacher professional development, and partnerships should last long-term • Developers from one area (i.e. scientist, classroom teachers) should observe the work environments of the other areas for extended periods of time	
Learners in grades 8-16	• The application of a developed framework for the adaptation of scientific investigation tools for inquiry based classroom learning, to a data visualization tool called ClimateWatcher, which is used in educational settings to facilitate investigations into climate.	• Case study / documentation of the process by which a scientific data visualization tool is adapted for optimal use in the classroom, • To use a three-step process, which follows understanding the expert tacit knowledge required to use the tool, re-designing the tool to convey that tacit knowledge, and developing activities to engage students with the tool, • To utilize five identified bridges: motivating context, activities, data selection, interface, and support for learning	• Scientific tools adapted for educational use provide students with more authentic experiences, • when bridging strategies are employed to provide learners with the knowledge that is already tacit for the experts using the tool	Edelson & Gordin, 1998
A 5th grade class of students	• Planetary Forecaster, an earth systems science unit developed for middle school students using the “Learning-for-Use” design framework, developed by Edelson, which is based on a learning model for developing useful knowledge	• Data collected from pre- and post- assessments, student work, and classroom observations of a class of 27 students at a public high school in Chicago, using Planetary Forecaster • An in-depth case study conducted through pre- and post- interviews of three of these students, of varying academic abilities (determined by the teacher)	• Significant misconceptions that existed prior to engagement with the unit were no longer apparent after • Students understood the “that” and “how” of the concept introduced in the unit, but were missing the “why.” A recommendation is made to redesign the curriculum to better explain the “why,” but it is also suggested that there may simply be too many knowledge demands of the task in this unit • It may be that some of the students misconceptions are due to images and accounts offered in popular media • New misconceptions not anticipated were identified • The activities that students engage with in Planetary Forecaster helps students to	Edelson et al., 2002

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
			better understand scientific concepts, but did not address all misconceptions	
Nine to twelve year old students at a Montessori school	• Explorations on GLOBE (Global Learning and Observations to Benefit the Environment), an international environmental education program, and develop criteria for training material for STSP programs.	• Observations made in a classroom of 9 to 12 year old students using the GLOBE explorations at a Montessori school in Boulder, CO	• A simple model of content consistent with the Web is developed. This model begins with the main elements of pictures and descriptions, arranges those elements into groups, which also have descriptions, and using technology that enables the creation of a number of presentations, allowing those presentations to be shared, as well as other forms of communication, between scientists, teachers and students (this forms a community of learners, and traditional roles are blurred) • Barriers to the fully successful implementation of this model will dissipate as technologies improve	Haberman et al., 1998
Middle and high school teachers	• The Gulf Stream Voyage, a CIESE product, in which students investigate the Gulf Stream through various real-time data sources.	• Teachers interacted with the Gulf Stream Voyage Web Site and used it with their students, recording a journal of their experiences. Face-to-face and phone interviews were conducted.	• Teachers were generally able to use the site as intended, keep students on track, access the real-time data, and solve the problems presented in the lessons • Real-time data can be successfully implemented in classroom settings, and it provides authentic, engaging, and meaningful learning experiences	Hotaling, 2005
Elementary, middle and high school students	• The *Earth Day: Forest Watch* program, in which students collect and assess data about the health of white pine forest stands, and then compare their results to data given by the Landsat Thematic Mapper (TM) for their local area. Students use mathematics to investigate their research questions, and learn the connection between mathematics and other disciplines.	• A description of the project, as a student would go through it	• Argue that environmental data analysis can be successfully implemented in middle school and early high school classroom to meet mathematics content standards (algebra and geometry)	Lauten & Lauten, 1998
The WISE development team	• Web-based Inquiry Science Environment (WISE), which is a library of inquiry-based science	• A description of the many projects on WISE • Lessons learned and best	• Steps of lessons must be open enough to engage students in inquiry without being so broad that students can easily	Linn et al., 2003

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
	learning lessons for grade 5-12, incorporating real-time data and current real world science, on the internet • Teachers can customize the site and lessons to their liking • Four major categories of lessons: investigation, controversy, critique, and design • great example of a project model: students build an initial model, test it in the local environment, revise their model, compare results to findings from prior years, and record the difference	practices of the WISE development team, culminating from research and evaluations of this program	get lost • The science doesn't necessarily need to be "simplified." WISE developers often offer very detailed steps for the first inquiry investigation, and then less detailed steps for subsequent investigations • Each lesson regularly incorporates "prompts," or questions, asking students to reflect on a concept or their own learning, or make connections between learned concepts or ideas • Having students work in groups of two is more effective than larger groups • Having the teacher initiate a class discussion about the students' findings and then encouraging them to post them to a discussion board involved much more student participation (90%) than a classroom discussion alone typically does (15%) • Criteria for technology projects that support knowledge integration: 1) works with science in the existing school curriculum, 2) is locally adaptable, 3) allows teachers and students to post revisions and suggestions, and 4) addresses student misconceptions • Make science and scientific evidence accessible by including evidence pages, pivotal cases, an inquiry map, and the inquiry question itself • "make thinking visible" by asking students to report their ideas, test them against identifiable criteria, and holding them up to recognized standards	
Results of a meeting of 60 data visualization experts associated with the CILT	• The Center for Innovative Learning Technologies (CILT) was founded in October 1997 with a grant from the National Science Foundation (NSF) to stimulate the development and study of important, technology-	• The paper includes a general review of a variety of visualization and modeling (VISMOD).	• Visualization and modeling tools are used in a curricular context. • The CILT is building a database of design principles which will provide a framework for the development of new learning environments (http://cilt.org).	Kali, 2002

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
(Center for Innovative Learning Technologies) University CA/Berkeley, Stamford and the Concord Consortia	enabled solutions to critical problems in K-14 science, technology, engineering, and mathematics (STEM) learning. • CILT has engaged the collaborative efforts of a wide range of people, institutions, and organizations including cognitive scientists, computer scientists, natural scientists, engineers, classroom teachers, educational researchers, learning technology industry leaders, and policy analysts.			
Classroom teachers – general review and recommendatio ns	• Teachers are presented with many choices of selecting and using data collection technology. • Teachers are encouraged to not consider one choice (such as microcomputer based laboratories MBL vs. calculator based laboratories CBL)superior to another, but rather select carefully based on the educational needs of the student.	• This paper is a general review and series of recommendations regarding the teacher decision making about student data-collection technology. • There are a series of questions the authors encourage teachers to ask themselves in technology selection: 1) why should my students use this technology? 2) is the use of this technology appropriate both pedagogically and developmentally? 3) Is the use of the technology justifiable (time, money to prepare for its use), 4) How do I choose the type of data-collection technology to use with my students?	• The NSES refer to technology as exciting tools which allow students to conduct inquiry and understand science. The appropriate use of technology is recommended: • Grades K-4 "Employ simple equipment and tools to gather data and extend the senses • Grades 5-8 Use appropriate tools and techniques to gather, analyze, and interpret data • Grades 9-12 Use technology and mathematics to improve investigations and communications. • Author claims that research has shown that use of data-collection technologies can strengthen students' graphing skills. These tools help students understand information on a graph by linking the concrete experience of data gathering with a symbolic representation in real time (no specific ref stated to support this statement).	Krueger & Rawls, 1998
Elementary and secondary school students and teachers	• GLOBE (Global Learning and Observations to Benefit the Environment), an international environmental education program, and develop criteria for training material for STSP	• Evaluations from years 1-9 of the program, with successive testing and revisions of the various components of the program • Teacher surveys, student surveys, site visits, which	• An estimated 85,000 students participated in GLOBE in the United States during its first year. • There is strong teacher and student enthusiasm and support for this program, especially its adaptability to a	Means et al., 1996; Means et al, 1997; Means et al, 1998; Center for

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
	programs.	incorporated interviews with teachers and administrators, classroom observations, and in formal discussions with students, analysis of data submissions (added Year 5), case studies (added Year 6)	variety of contexts, and its inquiry and collaborative learning aspects • Participation in GLOBE increases the likelihood that teachers will engage their students in actually doing science, and students gain a new understanding of science and how its conducted • The hands-on activities, use of technology, and involvement in real world science aspects of GLOBE appeal to students and give them a sense that what they are doing has value • GLOBE students developed the ability to apply more broadly principles of data collection and analysis • Science and math learning in GLOBE classes is enhanced, as well as student understanding of what it means to do science • A local "franchise" model of teacher training has proven very successful and greatly increased the number of GLOBE teachers trained • A significant investment of time, motivation and persistence is required by the teachers • Technology should be more "goof-proof" and easy to use • More mechanisms for teacher support and training are required • Student data collection must be more than just that; it must be integrated with a conceptual understanding of what they are doing (learning activities that meet this goal should be developed) • Model classroom strategies for getting the entire class involved (not just small groups of students) should be provided to teachers • GLOBE is most successfully implemented as a whole-school program, and strong administrator support is integral	Technology in Learning, 1999; Center for Technology in Learning, 2000; Center for Technology in Learning, 2002; Center for Technology in Learning, 2003; Center for Technology in Learning, 2004; & Center for Technology in Learning, 2005

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
			• Implementation of the program should be supported for a variety of grade levels and contexts. These should be provided, but also the ultimate way the module is used should be left up to the educator • Classroom assessment materials should be provided to teachers • Datasets that appeal to teachers (and are used by teachers) most relate to concepts that are commonly found in curricula (such as weather) and are straightforward and easy to use • Materials should be well-integrated across investigation areas, highlighting the interdependencies of Earth Systems • Data collection and analysis skills should be emphasized throughout the curriculum and well-integrated with science concepts • "25% of teacher training time should be helping teachers to learn how to support their students in planning, executing, analyzing, and communicating research investigations" • Scientists should be actively involved in recruiting and supporting schools • Elementary teachers especially need support in the areas of science content • In 2000, there was a notable decrease in number of teachers reporting a lack of internet access or technological apprehension as a barrier to implementation • Curricula should be integrated with content standards • Partner institutions who act as mentors for their local school has proven to be a very successful strategy, although funding issues often led to challenges for the partners in sustaining their role • Teachers use the teachers guide (background information, directions, field guides and diagrams) in planning	

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
			their lessons, but not in their teaching • Teacher did not use the provided standards alignment charts (instead, they just used their own knowledge of their local standards) • Teachers rarely used the web site for anything besides reporting data (the preferred the paper guide for activities) • Teachers never used GLOBE materials alone for their lesson; rather they supplemented them with materials from textbooks and other sources	
4th grade students in a self-contained classroom	• The JASON project is a international, multimedia hands-on science education program designed to expose students and educators to state-of-the-art science and technology. .	• Qualitative case study approach (Lincoln and Guba 1985). Primary source of data were derived from semistructured one-on-one student interviews (4 students of 18 in class selected on basis of gender, achievement history, and willingness to participate) interviewed 4 times (30-45 minutes each) over the course of the school year. Core interview questions included: What science are you doing in class right now? How is it different from other subjects in school? How do you know when you are doing science? How would you define science? What do scientists do? • The study set out to describe how the JASON project was implemented in a self-contained 4th grade classroom and examine the international curriculum initiative within the overall context of a student-scientist partnership model (where students partner with scientists to collect actual data which is used to investigate real-world environmental questions) of	• Overall, results indicate that the JASON project had a notable impact on short-term attainment of science content for participants, however little change was seen in their conceptions of the nature of science over the 6 month time frame of the study. • Interestingly – most of student prior knowledge about the topic area (rainforests) in the study was derived from experiences outside of formal school (Discovery channel, museums, etc). • Professional development implications – teacher did not stray from what was modeled/presented in professional development training. The teacher cited lack of time as the discouraging factor in determining what/how to teach JASON materials. • Student –Scientist partnership model if successful must be viewed as complementary and even beneficial to testing initiatives which are driving the choice of curricular programs. • Must encourage students' conceptions of science to include scientists engaging in experiments and natural observation – go beyond content focus and embrace science teaching and learning as portrayed in NSES and AAAS	Moss, 2003

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
		science education reform. • A secondary goal was to examine changes in student perceptions of the nature of science as a result of participating in JASONTeacher was interviewed twice over the course of the school year. Regular class visits and on-going discussions with the teacher also occurred. • All student interviews were coded using an open coding strategy to form specific data categories (cross interpreted by two coders).	benchmarks.	
High school students in an innovative conservation biology class	• This project was a partnership between Valley High School (pseudonym) and the University of New Hampshire designed to examine the conceptual development of high school students understanding of scientific research over an entire school year. • Students participated in 4 science projects over the course of the school year including a local watershed water quality monitoring project, a computer based populations dynamics modeling project, a land cover/land use mapping project using Landsat Thematic Mappers satellite data, and the Forest Watch project (monitoring white pine).	• Seven students from one project based class. Students were selected based on their willingness to participate, gender, achievement history. • Students were purposefully selected and data consisted of audio recorded semi structured student interviews which were transcribed verbatim. • Students were interviewed individually for 30 minutes 6X over the course of the school year. • Data was coded and interpreted by a pair of researchers. These coded snapshots allowed the researchers to determine if any conceptual change occurred for each student regarding his/her understanding of scientific research.	• Results indicate that students' conceptual understanding of scientific research including development of researchable questions, data collection, data analysis, drawing of conclusions, and communication of results rarely evolved over the course of the school year, remaining rudimentary. • Students had uniformed notions of scientific questioning, viewed data collection as only following prescribed steps and ultimately repetitive, and had little experience with data analysis or the communication of scientific findings. • Critical factors contributing to these student perceptions included insufficient exposure (to posing questions, data analysis, and communication of results) and a lack of sense of partnership (not communicating with UNH scientists directly – not involved in generation of research questions). • The design of the student-scientist partnership should be reexamined.	Moss et al., 1998
Secondary School Teachers and	• a pilot project, devised by research scientists, conducted in Ireland in 1982, in which	• a case study of this project • reporting of the air quality improvements over time as a	• report entitled, "An Air Quality Survey of the Greater Dublin Area carried out by Second Level Students" was	Murphy, 1998

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
scientists involved in the collaboration in Ireland	students collected air quality data and reported their findings back to the scientists	result of this project • reporting of the overall success of the project	published in 1988 • the sale of bituminous coal was banned in Dublin the same year that this report came out. This was a move that had previously been opposed by residents of the city, eventually resulting in improved air quality in the area • visits from the research team to the schools emphasized for the students and teachers the importance of what they were doing	
The CoVis development team	• A CoVis project called WorldWatcher, which allows pre-college students to create dynamic color visualizations of datasets from various scientific research organizations, in order to support their scientific investigations • WorldWatcher makes data visualizations used by the scientific community more accessible for students in one of two ways: 1) supplying an interactive schematic diagram, graphically depicting relationships among variables and linking students to data, and 2) an online notebook that allows students to write text as well as embed multimedia objects, that students can use to record their progress and save their visualizations, and teachers can use to create projects • WorldWatcher offers both customizable, well-defined map displays for visualization and embedded calculators to perform mathematical operations on the visualized data	• A description of CoVis and WorldWatcher • Lessons learned and best practices of the CoVis development team, culminating from research and evaluations of this program • Reporting of the overall success, and successful outcomes, of the project	• Middle school and high school curricula have been developed and used for middle and high school students, which integrates inquiry-based learning, hands-on science, and student teamwork • The CoVis vision of a scientific "collaboratory," in which university researchers, schools/teachers and/or science museums and learning centers, and students work together using CoVis supplied products, has been successfully integrated into the day-to-day learning of many challenging learning environments	Pea, 2002
Secondary	• RTEI, or real-time experiments	• Observations of, interviews with	• 6 of the 17 teachers implemented, and	Sassi et al.,

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
School physics teachers in Italy who were interested in using real-time experiments and images (RTEI) in their classroom and their students	and images, in which computers are used in a classroom setting to acquire data and display it for the purposes of science teaching • The RTEI rationale is to have teachers work with their student to: 1) demonstrate otherwise unobservable phenomena, 2) compare RTEI results with other measurements, 3) be able to distinguish system fluctuation from real data anomalies, 4) engage in game-like or challenge-oriented tasks, and 5) understand mathematical functions in data and how they relate to theory	and questionnaires given to 17 teachers using RTEI in their classrooms, students' tasks and assessments, and informal interviews with students • Short case studies, or "stories," written up • The creation of training materials for a two-session teacher training workshop for the use of RTEI in the classroom	often enriched, the RTEI rationale • 11 of the 17 teachers partially adopted the RTEI rationale • in order to better meet the rationale, teachers must 1) feel comfortable that students understand the tool and how it works, 2) focus more on the conceptual understanding of a "real" instance versus an "ideal" instance, or model, and 3) place more emphasis on helping students in decoding graph images • teachers should be trained to reconsider their entire classroom approach, from the way they structure their material, to the way they understand the learning process • classroom activities using RTEI must do more than guide students through a step-by-step process or simple processing of collected data through pre-defined algorithms • training materials should include putting the teacher in the place of the students, so that they better understand student difficulties	2004
Middle school students and teachers	• Sea Maven is a web-based learning tool that has been developed to enable middle school students to actively engage in collaborative learning in environmental sciences (using a network of platform sensors for monitoring oceanographic and meteorological processes.	• Formative assessment of the Sea Maven web product. • The Author used a combination of teacher focus groups and student assessment surveys to evaluate the success of the Sea Maven product.	• Backend relational database designed to allow teachers to monitor their students' performance was not used by the educators in the study. They preferred to monitor their student's activities in the classroom. • There were significant connectivity issues including slow load times and screen freeze ups were more common then expected. This was due in part to local LAN networks at the schools were slowed by the numerous behind the scene checks that verify the users computer has the appropriate plug ins (Flash and Quick time) and potentially poor network configurations. • Materials should have multiple levels of intellectual engagement to encourage	SeaMaven

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
			synthesis and analysis of information.	
High school students and teachers	• An authentic science experience for students designed to introduce real science topics and methods to students and teachers through hands-on field based programs. The program is called Boreal Forest Watch and involves the collection, analysis, and interpretation of forestry data. • To use student-collected information to build a long-term database for future global change studies in the boreal region	• Case study/documentation of the pilot year of the BFW program highlighting the importance of student-scientist partnerships and joint participation in research linked to global change studies of the BOREAS and to local ecological monitoring efforts of the Prince Albert National Park. • Students select/set-up a permanent study plot on a semi-annual basis, conduct a series of core science protocols/measurement activities, collect data and analysis on yearly basis, submitted to scientists for archive and additional analysis.	• Program offers unique learning opportunities and fulfills the Parks Canada's responsibility to conduct ecosystem management programs. • Complements the parks' regular interpretive programs providing a more quantitative scientific approach to learning about the boreal forest. • Designed in partnership with the Saskatchewan Education CORE curriculum. This made it possible appealing for the teachers and functional in the classroom. • Equal value on the educational value of the content and the scientific validity of student collected data.	Spencer et al., 1998
K-16 educators	• The Adopt-A-Drifter program, which partners one US school and one international school to adopt a data-collecting buoy which is deployed into the ocean. A teacher from each school is on board the ship when they deploy the buoy, and they can bring that experience back to their classroom, along with the students' access to the buoy's data and apply it to their learning	• A description of the program and how the 5 E's model of education (engagement, exploration, explanation, elaboration and evaluation) is applied to the lesson plans that have been developed for it	• Student investigations made with this program provide students with new knowledge about ocean currents, processes, modeling, and using and analyzing data. • Students develop reasoning skills by practicing science in a way that is more akin to real world science. • The data provided by the buoy can be used in open-ended and guided classroom investigations.	Tweedie et al., 2005
Middle school math teachers and students`	• SkyMath, an online curricula that teaches mathematics concepts incorporating real-time weather data	• Three-year long evaluation, in which the module was revised and re-evaluated a number of times • Exploratory methods were employed - classroom observations and interviews (in-person and phone) with students, teachers, administrators, college faculty,	• Students are effectively learning mathematics and science concepts using this module • Overall, students and teachers enjoy using this module • SkyMath is flexible enough to fit into a variety of ways, adapting to grade levels, learning styles, and class formats • Teacher resources such as teaching instructions, background information,	University Corporation for Atmospheric Research, 1997

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
		and parents	and teacher stories make SkyMath easier for teachers to use • It is difficult for teachers to complete the SkyMath module in the six-week time frame suggested because of scheduling constraints • Technical difficulties were frustrating and slowed progress • The impact of the module is reduced when it is not connected to the curriculum taught in the rest of the year • Partnerships with other schools and students must have teacher support and involvement in order to be effective and meaningful • This type of module is more appealing to teachers who have a hands-on teaching approach	
5th grade students and their teacher, who was a co-developer of the curriculum	• A WISE project called *Plants in Space*, in which students collect data on plant growth, and use WISE software to graph and analyze their data	• A 2 year case study of 46 5th grade students (23 each year), their teacher, and their experiences implementing the Plants in Space curriculum • The curriculum was modified based on results from the first year and the modified version was tested in the second year	• The curriculum successfully promoted knowledge integration in year one. • Modifications were made to make the curriculum more visual representations of photosynthesis, a concept which students were not getting with the original design	Williams & Linn, 2002
An urban 5th grade teacher	• A WISE project called *Plants in Space*, in which students collect data on plant growth, and use WISE software to graph and analyze their data	• 2 year case study of a teacher as she integrated the WISE program into her 5th grade classroom • data obtained from videotapes and transcripts of instruction, audiotapes and transcripts of interviews conducted with the teacher, and retrospective interviews	• over time, the teacher focused more on conducting real inquiry and less on logistics, as a result of repeated opportunities to teach a WISE unit • support form the development team helped the teacher reflect on her teaching and her students' learning	Williams et al., 2004
K-12 teachers	• This study evaluates the student-teacher-scientist partnership (STSP) aspect of GLOBE (Global Learning and Observations to Benefit the Environment), an international	• Conducted phone interviews with GLOBE teachers about their experiences with the program • Developed "Draft Training Material Design Criteria"	• Students should be involved in the full scientific process, from forming questions to analysis • Introductory-level background information should be provided but kept separate from data collection	Wormstead et al., 2002

Audience	Program Description	Eval/Research Goals & Methods	Findings/Results	Source
	environmental education program, and develop criteria for training material for STSP programs.	• Requested feedback on the draft criteria from GLOBE teachers and teachers participating in other STSP programs • Revised the draft criteria based on that feedback	information • Include a student-centered section • Organize materials in a clear, easy-to-follow, graphical layout • Provide consistent formats for lessons, in a step-by-step format • Start lessons with basic concepts and build up from there • include hands-on and inquiry-based lessons whenever possible (include outdoor lessons whenever relevant) • provide strong support for teachers, including follow-up workshops • consider time and resource constraints	
Community college and middle school educators	• The Alliance + project is a national training program funded by the Department of Education designed to provide hands on training for K12 teachers to integrate the Internet resources in the classroom curricula and improve science and math education. The project is lead by the Center for Improved Engineering and Science Education CISE at Stevens Institute of Technology.	• Logic model that links outputs to outcome-- trained teachers with the capacity to integrate technology in the classroom that are supported by the school's administration to take full advantage of real time date bases, collaborative projects, and other resources uniquely available on the web to improve teaching and learning • This report was a formative assessment of the first year of the Alliance+ project	• Continue to develop methods to overcome obstacles to connectivity and access to computers. Encourage teachers to use computer at home to enhance familiarity and expertise • Support teacher training—Alliance + is encouraged to redesign their course to a 10 week format with time for reflection and integration into school curriculum. Develop a pretest for the teacher training that would screen teachers in need of basic computer skills training. • Increase use of collaborative projects (seen as painless way to introduce more teachers to the use of technology in the classroom) • Strengthen mentoring and support among trained teachers and their turnkey mentees. Involve school administration and technology staff as much as possible – fully integrate them into training models.	Yepes-Baraya, 2000

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Appendix 2
Stakeholder Interview Instrument

Date: ____________________ Interviewer: ____________________

Interviewee: ______________________________________

Affiliation: __________________________________

Introduction
As you know (or I hope you know), I'm working with Janice McDonnell on an assessment of K-12 teachers' needs/interests/abilities related to the use of data streams, in particular SWMP & IOOS data. We're starting this assessment with interviews of decision makers, like yourself, who play a major role in directing or funding the development of educational products based on SWMP/IOOS data.

I am calling to schedule an interview time with you. The interview should take about a half hour or so. When could you be available for such an interview?

Note for interview: Date: _______ Time: _______

And should I call you at this number, or a different one? Note number: ___________________

If you need to reach me for some reason, my name is [your name] *and you can reach me at* [phone].

Thank you. I look forward to talking with you on [Repeat date and time].

End call.

Day of Interview
I am calling to interview you about the development of SWMP/IOOS education products. Is this a good time?

Do you have any questions about the purpose of this interview or the assessment we're doing before I get started with my questions?

May I audiotape this interview (that way I don't have to try to write everything you say and the results will be more accurate)?

Great. Thanks.

Interview Questions

--Let's start with a description of your vision/thoughts about the integration of SWMP & IOOS data *(or, if not familiar with SWMP/IOOS, then real-time data)* and their use by K-12 classroom teachers.

--Who do you think is the primary K-12 audience for SWMP/IOOS data (RTD) & ed products?

--Ideally, what do you think SWMP/IOOS data (RTD) and resulting ed products could offer K-12 classroom teachers? How could they impact/enhance classroom practice?

--What do you see as the ultimate long-term goal/end point for teachers & students using RTD data in the classroom?

--What might those ed products look like/feature/offer?

--Are you aware of any current (or in the works) education products (by NOAA or others) that fit your vision for the SWMP/IOOS (RTD) ed product(s)?

--What do you think will be the barriers to developing SWMP/IOOS data (RTD) & ed products? And, to K-12 use of these data & ed products?

--What are your thoughts about how to disseminate these ed products, that is, how do you get them to teachers and in what format(s)?

--Based on what you know about this assessment, what decisions do you hope to/want to be able to make using the results from this assessment project? Any particular questions/issues that you'd like answered?

--Before we end this interview, do you have any other thoughts/comments about SWMP/IOOS data (RTD), ed products or this assessment that you'd like to mention that we haven't addressed yet?

Those are all the questions that I have. I appreciate your time and thoughtful responses.

Appendix 3
Stakeholder Online Survey

To see this survey online visit http://www.surveymonkey.com/s.asp?u=51541789289

Welcome
We're asking for your guidance.

NOAA's (National Oceanic & Atmospheric Administration) Office of Education is investigating the possibilities of developing educational materials for K-12 classrooms that make use of real-time data* from SWMP and IOOS.**

You have been identified as a stakeholder — someone with fiscal or decision-making interests in this project. We'd like your thoughts on the ideal use of SWMP/IOOS data in K-12 classrooms and the kinds of ed products NOAA could offer teachers that would enable them to use such data in their teaching.

Please take a few minutes to complete this short survey. Your responses will be kept anonymous and confidential. ***Just click on "Next" to continue.***

At the end of this survey you'll find a few real-time data education websites if you want to explore. If you have any questions about this survey or needs assessment project, feel free to contact:
Janice McDonnell
Jacques Cousteau National Estuarine Research Reserve
Rutgers University
732-932-6555 x521
mcdonnel@marine.rutgers.edu

We value your input. Thanks.

**Note: For this project we're defining real-time/near-real-time data (RTD) as environmental data that you can access as the data are being collected (or shortly thereafter) to study current conditions or events.*

***SWMP is the System Wide Monitoring Program (of the National Estuarine Research Reserves) and IOOS is Integrated Ocean Observing System.*

Note: Depending on your response to some questions this survey is set up to skip you over irrelevant questions, so don't be concerned about the numbering sequence as you proceed.

1. What is your current job position? *(check all that apply)*
   - director/administrator/manager
   - coordinator
   - program manager
   - educator
   - researcher/scientist
   - data manager/technician
   - technology manager/technician
   - other *(please specify)*

2. For which agency/group do you currently work? *(check one)*
   NOAA Coastal Services Center
   NOAA National Estuarine Research Reserves
   NOAA National Marine Fisheries Service
   NOAA National Marine Sanctuaries
   NOAA National Ocean Service
   NOAA National Sea Grant
   NOAA National Weather Service
   NOAA Office of Education
   COSEE
   IOOS
   Other *(please specify)*

3. Are you familiar with SWMP (System Wide Monitoring Program) and/or IOOS (Integrated Ocean Observing System)? *(check one)*
   yes, familiar with both SWMP & IOOS
   yes, familiar with SWMP
   yes, familiar with IOOS
   no, not familiar with either
   other *(please explain)*

Note: If checked "yes, familiar with both" above, then asked this question….

4. Because you stated that you're familiar with SWMP and/or IOOS, please tell us your thoughts regarding their integration and use in K-12 classrooms.

5. Are you an educator at a NERRS (National Estuarine Research Reserve) site or in the NERRS program?
   yes
   no

Note: If checked "yes" above, then asked the next three questions….

6. Do you use SWMP or other real-time data (RTD) in any of the education programs your current NERRS' education programs?
   yes
   no
   not sure

7. Do you foresee using SWMP or other real-time data (RTD) as part of your NERRS' education programs in the future?
   yes
   no
   not sure

8. Do you think RTD should play a key role in NERRS education/outreach efforts?
   yes, definitely
   probably
   not sure
   probably not
   no, definitely not

9. Who do you think should be the primary K-12 audiences for NOAA education products based on real-time data (RTD)? *(check all that should be included)*
   K
   1
   2
   3
   4
   5
   6
   7
   8
   9
   10
   11
   12
   other *(please specify)*

10. What do you think should be the goals of NOAA K-12 education products based on RTD? *(check all that apply)*
   improving inquiry skills
   better math education
   better stewards of the environment
   greater understanding of the ocean/atmosphere interface
   better science education
   improving ocean literacy
   better knowledge of the environment
   connecting students to real-world science
   better understanding of estuarine/coastal ocean research
   greater awareness of science career paths/choices
   preparing students to be scientists
   other *(please specify)*

12. What do you think should be the primary goal of NOAA K-12 education products based on RTD? *(check one)*
   improving inquiry skills
   better math education
   better stewards of the environment
   greater understanding of the ocean/atmosphere interface
   better science education
   improving ocean literacy
   better knowledge of the environment
   connecting students to real-world science
   better understanding of estuarine/coastal ocean research
   greater awareness of science career paths/choices
   preparing students to be scientists
   other *(please specify)*

12. Do you think K-12 students collecting data in the field is an important part of understanding RTD?
   yes, definitely
   probably
   not sure
   probably not
   no, definitely not

13. Do you think K-12 students sharing their field data with other students is an important part of understanding RTD?
    yes, definitely
    probably
    not sure
    probably not
    no, definitely not

14. Do you think K-12 students contributing their field data to scientists' data is an important part of understanding RTD?
    yes, definitely
    probably
    not sure
    probably not
    no, definitely not

15. Which data formats would be most useful to K-12 teachers? *(check all that apply)*
    comparable data (different sites)
    quality assured/controlled (QAQC) data streams
    data visualizations (maps, graphs, etc.)
    raw data streams
    packaged lessons/lesson plans with RTD
    comparable data (different parameters)
    other *(please specify)*

16. Which real-time data streams do you think teachers are most likely to use?
    (check all that apply)
    algal blooms
    animal tagging/tracking
    bathymetry/topography
    currents
    directional wave spectra
    dissolved oxygen (DO)
    fish species & abundance
    ice concentration
    nutrients
    ocean color
    optical properties
    pH
    river discharge
    salinity
    seafood contaminants
    temperature: air
    temperature: water
    turbidity (clarity/cloudiness)
    vector currents
    video/live camera
    water contaminants
    water depth
    water level
    water quality
    waves
    wind vector
    zooplankton species
    other *(please specify)*

17. What do you think should be the essential features of NOAA K-12 education products based on RTD?
(check all that apply)
raw data streams
quality assured/controlled (QAQC) data streams
packaged lessons/lesson plans
information on the technology, that is, how data are collected
info on scientists who use RTD in their research
lesson plans for teaching science concepts with RTD
lesson plans for teaching math skills with RTD
lesson plans for teaching the science process with RTD
maps to show where RTD is being collected
assessments for use with lessons
assessments tied to state tests
alignment to state/national standards
other *(please specify)*

18. What do you think would be the best format(s) for NOAA K-12 education products based on RTD?
(check all that apply)
mobile devices, such as PDAs, cell phones, etc.
web-based/websites
supplemental materials associated with textbooks
hands-on kits
print materials
media, such as CDs or DVDs
other *(please specify)*

19. What do you think are the best ways to reach K-12 teachers with education products based on RTD?
(check all that apply)
aligned with state standards
pre-service training
shown to improve student test scores
tied to current events
tied to local issues/events
integrated with state curriculum
in-service training
packaged for easy use
shown to make learning interesting/engaging for students
other *(please specify)*

20. What are the greatest barriers to getting RTD into K-12 classrooms?
(check all that apply)
format/presentation of data
student abilities
funding
time
state standards
access to computers/Internet
student interest
teacher abilities
availability of data
awareness that the data exist
teacher interest
state/national testing
other *(please specify)*

21. What are the best ways to overcome the barriers you checked above? *(check all that apply)*
    greater accessibility to computers/Internet in schools
    in-service teacher training/professional development
    national ocean literacy standards
    greater data availability
    better promotion & awareness that RTD is available
    systemwide science education reform
    pre-service teacher training
    better data visualization/formatting for education use
    easy-to-use RTD lesson plans
    other *(please specify)*

22. What are the best K-12 education products based on RTD that you know are currently available?

23. What would you like to know about how K-12 teachers use RTD in their classrooms?

24. Do you have any other comments/feedback about the use of RTD in K-12 classrooms?

Below you'll find more information about the agencies involved in this RTD education project and a small selection of web sites offering RTD to educators and the public.
Just click on the name to visit the site.

NOAA Education
National Estuarine Research Reserves (NERRS)
Integrated Ocean Observing System (IOOS)
COOLClassroom
Eyes on the Bay
Monterey Bay Aquarium Research Institute (MBARI) EARTH
NERRS Centralized Data Management Office (SWMP data)
Tagging of Pacific Pelagics
Water on the Web

Or, click "Done" to finish.
Thanks for your time.
Done >>

To see this survey online visit http://www.surveymonkey.com/s.asp?u=51541789289

Appendix 4
Focus Group Checklist

Several weeks to one month before the focus group(s):

1. Identify the group(s) of people to be interviewed (sample). _____
2. Identify the moderator(s) and assistant to the moderator (if needed). _____
3. Draft an interview guide. _____
4. Test and revise the interview guide. _____
5. Choose location(s) and times, and confirm. _____
6. Determine incentive(s) to offer, and how to acquire and deliver them. _____
7. Recruit the participants. _____
8. Send written confirmation(s). _____

One week before the focus group(s):

1. Email each participant to confirm that s/he is coming and has directions. _____
2. Include URL to pre-meeting survey in email and ask to complete by the Wednesday before the meeting. _____

One day before the focus group(s):

1. Make sure you're ready. _____
2. Draw up a seating chart and/or prepare nameplates/nametags. _____
3. Practice using the recording equipment to make sure it's working. _____
4. Have incentives organized and ready (if handing out on the spot). _____
5. Get snacks/refreshments. _____
6. Prepare sign-in sheets. _____

The day of the focus group(s):

1. Arrive early to set up room, equipment and refreshments. _____
2. Arrange tables and chairs so everyone can face one another. _____
3. Welcome participants and ask them to sign in, complete pre-meeting survey if they didn't online, and sign videotaping permission forms. _____
   Orient them to their surroundings (if needed).
4. Introduce yourself and have participants introduce themselves (if they don't know one another). _____
5. Let participants know that the discussion will be recorded, but assure them that their names will not be used in any written report. _____
6. Remind participants to relax and for everyone to engage in the process. _____
7. Start with an introductory question and move to meatier ones. _____
8. Allow the discussion to follow tangents, as long as they're relevant to the evaluation. _____
9. If someone isn't talking, encourage him/her by asking him/her a direct question or conducting a round robin whereby everyone takes a turn responding to a question. _____
10. Thank the group for their participation and ask if there are any final questions. _____
11. Distribute the incentives (if appropriate). _____
12. Label the tapes and forms immediately. _____

Appendix 5
Focus Group
Pre-Meeting Teacher Survey

Thank you for agreeing to participate in this teacher focus group on your use of real-time data* in your teaching. We'd like to know a little more about you and your teaching situation. Please take a few minutes to complete this short survey. Thank you.
**Note: We're defining real-time (or near-real-time) data as data that you can access as the data are being collected, or shortly thereafter, to study current conditions or events.*

1&2. Your name (first & last): ____

3&4. Contact information: ____________________________ (phone number) ___________________ (email address)

5. Your school: __________________________ 6. School district: ________________

7. City: _________________________________ 8. State: ___________________

9. School setting *(check one):* ____ rural ____ suburban ____ urban

10. What is the racial/ethnic mix of students at your school? *(approximations okay)*
____% Asian
____% Black/African American
____% Hispanic/Latino
____% Native American
____% Pacific Islander
____% White/Caucasian
____% Other
____% Don't know

11. Which grade/grades are you teaching this year (2005-2006)? *(check all that apply)*

____ K	____ 7
____ 1	____ 8
____ 2	____ 9
____ 3	____ 10
____ 4	____ 11
____ 5	____ 12
____ 6	____ other *(specify)* ____________________________

12. Which subject/subjects are you teaching this year (2005-2006)?

13. How many years have you been teaching? ___________

14. What is your training/schooling in the sciences? *(check all that apply)*
____ None
____ Inservice/professional development workshops
____ Teaching credential with science emphasis
____ BA/BS in a science field
____ MA/MS in a science field
____ PhD in a science field
____ Other *(please specify)* ________________________________

15. What is your training/schooling in computer & technology use? *(check all that apply)*
____ None
____ Self-taught
____ Inservice/professional development workshops
____ College course(s)
____ Teaching credential with computer/technology emphasis
____ BA/BS in a computer/technology-related field
____ MA/MS in a computer/technology-related field
____ PhD in a computer/technology-related field
____ Other *(please specify)* ________________________________

16&17. What's the computer set up at school? and How many computers in each?
____ Computer(s) in my classroom #: ________
____ Computer(s) in a computer lab #: ________
____ Computer(s) in the library/media center #: ________
____ Other *(please specify)* ________________ #: ________

18. How regularly do you have your students use computers at school as part of their lessons? *(check one)*

never	rarely	sometimes	often (monthly)	regularly (weekly)

19. How regularly do you have your students use the Internet/websites at school as part of their lessons? *(check one)*

never	rarely	sometimes	often (monthly)	regularly (weekly)

20. How regularly do you have your students use the Internet/websites at home as part of their lessons? *(check one)*

never	rarely	sometimes	often (monthly)	regularly (weekly)

21. How regularly do you have your students use real-time (or near-real-time) data** as part of their lessons? *(check one)*
***Note: We're defining real-time (or near-real-time) data as data that you can access as the data are being collected, or shortly thereafter, to study current conditions or events.*

never	rarely	sometimes	often (monthly)	regularly (weekly)

22. If you have used real-time/near-real-time data in your teaching, please tell us what kind of data and from which sources?

23. With which of these real-time/near-real-time data streams are you familiar?
(check all that apply)
___ algal blooms
___ bathymetry/topography
___ currents
___ directional wave spectra
___ dissolved oxygen (DO)
___ fish species & abundance
___ ice concentration
___ nutrients
___ ocean color
___ optical properties
___ pH
___ river discharge
___ salinity
___ sea level
___ seafood contaminants
___ temperature: air
___ temperature: water
___ turbidity (clarity/cloudiness)
___ vector currents
___ water depth
___ water contaminants
___ water quality
___ waves
___ wind vector
___ zooplankton species
___ other *(please specify)* ____

24. Which of these real-time / near-real-time data streams have you used in your teaching? *(check all that apply)*
    ___ algal blooms
    ___ bathymetry / topography
    ___ currents
    ___ directional wave spectra
    ___ dissolved oxygen (DO)
    ___ fish species & abundance
    ___ ice concentration
    ___ nutrients
    ___ ocean color
    ___ optical properties
    ___ pH
    ___ river discharge
    ___ salinity
    ___ sea level
    ___ seafood contaminants
    ___ temperature: air
    ___ temperature: water
    ___ turbidity (clarity / cloudiness)
    ___ vector currents
    ___ water depth
    ___ water contaminants
    ___ water quality
    ___ waves
    ___ wind vector
    ___ zooplankton species
    ___ other *(please specify)* ____

Thank you.

Appendix 6
Focus Group Session Script

Introduction

Good [morning/afternoon].
Welcome and thank you for participating in this focus group session.
My name is Chris Parsons. *I'm an independent evaluator from Monterey, CA, who has been hired to facilitate this meeting today. I'd like to have a few more people introduce themselves.*
Janice
Madeline
Site Host

We appreciate your time, but more importantly your expertise as educators working in K-12 classrooms. We've invited you here today because of your interest and experiences using RTD and computers in your teaching. I'd like you to introduce yourselves. Please share your name, school and the grades and subjects you teach.
[Teacher Introductions]

This session is funded by NOAA's Office of Education to learn more about the use and usability of RTD in K-12 classrooms. For this project we're defining real-time data (RTD) as data that you can access as the data are being collected (or shortly thereafter) to study current conditions or events, such as weather or tsunamis or hurricanes or currents. We're conducting six focus groups around the country and what we learn will help NOAA with the development of educational products for classroom use.

Our agenda is as follows:

9 – 9:30	*Introductions*
9:30 – 10	*Discussion: Teachers' Current RTD Use*
10 – 10:10	*Where Do RTD Fit? Exercises 1*
10:10 - 10:25	*RTD Overview PowerPoint*
10:25 – 10:30	*Where Do RTD Fit? Exercises 2*
10:30 - 11:15	*RTD Websites Review*
11:15 – 12:00	*The Ideal RTD Ed Product*
noon	*Closure & Thanks*

This session is fairly informal. If you need refreshments, feel free to get up and get something to drink or a snack. As you can see, we don't have a formal break scheduled. You're welcome to use the restroom at any time or during the website review time. The restrooms are [give location].

I may take notes from time to time, usually to remind me of a follow-up question. I won't be writing what you say. For that we have the [video/audio] tape recorder. We're taping this session to help us with the analysis of your comments. In our final report all comments will be anonymous—your names won't be used and comments won't be attributed directly to any one person.

I have general questions and activities to guide our discussion, but that's what I want to have, a discussion. All of your points of view are valuable and I encourage each of you to participate. So please say what you think and don't worry if your point of view differs from others in the group. I also ask that you respect each other and let someone finish what they have to say before you jump in to add your thoughts.

Are there any questions at this point?

Teachers' Current Use of RTD
Let's start with how you're currently using real-time data in your classrooms. What data do you use, where do they fit in your teaching, why do you use RTD, what's your students' responses to using RTD?

Where Do RTD Fit? Essay
I want you to use the blank sheet of paper in front of you to answer a question. You can answer in an essay form or bullets, but write enough so that I understand your answer. The question:
At what stage or stages of your lesson planning/teaching process do you use RTD? Where do RTD fit?

Where Do RTD Fit? Map 1 (see Appendix 5)
Using this map/graphic organizer and a colored pen near you, write RTD in bubbles to show me where RTD fit in your teaching.

Collect the essay and map

PowerPoint Intro (see Appendix 7??)
NOAA has specific RTD data streams in mind as they think about the development of education products. Janice has a short presentation to introduce you to those data streams and some of the exciting things happening with RTD.

Where Do RTD Fit? Map 2 (see Appendix 6)
Again, using another map/graphic organizer and a colored pen near you, write RTD in bubbles to show me where the SWMP/IOOS RTD would fit in your teaching.

Collect the map

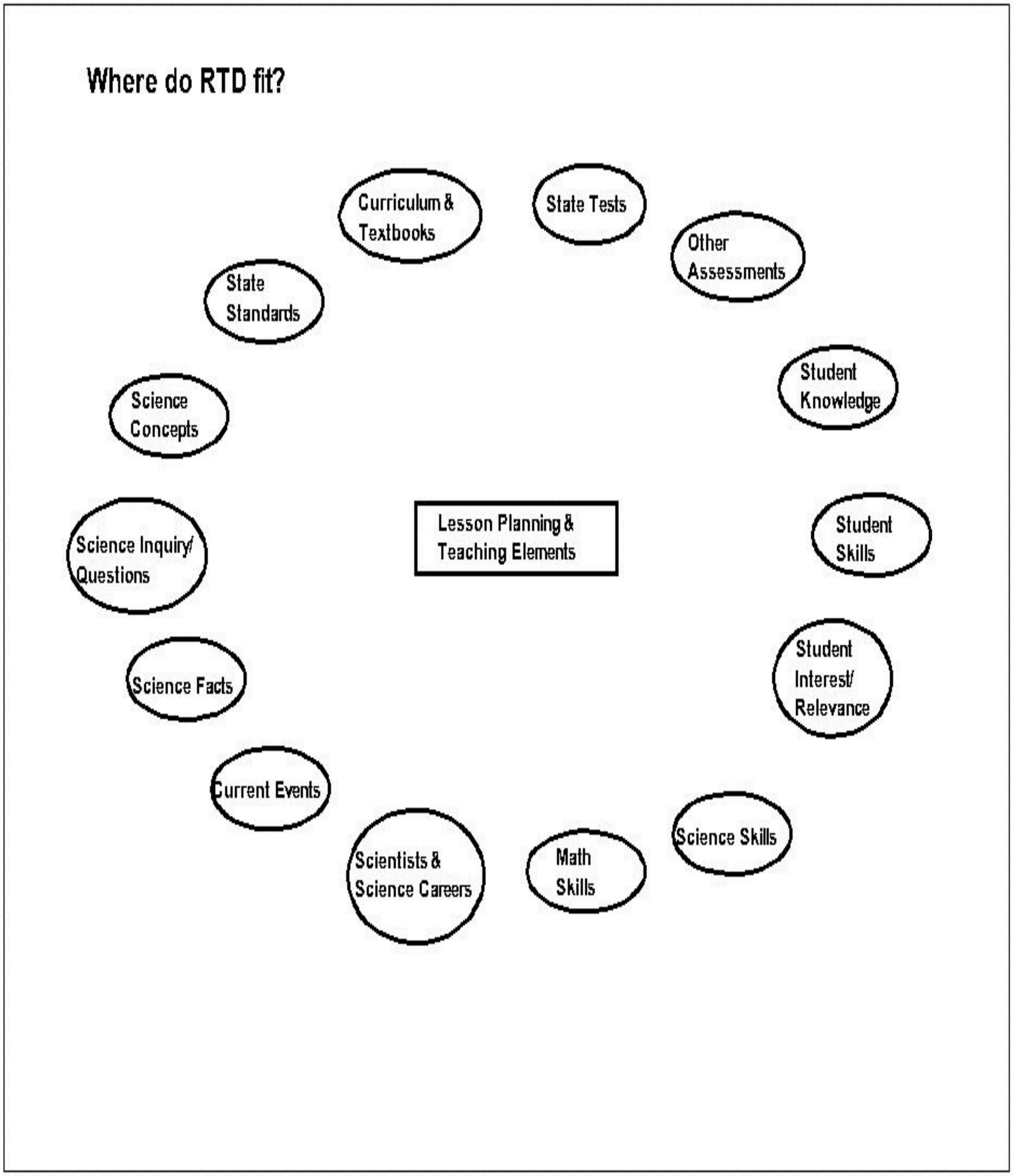
Website Review Feedback (see Appendix 8)
We have two education products (websites) that we'd like you to spend some time reviewing. They represent two different ways of presenting RTD for public access. The CDMO site offers the SWMP data that Janice talked about in her presentation. The Eyes on the Bay site presents Chesapeake Bay data. We'd like you to take a look at these sites, then use the form I'm about to give you to provide us with feedback on each of these sites. We'd like you to review both of them, so I'm going to ask everyone on my right to review the Eyes on the Bay site first, and those on my left to review the CDMO site first. Then about halfway through the review time, I'll ask you to switch to the other site. You'll have 30 to 40 minutes for this review session.

Collect the feedback forms

Ideal Ed Product
For the last part of our session, I'd like you to talk about what would be ideal for you in terms of an education product(s) that focused on RTD. You can use examples from the two websites you just reviewed or other sites/products you've used.

End
Those are all the questions I have.
I want to thank you for your time and your thoughtful feedback.
We have a few thank you gifts in the back; please pick them up as you leave

Appendix 7


Where do RTD fit?
Curriculum & Textbooks
State Tests
Other Assessments
State Standards
Student Knowledge
Science Concepts
Lesson Planning & Teaching Elements
Science Inquiry/ Questions
Student Skills
Student Interest/ Relevance
Science Facts
Current Events
Science Skills
Scientists & Science Careers
Math Skills

Appendix 8
SWMP/IOOS PowerPoint Presentation

You can view the PowerPoint Presentation shown to teachers giving an overview of SWMP and IOOS data at: http://marine.rutgers.edu/outreach/rtd/.

Appendix 9
Website Review Feedback Form

Which website did you review? Website name: ________________________________

1. Have you ever visited this website before or used it in your teaching? *(check one)*
   ____ yes, have visited   ____ yes, have used it   ____ no, neither   ____ not sure

2. How easy was it for you to find the real-time (near-real-time) data on this site?
   (circle a number from 1 to 7)
   not easy ... *very easy*

1	2	3	4	5	6	7

3. Rate each of these usability issues for this website. *(circle one choice for each issue)*

Issue	Always	Most of the time	Sometimes	Never/ Not at all	Doesn't apply
From the beginning, I knew where to go to find what I was looking for.	3	2	1	0	na
I knew where I was as I moved through the site.	3	2	1	0	na
I found what I was looking for.	3	2	1	0	na
The information was clear, easy to read.	3	2	1	0	na
I understood what kind of real data was available on this site.	3	2	1	0	na
The data were presented in ways that I understood.	3	2	1	0	na
The data were presented in ways that I could use.	3	2	1	0	na
The site presented the information I needed to understand the data.	3	2	1	0	na
I felt frustrated using the site.	3	2	1	0	na
I was overwhelmed by the data on this site.	3	2	1	0	na

4. Thinking about how you use real-time data in your teaching, how useful would this website be to you? *(circle a number from 1 to 7)*
   not useful ... *extremely useful*

1	2	3	4	5	6	7

5. How does this website compare to other real-time (near-real-time) data sites that you've used? *(circle a number from 1 to 7)*
   not nearly as good ... *much better than others*

1	2	3	4	5	6	7

6. Was the website's real-time (near-real-time) data presented in a way that you could use with your students? *(check one)*
_____ definitely   _____ probably   _____ not sure   _____ no

Please explain your response above.

7. What parts/aspects of this website would be most useful to you and why?

8. If you were confused or frustrated at any time using the website, please tell us what happened.

9. Would you use this website in your teaching? *(check one)*
_____ definitely   _____ probably   _____ not sure   _____ no

10. Would you have your students use this website? *(check one)*
_____ definitely   _____ probably   _____ not sure   _____ no

11. Would you recommend this website to another teacher to use? *(check one)*
_____ definitely   _____ probably   _____ not sure   _____ no

12. Do you have suggestions on how to improve the presentation of this website's data to make it more useful to you and your students?

Grade(s) you teach: _________

Your initials: _______________

Thank you!

Appendix 10
Currently Available RTD Education Products
Suggestions from Stakeholders & Teachers

Because we received so many suggestions from stakeholders and teachers, we decided to develop a website with an annotated list of the currently available RTD online resources. You can find that list at http://marine.rutgers.edu/outreach/rtd/.

Appendix 11
Stakeholder Online Survey
Responses to Question 4

Online #4. Because you stated that you're familiar with SWMP and/or IOOS, please tell us your thoughts regarding their integration and use in K-12 classrooms.

I think if we do this right, this can engage thousands of students to learn about science and estuaries. It needs to be very basic.

I think it offers a great opportunity to teach about estuaries and the ocean while meeting math and science standards. The data seem well suited for classroom use because so many teachers already collect water quality data on a limited scale with their students, the graphs used to interpret the data are easily produced and understood by students, and the topics (density, requirments for life, etc.) align closely with science standards.

With the Ocean Literacy movement, this is such an important connection to make. It's a great idea, but the process may take some time...most of the teachers and students I've worked with have some difficulties with the data-either technical difficulties or problems translating what the data mean and how it can be applied in their classroom.

Great potential!

I just used the SWMP data for the first time for a group of high school chemistry classes. For a field trip here to the reserve, one station was in our computer classroom focusing on the SWMP data. I adapted the activity from the 'York River Water Quality Curriculum', from the Chesapeake Bay NERR. It was a self-directed activity, supervised by the classroom teacher with no prior preperation by the students or teacher. The activity went well and I will be repeating it again. I think self-directed activities, with teacher resources and follow-up questions/lessons/activities are a great way to engage classrooms with a local/regional NERR. this is especially true in light of budget crunches at schools and their inability to take many field trips. The downloadable nature of the data lets students and teachers get more involved with the data and is something I have net yet explored.

It would be really useful if the data sets from these observing and monitoring programs could be effectively translated for use in the classroom to support principles in physical, biological, sciences. Also these programs offer a multidisciplinary approach to understanding ecosystems. Data translation could be as simple as formatting for use in excel format, visualizations that could be incorporated into GIS tools, etc.

This might be a good user group for these data if it can be presented in a way that is accessible (age appropriate) and if the tasks meet the educational objectives for target grade levels.

The use of this data has fantastic potential if the activities which use the data can reliably access the data sets. The web portals that provide this access should be dynamically designed to make the interpretation of the data interesting and reasonably easy as a jumping off point. Teachers should be able to depend on the sites and point students to access the data and conduct investigations that result in a satisfying and meaningful outcome. From the sort of pre-digested approach, students should then be able to carry on to some more novel work.

Teacher professional development programs with which I have been involved show that teachers want to integrate REAL data in their classroom teaching, but are intimidated by it. They need products and tools in place if they are ever going to use data in their classes. This feedback has come from high school level classes. I find that elementary and middle school teachers are overwhelmed with the wealth of teaching products available to them and don't know where to start. Any products developed need to have a support system for teachers wishing to use them.

As long as students can do activities that let them actively retrieve the data in person and them apply it to some real world situation I think it will be engaging.

I think this would be most used at the 9-12 grade level. I know that some schools have technical difficulties getting access to the internet...schools don't have money to upgrade computers or internet capabilities. THis would present a challenge for integration of this data.

I think it will be great to develop activities which will allow classroom teachers to use both SWMP and IOOS data in the classroom. I do think that initially there will need to be extensive trainings to show teachers how using this data will help them meet education standards that they are required to address.

Appendix 11 (continued)

One of my first comments is to try and ensure that it's clear that IOOS data collected by the NERRS system is considered to be SWMP data and not a separate data collection effort. The near-real time data collection that is being added to the national IOOS effort are just the SWMP data sent more rapidly for users--the data collected are the same, the time intervals for sampling are the same, and the placement of the sampling sites have not changed at all--all data collected is SWMP data. Thus, there are two approaches to consider when thinking about integrating this data into the classroom. The first is the use of near real-time data (that data that is being sent more rapidly to better support IOOS missions) versus the use of collected static data that SWMP has accumulated for the last 10years. Using real-time data for highly developped classroom curricula strikes me as being pretty challenging (e.g. data availability, data inconsistency w/regard to hypothesis at that time--ie not meeting expectations for the curricula, etc), however, using real-time data to track sudden events (e.g. storms, etc) could be very useful and informative (but does require flexibility with planning on the instructor's part). The use of static (ie long-term data collected) strikes me as being more useful for teacher curricula exploring data trends in estuarine environments (ie. seasonal/annaul eutrophication events, periodic low dissolvoed oxygen events, temperature/salinity increases/decreases, etc)--the coursework can be worked out by the teacher in advance without the concern of not having the real-time data avail at that time and the interpretation of that data can be explored and examined more intensely give the period of time used. An additional comment would be that in the use of near real-time data in classrooms the teacher needs to be pretty confident that the data that they are exploring/discussing are appropriately explained, basically that the interpretation of the data at that time is accurate so that students are learning the right information. There are many reasons why there might be a low dissolved oxygen environment, there are many reasons that one might observe a spike in temperature--and the use of near-real time data in a classroom (depending on the level of student) should be used with multiple hypothesis/options for interpretation. We don't want to be teaching something that is not accurate--the static data interpretation can be researched and presented with perhaps more confidence for describing the phenomena observed. This is not to say that near real-time data can not also be interpreted confidently--just that it could be more challenging for use in a classroom curricula at that exact moment of time. The inclusion or 'real' data (static or near real-time) is an excellent way to connect students to their environment, to help them observe and discuss the interconnectedness between observations, and to expand from the abiotic information (that collected through SWMP) to the biological information that may be more 'real' to the student (e.g. low dissolved oxygen with potential links to fish kills, greater impervious land surfaces influencing eutrophication, etc). The SWMP data is also a great basis for building student compentence in graphing and displaying data usefully for interpretation. This can link solidly to the scientific writing and reporting--a critical link to making students (the general public) understand what the data means and what actions might be causing/resulting from the interpretation.

I feel that there are many middle and high school teachers who are interested in using water quality data. I do not think that teachers will utilize the data if it is not extremely easy for them to access. Teachers also want data collected from their local area.

I would like to see some principles of interpretation as defined by Freeman Tilden and Enos Mills used in the development of materials. Interpretation involves provocation, revelation, personal relevence, and connections to the whole rather than just one phase. It should be engaging, inteactive and dynamic.

As school budgets increasingly limit opportunities for classes to reach out beyond the classroom, opportunities are expanding for bringing the world into the classroom. SWMP and IOOS data provide a good base for such efforts, allowing a local and global perspective.

One of the most valuable potential uses for SWMP data is its incorporation for teaching of math skills in middle and high school. It also provides local examples of scientific principles and concepts that students must learn as part of state and natioanl curriculum requirements.

The students need the background and experience to make the data relevant and understandable. There needs to be a curriculum that has the younger students learning the basic science behind the parameters being measured, as well as the basis for the technology being used to make the measurements. They should have hands on experience with basic water quality or weather data measurements. For example, younger students can use a secchi disk to measure turbidity and learn about light scattering, which is the same principle exploited by the nephelometers in the research datasondes. The problem we are facing is that many high school amd middle school students have not had any science and will need some backgound work before the data makes sense. It will not be worthwhile to just have them pushing around numbers on graphs without this background work to make the numbers meaningful.

Appendix 12
Stakeholder Online Survey
Responses to Question 23

Online #23. What would you like to know about how K-12 teachers use RTD in their classrooms?

Actual comments

examples

How are they getting the students engaged with the material? Are the students really understanding the significance of the data?

How frequently do they use this? Would they want to use it more and if so what would they need to make that happen? How does this relate to other curriculum and field trip opportunities?

how NOAA can be more supportive to teacher needs greater communication between teachers/scientists

I would like someone to gather a variety of successful examples and offer an in-service training associated with an annual NERRS Education Coordinator's meeting. Who, what, where, how is it being done.

If science teachers are the only ones using RTD in their classrooms. Exactly how much of their classroom teaching is dedicated to state test topics.

I'm not aware of use in my area so local uses etc.

Impacts on learning? Anecdotes on how RTD changed lessons or students' enjoyment of curricula. Usefulness of RTD as a tool for applying real data to lessons? What are the best products and tools using RTD for teachers?

It is crucial to know whether exercises will be teacher led with whole class or used by students with no direct supervision.

Not sure I understand this question. Is this how teachers are currently using it in their classrooms, or once it's available how they plan to use it in their classrooms?

relevance to classroom curriculum - how does access to RTD support classroom activities? Can students relate to RTD? Does it help them to understand the scientific process better? Does use of RTD help students to better understand the interdisciplinary nature of different classroom disciplines (i.e. physics, mathematics, biology etc.)?

Teacher focus group would be very valuable, however the best data would come AFTER they tried to use the material in the classroom. It's one thing to brainstorm while well caffeinated, and another to implement in a classroom with 26 students.

The ease with which near real-time data are used, the frequency that the data is used, the top 5 data that are used for water quality discussions (e.g. dissolved oxygen, PAR, satellite color information, etc). What's missing for the teacher's information/support?

What parameters do they target? What parameters would they like to see that aren't widely available?

What they find useful? What their students find interesting? How the fit it in state and national standards and testing?

what they use, what they prefer, what works best and what kind of feedback they get from students.

what they're currently using and where it comes from if they could pick any RTD, what would be most utilized in their classroom?

What training and support would be required to motivate a teacher to use RTD?

Why are some teachers able to use the data but not others? Who is more likely to use the data middle school teachers or high school teachers? Private school or public? The informal feedback I get from teachers is that high school classes are so test oriented that the teachers don't have the freedom to do this kind of teaching. I would like to know if that is true.

Appendix 13
Stakeholder Online Survey
Responses to Question 24

Online #24. Do you have any other comments/feedback about the use of RTD in K-12 classrooms?

create more NOAA partnerships with the education community, like the National Science Teachers Association and The Weather Channel, USAToday

I think hands-on activities should be focused on.

I think this is an exciting opportunity to connect students in the classroom to real time data, to be a part of the process of understanding our climate/ocean conditions and how these factors affect biodiversity.

I think time and lack of experience are the most significant barriers. If we can train teachers in how to use data, then provide data in a ready-to-use format, it will help teachers overcome these.

I would like to see the inclusion of some type of interface associated with the RTD - i.e. the ability to ask questions of a NERRS education or research staff person. That communication does not need to be real-time. I think an FAQ page on the website would take care of most common questions from teachers/students.

Let's get something we can really use! The system is conceptually fantastic, but it hasn't really panned out yet.

One question that I kept getting stumped on throughout this survey was state standards. I think it's critical to be tied to state standards to get the products used in the classroom. But, I think it would be a huge undertaking to try and align these curricular activities to the state standards, although, the state should be aligned to national standards. So, I guess when I was answering many of these questions I made the assumption the each state would work with the activities and align with their state's standards - which would hopefully encourage use by classroom teachers. But that also leads to the next question - who at each state will take on that responsibility? Maybe funding could come to a state partner (NERRS for instance) that would take the activities and align to their state's standards.

Take K - 6 entirely out of the picture. You can't be everything to everyone. Take a crack at it and then make edits as we learn. The end goal is for students to get into the data and make their own graphs and stats to answer their own questions. This is not a pretty process. Empower them and let them go. Too many visualizations turns young brains off.

You should check out the notes from the Estuaries 101 session during the NERRS Education Coordinator meeting. All of the Education Coordinators listed goals for the system-wide education program, many of which relate to using RTD in the classroom.

Appendix 14
Teacher Website Feedback
Responses to Question 6b

6b(7b). Explain your response above: Was the website's RTD predented I a way that you could use with your students?).

Comments on CDMO Website

The provisional RTD page gave a very clear image of the data by using pictures of each instrument.

It would take a bit of time studying the data to develop web guests/labs that would guide students here, focus on their level and then apply. The time limitations in doing the might prevent me from using it.

for example, temperature data over a 24 period was graphed, which I would be able to use to show the influence of the sun(?)

Students could access data from around country and compare to other NERR centers.

I liked the map & how you can move it & click on what ever you want. Also, how it shows the instruments/devices used allowed students to get a better understanding of how it is developed.

Yes in some ways. It would take a lot of prompting. I like how they show guages and thermometers for data. It's like you are taking a reading. I think there are too many steps to get where you'd need to go for middle school students.

Some data-intro to data collection & study of US ecosystems outside of CA

I found it but it took some hunting

Would like to see more data (i.e. rainfall) in order to evaluate all possible variables. A map of area and info on local populations

My students are very "local"; they would like a site at Boston. Getting them interested in the Chesapeake and it's problems would be a challenge.

Need to access data quickly! An advantage is to be able to get local data.

Great information. The problem lines in finding the data, which was not as difficult as the second site we looked at today.

Info was there, but not clear how to find it.

Not sure how to help them create meaning; not as user friendly for middle school

Error messages, difficult to graph (too many steps/clicks)

I really like the thermometer & gauge simulation. That's what makes it "real". The data sets are overwhelming to students, but comparitively manageable (with the filter provided) and the graphs are great!

I don't think wind speed and temperature would interest them. Dissolve oxygen, nutrients, etc., might

I had difficulty; hard to explain to students if I don't know where I'm going.

I think the graphics on the website were great. Very student friendly (the thermometers, maps, barometers, & graphs). I liked that there was a link under the RTD to explain the abreviations.

A bit too confusing to navigate for my students. Might simply print out data and graphs for them?

This site included tabular data, which could help my students. However, the data sets available could easily overwhelm my students if they tried to use too much data at one time.

We couldn't accesss the data. It relied on software not loaded on the computer.

No explanations of data parameters (that I could see). Difficult to navigate

It is a very long list of data. I think my students would get overwhelmed very easily at the site. I could print out certain pages and thin it out for them.

Hard to manuever

They would need explicit directions and, a back-up activity better be ready in case the website isn't providing what is needed or the kids aren't finding what they needed.

Once I figured it out….I really liked how the students could graph two parameters.

The data included West Coast data, which is great. I didn't find Elkhorn Slough on the site until learning how to find it from a peer.

It was presented visually in a way they could relate to easily.

Graphic nature of the display & ease to move to other indicators.

Data was presented with graphing ability & statistical ability. Data available from 3/11 back to Jan - comparison ability.

The salinity, pH (all water quality data) graphs were very useful, although it would be great to have a scientist observing the same data to explain anomalies.

Students could use this info to compare our conditions with other locations

Appendix 14 (continued)

The data was presented on (?), graphs & tables. ??
Because local data in included
Hard to use at 1st. However, a very powerful website. Appropriate for my classes.
This website would work good to help my students practice data analysis. It would be more useful if I used these parameter in our field research which I should and I'm planning to add some of them). The program used for graphing was very nice.
On the data page, only 10 data points were shown yet graphing covered several months. No ablility to print graphs in standard format or download data
Estuary lessons are useful. PDF curriculum & watershed exploration are nicely done.
Presentation, graphics, charts are very clear.
It was both in data table format and in graphs.
Laid out intuitively in terms of navigation and data parameters/acquisition, etc.
I would need to capture and manage all data.
The archived data would be easy to use. The real time data would have to be collected over an extended time for it to be eful (not as realistic for some situations/lessons).
Yes if it runs properly. Lots of problems with tech stuff.
It was pretty easy to relate to location & data measures, and find my way to what was there/what I wanted.
I need to get use to using such data, to be able to see it valuable. Need to get familiar with website.
I had to look around for data I could use, my students know less than I do.
When I found individual station data it looked like it would be very useful, and graphing component is great - comparing different factors graphically.
Once I found data that I was looking for the site was useful. Not easy to get to useful info.
Once I was able to access the data (which I found difficult to access) the data was clear & relative to marine biology.
D.O vs. temp data useful in AP. Looking at salinity at different sites and disccussion about estuaries.
Some links were difficult to follow, while others had clearly presented information
Foundational information would have to be provided, basic definitions, etc.
The effort to get the data retrieved is not worth the time, when you can display a graph or data on your own to the children. Students would be very frustrated & lose the point of the exercise.
I had a very difficult time finding the data I was looking for. Is this site totally operational? I could only get data for one parameter, when I tried to graph two sets of data at once I kept getting only one set of data.
Had problems reviewing data at first for state (NJ, NY, etc.)
Most of the stations said no data available. Data tables were not labeled with units. You needed to click to another page to get the units. Students will not not notice this.
Problem getting data
My computer did not have Google Earth and couldn't access data. My neighbor's did but the first four locations we selected had weather info only, no water quality data.
Not presented in a time-continuous fashion. Thus, there is not much relationship of how these data fit into the "Big Picture".
Doesn't seem teacher/student friendly
The data is confusing in Real Time was no "key" to help interpret the data. I had no clue what I was observing
The data should be a graph, not a list! (or the option to choose) . Most of the data I looked for was not available

Comments on Eyes on the Bay Website
It gives the opportunity to study water quality components we would not otherwise be able to do. Our text's study food webs in this area. It could be used (data) with math applications - tables were clear!
It would be nice to download the raw data for use in programs such as Excel or Quattro Pro.
The data is easy to access and explains what you are looking at, gives relevant definitions and explains effects. The graphic displays show great visuals to compare!
Good menus; user-friendly
easy to navigate, bright pictures with simple guides to get info.
They need reference information so as to critically examine their own data.
Liked the graphics; need to navigate quickley; seemed easy for kids to use
Yes - love the graphs. Data organized in a condensed manner. I don't think my students would get overwhelmed

Appendix 14 (continued)

The maps provide a nice overview and the graphs help students visualize the data sets. The ability to download "raw data" is also nice, but it's sometimes slow and hangs up.
It was complex enough that students will have to think, but they will be rewarded with exciting charts and graphs
Very colorful and appealing to students
I thought that the tables and graphs were clear and not difficult to locate.
The data was presented in tabular form & was acessible in graphic form, both of which is usable with students.
Promotes the understanding of the ecological roles organisms play in the environment and what acceptable parametes (DO, salinity, etc.) are in a healthy ecosystem.
Students can choose a specific site and receive continuous RTD, there are many areas to choose from.
It would be helpful to look at conditions that would be favorable to abundance of life. I'd use some of the hurricane data.
good info--have to figure out how it is meaningful to my students and what concept in the standards it addresses
In reference to using the process of science collections, but I would try to find a more local website to Monterey Bay. More relevant data.
Has a plethora of info available to better understand the data/factors that influence the data.
Wish there was a monitoring station in NE but liked seeing data from across the US.
Compare yearly results to our results for DO, temp, turbidity.
Could ask students to observe data and predict next set of data based on certain parameters. Use with comparison of "pond study" data from school.
My students use tables as well as graphs and would have difficulty if they only had graphs available. Also, they might get confused wth the vertical lines on many of the graphs.
If I lived in the area it would have more relevance, and would be interesting to use in a watershed unit.
Too complex. Liked seeing lesson plans. Too many words for kids.
The graphs were pretty good, but it would be good to have better data for right now (i.e. current temp, wind direction, etc.).
I really liked the graphs that had the month average, the montly ranges and current data! Kids would get it.
If there was a website similar to this (easy for many ages, kids thru adult) to understand, I would heavily rely on it in my teaching.
Downloads directly into Excel. I would develop something w/ the data, not have the students go to the site for it.
Data was presented in a variety of ways, graphs, chloropleths, data students can analyze relationships, convert data representations etc.
The data was in graph format easy to read
Great site, great data, emenently usable
It shows the paremeters on a monthly basis and in a graph/table. Using the table, we could graph the data. Using the table and the graph, we could identify trends. After identifying the trends, we could then discuss the affects on wildlife fisheries.
I could use complex data with my higher-ability students and was please to see very simpified version (at least for the data I was looking for) for my lower-level kids.
Wonderful…I like the lesson plans that go with the site. In addition the last activity which could encourage teachers/students to do a service-learning project.
I would use this site if it was relevant to my geographical area of interest.
To motivate my student I must use sites and data relevant to their experiences and {?} live
well labeled with nice graphics
The data had information about the site and the data. The links to the data was good so you knew what you were going to get.
The spreadsheet/graph data is excellent and data maps are well done.
Several types of data presented and easy to access
In the Marine Biology class I would use it continually. In the Biology class I would use it for graphing, data collection, photosynthesis
This site is easy to navigate & easy to understand. The data is visual (graph) and clear. The data is present and current and easily accessable.
The Continous Monitoring Latest Result pages are excellent. Great data sets, very clear.

Appendix 14 (continued)

Easy to move between stations. Lots of maps, so simple to connect locations with data. Good explanations of what data means. Data dowloads to Excel quickly, even a very large data set.
Very student friendly, easy to access and understand
It was easy to access and provided a lot of useful data, graphs & other info.
Everything was clearly labeled and the types of data shown was explained right below each graph.
Water quality data presents DO and Temp degree F so my students could use a monograph to check the % saturation.
Supports links excellent, with basic definitions, like a textbook.
The students would first need some content background. Some pages did explain what the data was, but as I entered to RTD portions I had to rely on what I know. (I did find it later: it was down the page further. This maybe should [be] up top more?)
This data waas overwhelming for such a specific area of the country. It may be helpful if my students were closer to this part of the world. Tables of information of water quality were easily aquired & could be useful.
Looks like I could use it as comparison to local estuary.
There were good data tables & graphs - allowed me to "see" the relationships - and copy data - and the download feature made it simple to use it away from the computer.
Just may need to learn how to download and use data
It seems harder to analyze the relationship between parameters. It did a real good job of showing patterns/trends throught out the river.
With work I could get to some portions (and there could be others) that would be useful. Letting kids surf would get them to go infor/scientists.
There were graphs of the data.
Unlike the other site, on this site I couldn't graph 2 parameters similtaneously, which I'd like to do to meet the objectives of the AP Bio. (College Board) D.O. lab.
I think I would need to mitigate some of the clutter. If students were navigation the page, they would get confused by crowded pages.
Lots of blocks of text. Kids do not do well when expected to read so much--particularly on a screen.
limited access to lesson plans; cannot overlay graphs; ability to download info / data was restrictied on this computer.
Data was pre-processed, not arranged in table or graph (raw form). If we were examing a particular site & comparing collection area to collection area, this site (or a similar one) might be useful.

Appendix 15
Teacher Website Feedback
Responses to Question 7

7. What parts/aspects of this website would be most useful to you and why?

CDMO Website

"About Data" - parameters and metadata - helpful way to learn about what data is available.
1. Real data 2. Graphs
Amount of data covered [but] only if you could use it.
Archived data
As in question #7…the presentation of a data set can be used as an interpretation tool by me.
Being able to get data from many locations.
Collecting the data and graphing of information to compare (related) parameters such as D.O. & pH, temp. & D.O.
Data for graphing and interpretation.
Data from Weeks Bay (compared to other locations)
Data list and graphs
data tables & graphics
Disolved nutrient info - could use to compare populations and influences on water quality
Easy for students to navigate and easy to export to Excel.
Elkhorn Slough work
Explanations of different water parameters
Fresh water (Great Lakes) data, for comparison to student collected data.
Gauge simualtions; Graphing 2+ parameters; Filtering features for the data
Get data-graphing with fusion charts
Good explanations of terms. It is neat that you can check RTD at more than one area, but you are limited in information. Middle schoolers would love the way this site graphs data. I like how you can do 2 parameters a once.
Graphing (espcially graphing 2 paramters simltaneoulsy to investigate relations between the 2)
Graphing feature, comparing Delta in two parametes. Water quality data. Probably other things I didn't investigate.
Graphing more than one parameter on same graph
Graphs
Graphs and data and satellite views and maps
Graphs and data provided when we finally found it.
Graphs--comparison graph
Having them ain part of the site….photos come up. The RTD that you would get gave you the # of the test & they would give the picture of the device with the proper settings, pretty cool.
I like being able to visit site all over the country.
I like the gauges that could be read (temp, wind speed, etc.). The graphs (weather data) and the ability to graph 2 parameters at once.
I liked the back arrows. I liked the explanations of the water quality indicators. I liked the estuary one field trip
I teach water quality testing & human inmpact on our oceans, so this data will be very relevant.
I would be hard for me to use this data, I teach life science and a lot of time I don't have time to get this in-depth in the study of ecology because there is so much I need to cover.
If a student clicked on "Explanations of Water Quality Data" a helpful description on parameters and units popped up.
If data was accessable I would use it, but it took me 12 minutes to find RTD! That is way too long. It should take me less than 1 minute to find RTD.
Info and data on organisms, habitats. I did like the left side-bar which helped with navigation. Seemed to provide a broader perspective with US map; able to zero in on area of interest.
It was NJ; design was simple; no info overload
Lesson plans - could use them anywhere.
Lesson plans for teachers
Liked the link to Google Earth and the ability to link to geographic site with the map. Liked the abliity to graph 2 parameter at once.

Appendix 15 (continued)

Links for student research; lesson plans for curriculum; research data -monitoring data; IOOS-NERRS real-time data; stewardship projects for service learning activities.
Looking at weather patterns and water quality at various locations around the nations. Compare them to human activities.
Loved the graphs when they worked--I would have diff. students/groups graph diff locations and compare. Great Google Map :)
Many of the links wold be useful to my different classes; coastal management, invasive species, habitat restoration.
More global. Graphics
Picking specific data to teach about e.g. pH
Real time data charts
Salinity, D.O., pH, Temerature data
Salinity, pH, turbidity, tempurature are all aspects of what I teach in my classroom.
Shows a larger system
Site is easy to use
Tables and graphs
Tables and graphs
Tabular and graph data were both available, allowing me (and students) to view it in the most useful form.
The fact that it is regional is great but software problems are totally unexceptable.
The Google map & list of sites
The graphic real-time data was excellent. Visuals always help to understand a concept.
The graphing and comparison if I could get it to work!
The interactive map for comparing weather maps from intellicast.com to current local conditions.
The lesson plans because I'm always looking for the BEST way to teach a concept.
The potential is strong for measuring the differences across the U.S. as the jet stream and other "weather" factors do their thing.
The satellite mapping capabilities….that's it.
The water quallity data-charts & real-time.
The Weeks Bay data is our local ecosystem. The real time data for the 8 participating sites
water quality
Weather station data--I liked the presentation. It was easy to compare between sites.
Well the "About Data" icon is essential because it aids in understanding the data; especially parameters, which includes an explanation of the units being used.

Eyes on the Bay Website
1. Graphs and data shown. 2. If a station was not working it told you when you clicked on it.
1. See above. 2 background info about toxic algae, etc.
Able to access specific data easily and rapidly
Actual lesson plans/pages are built into this site.
all
As a teacher I'll like to learn how to gather data in Gilroy's neighborhood and put the info in a similar level site.
At the top of the site it had moving links for lessons plans, etc., it would be nice to have them stationary. I know that they are on the bottom, it was distracting.
Background information; real-time data & near-time data
Brings a lot of data to one place
Colorful charts Good explanation (definitions) Fairly easy to navigate
data from across the US
Data tables
Data tables for students to calculate statistics, graph, discuss reasons why data makes sense.
Data tables of actual data collected.
Data, graphs & other infor (i.e., research) immediately tell you when some way [don't] ?? or data not available -- now time wasted.
Definitions and explainations of different types of data collected and how it connects to one another.
difficult to find lesson plans

Appendix 15 (continued)

Downloadable data directly to Excel. Graph/data table interface. Maps
ease in choosing site and parameters. Lesson plans to see/use
Fast access to very clear RTD. Easy to change data parameters.
For the subjects I teach now, the expanations of the data & the graphs of the data would help so we can compare habitats.
Graphics/charts--major map locator (geographic) opens up opportunities for students who are not familiar with Ches Bay to investigate the Bay.
Graphs and explanations of the parameters being measured.
Graphs and short and long term [data]?
Graphs on water quality
Graphs that come up automatically, statistics are done and in tables. Station map once explained to students can lead to multiple sites.
Graphs, the area map with the direct links.
Having the specific "Eyes on the Bay" lesson plans was helpful in brainstorming how the RTD might be used. Also like the current event links.
I like the lesson plans, they should have more, I found them by dumb luck, not by link.
I love graphs! Easy for student to see the trends; easy to talk about with the students. Description of data, or other monitoring things at this site were very clear and concise.
I love the satellite imagery. Great visual for students, easy to access. I like when you scroll over the area, it tells you the name. I like that it has definitions for relative humidity, etc. Alignment of state standard is excdellent, too! Explanations re great, like the lesson plan ideas. I also like how it give monitoring stories.
I loved the explaination of DO, salinity, etc. that were given below the data graphs. I thought they were well-written to be easily understood by students.
I think it would keep the kids interested. Good diagrams & definitions.
Info about particular habitats, organsims, etc. and yearly graphed data, but would like to see the ability to compare different parameters (it might have been there but I didn't find it.).
Information on harmful algal blooms, and marine organisms.
It makes coastal issure REAL and it makes them seem to be things that lots of REAL people are working with.
Large amount of data sets could be correlated to weather events. Hyperlinks to narratives on water quality parameters are extremely helpful.
Lesson plans for teachers
Lesson plans with explanation of grade level. I like the way they are organized, the fact that time frame/grade level are given. Reference background info is given. Relevance is given in the beginning.
Lesson plans; water quality mapping; continuous monitors; HAB events; stations for data
Mapping and graphed data
mappings and posted data
Maps with lesson plans
Maps, datalist, graphs, explanations for all
*Nice maps with very quick access **if** you guess correctly about where to go.*
Numerical data I.D. of organism (i.e. algae) Graph interpretations
real data
Real data that appeared to be exportable to Excel (I tried it myself).
RTD is clear. Lots of different stations in a small area, which is very useful. The site is visual, easy to navigate and clear.
RTD would be helpful to compare to an estuary closer to our area. Tables of water quality data could be accessed for the students to take & graph.
Supports links, almost like a whole curriculum. Many pages I would print and distribute to students.
The chart depth levels--excellent. Benthos/neckton @ different levels. Useful to explain why diff organisms
The data sets, ability to see the whole year.
The hurricane data. I would probably also use some of the current ocean data. If teaching weather might use some of that data.
The interactive map where you would click stations and the list on the side of the map where you could go to types of data.
The layout is "to the point" and intuitive. If it is easy for me to find, as the teacher, it will make explanations of how to navigate the site to studens easier as well.

Appendix 15 (continued)

The lesson plans were helpful. The stories were good. I'd have preferred a more mystery approach with [reneal?] after kids analyzed the observations and data.
The maps of stations was superb, especially with the key the described what each of the sites provided. Also the access to current and archived data was great, especially since they may be breaks in the days when you see students (i.e. weekends) and you still want the students to see the data. Data collection doesn't stop because classes don't meet. Access to lessons that use the data is extremely helpful. The Flash movie was terrific, too!
The RTD and the tables of recorded data are most useful - for data driven understanding and the images & photos give it context.
The RTD but also the archived data sets. The number of recordings stations in order to make geographic comparisons. Tremendous amount of info.
The trends of data and being able to view the graphs in real time.
The variety of data would help make in more meanigful to students. The ease of locating the monitoring site via the map makes accessing the data eaiser.
This seems good if you are focused on one parameter-maybe you could have the students create a graph to include more than one parameter.
Water temperature, chlorphyll chlorophy - had links to tell more about it.
watershed info with local sources of pollutants
weather HAB vs. water quality
Yearly graphs - to see patterns.

Appendix 16
Teacher Website Feedback
Responses to Question 8

8. If you were confused or frustrated at any time using the website, please tell us what happened.

CDMO Website

1. I couldn't pick D.O. in mg/L (only D.O. % saturation. 2. I had trouble finding where to set data parameteres at first.

A little worried about reliability of access to RTD.

As explained above, data was not available. When we finally found some, units were not indicated on the table and on further investigation turned out to be parts per thousand, degrees F, % saturation. Not what I would expect.

Asked for data but had difficulty getting to exact data sets.

complexity of procedures

Computer illiteracy; how to find things; return to screens.

Confused at times to locate information and data

Data list long and lots of abbreviatioins

difficult to interpret data, navigation system is not clear enough.

Explanation of significance of parameters should be up-front as on "Eyes on the Bay" site. Can't assume people know why what they are looking for is significant.

Getting 2 parameters on a graph

Had difficulty getting back to CDMO

Had to figure out where to go - not clear - lots of steps.

Had to look for data

hard to find specific data, a lot of steps to get there (harder for middle schoolers) kept getting "page not found"

Hit dead ends with no data over & over

I couldn't get to where I wanted (i.e. water quality)

I felt like the site had a lot of data, relevant data, but it was not easy for me to find until some trial and error site navigation.

I guess the confusion came from having to "discover" how the site was set up. I would have to spend a lot of time setting up the instrulction of the site.

I had to go thru too many pages to find the exact data I was looking for

I had to take time to read my options…which I would have to do on any site

I was confusesd because I thought there would be graphs showing changes over time (if there were I didn't find them).

I was frustrated at the speed sometimes. I even had a macro fail. Also, I like to see tables & graphs at the same time. Not all monitoring sites had data available.

I would like to know the sources of the dissolved nutrients that they measured

It took five different tries before we got data!!

It took many "clicks" to actually get to the data. Navigation was not very clear.

It was not easy to navigate to the location of real time data

It's hard to navigate "backwards". It would be nice to click on NERR site name to go back to the main page to select what to graph (You need to identify 9999.00 is an error msg.)

Just took a little time, site is user friendly

Looking for RTD, if I were an 8th grader, I would have a hard time finding the RTD with no assistance available.

Map did not pop up at first. Not clear that the submit key needed to be clicked to find data. Some terminology may be confusing for students, example: "parameters" to find explanations.

Most data is missing (you should not be able to enter a date for missing data) 425 page manual?? Web page does not fit in frame of window when maximized. Side bar menu resets to default when clicked on. It should stay expanded.

moving between data sites

Navigating the website at 1st.

Navigating was unnecessarily complex

Appendix 16 (continued)

Needs to have units of measure on the data table. Data was not current.
Data would not load. Google Earth didn't load.
Won't work on a MAC
No Jacques Cousteau data. I would like to see that info, too.
Not clear how to move throught the site. Some areas would not come up.
Some data grossly off.
Only by tech problems and too much clicking (too many pages to get to what I wanted).
overwhelming - hard to find where to go at first, then it got easier.
Pictures not available. Data chart not filled in even though data was all checked off.
RTD not easy to access at times. If I was looking for a specific parameter, it would be diffiicult.
Some data graphs did not match up to the assumed results such as when D. O. increases, pH should also.
The "get data" button didn't work properly at first. It was probably a system problem with my system, though.
The "graphing" links were anything but graphical in their format.
The data points seemed exteme in a couple cases.
The necessity to have Google Maps installed on the computer was a frustration. Down loading data was not an "automatic" where one would be able to click-save-open in Excel. It wasn't easy to "access" RTD from the map, but once in the archived data site, the RTD was accessible.
The submit button sounds like you are submitting data rather than trying to find the data.
There is just a lot of information on this site and many links. I would be going in looking for things to apply to a 7th grade life science class and I may feel overwhemed.
There were too many steps involved in getting some of the data presented.
Too much work to get data. Chart mising data--only 1 parameter
Trying to get back to an area of interest, and a hard time getting to graphing area (but once there it was great).
We attempted five times before finally getting RTD
W-Q data missing for Elkhorn Slough
Yes, at times; it's stations did not seem to be reporting the same information.
Yess…I sometimes go pages that "could not be displayed" or other errors. It took a while to figure out….but once I did, I found it very useful.

Eyes on the Bay Website
A little high level for my students. I would need to walk them through it a few times.
Feel like I'd need a few hours to explore this site - a wealth of info.
finding lesson plans
First map a little [crowded?] but liked how quick you could get to [data?].
Found it pretty user friendly, would have to provide students with "road map"/guide for the site, what do I want them to visit, in what order, etc.
Hard to figue out (in 20 mins.) what's there, what to expect and what to do with it.
I clicked on "Current Paremter" thinking that would give me the data (because I hadn't scrolded down enough to see the data), but instead it explained the paremter.
I kept getting lost in the clicks and needed to discipline myself to use the links after I finished the reading…guess I'm not so different from my students.
I need more time to explore.
I tried to download a data set and it hung up. I also clicked on a station that had no data.
I tried to find data tables. And there were many locations. I wasn't expecting so many rivers and bays. I did not know where to look or begin.
I was frustrated that I could not find a comparable site for the salinas River/Monterey Bay Sanctuary.
I would place the link to lesson plans on a side bar. Teachers would look for those near the top.
Information over load. Create "sidebars" with buttons, very text heavy in some places.
It is overwhelming to go onto the home page and see so many stations. If you are not sure exactly what you are looking for it takes awhile to find info to use. I would spend a lot of time seeing what's there before I find somethng I can apply.
Just wonder why farenheit is used rather than celsius?
no (3)
No confusion (5)
No frustration! Easy to use, cleary referenced data
Not at all.

Appendix 16 (continued)

not finding the graphing section (time constraints); too much information in one page
Rollover stations - wasn't sure what that meant at first. The station map had enormous amount of information and was overwhelming at first.
So much info to look at at first glance
Sometimes there was no back arrow
Surfing leads one to interesting places, but sometimes hard to get back to it , or back to other info. (based on this short visit)
The dots were too small to get to, they were too small to end up on the map.
The first few I clicked on did not have data available. The help link was too detailed and wordy
The first page with all the different colors I was overwhelmed at first. I really had to focus on that. This might be confusing to students.
The person next to me and I disussed strategies (successfully)
The rolling info bar took me a minute to catch on what was going on there. I really like it, but it was new to me.
There's a lot of info here. It would take me a bit of time to sort it out but the site itself is highly motivating.
This is a new site & I don't know everything that it has.
<u>Too much</u> info; <u>not</u> my area (Gulf) - less likely to get student's interest
Too muich info, options, & choces o where to go.
Unlike the other site, on this site I couldn't graph 2 parameters similtaneously, which I'd like to do to meet the objectives of the AP Bio. (College Board) D.O. lab. Also, there was so many links, it was more easy to get lost and overwhelmed.
Using the back button got me lost a lilttle. Also, it was important to return to the staion map. Also, the data links on pages could cause confusiion
would like to see same set up for other locations around world
Yes, at first

Appendix 17
Teacher Website Feedback
Responses to Question 12

12. Do you have suggestions on how to improve the presentation of this website's data to make it more useful to you and your students?

CDMO Website: Elementary & Middle School Teacher Suggestions

Add a way to make a graph with 2+ parameters, somehow. Somehow make results fit on one page width. It's difficult to see/print when you have to scroll.
Better explanation of how to move through the site (how to find table, graph, explanation, etc.)
have side list "CDMO, etc" more visible. Nice graphics, graphing was great
Have the RTD easier to get to.
Having the "mission statement" of CDMO on the entire Home Page seemed like a waste of space. The Eyes on the Bay site did a better job of conveying what data you might find on their site on their Home Page.
I really would have liked more time. It is very beneficial to work with students on sites to determine their usefulness. They can look great but you really find out when working with students.
Include information that directly links the data you're giving to why your bothering to give it.
lesson plans; units on data columns
Links need to work; Data needs to be there; Needs lesson plan ideas.
Look at "Eyes on the Bay"!
Make links more direct
Make navigation easier. Present data more clearly - individual tables or graphs for each category.
Maybe collect it monthly
More links or easier to access from home-page. Students would struggle getting from page to page and back.
more visual rather than reading, point click
needs more info on weather and links within each page to explain info collected
No units give for data. Very difficult to instruct a student to get to the data - TE 2006, Hudson River, real time Hudson water quality. Lesson plans! Relevance! Compare data at various geological locations.
Once more of the biological data gets up and running I may use it more. Also if there were sites closer to home. I'd have a hard time getting my 7th graders to realize that what is happening in Alaska really can affect them.
Put this (response sheet) online & we can respond more specifically
See above #6 and #7
See answer for number 8
See answer for number 8
This is not user friendly. It may require more knowledge on the content than would be appropriate.
This was a good site for my advanced students and my general ed population. This could be difficult for my special ed population.
1-800-WX-BRIEF (can talk to people about WX data) HTTPS://WWW.DVAT.COM (weather data available to pilots. There might be a way for students to get info) HTTP://HOME.ACCUWEATHER.com AVIATIONWEATHER.GOV (Good site and you don't need a password)

CDMO Website: High School Teacher Suggestions

archive data for last 12-24 hours so that teachers can access current trends (not year old trends)
Change the name or add instructions for the submit button. Add units to data tables (not essential).
Color code "stars" to determine which stations are up and running.
Data as graphs and tables; Fit page to window (no scrolling side to side); Side bar should not collapse; Make data retrievable (if data is unavailable, it should not be an option as a date).
Difficulty accessing information; site was somewhat sophisticated for younger students.
Downloadable comma separated data sets, like to be able to jump to other data stations w/ a menu always seen on the left.
Easier user interface & more local real time data
Easy to navigate. The manual (pdf file) is great but way too dense for the HS students; generate a "quick guide". Love it!! Overall.
Emphasize source of basic definitions, like what "O2" stand for, etc. Good place to start.
Have more data from New England area.

Appendix 17 (continued)

Honestly, I could not understand enough to make a meaningful response to this.
I really liked to opening "goggle" page. Great perspective I liked the station ID (lat/long) go for GIS work.
I think it would be slow to use on computers with a slower connection, or slower processors. This could get frustrating--maybe a simpler version--low graphic quality?
Lesson plans from teachers that have been successful using this data with their students and their feedback.
Let user know ahead of time if site is currently down or having problems
looks great!
Lose the instrument display and link the graphing directly with the home site.
Make it easier to find the data.
Make this easier to access, navigate, have data there
Maybe have a scientist at the site (via e-mail) be able to communicate events that may explain anomalies.
Maybe info in spreadsheet format optional.
need to make navigation easier
Need W-Q data on Elkhorn Slough
Needs to be more non-scientist user friendly (make this one like Eyes on the Bay!)
Needs to be more user friendly. Students get very frustrated if they cannot easily locate the data and this makes it more difficult for the teacher.
Put in units on data tables. Make data available or warn on links when none is available.
Real-time data provided
RTD should be made clearer: (examples) DO, species lists, etc. clearly identified.
Simplify presentation. You could not graph data for full year, limited to 4 month periods.
Simplify. Flash stuff not necessary.
Why not use the metric system?….or at least next to °F?

Eyes on the Bay Website: Elementary & Middle School Teacher Suggestions

Accommodate different grade levels
Add a way to compare 2 data sets. Create an easier to find web address (I lost the IE window and had a hard time finding the site again).
Gateway could be divided [filters for different levels of entry] WebQuest based on site. Tutorial or online quiz?
I liked being able to toggle on/off the different types of stations.
I would really need more time to evaluated this fairly.
I'd need to have more time with the website. It did not seem to have lesson plans.
Initial home page: "REAL TIME DATA" heading, with list of links that are the types. Right now, there is an assumption that reading top to bottom, left to right, you'll understand how to access the info.
Just adding an option to download the data.
More lesson plans for teachers
No. I love it.
The data is fine as is the design. It just doesn't fit what I teach. Would love something like this focused on NJ watersheds.
The one lesson plan (72 plus pages) I surveyed was long. It might be better broken into sub units, packets. I don't know the IT effect of loading such a large PDF file. {Rubric?] evaluation of student work would be helpful.
This data would also be hard for me to use because it's not close to home. Unfortunately some of my students don't even know where Chesapeake Bay is. If I lived in this region I would be able to find many more uses for this data.
Would be great if there were CA sites this useful.

Appendix 17 (continued)

Eyes on the Bay Website: High School Teacher Suggestions

Ability to superinpose graphs, i.e. compare temp. with D.O.
Activities that use the RTD. Need more time to comment.
Allow users the ability to graph 2 parameters simultaneously on same graph to assess potential relationship between factors.
Clean up the layout. Content is great!.. but pages need to be more navigatable.
Comprehensive menu or overview of site at log-on.
Create a student section with less links and more direct focus to keep students on task.
Excellent
Excellent website
Have a Excel format along with graph format.
I think it is clear and well presented.
Include degrees Celsius
Instructions disappear without "clicking". Have a "zoom in-zoom out" on the station map so the monitoring stations becomes more spread out and easier to see.
It would be nice to be able to look at all of the parameters together instead of having to look at them separately (sort of like a set up for the rivers). Also, the river data seems to be old.
It's great for Maryland…not too relevant for Alabama students.
No, great site
None, I think the site is fine as it is.
PDF alignment with California Science Standards
presentation was fine, just too much info of a specific area for me & my preference
Satellite views and /or maps
Satellite views and maps
Seems easier to navigate than the other, and had some yearly graphed data.
Site focused too much on Maryland (Ches. Bay). For use of students outside that area, it loses its appeal.
The station map was very busy--I understand it. There is a lot of info but it makes it some what formidable to dive into.
US or world map with location points is good.
WELL DONE!! Useful and accessible

Appendix 18
COSEE-Mid-Atlantic
Best Practices for Teacher Professional Development
Literature Review
1/16/04

Recommendations

Based on my review of the current literature, effective teacher professional development includes all or many of these...

- define who your target audience is (not just grade level, but also phase of professional career and any content/skill prerequisites)
- state outcomes (what teachers are to gain from the workshop/course AND supposed to do back at school)
- base the content on state ed standards and/or local reform initiatives and strategic plans (so teachers will be supported by administrators and districts)
- build on teachers' prior knowledge—their current science knowledge, skills and attitudes (front-end evaluation)
- develop teachers' knowledge of science content through immersion in process
  AND pedagogy (how best to teach the content and set up student learning environment)
  AND lab or technology skills (if they need them to teach the content)
  AND assessment skills (how they will know this works with their students)
- model exemplary pedagogy throughout the workshop/course
  (teach with methods you expect teachers to use; teachers should experience the content in a way that is similar to what their students will experience)
- base course pedagogy (methods) on the best available research on what works with students AND discuss the pedagogy you're modeling with teachers
- involve teachers in reflecting, practicing and planning what they are to do in their classrooms
- address teachers' concerns about change (initiation, implementation and institutionalization)
- establish a community of learners among teachers by:
- offering a longer, sustained program (intensive initial training, 1 to 6 weeks suggested) AND regular follow-ups (for up to 3 years)
- offering opportunities for leadership as agents of change
- choosing several teachers from same schools, grades, districts, etc., to work together
- offer incentives and make teachers accountable
- gain outside support (administrators, schools, parents, community)
- have teachers assist with the redesign & improvement of the workshop/course (formative evaluation)

These recommendations for effective professional development are based on researchers' and practitioners' review of the literature and professional organizations' standards, but they caution that most published data are self-reports (what teachers say are the most effective methods for professional development). Few studies have looked at the ultimate measure of effectiveness—the impact on students. (That's because it is so difficult and costly to gather the empirical data.) Studies that have linked professional development with student outcomes (specifically Cohen & Hill 1998 & 2000; Kennedy 1998, 1999; Wenglinsky 2002) state that effective professional development includes

- developing teachers' knowledge AND teachers' pedagogy
- providing follow up and support
- helping teachers accommodate diversity and promote equity among students with culturally diverse backgrounds and limited English proficiency.

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Note: I could have listed many more individual projects, studies and publications for this topic, but included only these because they offered the best overviews and were the basis for the list above. CP

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