# *The Internet and Classroom Learning*

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*An excerpt from chapter 6 of* Network Science, A Decade Later: The Internet and Classroom Learning, *a new publication that is based on four years of research. It examines the role of technology in fostering inquiry-based approaches to teaching and learning. Reprinted with permission of Lawrence Erlbaum Associates, Publishers.*

We are less convinced today that the Internet will provide an easy route to improved learning; we have come to believe that people-to-people connections and especially face-to-face communication play a central role in learning. On the other hand, we have become even more impressed by the power of the technology and remain convinced that this power will ultimately be harnessed for the improvement of education. While technology evolves quickly, however, the human ability to understand, shape, and incorporate these changes evolves slowly. Access to distant resources—experts, peers, teachers, texts, images, and data—is rapidly becoming commonplace, but the understanding of how to make good use of these resources is only slowly emerging. The time required for the development, refinement, and adoption of appropriate new pedagogies may be a decade or more.

## Reccommendations

To our colleagues on this long journey—project organizers, curriculum developers, researchers, and teachers—we pass along six recommendations. Although we ground these recommendations in our research on network science curricula, we seek to apply them toward educational uses of technology generally and toward use of the Internet in science education specifically.

### 1. Use the Internet to broaden the context of locally grounded inquiry.

For curriculum to use the Internet effectively, it should employ the Internet as a supportive context for extending student inquiries. Students can now investigate almost any topic using resources available on the Internet. However, teachers and curriculum developers should anchor initial investigations in local phenomena so that the concepts involved remain comprehensible and meaningful to students.

### 2. Maintain the classroom, not the online community, as the primary learning environment.

The most effective network science curricula foster a strong sense of inquiry within a classroom rather than among distant classes. The locus of the inquiry is in the classroom with extensions into the local community; teachers are responsible for developing appropriate classroom norms and mentoring the inquiry process. The network provides

resources in the forms of expertise, data, and information, all of which support and extend classroom-based inquiry.

**3. Provide teachers and students with multiple entry points for technology use and curriculum.**

The complexities of technology use in classrooms challenge teachers. In the past, we have encouraged some teachers to learn how to use these technologies while they make significant changes in their curriculum and pedagogy. Yet many of the most effective teachers have taken 3 to 5 years to make these inter-related changes. In designing innovative curricula that make use of new technology, developers should keep this long transition in mind and create materials with multiple entry points to accommodate teachers' developing expertise with each component.

**4. Help students locate educationally productive Internet resources.**

One of the most common arguments for connecting schools to the Internet stresses the benefit of giving students access to a vast store of information. Too often, however, students who access information via the Internet get in over their heads, finding little of relevance or appropriate to their knowledge level. Some curriculum developers now provide teachers and students with pointers to conceptually appropriate web sites and browser frames that keep relevant information in front of students as they move from site to site.

**5. Use data to deepen student inquiries.**

Network science has tended to focus on the problem of getting data to students, skirting the issue of how to get students analyzing data. Furthermore, curricular support when offered has consisted mostly of advice on how to make or interpret various types of statistics and displays. Curriculum developers and teachers should avoid giving recipes for data analysis and should instead emphasize the role of judgment, hypothetical thinking, and critical reasoning in examining data.

**6. Use of the Internet should reflect what we know about student learning.**

Although the metaphors of student as scientist and students surfing the Net have been compelling for some, they are not anchored in what we already know about how students learn. For example, we know that teachers and curriculum developers should work to help students define one or more guiding questions for their work, and that curriculum should be driven by conceptually appropriate questions and offer a suitable degree of complexity to sustain the inquiry.

Educators must be careful not to confuse easy access to resources with learning. Student use of sophisticated or complex data sets and information can lead them into topics that are not comprehensible. The appeal of using technology needs to be tempered with careful consideration of the benefits teachers or curriculum developers expect. Technology opens many doors; educators need to be prudent in their choices about which doors to enter.

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Let us turn now to look at how these themes are realized by real students and teachers working in the complex institutions called schools.

The following two-part vignette is the story of science and math learning in a class taught by Debra, an elementary school teacher. Debra is not a fictional character but a composite of some of the teachers with whom we have had the privilege to work and in whose classrooms we have observed.

As we first meet Debra, she is already a teacher widely regarded as accomplished and skilled in inquiry-based teaching. Debra's class is functioning well, using computers in limited ways and without any online connection. We come back and look at the same classroom 3 years later to see the ways in which Debra has strengthened her teaching through the integration of technology.

## Inquiry-Based Teaching and Learning: Initial View

Debra is a well-respected teacher at Brookside Elementary School with more than a decade of experience teaching young students. Like many other teachers, she has at one time or another taught every subject. In the last few years, she has specialized in math and science.

Until she attended a summer workshop on ecology 2 years ago, she like her students had little idea about the rich diversity of life present in the area immediately surrounding the school. Now alert to the possibilities, each spring Debra has her class study wildlife in the vicinity. The ecology unit is an integral part of her goal to help students appreciate the local environment, learn the interrelations of species in a given area, and master basic plant and animal taxonomy.

Drawing ideas from a variety of curriculum guides including Schoolyard Ecology (from GEMS) and Eco-Inquiry (from the Institute of Ecosystem Studies), Debra bases her unit on the question, "Who lives here at school with us?" She begins with the students working in teams to identify plants and animals. Science curriculum goals relating to ecology, biology, and geology are fulfilled as the students conduct extensive field investigations. The district-required math objectives regarding measurement and area coordinate with these investigations as students note sizes of specific species in field guides and practice measuring areas as they mark off their study sites.

The students are generally enthusiastic about this work and enjoy having the outdoor sessions as a part of their class work. Following the fieldwork, Debra and her students engage in class sessions to discuss and share what they have found. The students make regular reference to CD-ROMs and frequently choose to use ecology simulations (recommended by the school's computer coordinator) in their assigned weekly computer time slot. Although these simulations do not advance key curriculum goals, they are popular with the students, many of whom had not used computers in the earlier grades.

The ecology unit culminates in students creating museum-style displays that detail the life forms present in each area of the schoolyard. On presentation day, the classroom is filled with pressed leaves, photographs of animal tracks and birds seen in the area, and terraria holding

pill bugs and other insects. Because each team of students has been assigned to a different part of the grounds, the sharing session highlights the diversity of habitats within the schoolyard.

Despite the many compliments from her principal, parents, and colleagues, Debra thinks that the presentations are too formulaic and lack the excitement that motivated the student investigations in the first place. Furthermore, she is looking for ways to extend her students' understanding of ecology well beyond what they learn from studying their local site.

## Inquiry-Based Teaching and Learning: Three Years Later

As Debra continues to grow as a teacher, she defines a clear goal to motivate her evolving curriculum: She seeks out ways for her students to develop a broader and deeper understanding of ecology. As part of her strategy for realizing this goal, she enlarges the set of resources available to students, including many posted on the Internet. In this endeavor, she is aided by Jill, the educational technologist who joined the school staff 2 years ago.

The school district's decision to replace the role of computer coordinator with that of educational technologist reflects a significant shift in the school district's priorities. Whereas the computer coordinator kept the computers running, showed faculty how to use them, and recommended software for purchase, the educational technologist is an experienced classroom teacher who works with teachers to integrate technology into their curricula. Jill has helped Debra reshape her science and math curricula to incorporate new possibilities afforded by technology. In the past, computers were used as an occasional reference source and as a recreational device. Now, most class projects make frequent use of computers. In her math curriculum, Debra has identified key skills, concepts, and tools that students require in their science investigations, including data analysis software that helps students record and organize data and represent these visually.

With computers in use in classrooms throughout the school, students are able to build on their skills from one year to the next. Debra can count on her fourth graders to know how to use a word processor and a web browser and reasonably expects many to solve common technology glitches as these occur. The fifth-grade teachers, in turn, have revised their curriculum to make use of their incoming students' skills, especially their ability to work with software that organizes and represents data.

Involvement in online curricula and resources has provided the larger context Debra was hoping to find. Two years ago, Debra learned about Journey North at a regional NSTA conference. She chose to add several of the Journey North investigations to her existing unit, knowing that her students would be excited to participate with other students across the country. Indeed, their investigations of signs of spring, including when tulips first bloom and when monarch butterflies return from Mexico, have been successful. Debra appreciates the way her students can generate their own questions around each of these investigations and analyze data from the web site to pursue their questions.

Using Internet resources, students in Debra's class compare their data and observations with those from schools in other parts of the country. This year, they noticed that their tulips bloomed 2 weeks later than the same time last year. This observation puzzled the students

until they noticed that no other school in their region had yet reported the blooming of their tulips. By referring to the Accu-Weather database, the students saw that March in their region was unusually cold this year, and they offered this observation to account for the delayed blooming. They then began looking at data from other regions to see if temperature data could help them predict when or where blooms would be seen first.

Whereas in the past, students' work would culminate with a presentation of their observations and data, student presentations now typically include data collected by others as well. A few of the students have even developed multimedia electronic displays, which include links for downloading and adding current information. One pair of students who are following the path of an electronically tagged eagle update their page daily, allowing the class to make and test predictions about where the eagle will go next based on their understanding of the bird's migration pattern.

One event in particular helped Debra gauge her own success as a teacher. Based on the students' finding that tulips were blooming later this year, the students suggested that they create a local archive in which to save data collected at their school so that future students would be able to study how local habitat changes over time. Debra is pleased to see that many of her students have learned to see their locally based investigations as part of patterns.

In this second part of the vignette, Debra's class remains substantially the same: Students are actively involved in local investigations, building understanding through firsthand experience. However, as a result of Debra's growth as a teacher, the questions that students are asking are broader in scope, deeper, and more reflective. Students' engagement in good science learning is due to Debra's skill in using the numerous resources available to the students, in helping them structure their investigations, and in mentoring the discourse in the classroom.

The addition of the technology has not driven these changes in teaching and learning but has supported them. Her students' study of ecology is still grounded in the investigation of the local ecology but is no longer confined to what they find there. Through their use of Internet resources, students are now able to compare local ecology both spatially (as they compare what lives on their school grounds with what is happening at other schools) and temporally (as they compare temperature conditions from one year to the next). In this way, the local phenomena at Debra's school are not isolated events—they occur in a pattern that makes sense geographically and seasonally. Students see the natural phenomena of spring, such as leaves budding and the lengthening of daylight hours, as part of a larger pattern of change in the environment as the season progresses.

With the Internet, Debra and her students have access to a richer set of resources than they are used to. These resources, in turn, have supported the students' use of data, including up-to-date maps and other data displays, and stimulated dialogues among the students about these data. The integration of technology into Debra's curriculum has helped students achieve the objectives of new state frameworks and national standards (e.g., that students be able to make sense of data, engage in critical writing and discussion, and employ a range of reference sources).

Looking more broadly, we see Debra as a capable professional who is building from her strength as an inquiry-based teacher to make effective use of the Internet as one of several resources to support students' work. The use of the technology did not introduce inquiry to Debra's class. Instead, her experience and expertise in the pedagogy of inquiry enabled her to employ the Internet and data analysis tools effectively. Over several years, Debra's collaboration with others, most recently with the school's educational technologist, has led to deeper inquiries and more effective integration of computers into the fabric of the classroom.

Debra is one of a growing number of teachers in her school who report that technology has created not only new ways to communicate but also new reasons to do so. Reflecting the growing sophistication of the faculty about technology and teaching, talk of surfing the Net has largely been replaced by talk of how teachers can use the Internet as a tool for supporting student investigations. Through continuing professional development, including coaching, coplanning, and coteaching with the school's educational technologist and increasingly with one another, the teachers in Debra's school are beginning to realize the promise of educational technology—to provide crucial support for deepening inquiry-based teaching and learning.

Debra's own changes as a teacher would not have been possible without the priority that the superintendent and school board placed on updating the district's curriculum and student learning goals to reflect the infusion of technology throughout the district. Debra has contributed to and benefited from this essential process of revision.

## Final Reflections

Public enthusiasm for getting schools on the Internet is currently based largely on the idea that students should have access to the vast information resources on the World Wide Web. This perception of great intellectual riches online has led to the belief that the Internet should become a central component of modern education—essential to preparing students for the demands of the 21st-century workplace and for keeping the nation competitive.

The empirical and theoretical issues we raise in this study challenge educators to look past this broad and well-intentioned rhetoric to ask how access to this information can help deepen students' understandings of math and science. Certainly, accessing information on the Web, viewing images and movies, and running simulations excite most students, at least initially. However, if students are to learn anything of significance from this information, their excitement must eventually prompt thoughtful questions and reflection—and hard work. This is the sort of teaching and learning that an able teacher and inquisitive peers can help students undertake. Although there is strong evidence that the Internet can provide resources to support good teaching and learning, there is no evidence that it can replace the role of teacher and peers. Our research and experiences indicate the opposite: The universe of information has grown larger and more complex because of the extraordinary capabilities of new technologies. As a consequence, students need more than ever the guidance of experienced and skillful teachers to learn to their full potential.

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