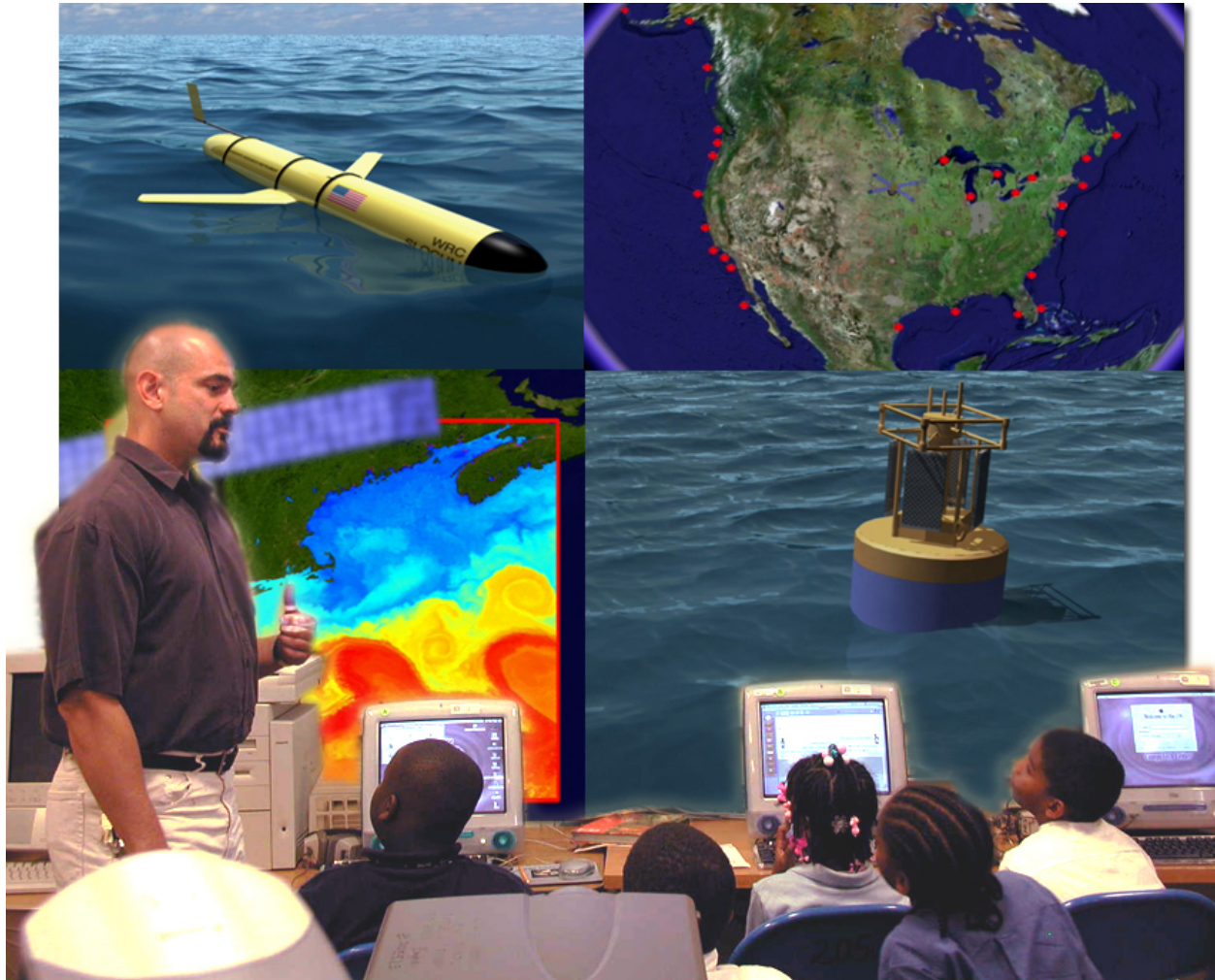


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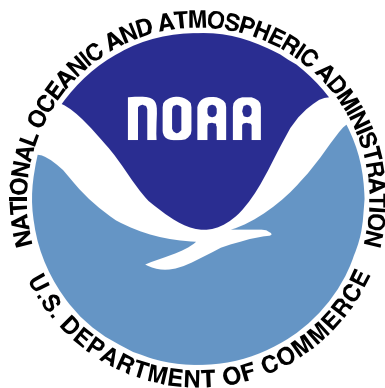
**SWMP/IOOS Real-Time Data in K-12 Classrooms:
A Front-end Evaluation**

**Final Report – Executive Summary
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SWMP/IOOS Real-Time Data in K-12 Classrooms: A Front-end Evaluation

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	<i>Stakeholders Ranking: Teachers Likely to Use</i>	<i>Teachers Ranking: What Teachers Use</i>
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 encountered 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.