GLOBE, STUDENT INQUIRY, AND LEARNING COMMUNITIES

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Abstract—The Global Learning and Observations to Benefit the Environment (GLOBE) database is a web-based archive of environmental data gathered by K through12 students in over 85 countries. The data are gathered under protocols developed by research scientists specializing in various fields of earth science. Students gather information, then enter and visualize the data via the Internet. GLOBE's potential is to provide two major components that affect sustainability and conservation: quality earth system data and science education opportunities for students. First, GLOBE maintains a quality, accessible database of millions of environmental data at a geographic scale never before attempted. Second, GLOBE is a real opportunity for students to learn field study and scientific research methods. GLOBE provides easy access to data and visualization tools via the Internet to help teachers and students understand, interpret, and ask relevant questions about the earth system. Students who have a greater understanding of how the environmental system in their community operates can make more informed decisions on sustainability and conservation issues on a larger scale.

INTRODUCTION

Global Learning and Observations to Benefit the Environment (GLOBE) is an international science and education program for K through 12 students. Initiated in 1994, GLOBE is currently supported by 87 countries and over 100 regional support groups, called GLOBE franchises, across the United States. Scientists involved in the program develop detailed guidelines for the collection of environmental data, monitor data quality, use the data in their own research, and mentor students. The GLOBE students, under the guidance of trained GLOBE teachers, collect data using the science protocols, input the data into a central database via the Internet, and use the data for their own research.

The dual role of GLOBE as a science and education program provides a unique educational advantage for students. The data students collect are of a quality usable by earth scientists and are easily accessible to anyone via the World Wide Web. Dr. Roger Bales, Principal Investigator for GLOBE Hydrology at the University of Arizona, has said, "GLOBE hydrology measurements fill a critical gap in water monitoring and assessment efforts in the United States and worldwide. GLOBE schools sample many smaller streams and lakes that are underrepresented in the professional monitoring programs run by government agencies. We have now reached the point where GLOBE constitutes one of the largest water-quality networks in the United States and is certainly the one with the most readily available data" (GLOBE offline, in press).

The GLOBE scientists along with other scientists who have already discovered and are using this unique database have a real interest in encouraging and mentoring these students. The students are provided with motivation to participate in science when they know the data they collect are 'real' and being used—not just an assignment to be discarded after grading. The value of what the students are doing has been illustrated by the number of scientists who are not directly involved in GLOBE, but are using GLOBE data or who have approached GLOBE for help in collecting special measurements.

David Verbyla of the University of Alaska, Fairbanks, asked GLOBE students to provide information on budburst in their area States." There is no network of on-the-ground plant phenology observations to validate growing season models and estimates derived from satellite data. GLOBE schools' plant phenology observations will be the only source of wide-spread growing season observations for research to better understand climate change" (GLOBE offline, in press).

Students are further motivated by the opportunity to provide valuable input into their own communities through their own research. Visualization tools provided on the GLOBE Web site allow students to graph and map GLOBE data in real time. New educational materials guide students through the process of research. The techniques of data collection and assessment, such as the creation of classified and assessed land-cover maps from Landsat images, are often the most current and accurate tools available for assessment of these regions.

EARTH AS A SYSTEM

GLOBE data students are collecting fall under a variety of environmental fields including atmosphere, soil, land cover, and hydrology. An investigation team or teams that include science and education co-principal investigators lead each of these areas. The GLOBE Hydrology Investigation Team includes three scientists from the University of Arizona: Dr. Roger Bales, Dr. Martha Conklin, and Dr. Katrina Mangin, and an education co-pi, Cyndy Henzel. The teams work together to ensure both the scientific integrity of the data and the educational quality of the learning materials.

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Citation for proceedings: Holland, Marjorie M.; Warren, Melvin L.; Stanturf, John A., eds. 2002. Proceedings of a conference on sustainability of wetlands and water resources: how well can riverine wetlands continue to support society into the 21st century? Gen. Tech. Rep. SRS-50. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 191 p.

Students are encouraged to make their observations in the context of the earth as a system. Rather than only collecting point data for a water site, students are asked to also collect and analyze soil samples, record daily atmosphere measurements, and create detailed land cover maps. The water data they collect can then be analyzed in the context of their specific site and other inputs to their system. Scientists are finding this wide spatial coverage of integrated data collection an invaluable tool for filling in gaps for earth system research. Students gain a greater appreciation of how the intricate involvement of many systems plays a role in understanding an environment. For instance, how does the character of your soil and type of land cover help explain the amount of input and quality of water at your hydrology site? What happens if the land cover or pattern of precipitation changes?

GLOBE recognized early in the development of the program that the exploration of watersheds was an excellent tool to use to gain a greater understanding of the interplay of the earth system on a local, regional, or even global scale. Students were encouraged to identify their local watershed, supply contextual information about their hydrology measurements, and interpret their findings in light of other measurements and environmental observations. Specific educational activities to achieve these objectives were difficult to develop in the first years of GLOBE, however, due to the lack of long-term data sets to use. But, by the beginning of this year, the GLOBE student archive contained over 4 million data points.

STUDENT INQUIRY

In 1999, GLOBE educators began development of materials to help guide teachers and students in the use of GLOBE data in student research. Through a number of research seminars for teachers, it was found that although most science teachers taught the steps of the scientific method, few felt comfortable leading students to develop appropriate research questions, collect and analyze data, and draw conclusions. The visualization tools provided on the GLOBE Web site were being underutilized: students were collecting and inputting data but never looking at it or using it for their own research.

Development of guiding materials to help students do their own research easily met the dual science and education roles within GLOBE. Scientists recognized that students exploring the database and using the data in their own research were more likely to recognize the value of quality data and consistency in data collection. Educators in schools across the country and around the world were scrambling to meet new standards that included original science research or inquiry.

Dr. Leon Lederman, Nobel Laureate: “GLOBE is the quintessentially ideal program for involving kids in science. GLOBE teaches science content and also the process of science. Facts are important, but the younger students are, the more important it is to learn the process of science. Science isn’t about providing answers as much as it is about asking questions. As a hands-on program, GLOBE provides opportunities for teachers and scientists to talk informally with kids and get them to ask questions” (GLOBE offline, in press).

Data collected by GLOBE students in the area of hydrology include measurements of transparency, water temperature, pH, conductivity or salinity, dissolved oxygen, alkalinity, and nitrate. New measurements for freshwater and saltwater macroinvertebrates are currently being developed and should be implemented by the end of 2000. These measurements, combined with those from the other GLOBE investigation areas, provide a comprehensive set of data from which students can develop research questions and projects. GLOBE, recognizing that any dataset is more valuable if it can be combined with other datasets, has provided reference datasets on the GLOBE Web site from other sources that allow students easy access. In addition, GLOBE data can easily be pulled out in table format to export into a spreadsheet or other analysis tool such as Geographic Information Systems (GIS).

GLOBE-A-THONS AND LONG-TERM MONITORING

The power of GLOBE student inquiry will hopefully be seen in two areas. First, students are being encouraged to collect quality, consistent environmental research data. GLOBE was developed with the idea of creating a large, accessible environmental data archive that would have both a wide spatial scale and long-term monitoring. We are also now encouraging GLOBE-a-thons, or intensive cooperative data collection by GLOBE students and perhaps other environmental organizations within a region. These may provide a snapshot of an entire watershed that may be then revisited over time.

Second, GLOBE student inquiry is filling a need within the schools for original student research. New materials will help guide students through the research process. The GLOBE Web site is constantly being improved with the addition of new tools for student visualization and research, more student data, and more access to other datasets. In addition, the Web site now provides space for publication of student investigations, communication being recognized as an essential component of the research process. Perhaps most important of all, GLOBE can help influence those students to become the mentoring GLOBE scientists for future generations.

THE GLOBE COMMUNITY

In 1995 when GLOBE trained the first teachers in the program, it envisioned having a GLOBE teacher in every school. As the program has grown, so has the vision. Because of the broad, rich content of the program and broad applications at all age levels, GLOBE began to encourage the training of teams of teachers in schools. These schools quickly found the value of local community resources such as parent volunteers, professional volunteers from other environmental groups and Federal, State, and local government agencies. Some of these groups, including such organizations as universities, museums, and parks, developed more formal ties to GLOBE and have become GLOBE franchises. The franchises take on the responsibility of training teachers and providing follow-up to local schools. Franchises have also taken the initiative in taking GLOBE beyond what can be provided at the Federal level. Franchises in Alabama and Montana have hosted GIS conferences for GLOBE franchises and trainers. Franchises

in Arkansas, South Carolina, Idaho, and Arizona have worked together to promote the second International GLOBE Student Conference to be held in Arkansas in June of 2000. Internationally, GLOBE countries have also been active in creating the community. For example, Finland hosted the first International student conference in 1998. Croatia recently hosted a land-cover symposium.

What this all means to education and the sustainability of the important data collection being done by the students is that the students are now part of a vast learning community. Students, teachers, parents, governments, universities, and others are all working toward a common goal. Students are not just on the receiving end with facts to learn and homework to turn in. They are an important part of a local effort to understand their own backyards as well as a global effort to understand how the jigsaw of local regions fits together.

CONCLUSION

The study of water has long been used as a key to developing student interest and skills in science. Many programs regionally, nationally, and internationally, have provided and still provide quality materials to help students gain an understanding of key science concepts like the water cycle and the measurement of water quality. Others have concentrated their efforts on the importance of developing an appreciation for the environment and conservation of resources. Although GLOBE obviously has some overlapping objectives with many other environmental programs, the strength of the program is not realized by competing for student time and resources.

GLOBE teaches students to ask questions based on observation, gather data in a scientifically rigorous manner, analyze data, and draw conclusions based on those results, and communicate the results to others in the community. This is the way to make good decisions about the environment. Good decisions will lead to sustainable development.

REFERENCES

GLOBE offline. [In press]. Scientists are talking about GLOBE; spring 2000. Washington, DC: The GLOBE Program.