How Does Technology Support Inquiry?

by

BOB COULTER

Current reform efforts in virtually every discipline promote the idea that students should be actively engaged in inquiry on a regular basis. Efforts to infuse technology into schools complement this agenda, with a common belief that technology is the key to improved inquiry. In many ways this is a plausible goal. After all, why spend the untold millions of dollars which are currently allocated to technology initiatives if they don't "deliver" a return in the form of better student learning?

To paraphrase an old anti-gun control advertisement, "Technology doesn't promote inquiry, teachers do." Despite rhetoric to the contrary, technology by itself cannot lead to better inquiry. In fact, in many current software applications, inquiry is actually undermined as students mindlessly answer multiple choice questions to rack up points toward a grade. A skillful teacher, on the other hand, can promote inquiry in class and employ technology in very powerful ways. The focus must always remain on the teacher's role, the work the students do, and the overall classroom environment.

The examples presented here show how technology can support and enhance an inquiry environment. Notice that in each example it is not the technology per se which makes the activity valuable. It's all in how it's implemented.

Video in support of inquiry

Despite the negative stereotype of lazy teachers popping in a videotape when they don't feel like teaching, video holds great promise as an inquiry tool. For example, a couple of years ago my fourth graders were engaged in an extended study of various biomes of the world. After constructing a robust conceptual structure of what constituted a biome, they were able to make good use of the video to extend their understanding to new regions of the world.

To begin the unit, field investigations near the school grounds helped the students to understand how climate, plants and animals interact to define a particular region as an ecologically distinct biome. In St. Louis, they studied seasonal change in the fall, noting changes in temperature and day length and the impact of these changes on the plant and animal life in the area. Leaves falling and birds migrating are but a few of the responses plants and animals have to living in the temperate deciduous forest.

Equipped with this understanding, they were ready to move into other biomes, applying their basic understanding of the interplay of biotic (plant and animal) and abiotic (climate and terrain) factors. Video tapes of life in deserts, rainforests, and on Antarctica allowed my students to learn about the temperature and precipitation in these regions and how plants and animals adapt to differences in climate. Cacti retaining water or rainforest plants shedding it provided a context for the class of how each region has distinctive features. Too often, students take the local community for granted. By making such deliberate comparisons we made the familiar surroundings a bit more strange, promoting greater ecological understanding and awareness along the way.

The critical piece here is the underlying framework which the students developed through extended, first-hand experience on the school grounds. Without this understanding of a biome being defined by the climate, plants, and animals, their study could easily have been just a collection of facts about each region. With their framework of biotic-abiotic interactions, the students were able to analyze a range of settings, seeing how each region was defined by the same ecological principles, even if the specifics were different in each region. In this context, the often maligned (and just as often misused) videotape took on a powerful role in supporting the students' inquiry.

New video formats

In the next few years, students will have increasing access to cutting edge tools such as video technology streaming through the Internet or being supplied as live, remote broadcasting through videoconferencing (see for example, the Jason Project at http://www.jasonproject.org, or the Electronic Expeditions program at http://www.stonybrookvillage.com/wardmelville/education/education.htm. Jason links students from around the world on an annual scientific exploration, with live broadcasts sent to institutions such as science centers or universities. The Electronic Expeditions project provides a more intimate link to one or two classes at a time which connect with a practicing scientist who is out exploring an ecologically sensitive salt marsh.

Regardless of the specific project or medium, the underlying principle remains the same: Video serves an important role in bringing students to distant places, but it is up to the teacher to ensure that the rest of the curriculum supports significant inquiry as the core of the experience.

Math challenges on the web

A number of math "problem solving" web sites have sprung up in the past few years., including the Math Forum Problem of the Week contests http://www.mathforum.com/pow based at Swarthmore College and the Mathematics Contest program sponsored by the University of Mississippi and the University of Central Florida http://www.blahblah.edu/math and http://pegasus.cc.ucf.edu/~ucfcasio/problem.html. In these projects, challenging math problems are posted weekly for students to work on and submit solutions online. For the past few years I have used these problems to promote student inquiry, but virtually all of the benefit has been realized off-line. As with videos, the key is in how you structure the class to make use of the problems and the exchange with the online mentors.

The sample problem shown here is typical of the problems posed to elementary students:

> Our school is going to have a special treat day very soon! There are two main items that we can order: veggie dogs and hot dogs. In my class of 27 students, 22 have placed orders. There are 15 people who ordered a veggie dog, and there are 10 people who ordered a hot dog.
>
> There are two sizes of hot dogs: large and small. Of the people who ordered only a hot dog, there is one more person who ordered the large size than ordered the small size.
>
> How many people will be receiving large hot dogs?

Students solving this problem successfully will need to employ logic and reasoning as well as some basic computation skills. If they generate a solution, students are invited to submit their solution online to have it checked by an "online mentor." When I worked as a regular classroom teacher, I made the most of these problems by having students present their work to their peers, who in turn would judge whether it was an adequate solution. In this way, students enhanced their presentation skills as well as their problem solving abilities. It was gratifying to watch students become increasingly articulate about their mathematical thinking both orally and in writing over the course of the year. Also, we developed a real spirit of inquiry as students wrestled with what the problem was asking, what different ways the problem could be interpreted, and which alternative solutions were valid.

In this context, the response from the person online checking the students answers is of secondary importance, though their presence did help to promote growth in writing skills since students knew that they would have to make their thinking understood. Some of the best thinking, however, was in students' response to the "online mentors." I found that students often considered alternatives which the supposed expert never considered, and in a few cases were even more correct than the "experts."

Debating an answer

For example, the sample problem given here is unsolvable as it is written. Since there is no data given which helps to determine the hot dog size preference for the three students who ordered both a hot dog and a veggie dog, it is impossible to answer the question "How many people will be receiving large hot dogs?" In assessing the validity of the problem as it was written, the students working on it were challenged to think critically about all of the features of the problem and how it could be solved. In this case, critical information was missing, though when this was pointed out in an email message to the coordinator of the project, she insisted that there was adequate information and that students simply needed to read the problem more carefully.

Ironically, a student I was working with on this problem submitted what he knew to be an incomplete solution, giving the size preferences for only the 7 who ordered only hot dogs and pointing out that he didn't have enough information to go further. The online mentor for that week reviewed his solution, and he was given full credit.

The larger issue here isn't the contradictory responses which came about from the project staff members. Rather, notice the higher level thinking which the student was engaged in as he:

considered the problem situation,

decided if it was solvable,

articulated his concerns about the problem,

assessed the contradictory messages he received from the two online experts.

That is precisely the kind of higher order inquiry about mathematics which we hope to instill in our students.

The combination of a challenging problem, an inquiry-oriented environment, and the give and take with online mentors about mathematical thinking made it happen. Each of these three facets contributed to a successful learning experience.

And the key to effective use

I believe we should look past the specifics of the technology to see whether the task is engaging and worthwhile, and if it can promote the kind of inquiry you want to sustain in your classroom. There are many great inquiry projects available, most of which can be extended considerably with the infusion of technology. The key, however, isn't the technology, it's you as the teacher, the kind of work you ask students to engage in, and the type of classroom environment you create. By modeling a disposition toward inquiry, rewarding creative and critical thinking, and employing technology resources where they are helpful, your class will have richer inquiry experiences.

Comparing environments: Before using video images, websites and other resources, local field investigations help students understand a nearby, ecologically distinct biome. (Here, collecting water and ambient air temperature data.)

Bob Coulter is the Instructional Technology Coordinator at the Missouri Botanical Garden, leading teachers and students in a variety of environmental monitoring projects.
His new book, Network Science a Decade Later: The Internet and Classroom Learning, *co-authored with Alan Feldman and Cliff Konold, has just been released by Lawrence Erlbaum Publishers. A review will appear in the next issue of* ***Connect****.*