USING AUTHENTIC OCEANOGRAHIC, CLIMATIC, AND POLAR DATA WITH STUDENTS: IMPROVING STUDENT UNDERSTANDING OF ENVIRONMENTAL PHENOMENA

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Abstract

Information on climatic change, ocean acidification, and the melting of polar ice sheets fill todays headlines. Students typically do not have experience in collecting and interpreting real oceanographic or climatic data, and may not have an appreciation of the scope or impacts of these environmental changes. Instead of requiring students to find and use actual data, they are usually provided with datasets that are not current or representative of actual environmental conditions. We compare and contrast student understanding of oceanographic, climatic, and polar phenomena when taught using authentic data and data analysis with Geographic Information Systems (GIS) and Remote Sensing techniques with non-inquiry based instruction. The focus of this study included climate change, ocean core data, phytoplankton/zooplankton studies, and satellite studies of the Monterey Bay area. Results suggest students gain a greater understanding of environmental phenomena when using authentic datasets, and they also perform better in designing experiments and interpreting results.

Introduction

This study examined how the presentation of content material from a variety of sources affects student understanding of oceanographic, climatic and polar phenomena. Because of the Internet, a wider variety of data sources are accessible to researchers and students in a variety of formats than to researchers in the past. Today's student must work in a data rich environment, and students need to be exposed to real data so that they can develop the tools necessary to answer their own questions (Merchant 2007).

Educational institutions now have greater access to Geospatial Technologies such as ArcExplorer, Arch View (both from ESRI) and Google Earth than ever before. The combination of lower cost geospatial tools, and increased computing and network resources, allow properly trained teachers and students to readily access and utilize oceanographic, environmental, and even polar data. Providers of data include U.S. Geological Survey (USGS) National Aeronautics and Space Administration (NASA), National Oceanographic and Atmospheric Administration (NOAA). In the Monterey Bay area data sources also would include Central and Northern California Ocean Observation System (CeNCOOS) and the Sanctuary Integrated Monitoring Network (SIMoN).

How do students benefit from utilizing authentic real world data? Doering and Veletsianos (2007) summarized the research that demonstrated the importance of employing authentic learning experiences and collaboration amongst peers in order to maximize educational outcomes. Students are more engaged with learning when they can make a connection to their own lives. Learning collaborative skills is also critical in training a modern workforce. Integration of real world data into instruction and projects that require collaborative efforts offers a promising pedagogical path, especially when geospatial technologies are used (Kerski 2003).

In order for teachers to make good use of available data, training on the use of, and integration of, geospatial technologies needs to be made available to pre-service and in-service teachers. Numerous geospatial applications exist that can inexpensively integrated into a classroom setting. Data from most of the sources listed, for example, is available in the format used by Google Earth (.kmz and .kml), which is available for no charge and is immensely popular with students.

Methods and Materials

Students in a Geospatial Technologies class were presented with pre and post instruction tests in order to determine whether the understanding of oceanographic, climatic and polar phenomena is affected by the type and format of instruction they received. The students were placed into two groups comprised roughly of equal numbers of male and females. All students in the class were either high school sophomores (10th grade) or juniors (11th grade). One group was assigned a series of questions and tasks they must answer /accomplish and were provided traditional lecture and assigned readings related to oceanographic, climatic and polar phenomena issues being studied in the class. The other group was also required to answer these same questions but was also instructed on how to locate appropriate data and use this data with geospatial applications such as ArcView (ERSI) or Google Earth. The purpose being to allow students to use authentic data to assist in answering posed questions. Students in this group were trained on the use of the following sources of data:

- Central and Northern California Ocean Observing System (CeNCOOS)
- Giovanni: Goddard Earth Sciences Data and Information Services Center
- NEO: NASA Earth Observatory
- NOAA National Data Buoy Center
- National Snow and Ice Data Center

The students in both groups were given a multiple choice and short answer test prior to and following receiving instruction on how to perform their tasks in order to assess their learning as a result of each instructional approach.

Those students who received tradition lecture and reading assignments concerning Sea Surface temperature (Oceanographic), environmental conditions (leaf area index, Normalized Difference Vegetative Index, etc.) and polar phenomena such as albedo. Students in the second group received the same instruction and tasks as the first group but were instructed to answer the assigned questions and tasks using data that they had to obtain from the data sources they had previously been trained to use. Both groups were required to present their answers in a PowerPoint presentation and also were given a posttest.

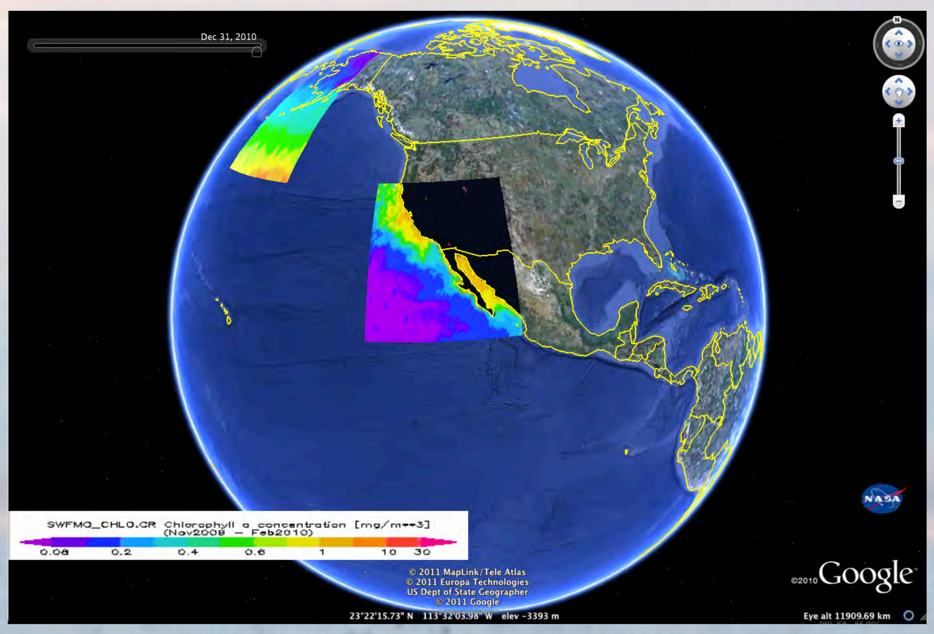

Figure 1: Example of student use of satellite Chlorophyll a data obtained from NASA Giovanni displayed on Google Earth

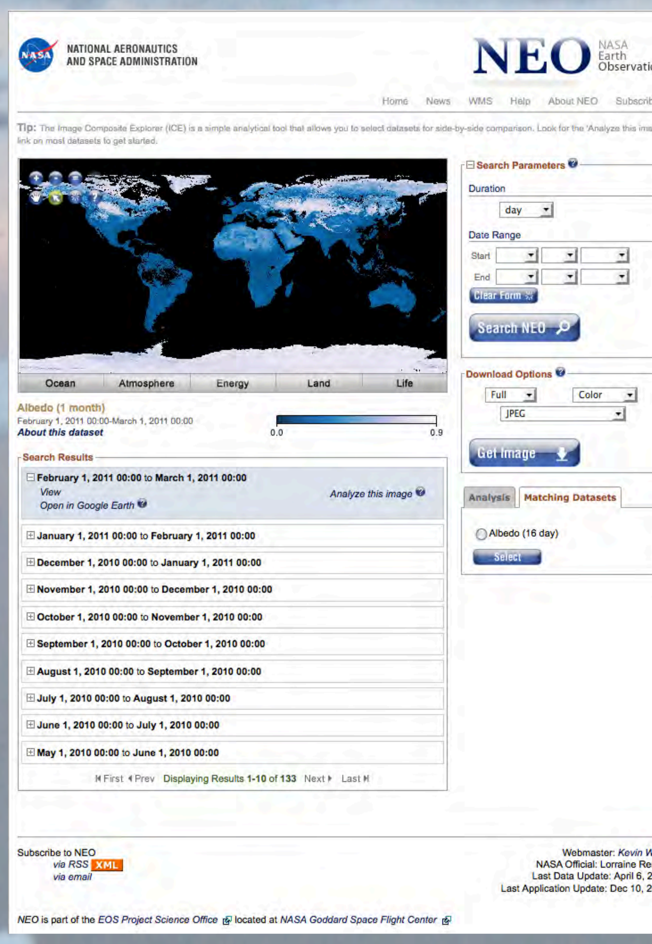

Figure 2: NASA Earth Observatory

Figure 3: Central & Northern California Ocean Observation System

Figure 4: National Data Buoy Center

Results

Each student was assigned a number based on whether they were in the control group or test group (i.e. Student 1-Test, Student 1-Control). Both classes received pre and posttests consisting of 25 multiple-choice questions and five short answer questions. The tests were administered on the schools Moodle server. Three science teachers familiar with the material taught scored the short answer questions against a rubric while the multiple choice questions were scored automatically by the server. The results for the multiple choice questions were added to the results of the short answer questions, which provided a combined score. The results of the study are presented in Table 1.

Table 1: Pre- and Post-test Results for Multiple Choice and Short Answer Assessments

	Pretest						Post Test					
Student	Multiple Choice		Short Answer		Combined Score		Multiple Choice		Short Answer		Combined Score	
Number	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test
1	17	16	1	2	18	18	19	22	2	5	21	27
2	14	15	3	2	17	17	18	25	4	4	22	29
3	18	17	2	2	20	19	18	20	3	5	21	25
4	16	16	1	3	17	19	17	19	5	5	22	24
5	16	15	1	3	17	18	19	23	4	5	23	28
6	12	14	2	2	14	16	21	22	3	3	24	25
7	9	10	3	3	12	13	20	24	3	3	23	27
8	8	10	4	2	12	12	21	25	2	4	23	29
9	17	16	5	2	22	18	22	19	2	5	24	24
10	21	18	2	5	23	23	25	18	1	4	26	22
11	13	19	2	1	15	20	17	22	3	5	20	27
12	17	17	4	2	21	19	20	22	4	5	24	27
13	12	13	1	3	13	16	19	20	3	5	22	25
14	11	12	4	2	15	14	19	23	2	3	21	26
15	11	11	1	2	12	13	20	21	4	2	24	23
16	20	19	4	3	24	22	20	20	3	4	23	24
17	9	17	4	2	13	19	18	20	2	3	20	23
18	22	8	4	1	26	9	20	25	3	4	23	29
19	16	15	2	1	18	16	20	29	4	4	24	33
20	15	16	3	3	18	19	20	21	2	3	22	24
21	12	12	2	2	14	14	20	22	2	5	22	27
22	15	17	1	3	16	20	21	24	3	3	24	27
23	17	15	3	1	20	16	19	25	2	3	21	28
24	12	16	4	1	16	17	17	23	1	4	18	27
25	15	14	2	1	17	15	19	21	2	5	21	26
Average	**14.6**	**14.72**	**2.6**	**2.16**	**17.2**	**16.88**	**19.56**	**22.2**	**2.76**	**4.04**	**22.32**	**26.24**
Std Dev	**3.62**	**2.82**	**1.23**	**0.92**	**3.81**	**3.15**	**1.70**	**2.43**	**0.99**	**0.92**	**1.69**	**2.39**

The results demonstrate that both groups showed growth following instruction. Both the control group and the test group had an increase in their post-test scores relative to the pre-test scores. The group of students who that used authentic data in an inquiry based instruction format showed the greatest amount of growth in the combined score.

Discussion

The data indicates that compared to an instructional approach based on lecture and reading assignments, using authentic data along with a inquiry-based lesson design improves students understanding of the material taught. While not measured in this study it was noted that students in the test group (the authentic data group) were more engaged with the material. All students in the study had received the same instruction on the use of ArcView, Google Earth, and ImageJ (image processing software used in analyzing Remote Sensing data). Only the test group was permitted to use these geospatial tools. Those students who used geospatial tools had significantly higher post-test combined scores then those who were only allowed information obtained from lecture and reading assignments. While the use of geospatial tools and inquiry is more time consuming, students in this study showed greater understanding of the material.

References

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