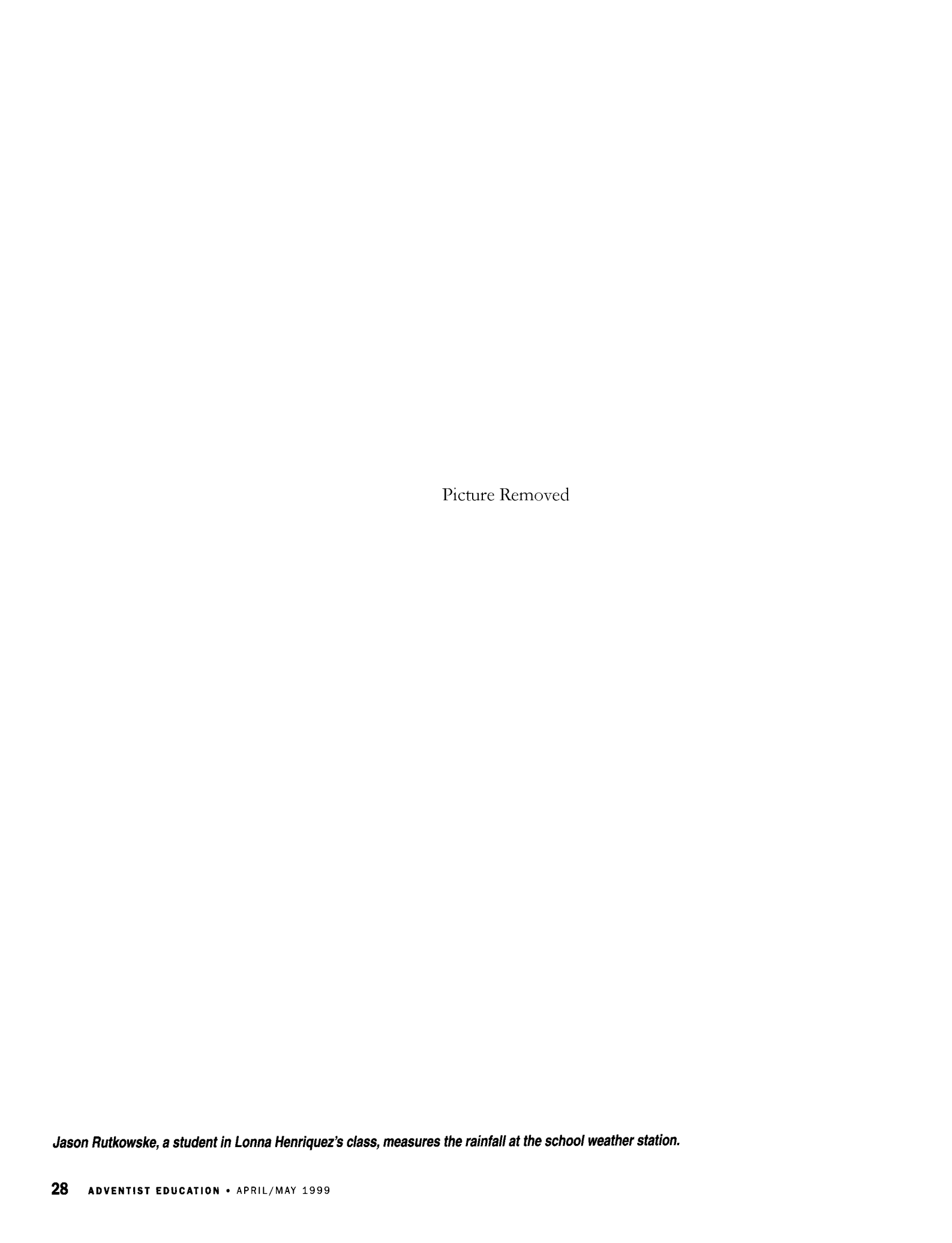

Jason Rutkowske, a student in Lonna Henriquez's class, measures the rainfall at the school weather station.

Your Students Can Be Global Scientists

By Lonna M. Henriquez and Gerald A. Linderman

If your students could assist real scientists while working out-of-doors, using the latest computer technology and being of service to their community, would they be more interested in learning? Would they put forth more effort and do better work?

Benchmarks of Science Education

According to scientists and science educators, "approaches to learning and teaching science should basically parallel the procedures and attitudes scientists use in doing science."[1] As we incorporate the North American Division Curriculum Futures Commission's core elements into the curriculum, the dilemma is how to accomplish all this, along with the many other expectations we face in elementary and secondary classrooms.

As students become engaged in the world outside the classroom, they learn and retain more. Ellen White tells us that Jesus' "education was gained directly from the Heaven-appointed sources; from useful work, from the study of the Scriptures and of nature, and from the experiences of life [which are] God's lesson books, full of instruction to all who bring to them the willing hand, the seeing eye, and the understanding heart."[2] Ask adults what was memorable about their elementary school experience, and most will recall real-life activities in which they actively participated, both emotionally and physically.

To make science memorable, teachers must put class activities in a real-world framework in order "to address the most crucial

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As one of their GLOBE assignments in Gerald Linderman's class, Brent Ford and Kimberly Magers test for dissolved oxygen in the local creek water.

problems of society. Problems . . . must become the focus of good teaching and thoughtful learning."[3] Problem-based learning is "grounded in the idea that school should be about doing real things in real contexts in order to prepare students to perform in the adult world."[4]

In its 1997 report, the North American Division Curriculum Futures Commission encouraged Adventist educators to teach responsible citizenship through "civic responsibility for one's local, national, and global community" by taking "an active role in nurturing and preserving one's environment."[5] This is an important aspect of stewardship.

According to the Futures Commission, students should be able to "adopt a systematic, logical approach to decision-making and problem-solving based on a body of scientific, mathematical, and historical knowledge, within the context of a biblical perspective."[6] These thinking skills should also relate to real-world experiences. Students must also gain competency in information and computer technology and develop the skills to effectively interact with other cultures.

The authors of this article were excited to find a program that provides an elegant solution to these challenges. Though not designed for multigrade classrooms or the one-teacher school, it is easy to use and particularly effective in these settings, since the kindergartner and 8th grader can both be involved.

How Does GLOBE Work?

Global Learning and Observations to Benefit the Environment (GLOBE), a hands-on international environmental science and education program, links students, teachers, and the scientific research community in efforts to learn about our environment through student data collection and observation.[7] The GLOBE program teaches students about science by making them contributing members of a scientific team.

GLOBE students get to do real science by collecting and providing valuable environmental data to the scientific community that otherwise would be too expensive to obtain. It has become a global volunteer monitoring network of K-12 students. Teachers instruct students on how to take measurements, help them understand the relevance of their observations, and aid them in analyzing the data, while encouraging them to make predictions about environmental conditions around the world.

These students in grades K-12 take careful "environmentally meaningful" measurements such as cloud type, temperature, and precipitation, which are then sent via the Internet to the GLOBE scientists. In response, the students "receive vivid images composed of their data and data from other GLOBE schools around the world."[8]

"The measurements taken by the GLOBE students serve two important purposes. First, participating scientists use these data in their research programs to improve our understanding of the global environment. Second, students learn how to carry out a scientifically rigorous program of earth observations, but also learn to use their own measurements, together with data from other GLOBE schools, as a key part of their study of environmental science. Through contact with and mentoring by scientists, the students receive feedback about the value of their data sets in world class scientific research."[9]

How Does GLOBE Benefit Students?

1. *Students are motivated.*

At 8:00 a.m., the excitement in the 7th- and 8th-grade classroom was palpable, although the sky was almost entirely blue. The students reminded me (L. Henriquez) hourly that we needed to go outside to identify the cloud cover and types. As we looked up at the sky, we were amazed to watch as clouds whipped by the wind changed from white, wispy cirrostratus shapes into dark, colliding cumulonimbus clouds.

As we dismissed early, waiting for Hurricane Bonnie to arrive, a parent said to me, "My child is always looking up and naming the clouds on the way to school. I wish I could come back to school and do what my child is doing."

This parent had noticed what many teachers have observed—that when a student is interested in what he or she is doing, learning is a delight. "True education," explains Mrs. White, "is not the forcing of instruction on an unready and unreceptive mind. The mental powers must be awakened, the interest aroused. For this, God's method of teaching provided. He who created the mind and ordained its laws, provided for its development in accordance with them."[10]

2. ***Students desire to do quality work.***

When middle school students realized that their atmospheric data was being studied by the meteorology department at the University of Oklahoma, the home of the famous tornado chasers portrayed in the movie *Twister*, their desire to collect good data showed a marked increase. Knowing that scientists trusted them to collect data was highly motivational. Students willingly collected data during their lunch periods and on weekends and holidays. These students wanted to make meaningful connections between the information they gathered and the world in which they lived. Also, having their data posted immediately for the world to see and judge placed pressure on them to do quality work.

"[F]or students to do quality work, it is crucial that they see that it is for their benefit, not the benefit of their teachers, school system, or parents."[11] "Young people, especially, will not work hard for distant rewards. If they are to put out a lot of effort, they want an immediate payoff."[12]

3. ***Students are turned on to science.***

A 5th grader races out of the classroom yelling, "I love science!" on her way to the rain gauge. Two 7th graders stare in disbelief as a sample of their local creek water is transformed from clear to murky orange to purple as they test for dissolved oxygen. Two 8th graders hunch over a Landsat image[13] of their community, discovering for the first time wetlands and a large landfill a few miles from their school. These GLOBE classrooms have entered what the authors call the "Wow! zone," where students are engaged in learning and thoroughly enjoying themselves.

4. ***Students use technology to become "data literate."***

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Co-author Gerald Linderman and two of his students, Michael White and Kimberly Magers, check the high, low, and current temperature for the day.

Students gather around the computer to analyze a satellite image of worldwide soil moisture. Before looking at a specific area, they discuss predictions about the soil moisture in various locations at this time of the year. They next determine what colors would be on their image. The students then manipulate the visual image of the world to find their chosen region, zooming in to see if their predictions are correct.

5. ***Students work in a multicultural environment.***

The GLOBE program "School to Schools" allows students from different cultural backgrounds to work on collaborative investigations. More than 5,000 participating schools from 60 countries are registered as GLOBE schools. By sharing information, young people can become acquainted with students in other lands and learn about their local environment in a way that had not been previously possible.

Two students were surfing the GLOBE World Wide Web site hoping to find a project topic of interest. They decided to investigate "Digital Earth," which allows

students to digitally build maps, such as contour or street maps, overlapping their collected data with these maps. For example, students in Raleigh, North Carolina, can make a geological map of their area with an overlapping map of city streets and their atmospheric data. Students in China are making similar maps of their towns.

How Does GLOBE Benefit the Teacher?

1. ***Activities for different learning styles.*** This program meets the needs of students with many learning styles because of its varied activities. For example, students not only read instruments and analyze visualizations and data, but also send their observations to scientists, build simple instruments, and communicate with other GLOBE schools.

2. ***Complete lesson plans.*** GLOBE's teacher's guide provides extensive lesson plans and field activities on three different instructional levels: beginning (grades K-4), intermediate (grades 5-8), and advanced (grades 9-12). The guide also provides ready-to-use field and classroom activities to supplement the science curriculum. For example, when studying cloud cover, the K-4 activity can be as simple as matching the sky to pictures; middle school students identify cloud types based on structure and height and then estimate the percentage of cloud cover; high school students measure and calculate the percentage of cloud cover.

3. ***Minimal cost.*** Data collection for the Cloud Observation protocol[14] requires no instrumentation. Water-quality testing can be as simple as reading a thermometer and matching colors with pH indicator paper to test for acidity. Measurements for atmospheric experiments require a weather station instrument box, two thermometers, and a rain gauge, which cost less than $200. Parents and community members are often willing to donate funds and build an instrument box when they understand the GLOBE program.

4. ***Excellent support.*** The "info and help" icon at the Web site provides answers to most questions. During the day, experts will cheerfully answer phone inquiries and help with problem-solving. Trainers currently using GLOBE in their classrooms are available by phone or electronic mail.

5. ***Integrated curriculum.*** Students concentrate on science and math as they work in teams to take accurate and consistent daily measurements. They learn consensus building and how to do cooperative problem-solving. They calculate solar noon, create and analyze charts and graphs, estimate percentages of cloud cover, and calculate ground cover using geometry and compasses. Language-arts skills come into play as students follow protocols precisely and explain in technical terms their observations and any unusual measurements. Social studies and foreign languages fit smoothly into the program when students choose to work with other GLOBE schools worldwide in collaborative research projects or to sim-

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Kelly McFarland goes to the GLOBE Web page, where the worldwide data is imaged, to look at current temperatures throughout North America.

To make science memorable, teachers must put class activities in a real-world framework in order "to address the most crucial problems of society. Problems . . . must become the focus of good teaching and thoughtful learning."

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ply compare data.

While doing land cover biology, Kelly McFarland and Brent Ford, students in Gerald Linderman's class, compare a pixel plot (ground-level survey of a 30-meter square of the Earth that corresponds to one specific pixel of an image of the area produced by a Landsat satellite) to the satellite image.

How Can My School Become a GLOBE School?

1. *Attend a training session.* GLOBE training sessions are held worldwide throughout the year. You can sign up through their Web site at http://www.globe.gov or phone (800) 858-9949 in the U.S. Although the Monday through Thursday training session is free, there is a charge for breakfast and lunch for the four days of about $80, and you must arrange your own lodging.

We have found the trainers to be knowledgeable, easy to understand, and eager to provide the background necessary to help you establish the GLOBE program in your school. The classes include instruction in performing the actual protocols, participating in the activities you will teach to your students, and short lectures. Trainers also provide materials and show how to construct some of the simple instruments needed to collect data. In addition to these instruments, you will receive a 247-page teacher's guide containing the lesson plans and protocols necessary to conduct the investigations. The teacher's guide is also on the Web, so misplaced pages can easily be downloaded and replaced.

2. *Collect data.* Teachers can assign students to participate in as many or as few protocols as time and skills allow. We suggest you start small and become more involved as you and your students become comfortable with the program. Cloud identification is a good beginning activity.

Training provides enough practice to make you comfortable with this protocol. You will bring home from training a full-color laminated cloud chart—the only equipment needed for this activity. Detailed instructions on collecting this data, as well as lesson plans for teaching concepts, are provided in the teacher's guide.

3. *Send data to GLOBE through the Internet.* If you have Internet access at school, the students can go to the GLOBE Web site and enter their data into an easy-to-use format. If your only access to the Internet is at home, you can use the data sheets in the teacher's guide to enter the data from home. You can print out the environmental data collected from around the world, including the information your classroom entered, which get updated daily on the Web site.

Conclusion

Baba Dioum knew the benefits of quality education: "In the end, we will conserve only what we love. We love only what we understand, we will understand only what we are taught."[15]

As Christians, we are to be stewards of this earth. Through GLOBE, students, teachers, and scientists have an opportu-

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Kelly McFarland and Kimberly Magers measure a pixel plot.

nity to not only gain knowledge of how nature works, but also to use this knowledge to make more informed decisions that improve the world in which we live.

Student participants can thus have their eyes and minds opened to God's creation in a way that will give them new understanding and a sense of responsibility for the earth.

If you want your classroom to be an exciting center of learning where students are motivated to do quality work while becoming literate in computer technology, exchanging information with other cultures and serving their community, you need look no further than the GLOBE program.

". . . ask the animals, and they will teach you.

Ask the birds, and they will tell you.

Or speak with the earth, and it will teach you . . . .

What creature doesn't know that the Lord's hands made it?"

(Job 12:7-9; God's Word Translation).[16]

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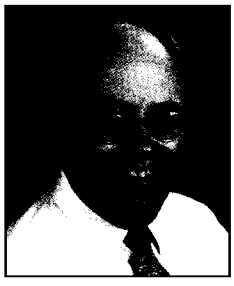
Lonna Henriquez



Gerald Linderman

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