Interactive, Collaborative Science Via the 'Net: Live from the Hubble Space Telescope

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During the week of April 15-19, 1996, over 60 schools collaborated in making scientific observations of their local weather conditions. These results were combined and displayed (via the Internet) daily, and compared to professional reports and satellite photographs. This activity was just a small part of the Passport to Knowledge Project "Live from the Hubble Space Telescope" (LHST).

LHST consisted of both live television broadcasts and an Internet presence. During the three television broadcasts made over the 1995-1996 academic year, students from around the world were able to select targets for the Hubble Space Telescope to investigate. They studied the theory and operation of the telescope; learned about our solar system and weather on Earth and other planets; analyzed data; discussed and debated results; and interacted with scientists, technicians and other experts directly.

LHST was the latest in a series of productions from Passport to Knowledge. Others have included "Live from Antarctica" and "Live from the Stratosphere." The Internet portion of Passport to

The Effect at One School

by Sheri Edwards

The 29 grade 5/6 students at Nespelem School were diligent about making the 10:00 a.m. weather readings. This was the week of standardized testing, but we timed the tests so ten o'clock was always free.

Starting Out Right

On Monday I trained the first groups of technicians to read their group's instrument and record the data. They reported back to the class, where each student kept a journal. The next day, each of Monday's teams trained another group of students who collected, recorded and reported their data. This collaboration continued through the week, and the class chart became the focal point of attention while students discussed journal entries with each other.

Students' journals consisted of picture/word entries: daily pictures of a thermometer, cloud, compass rose and flag pole (our weather vane and anemometer!) all indicating each day's data. Like real scientists, they were discussing, sharing and debating the gathering and recording of information. At recess at 10:25 a.m., they double-checked for any changes or drastic discrepancies.

Mid-Week

On Tuesday evening, I snapped a computer picture of all the charts on the Web site and printed out copies to show the students. They were so thrilled that we ended up framing, labeling and laminating each map, and hung them on the hallway bulletin board to share with the school. Everyone was talking about weather and looking for 119° W longitude and 48° N latitude (our location) on the maps.

We noticed how accurate the student-generated maps were when compared to The Weather Channel's maps. Students could be seen teaching others how to read instruments and record data. The students were so proud because they KNEW how to explain the gathering of information for weather maps. Self-esteem comes from accomplishments, and these kids were confident in their explanations.

At the end of the week, each student created graphs and charts of the week's data, learning another invaluable skill, another valuable accomplishment hooked to the real world of weather.

Tangents Prove Fruitful

The temperature was so cold that the students complained that spring must be late. Discussions indicated they did not understand the concepts of day/night and seasonal cycles, let alone the concept of weather. That is what is so important

Knowledge productions are run by the NASA K-12 Internet Initiative project. Other productions of this group include "Night of the Comet" and "Online from Jupiter."

The Internet portion of the production included a Web site, supported by e-mail distribution lists, plus FTP and Gopher sites. In this manner, even those with limited connectivity could receive some of the materials. The materials distributed include teachers' guides and lesson plans, background information, biographies and diaries of project personnel. E-mail to project personnel was screened by NASA K-12 project's Smart-Filter system, which uses a combination of volunteer labor and computer technology.

◆ The Weather Activity

The planets chosen for study in LHST were Neptune and Pluto. On both of these planets, weather is a major factor of interest. This is especially true of Neptune, where clouds and storms appear occasionally. So far, all of our observations of Neptune are photographs. One topic of interest is, How can one predict or determine weather from satellite photographs? Another topic of interest would be, How does the weather on Earth and other planets differ?

Any good experiment deserves a little control, and a hands-on collaborative weather activity has some excellent benefits. The equipment is inexpensive and can be scrounged, purchased or made. The data gathered were temperature, wind direction and

Technical Information

NASA's Web server **(http://quest.arc.nasa. gov)** is a Sun Sparc System 10 running Sun OS and the NCSA HTTPD 1.5 (National Center for Supercomputer Research - Hyper Text Transfer Protocol Daemon).

Our forms submission of both results and registrations was controlled by the CGI-mailer program written by MIT. This program gathers information filled out on a form and mails it to a pre-selected address, in this case a sendmail alias on the server. Some submissions were made via straight e-mail. In every case, the submissions were edited and concatenated into a master data file for observations of that day. The data were further split into individual files for wind, temperature, locations and cloud cover. The UNIX-based shareware package GMT 3.0 was used to generate the maps.

Perl scripts for each type of map were made. This effort took considerable time, mostly due to editing the data into the proper format for submission.

The Weather Channel was kind enough to send us their submissions directly via e-mail. Only minor editing of the .GIF images was required. After all the GIF and data files were prepared and uploaded to the proper directories (with copies to the FTP server), the "results" page HTML document was updated. This process was repeated twice for each set of maps to accommodate late submissions.

Estimated labor for the programming and administration was about 60 hours.

about hands-on, student-centered activities: through their discussions with each other and during class, students show their faulty perceptions so a teacher can guide them to make corrections.

During our side-tracking to learn about the seasons, we were drawn back to our research on the planets. The students had made lists of every fact possible (orbit time, moons, days, density, etc.). One of those lists reflected the tilt of the axis. During our discussion of the Earth's tilt, a very eager boy ran to the chart stand, flipped to the list chart, and pointed to the axis column. We noticed that Neptune had almost the same tilt as the Earth. So continued a discussion comparing the weather on various planets and many "what if" situations.

Excitement Builds Incentive

During a school board meeting, I explained the importance of updating each classroom so the students do all the work, including the Internet processing and researching. The principal was almost convinced to access a local Internet provider — it was those maps with Nespelem Grade 5/6 reporting that did the trick !

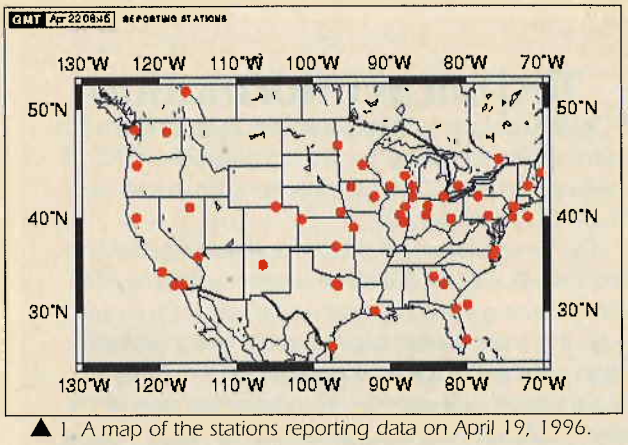
Everyone in school is talking about our Hubble trip and "those weather maps." The students at our end of the building are always asking what we are doing next, and next year's sixth-grade students are asking, "Do we get to learn about space and weather and the Hubble, too?"

Students who are asking to learn! Isn't that what we want? Students taking ownership and directing their own learning! When students want to learn, their interest allows them to understand more difficult concepts. For a teacher, it is wonderful to watch students accept the challenge to understand more than just the facts, to be able to grasp the "why."

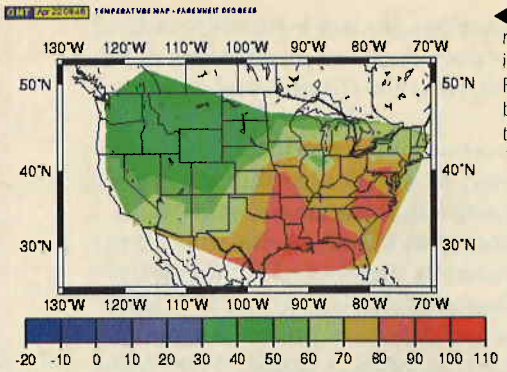
Taking Ownership

Of course, the students in my class are beaming. They also were thrilled when an issue of *Scholastic News* came out with the article "Pluto is in the Doghouse!" The article debates the planet/non-planet issue. One student slapped her issue on her desk and said, "I can't believe they are still arguing this. Don't they understand what a planet is? It has an atmosphere, it has weather, it has a moon!"

They knew what Marc Buie (one of the professional astronomers featured in the "Live from the Hubble Space Telescope" broadcast) said and totally agree. Next, the students noticed that the article's picture of the solar system was wrong: "Look! They've got Saturn as the fifth planet instead of Jupiter!" They wrote a letter to the editor about both topics, proud to know that the pictures in the article are THEIR OBSERVATIONS! What ownership!

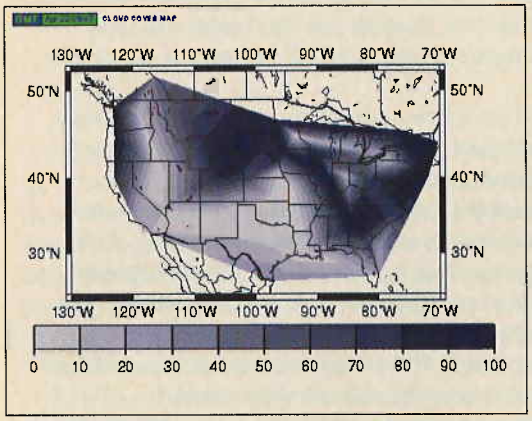


▲ 1. A map of the stations reporting data on April 19, 1996.

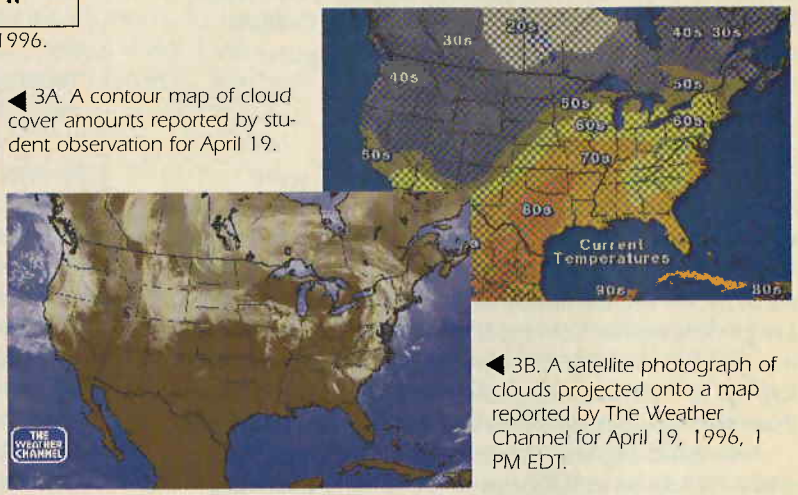


◀ 2A. A contour map of temperature in degrees Fahrenheit reported by student observation for April 19, 1996, 1 PM EDT.

▼ 2B. The same contour map as reported by the Weather Channel for April 19, 1996, 1 PM EDT.



◀ 3A. A contour map of cloud cover amounts reported by student observation for April 19.



◀ 3B. A satellite photograph of clouds projected onto a map reported by The Weather Channel for April 19, 1996, 1 PM EDT.

speed, cloud cover amount and cloud type. The only other requirements were a safe, supervised place to make the measurements, and an Internet connection to report and retrieve results.

◆ Methods

Both registration and reporting results were via e-mail. Optionally, a Web-based CGI form was available. Volunteer schools were asked to provide contact information as well as the longitude and latitude of their recording station. Over 60 schools registered (see Figure 1, Location Map).

On every day for a week (Monday through Friday), observations of temperature, cloud cover and wind were sent to the collection point (an e-mail address). This information was processed manually into an ASCII data file, which was used to create maps in both Postscript and .GIF format. The data and maps, along with maps prepared by The Weather Channel, were prepared and made available within 24 hours of submission. (See Technical Information Box sidebar for details.)

◆ Results

As you can see from the maps included (Figures 2a-2b, 3a-3b), there was remarkably good agreement between our student observers and our professional forecasters, as well as our satellite and our ground-based cloud observers.

But the fact that the student observers were accurate is beside the point; they gained a lot from the activity. They learned how to make observations and how to report them. They also learned how to use the Internet to submit and retrieve information.

Some of the students went to extraordinary effort to make certain their data were reported. A class from Muncie, Indiana, for example, borrowed another teacher's e-mail account to send in their reports because their teacher was unexpectedly hospitalized. Another participant commented that the student observations of cloud cover were so good that it argued against the usefulness of weather satellites. (See Effect at One School sidebar for further details.)

For a complete set of the results, you can view them at NASA's Web site: *http://quest.arc.nasa.gov/hst/events/map.html*.

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