ENHANCING STUDENTS' THINKING SKILLS

Exploring Model Technology-Integration Sites

Many teachers have made technology an essential tool in their classrooms, perhaps putting too much emphasis on computers, in particular, as the best way to get their students to think. In this article, Christopher Moersch not only evaluates some of the more promising ways in which students can be challenged to think but also describes model classrooms in which such learning takes place. Cross-curricular components in particular can be used by teachers to adapt for their own classrooms.

By Christopher Moersch

What should a model technology-integration classroom look like? Does each student have ready access to a computer, modem, CD-ROM player, and the Internet? Not exactly. In fact, the model technology classrooms described in this article have relatively few computers or perhaps none at all, with students using computers only in the school's library or computer lab. So what makes these classrooms unique? It's the manner in which computers are used as tools to support students' thinking and reasoning skills across the curriculum.

CRITERIA FOR SELECTION

Each selected classroom emphasizes students' use of complex thinking strategies such as problem solving, decision making, reasoning, experimental inquiry, and reflective thinking. Students are engaged to identify problems, perform research, analyze data, ask questions, and justify their solutions. This is not entirely new. Thinking-skill strategies have been used before as criteria for identifying model technology-integration classrooms. In a 1995 study of computer-using teachers, for example, Becker defined the exemplary teachers as those who engaged students in computer-based activities that involved higher-order thinking skills.

Computer-efficiency levels were also used to identify model technology-integration classrooms. Such efficiency has been defined as the degree to which computers are used to support more advanced thinking skills, consequential learning, and concept-based instruction (Moersch, 1996–97). Each cited classroom possesses a high level of computer efficiency, and the existing classroom computers support authentic hands-on inquiry related to a problem under investigation. Students might be gathering information from the Internet about their community's crime rates, analyzing data from another classroom's experimental findings on soil deposits in a nearby canyon, or creating a multimedia presentation on traffic safety for younger students. In this context, technology is viewed as a tool for students to discover solutions to authentic problems, communicate results, and retrieve information.

Finally, each teacher discussed in this article consciously or unconsciously employs a constructivist approach to classroom pedagogy. Constructivism represents a philosophical view on how we come to know and learn, and it can be summarized using three fundamental propositions:

1. Understanding is in our interactions with the environment.
2. Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned.
3. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings (Savery & Duffy, 1995).

In a truly constructivist way, teachers used students' ideas, experiences, and interests to drive their lessons. This encouraged student self-analysis and data collection that supported ideas and perhaps reformulated older ideas in light of new information. The students were also prompted to challenge each other's conceptualizations and ideas. Yager (1991) provides the scale shown in Table 1 for analyzing the degree to which constructivist learning occurs in any learning environment. If most of the answers to these questions are "students" or "yes," then a high level of constructivist learning is taking place.

Perhaps the single most defining attribute of Yager's scale—and the one occurring recursively in the classrooms cited—involves the statement, "Concepts and principles emerge because they are needed by students" (p. 54).

Who identifies the issue or topic?	Teacher ——— Students
Is the issue seen as relevant?	No ——— Yes
Who asks the questions?	Teacher ——— Students
Who identifies written and human resources?	Teacher ——— Students
Who contacts necessary human resources?	Teacher ——— Students
Who plans investigations and activities?	Teacher ——— Students
Are varied evaluation techniques used?	No ——— Yes
Do students practice self-evaluation?	No ——— Yes
Are concepts and skills applied to new situations?	No ——— Yes
Do students take action(s)?	No ——— Yes
Do concepts and principles emerge because they are needed?	No ——— Yes
Is it evident that students extend learning outside of school?	No ——— Yes

Table 1

MODEL SITES

What follows are narratives from teachers who have positioned the use of technology as a seamless medium to maximize their students' thinking, reasoning, communication, and problem-solving skills.

Mulholland Middle School, Van Nuys, California

Valerie Sampson, social studies teacher

Mulholland Middle School is part of the Birmingham Complex Family of Schools in Van Nuys, California. The school sits directly on the site of a former Army hospital used extensively during World War II. Although little remains of the hospital, Ms. Sampson used it as the basis of a student-led investigation on the concept of property.

I began by telling my students only that they would be making a presentation on property and nothing more. I wanted to keep a low profile and see what types of questions the students might ask. … I had them walk the entire 120 acres covering our school, Mulholland, and the adjacent property, Birmingham High School. I later shared with my students that the entire property was a former Army hospital. Students' natural curiosity took over and they began asking questions, such as, What was it called? Why did they build it here? What happened to the buildings? Many students went to the library to answer their questions. They conducted most of their searches on the Internet, looking for key words such as "Mulholland" and "Birmingham Hospital." They even found contact information for former hospital staff members.

Some students opted to use HyperStudio to create their presentations. Watching old movies and visiting with representatives of a local film company, the students quickly learned the art of storyboarding and scripting as well as the basic fundamentals of HyperStudio.

As students continued their research, their interests led them in a remarkable and highly unanticipated direction: They began to focus on illnesses and injuries, especially sports injuries. Because many of my students are involved in after-school sports, the concept of leg, knee, and foot injuries was quite alluring. Using our library's Internet connection, students explored sports-related injuries on a variety of Web sites. Using carefully crafted prompts, I was able to channel their enthusiasm toward conducting a schoolwide survey on sports injuries. After collecting this data from their fellow students, they tabulated and graphed the results using Excel. The survey results showed that most students were concerned about sports injuries and mostly about possible spinal injuries. My students then created a brochure in ClarisWorks about spinal injuries that they shared not only with Mulholland Middle School students, but also with Birmingham High School students and community members.

Rosa M. Parks Middle School, Olney, Maryland

Jody Smith, science teacher

Although her classroom has plenty of computers for students to use, Smith stresses that "computers are not the end-all answer; they must be used when it is appropriate." Appropriate use is tied directly to students asking questions and solving authentic problems in their community.

As a teacher, I always start with a question or problem that the students are interested in. In science, my class might generate a list of questions relating to a specific topic such as what scientists do or how scientists solve

problems. In consumer science, a research question might address how they could determine whether Coca Cola is an acid. By encouraging student questioning and researching, I help them begin to see links between what they are studying and the real world. As our district requires up to 60 hours of service learning credit, students are able to take what they have learned in science and apply it to something tangible outside the classroom.

We use the computer as a tool with which students can tabulate data, create graphs, make inferences, and draw conclusions. Their conclusions might lead them to further questions and research about an issue or problem (e.g., using a CD-ROM about water pollution or accessing the Internet to find additional information on soft drink beverages) that will eventually culminate with some sort of service learning project (e.g., an environmental clean-up, a community presentation on local biodiversity issues, a recycling campaign, or a multimedia project addressing local pollution using a QuickTake camera and HyperStudio). Regardless of the type of service learning project, we try to get students to use computers whenever they are needed.

Sam Houston Middle School, Amarillo, Texas

Linda Coleman, mathematics teacher; Peggy Smith, language arts teacher; Patsy Richards, science teacher; and Jim Rutledge, social studies teacher

One of Sam Houston Middle School's grade-level teams has integrated mathematics, science, social studies, and language arts, and here provides a provocative account of integrating existing computers into the classroom. According to Linda Coleman,

Our water unit provided a natural way to get students involved in taking action about local problems in the region as well as integrating technology within our existing content areas. In science class, students explored the concept of soil porosity and its relationship to the water cycle. Then they used computers to analyze local soil data in math class and related their findings back to the larger issue of pollutants entering the local aquifers.

Student questioning eventually led to the creation of several outdoor lab activities addressing the pollution problems in the Pala Dura Canyon. In the canyon, students conducted a series of water quality tests and explored the concept of carrying capacity. Students collected water temperature data at different elevations and soil samples and then conducted population estimates of the local fish and wildlife population. Later, they graphed and analyzed the data using LabQuest. Our language arts teacher provided a humanities connection by assigning specific novels relating to water pollution and having students write haiku about canyon wildlife.

Besides using the computer for data analysis, students used the Internet to find additional information about water pollution. They also linked up with a classroom in Yugoslavia and exchanged research data using e-mail. The students' findings about water pollution led them to create a flyer on the computer about how local citizens can minimize pollution of the canyon and local aquifers. We eventually plan for students to create a series of 30-second commercials about water quality using our own video camera and Avid Video Shop software.

Encino Elementary School, Encino, California

LaVerne Potter, fifth-grade teacher

According to Potter, in-school computer use prepares students for the experiences they may encounter in a business setting. At Encino Elementary School, students opened their own store and continue to run it.

Students were continually crossing a busy street to buy food from a local merchant. One of the problems was that our students knew that they were being cheated from a pricing standpoint. From a staff perspective, we were concerned about their safety as well as the incredible trash problem. After brainstorming solutions with our fifth graders, a decision was made to try out our own student store. What started out as a tiny chick transformed into a full-blown rooster.

We secured a donated rolling display rack and commercial-size refrigerator, arranged daily ice cream delivery, and purchased supplies from the local store. Within one week, we had a fully functional store. Our students conducted surveys of the entire student body to determine their food- and candy-buying preferences. Students used the computers to track inventory, determine percentages of profit and loss, and account for any slippage (stolen merchandise). Students spent a great deal of time looking at graphs to determine what products to sell as well as to make projections about future profit margins.

As the store became more popular, more students wanted to get involved. It was very natural. The students controlled the inventory, set policy for the board of directors and for profit sharing, and hired all of the student workers. Later, we even entered into a contractual arrangement with the school to lease property where the student store was located. Students used the computer to figure out the percentage of the leased area based on the total area of the school. Students also used the Internet to contact other schools about our student store. We are even thinking seriously about putting together a Web page about our store, hoping that other schools might want to follow our example.

Kualapuu School, Molakaii, Hawaii

Vicki Newberry, fifth- and sixth-grade teacher

The fifth- and sixth-grade team at Kualapuu School employs an open-ended, research-based process for students to complete their independent projects. Computers are used mostly as tools in the classrooms.

It seems that the computers in our resource center are in use all day long. Students are either using ClarisWorks to write portions of their research projects, conducting Internet searches, or crunching numbers from a survey.

Students spend 90 minutes a day receiving instruction on core information that is essential to their independent study projects. After the 90-minute period, students work in the resource center on a project tailored to their specific interests. Last quarter in social studies, students were asked to create historical time lines using TimeLiner as their independent study project. Using time as a thematic organizer, students searched the Internet for historical information about such geographical areas as Mexico, the United States, the Middle East, and Africa. This approach enabled students to integrate their map-reading and data-analysis skills within a historical context. At the end of the project, students organized a schoolwide international festival highlighting the specific time periods around the world.

Celebration School, Celebration, Florida

Tom Vitale and Heather Krawczwk, Neighborhood 3 teachers

Using computers as a seamless medium to promote student activism in the community is central to the curriculum in Vitale and Krawczwk's classes.

We are not so much concerned with how much time students spend on computers as we are with how students use computers. During the school year, our neighborhood completed a wetlands project. Because the town of Celebration sits literally in a wetland, the topic was very real to our students. Students wanted to explore not only how the wetlands affects their lifestyles, but also how their lifestyles affect the wetlands.

Students conducted several field investigations of the Celebration community and the surrounding wetlands. They used recording sheets to conduct a frequency inventory of all plant and animal life and collected water samples within a one-acre area. Back in the classroom, students tabulated their data and generated a series of graphs on the computer to help them determine the full extent of their impact on the wetlands. They created a series of Venn diagrams to compare the Celebration environment now versus how it was before the town was constructed. Students also used Encarta and Internet search engines daily to find additional information about Florida's wetlands. They used not only the text-based information but also the maps.

From their research, students concluded that water contaminants were much higher than they should be and that too many of the downed trees were being wasted rather than recycled. This discovery prompted students to write letters to the Celebration Town Manager as well as the Town Hall urging that the Celebration Company investigate their environmental practices during construction.

FINAL REMARKS

These teachers have assigned different learning activities and used different teaching strategies to achieve a final product, but their emphasis on student questioning, research, issue resolution, and higher order thinking skills has been consistent. And so has their use of the computer. Each narrative illustrates the use of technology as a tool to advance student's ability to think and reason and solve authentic problems. The technology has become transparent. Most important, these teachers have used existing technology and community resources to transform their classrooms into dynamic centers of purposeful and experiential learning that intuitively move students from awareness to authentic action. ■

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