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ABSTRACT

This Technology & Innovations in Education (TIE) workshop was presented on April 24 and 25, 1997, in Denver, CO, to help participants gain a big picture perspective of technology planning and related issues, understand a model for sound, practical technology planning, build capacity for leading a local planning effort, engage in the steps of the planning process, and network and collaborate with colleagues regarding related issues. The manual contains the following sections: (1) Outcomes and Agenda; (2) Planning Model Overview -- includes information gathering and gleaning, descriptive vision development, discrepancy analysis, action plan development, and issues and challenges to reaching the vision; (3) Workshop Activities -- four worksheets based upon the components of the planning model, and questions to enhance story writing for action plan development; (4) Evaluation Form; (5) Resources A: Systems & Resources -- seven items relating to strategic planning of technology programs; (6) Resources B: Technical Infrastructure -- 10 items pertaining to hardware, software, network building, and Internet resources; (7) Resources C: People Infrastructure -- four items pertaining to technology and professional development; and (8) Resources D: Teaching & Learning -- nine articles on the instructional use of technology. Thumbnail sketches of slides used in the workshop are also included. (DLS)

ED 425 699

REGIONAL TECHNOLOGY

PLANNING WORKSHOP

Developed by Technology & Innovations in Education (TIE) through support from the Mid-continent Regional Educational Laboratory (McREL). This product was developed with funds from the Office of Educational Research & Improvement, U.S. Department of Education, under contract #RJ96006101.

IR018951

Resource Manual 1997

Technology and Innovations in Education
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Rapid City, SD 57702

605-394-1876

http://www.tie.net

OUTCOMES

AND

AGENDA

Regional Technology Planning Workshop
Denver Hilton South
Denver, CO

Outcomes

Workshop participants will:

- gain a "big picture" perspective of technology planning and related issues.
- understand a model for sound, practical technology planning.
- build capacity for leading a local technology planning effort.
- engage in the steps of a technology planning process.
- network and collaborate with team members and other colleagues regarding technology planning issues.

Agenda

<u>April 24, 1997</u>

10:00 - 10:30 a.m.	Introductions and Agenda Overview
10:30 - 12:00 p.m.	A Big Picture of Sound Technology Planning
12:00 - 1:00 p.m.	Lunch
1:00 - 2:30 p.m.	Information Gathering and Gleaning
2:30 - 2:45 p.m.	Break
2:45 - 4:15 p.m.	Descriptive Vision Development
4:15 - 4:30 p.m.	"Headline to Headline" Wrap-up Activity

<u>April 25, 1997</u>

9:00 - 10:15 a.m.	Discrepancy Analysis
10:15 - 10:30 a.m.	Break
10:30 - 11:30 p.m.	Discrepancy Analysis
11:30 - 12:00 p.m.	Setting the Stage for Action Plan Development
12:00 - 1:00 p.m.	Lunch
1:00 - 2:15 p.m.	Action Plan Development
2:15 - 2:30 p.m.	Break
2:30 - 3:30 p.m.	Action Plan Development
3:30 - 3:45 p.m.	Wrap-up

PLANNING

MODEL

OVERVIEW

TIE Strategic Planning Model: A Process for Pursuing Technology-Infused Teaching and Learning

Grid for Viewing Planning Process

- Systems and resources
- Technical infrastructure
- People infrastructure
- Technology-infused teaching and learning

Major Components of the Planning Model

1) Information Gathering and Gleaning
2) Descriptive Vision Development
3) Discrepancy Analysis
4) Action Plan Development

Major Components of the Planning Model

1) Information Gathering and Gleaning

Establish a current, valid snapshot of the educational technology infrastructure, capacity, and integration surrounding the teaching and learning process. Gather, review, analyze, and reflect on the information to form sound impressions of needs, progress, and possibilities. Whether a few key snapshots or a whole photo album, this planning component offers an important benchmark for the planning process. Elements might include:

- mission and vision
- outcomes and/or curriculum standards
- current priorities for teaching and learning
- involvement in school reform efforts
- perceived strengths and barriers surrounding school reform initiatives
- current technology plan
- current technology infrastructure including hardware, software, networks
- current technology applications and integration
- staff skills with technology

2) Descriptive Vision Development

Build a vision of technology implementation and integration for impacting teaching and learning in the next 3-5 years. Via a collaborative team effort, form a concise vision that describes teaching and learning interactions among educational stakeholders. Elements of the vision might include:

- roles of students, teachers, administrators, and community members
- characteristics of teaching and learning activities
- structure of learning environments
- capacity of technical infrastructure
- capacity of people infrastructure

Major Components of the Planning Model

3) Discrepancy Analysis

Identify the gaps between the current status as established by the "information gathering and gleaning" activity and the vision produced by the "descriptive vision development" effort. Via honest, open interactions, define the "space" between "where the district is" and "where the district wants to be." Clarify and order priorities though the lenses of resources and reality. Often the discrepancy analysis reactivates aspects of the "information gathering and gleaning" or "descriptive vision development." Elements of the discrepancy analysis might include:

- shifts in school system and structures
- issues surrounding resources
- updating and repurposing technical infrastructure
- people capacity—knowledge, skills, practices
- curriculum—design, development, implementation

Major Components of the Planning Model

4) Action Plan Development

Identify actions that address the gaps noted through the discrepancy analysis process. This effort produces the "meat and potatoes" of the plan. Prioritize, prioritize, and again prioritize to ensure specific attention to those activities that are most critical to overall impact. For purposes of doability and manageability, focus on a few key priorities and identify a few action steps for each. Build in accountability. Action plan might include:

- Priorities/Objectives
- Action steps delineating tasks and activities
- Resources
- Persons responsible for carrying out actions
- Time Line for accomplishing each step
- Criteria that specify expectations for each action
- Data that produces information for determining progress and results

Related Planning Considerations

- Components of the planning process are sequential as well as cyclic and concurrent.

- Planning serves as a strong capacity building tool—maximize the opportunities.

- Planning is really more about process than it is about product.

ISSUES AND CHALLENGES TO REACHING THE VISION

Vision of New Learning Environments **"Communications Age"**	**Picture of Current Learning Environments** **Primarily "Industrial Age"**
School is everywhere Communities of learners Dynamic, flexible, evolving curriculum	School is a place Classroom groups of students Textbook driven, static curriculum
Learner centered processes and practices for learning	Teacher directed processes and practices for learning
Equitable access and seamless infusion of technology	Inequitable access and use of technology as an add-on
Technology facilitates multimedia-based communication, information sharing, collaboration	Technology primarily automates "traditional" practices
The pursuit of professional excellence is continuous and supported with new models and resources	Professional development opportunities are limited, detached from research and under funded
Teaching and learning reflect an increased quality of understanding and standards of excellence	Teaching and learning primarily reflect a quantitative level of understanding and varying degrees of excellence
New flexible and expanded roles for educational community stakeholders exist	Single focus roles for stakeholders are the norm
New organizational models of systems support a Communications Age vision of learning	School systems support linear learning sequences, time bound units of work, and age determined cohorts

Elements of Long-Range Technology Utilization Plan

Area	Basic "Yes & No" Version of Questions	Communications Age Version of Questions
Teaching & Learning	1. Does your plan specify curriculum goals to be achieved through the incorporation and utilization of technology?	1. What are the appropriate work and tools for the design of new learning environments? How does your district plan reflect changing curriculum, instruction, and assessment in response to changes in the tools of education?
Teaching & Learning System & Resources	2. Does your technology plan specify methods which you will use to reach your goals?	2. What processes, models, strategies, and practices has your district identified that will help reach the goals of your technology plan? How do these "methods" align with your vision of new learning environments?
Technical Infrastructure	3. Does your technology plan specify the types of hardware and software required to carry out your plan?	3. What is the fit between your technology infrastructure and your district's vision of new learning environments? How will the technical infrastructure address the role of technology as tool and discipline?
Technical Infrastructure	4. Does your technology plan incorporate the use of your school/district's existing equipment?	4. How does your plan maximize your school/district's existing technology investment? How can the district's existing investment contribute to your vision of new learning environments?
People Infrastructure	5. Does your technology plan include a staff development plan?	5. How does your technology plan demonstrate that your district values staff development? How does your plan reflect new roles for educational stakeholders?
System & Resources	6. Is your school/district planning for the on-going operational costs and staff development costs to execute your school technology plan?	6. What evidence in your technology plan demonstrates long-range fiscal considerations? How do these budgetary considerations reflect an understanding of changes in operational costs and staff development costs as a result of technology infusion?
Teaching & Learning	7. Does your plan support an educational program based upon standards?	7. What role and/or relationship do educational standards play in your technology plan? How does your plan address technology standards?
System & Resources	8. Do you have in place a regular review and update process of your long-range technology plan?	8. Does your plan include a process of incorporating formative and summative data for program review and revision? How will the review process address rapidly changing technology and school reform initiatives? What criteria will guide the review process?

3

WORKSHOP

ACTIVITIES

Mapleton School District

Technology Planning Workshop Worksheet

Component 1: Information Gathering and Gleaning

Nuggets

• Focus on a view of your district's technology program that encompasses a wide panorama.

• Do your best to set aside bias and view your district's technology efforts as objectively as possible.

• Be pragmatic and note specifics.

Activity

Review the data addressing your district's current educational technology program including such items as: a) the district's current technology plan; b) the current technology infrastructure including hardware, software, and networks; c) current technology applications and integration; d) staff skills with technology; e) district's mission and vision; f) priorities for the district's teaching and learning process; g) involvement in school reform efforts; and h) perceived strengthens and barriers surrounding school change initiatives. If you believe you are missing key data elements in order to build a valid picture of current technology efforts, identify those missing pieces and gather such data as soon as feasible.

Develop a brief description of your district's current status by responding to the following items. As you respond to the items, consider information regarding your district's system and resources, technical infrastructure, people infrastructure for technology, and integration of technology into teaching and learning.

1) The primary strengths of our district's technology program are:

- Consistency in equipment
- Low student to computer ratio.
- Technology plan exists
- School Board that likes Technology
- Supportive leadership
- Trained on-site Tech Person at each site
- Distrib. LAN / WAN
- Integrated voice and data system

2) The primary barriers for our district's technology program are:

- Not enough lines going outside the district.
- Staff development is a large barrier - Time
- Staff Development for technology is competing with other subjects
- Effecient utilization of resources
- Alignment of technology with the curriculum; this is not clear.
- maintenance / Upgrades
- Lack of on-going Technology Funding Feast / Famine

3) A headline that would best capture the current status of our technology program would state:

BEST COPY AVAILABLE

Technology Planning Workshop Worksheet

Component 2: Descriptive Vision Development

Nuggets

- Without a vision of where we're going, we'll never know if we got there.
- While visions are created from a "high altitude", they need to relate to "sea level" realities and practices so we can make valid decisions about time and resources.
- It is important that we "own" the vision.

Activity

To begin your vision, try this strategy. Imagine that it's five years from now. . . Your team is sitting in a restaurant and you spot several former district colleagues who moved away from the district and aren't aware of district happenings in that five year period.

Develop a brief description of your district's vision by responding to the following items.

1) Describe to your former colleagues the wonderful five years you just had--everything that you hoped for that happened at school, the goals that you met--even the ones you dreamed of that emerged and came true. Think about changes in your district's system and resources, technical infrastructure, people infrastructure for technology, and integration of technology into teaching and learning.

2) Describe what you overcame to achieve those goals.

3) Describe who you enrolled in the process and whose support you gained in order to succeed.

4) Write a headline that would best capture your district's vision.

Technology Planning Workshop Worksheet

Component 3: Discrepancy Analysis

Nuggets

- Getting from "where we are" to "where we want to be" requires focus and strategy.
- Clarifying priorities focuses your energy and resources to maximize impact.

Activity

Reflect on the headlines that your team identified for the first two components: Information Gathering and Gleaning, and the Descriptive Vision Development. Discuss how much "space" is created between the two headlines. If appropriate, reconsider and restate the headlines. This discussion and reflection offers an opportunity to revisit your district's "current status" and "vision" and note specific gaps. Summarize the "gaps" identified by your team by responding to the following items. Those gaps may address factors related to your district's system and resources, technical infrastructure, people infrastructure for technology, and integration of technology into teaching and learning.

1) The primary gaps between our district's current status and vision are: (Consider the following areas as you note specific gaps.)

System and Resources

Technical Infrastructure

People Infrastructure

Teaching and Learning

2) Given time, resources, or other constraints of our district, the highest priority "gaps" are: (As your team considers the list of gaps, consider some of the following questions. If we only had a few months to create an impact, which "gaps" should we focus our energies on? If we could only put the district's attention on a few "gaps," which ones would be "lynch pins" that would cause other things to happen?)

3) Draft objectives to correlate with the highest priority "gaps" noted above. (Here's where the team "translates" the gaps into objectives that focus attention and energies.)

<u>Objective A</u>

<u>Objective B</u>

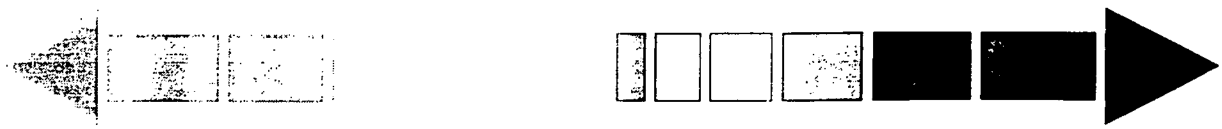
<u>Objective C</u>

<u>Objective D</u>

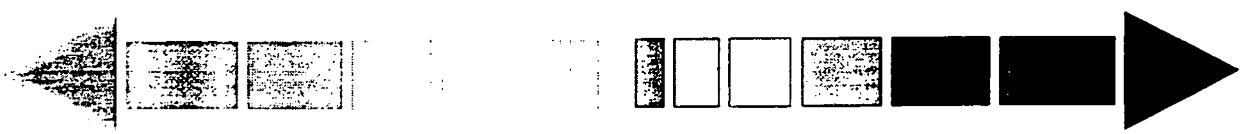
Discrepancy Analysis

Current Status | Vision

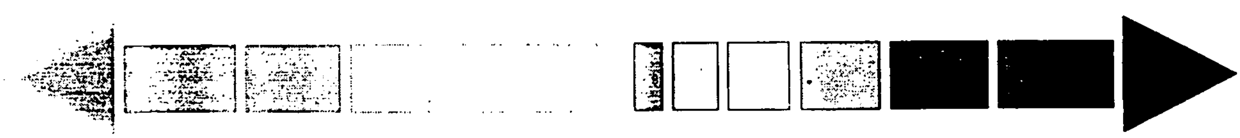
System and Resources



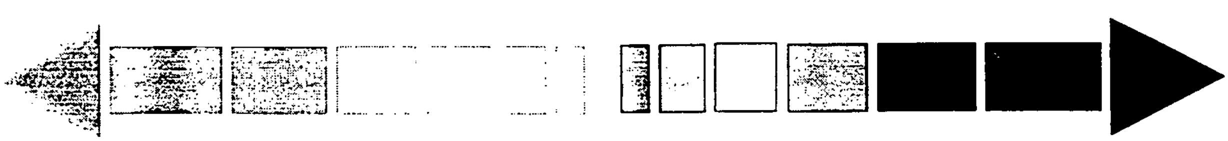
Technical Infrastructure



People Infrastructure



Teaching and Learning



Technology Planning Workshop Worksheet

Component 4: Action Plan Development

Nuggets

- Planning without action is simply a bill of goods.
- Defining what, who, and how builds the accountability component of planning.
- Focus action steps for achieving maximum impact for the investment of resources.

Activity

For each objective identified as an outcome of the Discrepancy Analysis component, write a story that depicts how that objective can play out meaningfully in your district. Develop concise, descriptive narratives that offer insights into operations and implementation in your district, including information about what, who, how, and when.

After writing the short story, complete the cells of the Action Matrix by drawing information from the story. If you discover missing elements that are important for the success of the objective, identify those items and add to the matrix. For our purposes, the elements of the Action Matrix include:

- Action Steps--Specific actions such as tasks and activities that operationalize the objective and lead to attainment of the objective.
- Resources--Description or notation of time, people, money, or other resources needed to facilitate the action step.
- Who--Identification of person(s), group(s), or entity(ies) responsible for carrying out the action step.
- Time Line--Specific dates for accomplishing the action step.
- Criteria--Descriptive information that specifies the expectations against which the action step will be measured.
- Data--Pieces of information that are used collectively to determine to what degree the criteria have been met.

Objective A

Short Story:

Action Matrix:
Objective A:

Action Steps	Resources	Who	Time Line	Criteria	Data

Objective B
Short Story:

Action Matrix:
Objective A:

Action Steps	Resources	Who	Time Line	Criteria	Data

Objective C
Short Story:

Action Matrix:
Objective A:

Action Steps	Resources	Who	Time Line	Criteria	Data

Objective D
Short Story:

Action Matrix:
Objective A:

Action Steps	Resources	Who	Time Line	Criteria	Data

Questions to Enhance Story Writing for Action Plan Development

1) Who are critical "movers and shakers" among the district's stakeholders for addressing the gaps?

2) What's currently in our "pile" of resources and our "pile" of barriers?

3) What do we need to bridge the gaps in terms of:

- equipment
- staff
- training
- time
- policies and procedures
- partnerships?

4) How much could we achieve by simply redirecting current staff, resources, and equipment? How much could we achieve by expanding/enhancing current staff, resources, and equipment?

5) What new staff, resources, and equipment will we need to accomplish the priorities?

6) What other major initiatives in our district could influence or impact the action steps? (For example, new building construction, standards-based curriculum development, or tax freeze.)

7) How we will we know/what markers can we use that will prove that we have achieved this goal?

EVALUATION

FORM

Technology Planning Evaluation

I am leaving this two day workshop with ....

- a better understanding of a practical, productive planning process

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- a stronger capacity to facilitate a technology planning process

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- experience with the development of a technology plan

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- collaboration with team members and others related to technology planning

  Not at All 1......2.......3......4......5......6.......7 Yes and More

Indicate the degree that the following components contributed ....

- Big Picture Overview of Sound Technology Planning

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- Information Gathering and Gleaning

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- Descriptive Vision Development

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- Discrepancy Analysis

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- Action Plan Development

  Not at All 1......2.......3......4......5......6.......7 Yes and More

- Collectively, the components contributed to a progressive, practical process of technology planning

  Not at All 1......2.......3......4......5......6.......7 Yes and More

What did you like best about this workshop?

In what ways will this workshop be useful to you?

What would you have changed?

Any additional comments?

RESOURCES

A) SYSTEM & RESOURCES

5

TIE Strategic Planning Model
Fall, 1996

A Process for Pursuing Technology-Infused Teaching and Learning

As educators acknowledge and relate to the value of changing organizational structures, changing curriculum and practices, and changing roles for stakeholders in response to the needs of Communications Age schools; they face the challenge of making decisions and implementing educational programming that moves their respective school communities forward productively and successfully. While committed and well-intentioned, many need support and direction to enhance and affirm their efforts.

Many school leaders have initiated planning activities in hopes of clarifying direction and gaining support for pursuing school improvements. Such planning processes are particularly useful if they are collaborative in nature and garner the active involvement of a broad base of stakeholders. A planning model developed by the Technology and Innovations in Education project and implemented with schools in the region is a collaborative process involving four primary components. The following information summarizes the model and is shared as a tool for educators to review, assess, or consider strategic planning efforts.

a) Information Gathering

This component involves the gathering of data about current educational technology infrastructure, capacity, and efforts surrounding the teaching and learning process. Planning leaders work with site leaders and the site's collaborative committee to compile data that provides a valid snapshot of the district's efforts to access and integrate technology as a vital part of the teaching and learning process. The information gathering activity is an interactive, collaborative process whereby planning leaders engage with district personnel to gain an accurate and informative picture of the district's current status.

As part of this component, planning leaders will review the data and offer impressions to clarify the current efforts. With input from the district, the impressions are shaped into a list of "possibilities and/or needs" that emerge from the information gathering activity. The list developed through the information gathering step should not be viewed as an end in itself, but rather a base line that can be revisited and updated as the inventory/strategic planning process continues.

b) Vision Development and Description

The second component of the process addresses building a vision of technology implementation and integration to impact the teaching and learning process of the district in the next 3-5 years. Planning leaders will interact with the district's collaborative team to form a vision that describes the teaching and learning activities that will be happening in the district in coming years. The vision should speak to teacher and student roles, characteristics of teaching and learning activities, and infrastructure that needs to be in place.

The vision developed as part of the planning process should be an extension or operationalization of the district's overall vision. If the district has not established a vision via other school reform efforts, or needs to update its vision, this is the right time to pursue such a process.

Typically, a vision reaches out a decade or more. For the purposes of this planning activity, it is advisable to look down the road three to five years. Given the dynamics of rapidly changing times, that is still a challenge and requires the thoughtful consideration of the collaborative team. The more descriptive the vision, the easier it will be to develop and write action steps later in the planning process.

It is important that the district "owns" the vision. While planning leaders will work to stimulate the thinking of the collaborative team, it is critical that the team members contribute actively to the vision development process. They need to be comfortable and committed, and hopefully enthused about the possibilities offered by the vision.

While the vision does not need to be lengthy, it should include enough narrative to present a meaningful picture of teaching and learning proposed for the district.

c) Discrepancy Analysis

The third component is structured to identify the gaps between the district's current status as established from the information gathering process, and the vision developed as an outcome of the second component of the process. The discrepancy analysis should be a fairly straight forward activity where the local leaders and collaborative team, with the help of planning leaders, honestly and openly note the gaps between "where the district is" and "where the district wants to be."

Sorting out priorities should be an integral part of the discrepancy analysis. District players and planning leaders may wish to revisit some aspect of the information gathering effort--maybe seeking more indepth information or pursuing data that wasn't noted in the earlier information gathering activity. Perhaps the discrepancy analysis will cause the district to revisit their vision in an effort to gain more clarity or expand their view. The outcome of the discrepancy analysis should be a concise summary of the gaps that emerge as a result of the group's dialogue and deliberation.

d) Action Plan Development

In the final component of the process, the local leaders, collaborative team, and planning leaders identify objectives and action steps that address each of the gaps noted through the discrepancy analysis process. The objectives and action steps comprise the "meat and potatoes" of the school improvement plan. First, the group must set priorities among the potential objectives. They need to confront questions such as: Which objectives are most critical to the overall effort? What level of resources can be garnered in the next few years to address these objectives?

Once the objectives are prioritized and clarified, the group begins the process of identifying action steps for accomplishing the objectives. The action steps will indicate what is to be done, what resources are needed, who is to do it, what the time line is, and how the district will know the step was accomplished. The answers to these questions might be organized in a matrix that forms the structure for the strategic plan. For example:

Objective	Action Step	Resources	Who	Time Line	Evidence

In order to keep the plan manageable, the group should probably focus on a few key objectives (probably not more than 10), and identify several action steps (typically 3-5) for each objective.

Once the action steps are written, the group should review the overall plan to confirm that collectively, the objectives respond succinctly and effectively to the gaps noted from the discrepancy analysis.

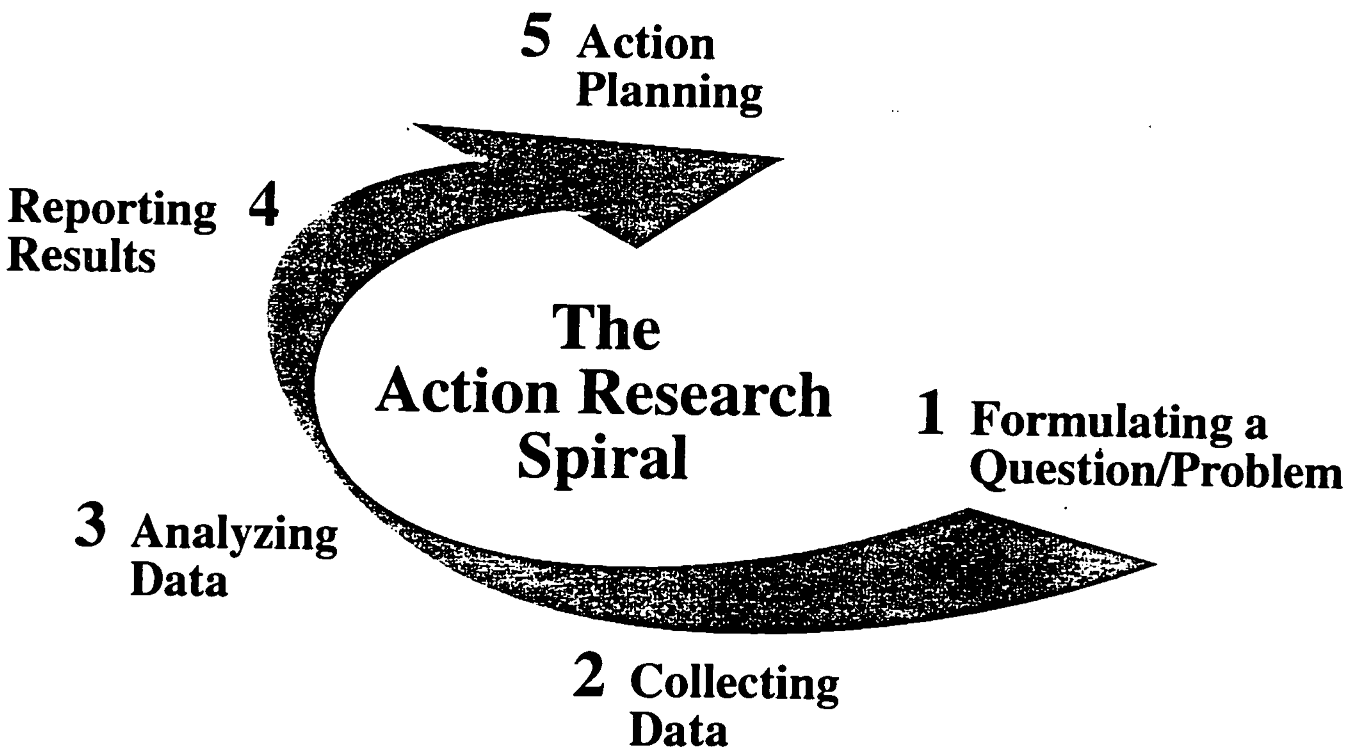
e) Related Planning Information

While the components of the planning process are sequential in that they lead to a plan, they are also cyclic and concurrent. That is, most collaborative team activities will involve some discussion of current efforts in the district, some consideration about building the district's vision, and some dialogue about gaps in the district's efforts. Planning leaders will work with local leaders and the collaborative team to ensure that the overall process attends to all components and produces a meaningful plan that can serve the district in the next few years.

Given the nature of the planning process, it can function as a strong capacity building experience for district personnel. Each component of the process can potentially stretch the thinking of the local team, build their knowledge base, and engage them in collaborative decision-making. The skills and experience the team acquires can serve the district well in coming years as they revisit, reconsider, and update the plan in response to new data, priorities, and resources.

The planning effort is more about "process" than it is about "product." While producing a plan is important and useful, it is the capacity building experience gained by district personnel that positions the district powerfully for continued progress with improving teaching and learning.

Spiraling Cycles of Planning, Acting, Observing, and Reflection



Maine Center for Educational Services, Sept. '94

GETTING AMERICA'S STUDENTS READY FOR THE 21ST CENTURY

Meeting the Technology Literacy Challenge

Jim Parry

A computers

understand

Internet

student

future

Technology

education

revolution

learning

skill

increased electrical capacity). The difficulty, however, is arriving at reliable estimates of what it will cost to meet all four goals. One reason for this difficulty is determining how schools should ultimately be outfitted. Another difficulty is the varied levels of technology currently found in schools around the nation. Yet another reason is that the technology itself is rapidly evolving.

Despite such complex variables, some organizations have produced estimates based on various models and assumptions. One estimate puts the cost at $109 billion over 10 years, or an average of $11 billion a year, taking into account both initial investments and ongoing expenditures. Another estimate puts the cost at between $10 billion and $20 billion a year over a five-year period. Yet another puts the cost at between $10 billion and $12 billion a year over five years. To put this into perspective, schools spent about $3.3 billion on technology during the 1994-95 school year.

The conclusion that leaps from these numbers is that schools alone cannot meet their need. It will take a partnership of the private sector, states and local communities, and the federal government to shoulder the financial burden of meeting these goals. Additionally, it will take careful planning to make certain that, in our reach for technological literacy, schools in all types of communities — middle-income, lower-income, and better-off communities — have access to up-to-date technology in their classrooms.

WHAT WE ALL CAN DO TO MEET THE CHALLENGE

The nation already has taken steps to integrate technology into schools, but what remains to be done looms large. While acknowledging the federal government's leadership role, the purpose of this report is to present a framework that states and local communities can use in developing local plans of action that will support the use of technology in achieving high standards of teaching and learning in all classrooms for all students. It will take contributions from all sectors of society to get America's students ready for the 21st century.

Federal Role

The federal government's role is to provide the momentum to support state and local efforts to meet the Technology Literacy Challenge. This is done through leadership, targeted funding, and support for activities that will catalyze national action. Building on current educational technology activities, the president proposed the Technology Literacy Challenge Fund. Making $2 billion available over five years, the fund would spur states, local communities, and other involved parties to step forward, produce matching dollars and in-kind contributions, and cooperate with one another in attaining the four goals. Additionally, in its leadership capacity, the federal government will continue to promote affordable connections, to support professional development, and to conduct research and development.

State and Local Community Roles

Appropriately, a number of states and local communities have been the leaders in moving schools toward an increased use of technology for learning. States and communities can continue to take the lead in developing action plans based on their own priorities. They can distribute funds based on the needs of individual districts to promote equity among schools, and use existing educational funds in new ways. They can invest in technological infrastructure to connect schools to networks. And they can make a concerted effort to build community support.

Higher Education and Private and Nonprofit Sector Roles

Institutions of higher education, businesses, foundations, and other organizations will need to shoulder a large share of the effort to integrate technology into schools. And the push is already on. Collectively, businesses have developed technology specifically for the education market and have donated millions of dollars of resources to schools. Colleges and universities across the country are training teachers in the effective use of technology. Still, these kinds of efforts will have to be magnified many times over for the vision of technological literacy to be realized.

Fostering the Use of Educational Technology
by Thomas Glennan & Arthur Melmed

The Technology-Rich School

Topics To Be Covered:

- Technology Uses
- Qualities of Technology-Rich Schools
- Technology Impact on Students
- Technology Impact on Teachers

Additional Topics:

- Questions asked by Teachers
- Lessons from Technology-Rich Reform
- Summary

Research-Based

- The model that Means and Olson looked for was a constructivist model characterized by student involvement in complex, meaningful tasks or projects. This emphasis on the student's participation forced changes in pedagogy.
- Based on empirical research consolidated by Means and Olson

A "New" Pedagogy

- Higher order skills
- Design, composition and analysis co-mingled with basic skills, i.e., writing. multidisciplinary, - requiring longer periods of time, - greater emphasis on teamwork and collaborative skills
- New roles for students will emerge

The Technology-rich school practices the distinction between computer use as:

- Learning how to use the computer
- Using the computer as an application to "extend" learning

The Technology-rich school employs technology in "essential" ways:

Making use of technology:

- Curriculum and Instructional base have been changed
- School day has been reorganized to make use of technology
- Staff development program in the district

The Technology-rich school employs technology . . .

- Staffing patterns reflect appropriate use of personnel for support and coordination of technology use

The School Budget

- Reflects expenditures on items related to technology.
- Devoted to instructional staffing for technology infusion in instruction
- Devoted to administration of technology infusion planning and instructional planning

The School Budget

- Dedicated to instructional software acquisition, replacement and maintenance

Qualities of Technology-Rich Schools

- Learner-centered
- Utilization and emphasis on curriculum framework
- Explicit individual treatment of students with disabilities according to their needs and capabilities
- Computer density which exceeds that which is common in schools today

Qualities of Technology-Rich Schools

- All schools have restructured their programs substantially
- Class periods lengthened
- Interdisciplinary programs introduced
- Project-based learning receiving considerable attention

Qualities of Technology-Rich Schools

- School programs appear to be a product of a fairly concentrated development effort or one explicit facet of a larger vision
- Teachers function as "roving coaches" working within the context of the student's engagement of their work

Technology impacted the students in the following ways:

- Added to the student's perception that their work is authentic and important
- Increased the complexity with which students can deal successfully
- Created a multiplicity of student roles
- Enhanced student motivation and self-esteem

Technology impacted the students in the following ways:

- Made obvious the need for bigger blocks of time
- Instigated greater collaboration

- ". . . [illegible]e effects that technology has on students depend on the instructional context provided by individual teachers. This finding implies not only that the impact of technology will vary from classroom to classroom but also that the issues of teacher buy-in, teacher training, and teacher support are essential to success."

Teachers were impacted in the following ways:

- An increase in teachers' technology and pedagogical skills
- Greater collaboration within their own school
- Increased collaboration with external school reform and research organizations

Teachers were impacted . . .

- Increased involvement in training and professional conferences
- Provided teachers with impetus to take on coaching and advisory roles

Teachers were impacted . . . :

- "Many of the technology applications require a broader and deeper knowledge of the discipline than may be required by curricula that assume that teachers transmit a fixed body of information." (Yerushalmy, Chazan, and Gordon, 1988; Wiske, 1990; Martin, 1987)

Questions [to be] asked by teachers who are engaged in technology integration:

- 1. What does the technology offer my students in terms of developing concepts and content?
- 2. How does it help them carry out inquiry processes?

Questions [to be] asked by teachers . . .

- 3. How will they work collaboratively or cooperatively?
- 4. What is the relationship between the technology and other instructional materials?

Questions asked by teachers . . . :

- 5. What knowledge, processes, and skills do students need before using the technology?
- 6. What new knowledge of content or discipline, of teaching, or of technology do I need in order to foster new learning in my students?

Lessons for technology-supported educational reform efforts:

- Time must be devoted to developing a school-wide vision
- Adequate technology access is needed for all students

Lessons . . . :

- This relates not only to the computer student ratio but also to the distribution of computers throughout the school building
- Teachers feel less obligated (inclined) to use technology when it is not present in their classroom.(Piele, 1989)

Lessons . . . :

- Good curricular content must come first
- Technology should be used across subject matters and classrooms
- The system must reward exemplary technology-supported activities

Lessons . . . :

- Opportunities for teachers to collaborate with peers must be available
- Teachers need time to learn to use technology and to incorporate it into their own curricular goals
- Easily accessible technical support is critical

- "Technology can support the education reform goal of promoting learning through collaborative involvement in authentic, multidisciplinary takes by providing realistic, complex environments for student inquiry, furnishing information and tools to support investigation, and linking classrooms for joint investigations."

- ". . . the research literature shows us that the instructional value lines in the way the technology is used and in the activity structure that surrounds it, rather than in the hardware or software itself.(Means, et al., 1993)"

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Information Literacy Standards for Student Learning

Today's student lives and learns in a world that has been radically altered by the ready availability of vast stores of information in a variety of formats. The learning process and the information search process mirror each other: students actively seek to construct meaning from the sources they encounter and to create products that shape and communicate that meaning effectively. Developing expertise in accessing, evaluating, and using information is in fact the authentic learning that modern education seeks to promote.

AASL and AECT are partnering to develop new guidelines for school library media programs and professionals that will contain information literacy standards for student learning. The standards are the litmus test by which school library media programs and professionals can define their roles and responsibilities to the learning community, and are the first component of the committee's work to reach final draft form.

The work of the Vision Committee on these standards has involved research to define these concepts and exploration of other national association standards to correlate learning concepts. Multiple reviews by both Boards, committee members, and a large expert panel from the greater educational community have also taken place. You, a member of AASL and a professional, are now asked to review this draft carefully, and to send the committee your thoughts.

—Betty Marcoux, Chair, National Guidelines, Vision Committee

DRAFT #5

October 7, 1996

The following three categories, nine standards, and twenty-nine indicators describe the content and processes related to information that students must master to be considered well educated. The items related to information literacy describe the core learning outcomes that are most obviously related to the services provided by school library media programs. The items related to the other two areas—independent learning and social responsibility—are grounded in information literacy and describe more general aspects of student learning to which school library media programs also make important contributions.

The latter two categories build upon the first so that, taken together and pursued to the highest levels, the standards and indicators present a profile of the information literate high-school graduate: one who has the ability to use information to acquire both core and advanced knowledge and to become an independent, lifelong learner who contributes responsibly and productively to the learning community. The standards and indicators themselves are written at a level of generality that assumes that individual states, districts, sites, and school personnel must provide the level of detail necessary to apply them across multiple sources and formats of information and to the developmental, cultural, and learning needs of all the students they serve.

CATEGORY I:

INFORMATION LITERACY

The student who is information literate:

Standard 1 Accesses information efficiently and effectively, as described by the following indicators:

1. recognizes the need for information;
2. recognizes that accurate and comprehensive information is the basis for intelligent decision making;
3. formulates questions based on information needs;
4. identifies a variety of potential sources of information;
5. develops and uses successful strategies for locating information.

Standard 2: Evaluates information critically and competently, as described by the following indicators:

1. determines accuracy, relevance, and comprehensiveness;
2. distinguishes among facts, point of view, and opinion;
3. identifies inaccurate and misleading information;
4. selects information appropriate to the problem or question at hand.

Standard 3: Uses information effectively and creatively, as described by the following indicators:

1. organizes information for practical application;
2. integrates new information into one's own knowledge;
3. applies information in critical thinking and problem solving;
4. produces and communicates information and ideas in appropriate formats.

CATEGORY II:

INDEPENDENT LEARNING

The student who is an independent learner is information literate and:

Standard 4: Pursues information related to personal interests, as

described by the following indicators:
1. seeks information related to various dimensions of personal well-being, such as career interests, community involvement, health matters, and recreational pursuits;
2. designs, develops, and evaluates information products and solutions related to personal interests.

Standard 5: Appreciates and enjoys literature and other creative expressions of information, as described by the following indicators:
1. is a competent and self-motivated reader;
2. derives meaning from information presented creatively in a variety of formats;
3. develops creative products in a variety of formats.

Standard 6: Strives for excellence in information seeking and knowledge generation, as described by the following indicators:
1. assesses the quality of the process and products of one's own information seeking;
2. devises strategies for revising, improving, and updating self-generated knowledge.

CATEGORY III:
SOCIAL RESPONSIBILITY

The student who contributes positively to the learning community and to society is information literate and:

Standard 7: Recognizes the importance of information to a democratic society, as described by the following indicators:
1. seeks information from diverse sources, contexts, disciplines, and cultures;
2. respects the principle of equitable access to information.

Standard 8 Practices ethical behavior in regard to information and information technology, as described by the following indicators:
1. respects the principles of intellectual freedom;
2. respects intellectual property rights;
3. uses information technology responsibly.

Standard 9: Participates effectively in groups to pursue and generate information, as described by the following indicators:
1. shares knowledge and information with others;
2. respects others' ideas and backgrounds and acknowledges their contributions;
3. collaborates with others, both in person and through technologies, to identify information problems and to seek their solutions;
4. collaborates with others, both in person and through technologies, to design, develop, and evaluate information products and solutions.

Thoughts about the Standards

Please read the draft form of the "Information Literacy Standards for Student Learning" carefully and respond to these questions. We welcome your comments.

What do you particularly like about these student-centered standards? ____________________

What other comments do you have regarding these student-centered standards? ____________________

What materials/staff development opportunities will help you implement these standards? ____________________

Any additional comments: ____________________

Send your responses to AASL / AECT Vision Committee, Attn.: Pamela Kramer, 50 E. Huron Street, Chicago, IL. 60611. Fax: 312-664-7459 E-mail: AASL@ala.org

Five trends influence the way today's schools are built

Shaping School Design

BY SANDRA R. SABO

How many classrooms do you need? Until recently, that was the standard question architects asked as they began the process of designing a new school. "But that's not the whole story anymore. Now we talk instead about space standards—what kind of spaces the school needs to prepare students for the real world," says Raymond C. Bordwell, director of educational facility planning for Perkins & Will, an architectural firm headquartered in Chicago.

"For instance, in an agrarian society, we had one-room schoolhouses that looked a lot like farmhouses. Industrial-age schools looked like factories—you'd enter one end of a hall of classrooms and come out on the other end, much like an assembly line," he continues. "Now that we're in the information age, what should our places of learning look like?"

As your school district grapples with that larger question, you must also balance the needs of students, teachers, administrators, and taxpayers. Architects who work frequently with school districts trace a number of changes in education and finance that are influencing how a school operates and, in turn, what it looks like. Here are five of those trends:

1 Shrinking resources. Getting bond issues passed is getting harder all the time. So when your district is faced with increasing enrollments and outdated facilities, you'll undoubtedly look first at improving what you already have. But approach renovation carefully, especially if the facility dates to the 1950s or early 1960s.

"Some schools built during the baby boom were thrown up quickly using cheaper construction methods. They also have low ceilings," observes Katherine N. Russ, a principal in the Raleigh, N.C., office of Boney Architects. "The schools built in the early part of the century are actually easier to renovate because they were built well and have generous proportions. That gives you room to bring in new ducts and cabling for computers." Still, it can be difficult to reshape the interiors of older schools because many of their walls can't be moved.

If you foresee the need for several new schools, one option is to purchase a large site and group buildings together. "Land costs are high, so you may pay a premium for a large tract, but in the long run it may be less expensive than three or four separate parcels," says Russ. "For instance, you can reduce your infrastructure costs by extending the sewers and improving access roads to just one site."

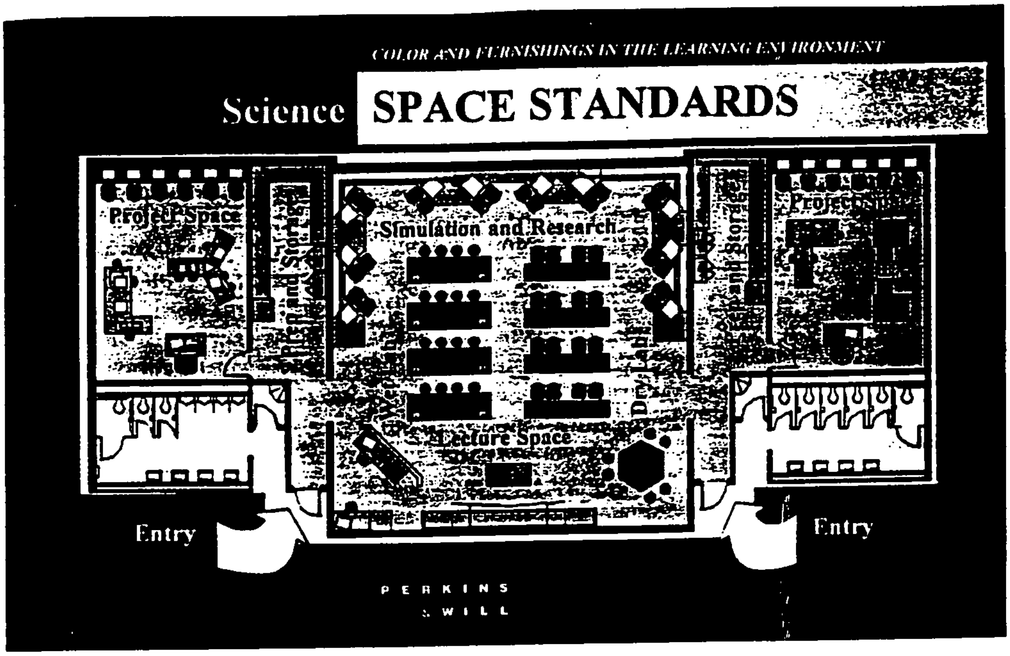
Although separate, the buildings could share a bus parking lot, athletic fields, and other facilities. "If schools aren't far apart, you don't need a full kitchen in each one," points out John R. Orrick, chairman of Smeallie Orrick & Janka, Ltd., an architectural firm in Baltimore, Md. "One school would have a regular preparation kitchen, and the others might have smaller satellite kitchens with warming carts."

Orrick also says districts sometimes pursue the idea of a prototype or model school whose design can be duplicated repeatedly. The one-size-fits-all approach can cut down on design costs, architects agree, but both Orrick and Russ advise caution. Using a single design can severely limit site selection and detract from the individuality of each school.

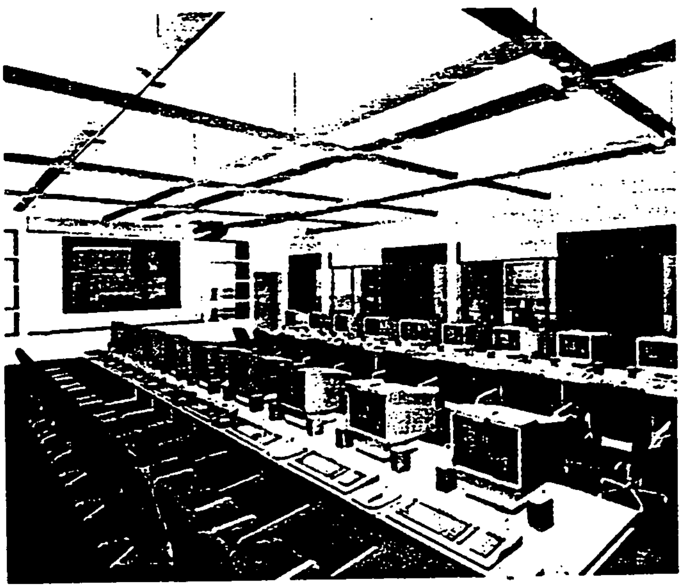
2 Joint partnerships. Increasingly, suburban developers are working closely with school districts to integrate schools into new subdivisions or planned communities. It's now routine to involve several representatives of the community on a school design team. Architecturally, the school-community link is often strengthened by pursuing school design that is in keeping with local domestic architecture. Residential building materials or design features, such as a sloped and shingled roof rather than a flat roof, can tie the school visually to the houses surrounding it.

The residential concept can apply to the inside of the school as well, says Steve Parker, president of Grimm and Parker, an architectural and engineering firm in Calverton, Md. "More of our clients are interested in bringing down the scale of a building so it has a house-like feeling. Big, institutional schools just aren't as friendly and inviting—espe-

Sandra R. Sabo is a free-lance writer in St. Paul, Minn.



Space standards for science classrooms and accommodations for technology are important considerations in design, says architect Raymond Bordwell, who uses graphics like these in presentations to school district clients.



Photographs courtesy Perkins & Will

cially to young children. We divide elementary schools into a series of clusters or houses of classrooms and, to follow the analogy, provide each house with a 'living room' that's shared space."

A "house" might include three first-grade classrooms or a kindergarten, a first-grade classroom, and a second-grade classroom, says Parker. In the living room, you'd find reading nooks, computers, and perhaps even a small kitchen where students could interact as a group. The same space could double as a breakout area for special education classes or for tutoring by parent volunteers.

School districts are also embarking on joint ventures with other organizations within the community. "We're currently involved in a project called the Education Village," Russ notes, "building two elementary schools, one middle school, and one high school in partnership with IBM, which is donating $2 million for the technology components." Russ says she expects such public-private partnerships will increase as businesses see the value of involvement in the education of tomorrow's workforce.

In another project, Russ says, a school district teamed up with the local parks system. "We're doing an elementary school adjacent to a new park," she explains. "The school system purchased a smaller site and won't have to build play fields. In turn, the park system will use the school after hours for its arts-and-crafts programs and won't have to put a building on its site."

3 Developments in curriculum. School design is evolving to accommodate new approaches in curriculum and instruction, architects say.

"There's a recognition that everybody doesn't learn the same way, so you have to provide individualized instructional opportunities for students," says Perkins & Will's Bordwell. "In modern instructional models, teachers aren't just dispensers of information—they're coaches and facilitators of learning. And students are much more responsible for their own learning."

How does that trend affect school design? For starters, it means that standard-size classrooms accommodating 25 to 30 students are on the way out. Taking their place are combinations of various-sized rooms, some with permanent walls and others with removable ones. To further encourage teamwork and student interaction, tables are replacing individual desks.

As Steve Parker explains, "The size of the grouping might accommodate up to 60 or 90 students, if you're putting together several groups for a presentation, or down to four or eight students for hands-on work. The teacher goes from one station or team to another, as opposed to lecturing from the front of a classroom."

Parker sees more high schools borrowing the cluster concept from middle and elementary schools to enhance a multidisciplinary curriculum. "Clustering by departments, a tradition in high schools for the last 25 years, is really being questioned," he says. "Instead of grouping all the science teachers together or all the math teachers, you have a cluster with teachers from various disciplines so they can interact and plan together." The implication for design? Schools need more teacher planning and preparation areas, preferably adjacent to the related instructional areas.

The decentralized approach applies to administrative areas as well. Placing offices for assistant principals and guidance counselors within the individual clusters, for example, makes those people more accessible and less foreboding to students. Similarly, Russ reports, more school districts are locating computers throughout schools,

What's hot, what's not

Remember when the concept of the open school swept the country some years back? That era has definitely ended, say architects who specialize in educational facilities. Other components of school design are still in transition, though. Here's a list to acquaint you with some of them:

On the way out

- Centralized administration offices
- Large, centralized computer labs
- Same-sized classrooms with desks
- Physical education facilities (gym and locker rooms)
- Cafeterias (one long food line and rows of long tables)
- Auditoriums (large house and small stage)

On the way in

- Offices throughout the school
- Computers in every classroom
- Variable-sized instructional areas with tables
- Health sciences facilities (including a weight room and exercise studios)
- Food courts (a variety of serving stations and seating arrangements)
- Community theaters (small house and large stage)

putting resources closer to students rather than in one central location.

When it comes to specialized spaces, Perkins & Will, for one, is moving away from designing auditoriums that can accommodate a school's entire student body. "How often do you use a big auditorium—three nights a year for the musical and four times during the year for a school assembly? It's not worth the infrastructure," says Bordwell, who believes a smaller theater with a larger and well-equipped stage represents a better investment for a school with a strong arts curriculum.

"We're also doing art classrooms that are more like studios," he adds. "They have high ceilings and exposed structures where you can hang three-dimensional art, plus large spaces dedicated to two-dimensional art such as painting and drawing."

4 **Advancements in technology.** In new schools, it's not unusual to find a large-screen television permanently mounted in each classroom, plus an in-house studio that can coordinate broadcasts throughout the building as well as between other schools in the district.

Computers are similarly linked, enabling students, teachers, and administrators in different places to communicate via e-mail, tap into information in a mainframe, and access the Internet.

These data, video, and voice transmission capabilities translate into miles of cables—plus the space to run the cables and house all the equipment. "Square footage is getting bigger," notes Bordwell, not just to accommodate computers within classrooms but also to provide training space for teachers so they can stay a few steps ahead of their students' grasp of technology. Bordwell predicts that high schools, which now average 150 square feet per student, might grow to 170 or even 200 square feet per student (a standard calculation for many office buildings).

Even with brand-new facilities, keeping up with the march of technology can be a challenge. Two full years typically pass between the design of an elementary or middle school and its completion; for high schools, the turnaround time is often four years. Many technological advances can occur in the interim. That's why Katherine Russ says more districts are holding back on bidding out a school's technological components. "They might wait until six months before the school is completed before awarding the computer contract," she says, "so the design must have enough space in the infrastructure to put the cabling in later."

Many schools that can't afford to install state-of-the-art technology right now are looking ahead and installing the appropriate wiring and cabling, as well as additional electrical outlets. Designing ahead for technology means less need later on for the kind of retrofitting that is the focus of this month's volunteer effort to wire schools coast to coast through state-by-state NetDay events.

5 **Extended use.** As increasing numbers of school districts consider the pros and cons of year-round schooling, school facilities are called on to hold more students and stand up to nearly nonstop wear and tear. On a year-round schedule, says Russ, "the school takes more abuse, and you don't have the break time in the summer to come in and do maintenance." And that calls for more durable—and often more expensive—materials.

Schools are also coming in for greater use after hours, both by students and community members. John Orrick says he often plans for flexibility in school facilities by placing a stage between the cafeteria and gymnasium in elementary and middle schools. "There's a curtain on one side and a flexible wall on the other, and the area looks like a stage from either direction," he explains. "A large production would be geared toward the gymnasium, and a seminar or large-group meeting would use the space from the cafeteria side."

Similarly, Steve Parker has designed dining areas on various levels to mimic the intimacy and flexibility of a dinner theater. The seating ranges from booths to rectangular tables to small round tables—anything to move away from what he calls "the flat institutional cafeteria that looks like it should be in a prison." Borrowing the food-court concept from shopping malls, Parker recommends several lines serving different types of food as a means of keeping students on campus during the lunch hour.

In fact, Parker prefers the term "student services center" to "cafeteria." As its name implies, the center offers much more than food. "Students really don't have much free time during school, but they have time before and after and around dining time," he says. "If they're really going to take advantage of student government, guidance counseling, career materials, and the media center, they must be able to access those services easily in one area."

Some of these trends might point to radical changes in the way new schools operate and look. But lest you think everything has changed since you tossed your mortar board in the air, rest assured that at least one school tradition endures: After experimenting with vinyl and rubber tiles, these architects say it's hard to beat a good old-fashioned wooden floor in the gymnasium. ■

CHANGES IN TECHNOLOGY CREATE NEW CHALLENGES FOR PUBLISHERS

Those who sell information on the World Wide Web are not likely to make money before the year 2000, says Forrester Research of Cambridge, MA. The company predicts that the typical electronic newsletter or magazine would lose $3.9 million over its initial investment before it would begin to make a profit.

More signs of the times are epitomized by changes in some of the classic series from many educators' childhoods. **Little Golden Books**, illustrated story books for new readers, are now also available as Little Golden Books Interactive Stories on CD-ROM, including puzzles, games, music and skills coaching, from Powerhouse Entertainment (214/233-5400, fax 214/233-6322, e-mail: pwrhseent@aol.com).

Encyclopedia Britannica, now available online and on CD-ROM as well as in print, is losing its 140 door-to-door sales representatives — a time-honored tradition and the leading source of sales, but no longer cost-effective. The layoffs are accompanied by an expansion into direct mail and advertising in broadcast and online media.

QED MEASURES SCHOOL SPENDING PLANS

Most American school districts intend to increase their technology hardware budgets this school year, and over half of the computers they plan to buy will be Apple Macintoshes, according to **Quality Education Data**. Sixty-five percent will spend more on hardware in 1996-97 than they did last year, compared to just 50 percent of districts that expanded hardware budgets in 1995-96. And hardware purchases will make up 62 percent of technology expenditures this year, compared to 58 percent in 1994-95.

The sharp increase in hardware spending is coupled with a drop in the percentage of districts increasing their software spending — from 50 percent of districts last year to 34 percent this year. "The emphasis on networks and the need for modern multimedia-capable computers appear to be shifting the purchasing toward hardware and away from software," says Jeanne Hayes, QED President.

Despite the interest in online computer networking, districts plan to spend less than 3 percent of their technology budgets on online services, QED says. "We expect that most of this spending will be on Internet direct access, rather than through proprietary services," says Hayes, adding that schools can reduce their online services costs with preferential rates on telecommunications because of the Telecommunications Deregulation Act of 1996.

In computer buying, school districts plan to purchase 55 percent Macintoshes and 39 percent Windows-ready machines. The Macintosh percentage shows a drop from 61 percent last school year, but a much smaller decrease than many expected.

Overall, QED estimates U.S. school districts will spend $4.1 billion on education technology this school year, up from $3.9 billion in 1995-96. Per-student spending for technology is expected to be $92.70 this year, compared to $90.17 in 1995-96 and $82.05 in 1994-95. The data is based on QED's May-June 1996 survey of school districts and is reported in *1996-97 Technology Purchasing Forecast*, available for $500 from QED, 1700 Lincoln St., 36th Floor, Denver, CO 80203, (303) 860-1832, (800) 525-5811, e-mail: qedinfo@qeddata.com, http://www.qeddata.com.

The Agenda of the Global Village Schools Institute (GVSI)

Jim Mecklenburger & Dennis Bybee

Several prescient observers in the 1960s foresaw a vastly different nation in the 1990s. One observer, communications philosopher and educator Marshall McLuhan, foresaw the impact of silicon chips and telecommunications on life in general and education in particular. He envisioned (at the time when images of the earth from space were first seen) the coming of "a global village" in which all the people and all the information would be as accessible to any person as if all humankind lived in a small town. Other observers coined expres- ns such as "third ave," "post-indus- rial," and "information age" to encapsule the great changes that were, then, just around the corner. Now we live in the early decades of that future, and we've borrowed McLuhan's evocative "global village" expression to pose the question: what will "schools" be like in the post-industrial/third-wave/information age/ global village era -- as fundamental change and unprecedented technology emerge for all to see and to use?

The Institute's stated mission is ***to assist and support those who conceive and implement the next generations of learning and teaching***. GVSI brings together two contemporary movements in education that naturally intertwine:

- *the urge to* reform;
- *the urge to use advanced* technologies.

GVSI believes that *reform* and *technology* are the warp and woof of achieving better education.

Pioneering educators have in their grasp both the ideas to be wiser and the tools to be smarter about how education is conducted. And, in pursuit of wiser and smarter education, GVSI brings information and support to pioneers, stakeholders and decision-makers at the leading edge of change.

Since 1994, GVSI has appealed to

- practitioners *who are creating new kinds of education in formal schools and elsewhere (including museums, libraries, home schools, communications companies);*
- researchers, theorists and advocates *who are conceiving of ways to think about and discuss new models of education;*
- entrepreneurs *who are crafting new kinds of educational services;*
- education leaders, *stakeholders and* decision-makers *who are considering new laws, new rules, new policies, and even new institutions.*

The Reform Agenda

In meetings and publications, GVSI showcases the people and practices of model schools, magnet schools, charter schools, hands-on museums, on-line libraries and other such innovative efforts. GVSI engages government leaders, entrepreneurs, management gurus, philosophers of education and researchers on cognition whose ideas and efforts suggest new ways for educators to think about and define educational strategies. And, GVSI apprises educators of the host of studies and policy pronouncements about the shortcomings of and opportunities for reforming curriculum, language use, time utilization, and other mainstays of traditional education.

The Technology Agenda

GVSI continually seeks the educational significance and the educational possibilities of the electronic sea changes in society. GVSI's meeting agendas and publications dwell on such topics as Internet use and development of educational intranets, simulation as an emerging teaching method, new approaches to evaluation and testing, home/school connections via telephone and computer networks, new roles of educators and students who team to create educational resources and experiences, electronic field trips and other distance learning strategies, privatization and other strategies for stakeholder participation and management of education, technological change and reinvention of the schooling process.

Reform and Technology Together

Whether society's quest for better education is first inspired by reform ideas or by technological opportunity, *reform and technology are synergistic—together more than the sum power of the two.*

Although today's reform initiatives are diverse, each of them postulates alternatives to one or more of the industrial-age concepts imbedded in conventional schooling: Today's conventional school emerged more than a century ago in America as a kind of "information factory"—a place dedicated to the manufactureing of informed people -- and it suited the era when America was building factories and organizing bureaucracies to manage almost every facet of life. Industrial-age education, long ago, was a remarkable innovation created to reform the Latin Grammar School tradition.

- America, climbing out of an agricultural and artisan economy, invented mass schooling just as it invented careers and assembly lines, shipyards and railroad lines. America applied the same kinds of linear sequences and heirarchical organizations to learning and teaching that it was applying to ginning cotton and smelting ore. The idea, adapted to education, was: Bring the resources to one place; establish reliable linear processes (such as kindergarten through graduation, textbooks front-to-back, courses of study from beginning-to-end, school days organized in progressive units); educators-in-schools would "manufacture" adults from children, just as workers-in-factories wove clothing from cotton and milled steel from ore.

• Industrial Age America invested on a massive scale in twin concepts pioneered by churches (the *house of worship*, and the *chapel*) and renamed these concepts with secular terms borrowed from colleges and seminaries: *campus* and *classroom*. School became every community's specialized island of learning -- organized to be disconnected from daily commerce, organized to be more information-rich than the rest of a community. [In the same spirit, Industrial Age America also built "campuses" and "classrooms" called museums and galleries, libraries and reading rooms.]

Campuses and classrooms are organized, accordingly, for

• Linear learning sequences *(e.g. the grade-level by grade-level curriculum, disciplines such as mathematics in phases arrayed from arithmetic to calculus, and standardized testing, for example)*

• time-bound units of work *(e.g. school days, courses, semesters) and*

• age-determined cohorts *(e.g. third grade, seventh grade) that are* professionally managed *(i.e., by teachers, librarians, coaches, administrators) to assure that students will "cover" the prescribed information units).*

Society's advanced **technologies** make the reform of any or all of these concepts feasible -- even desirable. Often it is the existence of these technologies (distance learning via satellite, or virtual libraries and museum exhibits on the Internet, for example) that enables education's stakeholders and decision-makers to understand the limits of current practice and the potential of reform.

GVSI believes that reform and technology are the warp and woof of achieving better education. Society's new technologies make reform of many conventional concepts feasible — even desirable.

• Information-age tools can be used to reconnect learners with the larger society and with each other, diminishing the isolation of campuses and the constraints of classroom spaces. Schools and other institutions can become less like "islands" and more like arteries on an information network. Learning need not always be "on campus," or in the "right" grade, or with one's age-peers, in order to be considered "schooling;" learning and teaching can occur anytime and anywhere the learners are.

• Information and contacts with knowledgeable people can conveniently and inexpensively be arranged at a distance (e.g. electronic field trips; the National Geographic Kids Network; Sesame Street and the other pioneering efforts of the Children's Television Workshop). Learners are only an electronic link away from family, libraries, experts, peers and information any time and without regard to where it resides.

• Technology can enlarge upon the array of learning paths, or even replace some conventional sequences entirely, relying instead on individualizing learning experiences, strategies of immersion, and explorations through simulation. Learning experiences can be triggered by learners' unique patterns of interest and background, instead of learning being bound to a school's prescribed timetable. Diversity can be managed; project-based calendars can be sustained. Students of different ages and experience can interact with each other, classroom-wide or world-wide. Disciplines (such as mathematics or history) can be used but also can be mixed in new ways (as in the mathematics of history, or the history of mathematics). Students or their teachers can select as readily among learning options as they presently select books from library shelves.

• Technology can help reorganize learning and teaching from time-bound units of work, offering opportunities to explore and study available at the time of student's interest, at the most convenient times of the day or year, with information and resources from any location.

• And technology can help educators complement or replace age-graded cohorts with opportunities for learners of diverse age and experience to study together and learn with and from each other.

Keynote speakers at the first three Global Village Schools Conferences exemplify GVSI's focus on the intersection of reform and technology:

• Ted Turner, in 1994, creator of CNN and other information-age inventions, who has for a decade devoted increasing attention to how children learn in and out of school.

• Reed Hundt, in 1995, chairman of the Federal Communications Commission, who is a tireless and successful advocate for policies and legislation that serve the information needs and entertainment needs of children.

• Kevin Kelly, in 1996, executive editor of WIRED Magazine and of the electronic service

(GVSI Agenda, *Continues on p. 14)*

(GVSI Agenda, Continues from p. 14)

as HotWIRED (on the Internet), is a chronicler and a guru of how people work and learn in the information age.

Similarly, GVSI's 1996 first annual *Inventing Tomorrow's Schools Awards* went to

- Tom King, the St. Paul school administrator who led the creation of the world-renowned Saturn School of Tomorrow, a school organized to make the entire city of St. Paul the 'campus' for students;
- Al Weis who has created ThinkQuest, an information-age nationwide contest in which teams of secondary-school youngsters, working together from diverse locations, create learning opportunities for other youngsters on the Internet;
- The John S. McDonnell Foundation whose research and development projects have created outstanding examples of how teachers and students can function in new and better ways in information-rich classrooms; and
- Asbury Theological Seminary, a Wesleyan college in Kentucky that has rethought the role of seminaries in the information age and created a world-wide presence through distance learning, Internet use, and new roles for faculty and students.

GVSI's key challenge is to create and manage activities where people engaged in reforms and in educational uses of advanced technology can share their wisdom and experience with each other and with others who will .elp transform education for all Americans.

GVSI's New Activities: With and Beyond the Pioneering

GVSI's conferences, small meetings, awards, electronic services and publications will continue to be a source of information and collegial support to leading-edge educators and institutions. But, if reform and technology are going to truly reshape education, pioneering efforts must move into the mainstream of eductional discourse.

GVSI must enlist the pioneers in the task of helping stakeholders and decision-makers to more confidently change the ways that education happens. It is one thing for decision-makers to acknowledge the potential of reform ideas and powerful technologies. The nation now has hundreds of compelling examples, and many leaders accept that "one day, education will change." It is quite another thing to jettison the comforts of tradition, so that education practices *actually* change nationwide. And so, decision-makers everywhere need more support, such as:

- insightful honest descriptions and analyses of what's happening in model programs;
- documented guidelines for redesigning learning spaces, revamping curricula, rethinking personnel training, and integrating technology;
- advice on issues they've never faced -- including pitfalls to avoid, shortcuts that work, funding, political, contractual and legislative strategies that have proven successful;
- translations of great concepts (e.g., students should work in teams, with teachers acting as guides) into workable ways to accomplish these concepts; and suggestions of how bold initiatives (e.g., every child will have access to the Internet) can be implemented in educationally significant ways;
- places to see, people to contact, studies to review, consultants who can assist.

In sum, a great many people need permission, encouragement, and decision support systems to imagine better education; and, once they envision what's feasible, many will need specific assistance in realizing their visions.

Who better to help local, state and national decisionmakers than the educators who have been pioneering the "next generations of learning and teaching?" ***GVSI's key challenge is to create and manage activities where people engaged in reforms and in eductional uses of advanced technology can share their wisdom and experience with each other and with others who can help transform education for all Americans.***

In the fall of 1996, GVSI is creating a set of structures to accomplish this communication, including a cohort of Associates, a membership cadre of Affiliates, and new uses of the Internet to engage many participants in ongoing discussion of issues. GVSI will continually canvas its Associates and Affiliates to help define the agenda of topics that GVSI will focus its efforts upon.

Topics

43

The following list illustrates the kinds of issues that GVSI will address:

- **The 10% Problem/Opportunity.** *The population of people attending schools is growing* *and is projected to continue to grow by 10% for a decade. Conventionally, in order to accomodate larger numbers, a factory-model school system would respond by enlarging the factory: increasing investment in buildings and classrooms, hiring more professionals and new cohorts of teachers, and other expansions of the "campus." In the fall of 1996, the US Secretary of Education is saying that these very strategies must begin immediately.*

Communicating the knowledge and experience of pioneers to stakeholders and decision-makers who will change education on a broader scale is GVSI's ultimate agenda.

Question: What alternatives are being pioneered that might address new demand with more efficient or effective "schooling" either with or without additional resources? What innovative distance learning strategies, teaming strategies, telecommuting, Internet usage and other technological approaches might help address the 10% problem/opportunity for school improvement?

• **Networks of Learners.** *School buildings have been designed for more than a century in much the same ways that factories were, into supervised production units known as classrooms. Today, most businesses have installed computer networks that (with or without the physical infrastructure of offices) enable businesses to work more effectively by organizing workers into self-directed teams.*

Question: Does the prospect of sophisticated computer networks -- such as the budding excitement in the business world about "intranets" -- offer more-effective ways to organize and manage the work of students and educators? What can be gleaned from the experience of those who have tried?

• **Home-based Learning.** *For many reasons, including some technological ones, the 1990s have seen a great increase in the number of families who teach one or more students at home, rather than sending those students to public or private school. Usually, public schools have reacted negatively, but some public schools and systems have sought ways to support home learners.*

Question: What are the ways in which combinations of home-learning and formal school resources can be beneficial to students and systems of schools alike? What examples exist? What roadblocks inhibit cooperation among home-learning and school-learning endeavors?

• **Internet for All.** *The Telecommunications Act of 1996 will almost immediately result in billions of dollars being invested in infrastructure for schools and libraries to make telecommunications available for education. The President of the US espouses a goal of having all students experience the Internet in schools by the year 2000. While only 10% of the nation's schools and students make any use of the Internet in 1996, 100% may be able to by the year 2000.*

Question: What new near-term opportunities does this offer? What have the first wave of educational users of the Internet learned that can ensure these incredible infrastructure investments result in cost-effective improvements in education? How might larger and more sophisticated uses of telecommunications technology get organized, financed and implemented?

• **Portable Technologies for Learners and Teachers.** *Computing power, that is useful to students and teachers, is being designed into smaller and smaller physical units, even as these units get more powerful and interconnected.*

Question: What do educators foresee/plan/ or wish to accomplish with laptop, notebook, palmtop and PDA devices that students can carry? What configurations of technology inside or accessed by such devices would make them ideal or more effective for educational use?

• **Equality of Opportunity and Access to Educational Excellence.** *Some purposes of schooling -- such as equality of opportunity, for example -- have been pursued with an array of strategies over many decades. But, with rare exceptions, advanced technologies have not been used or available for use by all learners.*

Question: What strategies that educators should consider that would advance equality of opportunity or other school missions? For example, can the goal of making the nation first in the world in science education be advanced by specific reforms or better uses of advanced technologies?

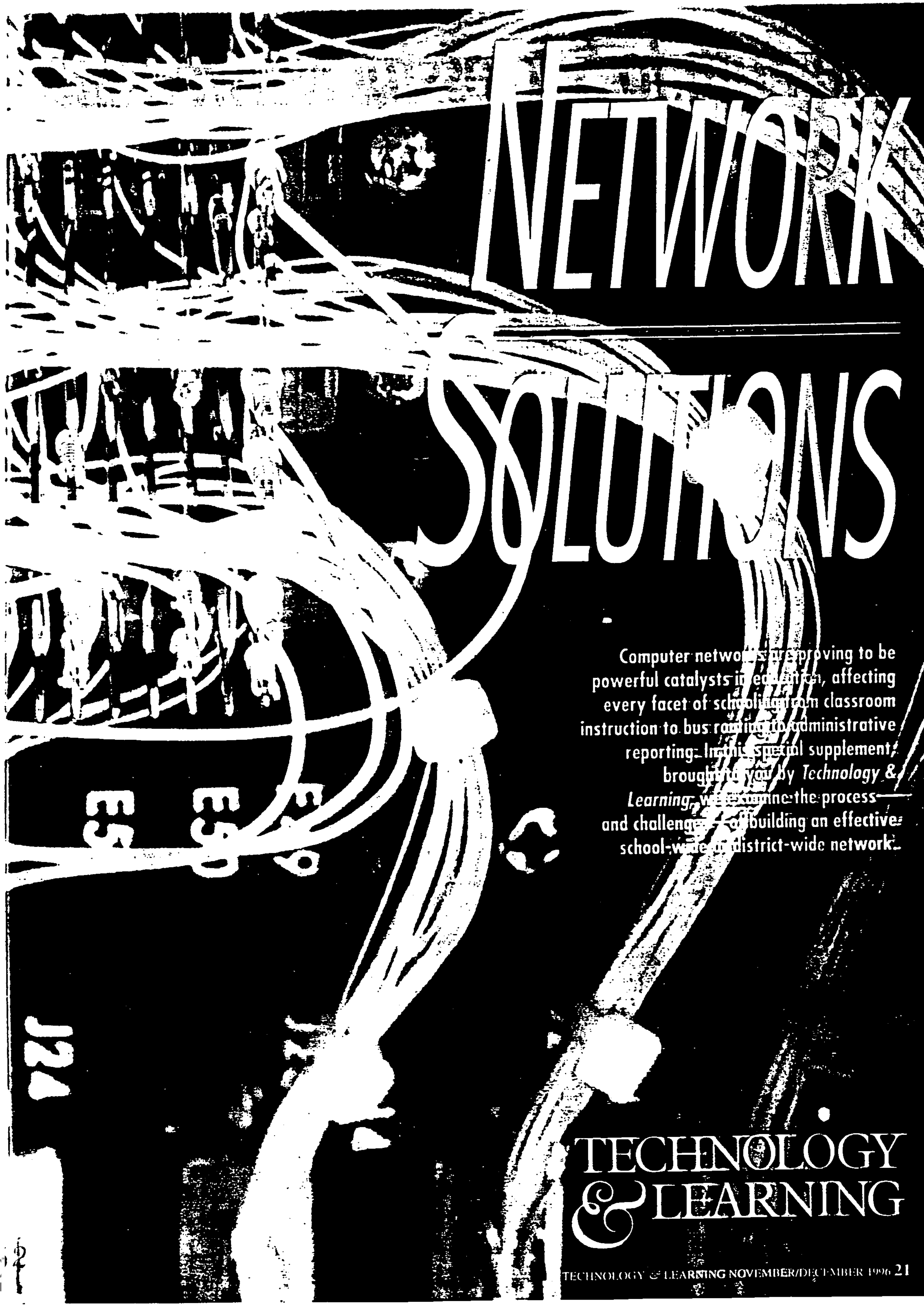
The Ultimate Agenda

In sum, GVSI's agenda is improvements in educational systems and methods everywhere. We foresee helping the nation get from its factory-model schools into effective information-age/"global village"schools with reforms which challenge traditional concepts of schooling and make educationally significant uses of advanced technologies.

GVSI serves the society's learning pioneers. But, to honor them, and for society to benefit from pioneering work, GVSI also wants to serve those who would learn from these pioneers. **Communicating th[illegible]edge and experience of pioneers to stakeholders and decision-makers who will change ed[illegible] on a broader scale is GVSI's ultimate agenda.**

RESOURCES

B) TECHNICAL INFRASTRUCTURE



NETWORK SOLUTIONS

Computer networks are proving to be powerful catalysts in education, affecting every facet of schooling from classroom instruction to bus routing to administrative reporting. In this special supplement, brought to you by *Technology & Learning*, we examine the process—and challenges—of building an effective school-wide or district-wide network.

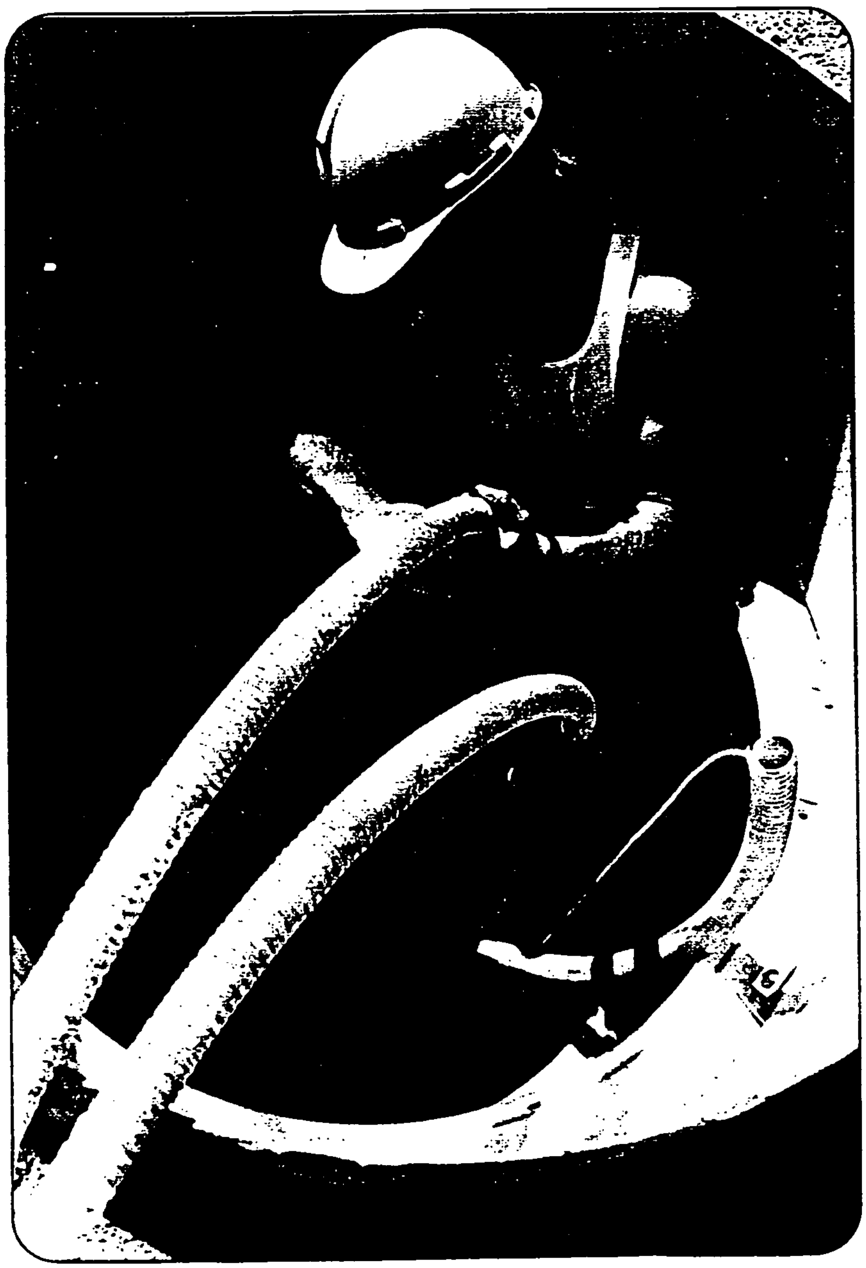
TECHNOLOGY & LEARNING

The Path to Successful Networking

By Robert Vietzke

Building a network for educational settings is a daunting task. It needs to be fast for student and administrative access from school or home. and secure so that outsiders can't break into it It should connect to the Internet. but screen out content that doesn't meet local community standards. Of course. costs neec to be contained. while still adopting the latest technology. Last but not least. it needs to be both educationally powerful and technically invisible.

Given these requirements. and the seemingly constant introduction of technology innovations to address them. the only certain path to successful networking implementations involves careful planning and frequent reevaluations along the way. Let's take a look at some of the changes in the networking landscape.



New Demands

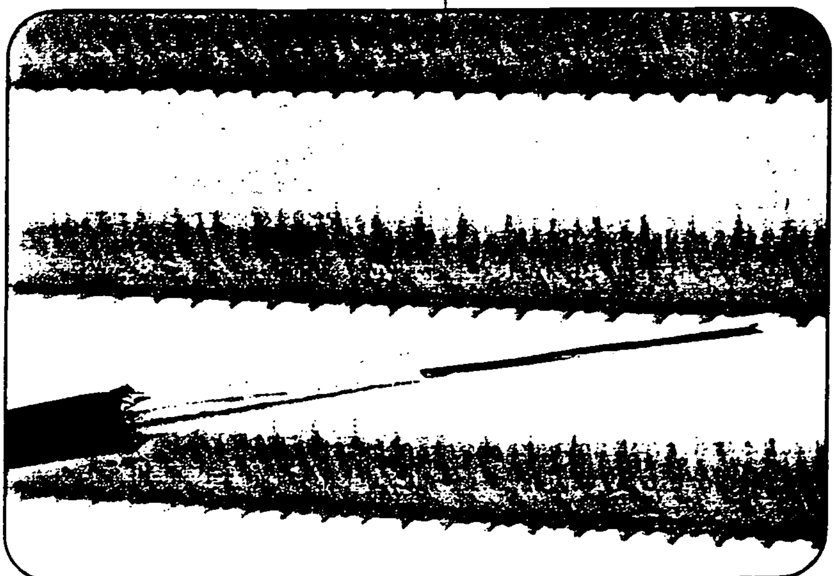
Gone are the days when a school's locc area network (LAN) merely provided a way to share printers or house applications in a computer lab. Today's educational networks do these things. but much more as well. Teachers want to check student records from home and use resources from the Internet to enhance their lessons. Administrators need to know. now. who qualifies for special funding programs. Parents want to send a quick e-mail to check on missing assignments or upcoming activities

To accommodate these new demands. current networks have movec past the era of AppleTalk and Token Ring to stabilize on an Ethernet-based platform using the MacOS. Novell. WindowsNT. or Windows 95 operating system. Ethernet has two primary advantages. First. it provides shared connectivity between workstations to enable sharing of files and printers at relatively high speeds. Second. Etherne works on many existing infrastructures. including coaxial. fiber. and copper wiring.

This core networking system has accelerated the development of new options for mass storage. wide area access devices. and network management software. Once. networked CD-ROMs meant a few CD-ROM drives attached to a server: now CD-towers offer speedy access to upwards of a

53

The Emerging Future



The networking landscape is complicated by two up-and-coming technologies: asynchronous transfer mode (ATM) networking and cable-based networking. Bandwidth is the rallying cry for these innovations. And it's clear that if we want to network video at the level we're used to from television, let alone add two-way interactivity into the mix, network capacities will need to expand. Here's a glimpse at these two leading contenders in the battle of the bandwidth.

These ATMs Don't Distribute Cash

ATM is a technology that could well provide the needed bandwidth—there are specifications for ATM networks running at speeds from 52 Mbps up to 622 Mbps. It also incorporates innovations that overcome some of the difficulties in transmitting interactive voice and video signals. For this reason, it's heralded as the next-generation technology that will bring video to the desktop.

As you might expect, there are some drawbacks to all this. The first is that ATM equipment is extremely expensive. It also remains to be seen how compatible this new technology will be with current systems, an important consideration for a school district that has recently invested in an Ethernet network.

Finally, although ATM hardware may indeed have the necessary bandwidth to deliver high-quality video and audio to connected computers, both the MacOS and Windows 95 will need significant modifications to transmit what the computers receive. Until that happens, and until applications are rewritten to take advantage of these changes, ATM will provide no better multimedia capability than Ethernet. The bottom line is that ATM is a work in progress. It holds promise, but for the time being, it will most likely be used as a high-end backbone on which to build future networks.

Cable: 500 Channels to the Desktop?

Another much-discussed method for increasing bandwidth is to use the cable wiring that currently runs to millions of televisions to deliver networked multimedia. Cable modems promise a total throughput close to 40 Mbps, which, if delivered upon, could make today's high-speed options seem slow by comparison.

These estimates assume that no one else would be accessing the network at that time. However, typical cable configurations include up to 500 homes, and older systems may include thousands of users per 40 Mbps of shared network segment.

Also, unlike ISDN and T1 services, many cable modem systems offer only "asymmetrical" 28.8 Kbps dial-up bandwidth for delivery of content back to the Internet. While this may be sufficient for the home user, educational sites that are hoping to host network services for access by others will want to wait for the next round of cable options to provide symmetrical bandwidth and smaller pools of users sharing the network.

hundred titles at once. Where network management once meant brand-specific monitoring of basic functions, network managers now access and control minute system settings. Even the hubs that comprise the heart of Ethernet networks are being upgraded with smart "switching" to allow full ten megabit per second (Mbps) throughput to every desktop.

Another important facet of educational networking today is the addition of wide area network (WAN) connectivity. Not long ago, wide area networking was synonymous with a modem and a phone line to the Internet. Now schools are looking beyond individual slow-speed connections to Integrated Service Digital Network (ISDN) or T1 connections that leverage their existing investment in the LAN and provide WAN access from every networked workstation. School-based Internet services for teachers and students are becoming common alternatives to parent- and teacher-funded private accounts.

Networking as Process

All this innovation would make some think that the task of planning, implementing, and administering these systems should also be simpler. However, this is not necessarily the case.

While interconnecting LANs and increasing their resources may broaden the reach of network access, it also forces the consideration of difficult issues about not only technology, but also data security, content awareness, and content filtering. That's why a thorough process in developing network plans is so essential.

As with any plan that will affect an entire community, getting input from all the concerned parties is a must. Parents, teachers, students, and district- and site-level administrators, as well as members of the larger community, need a chance to voice concerns and create a vision for how networking will enhance education and prepare students for the challenges they will face beyond the classroom.

Of course, as soon as these topics are addressed, new technologies will come along and change the equation. Building room in a network for such disruptions turns out to be one of the best planning strategies, as change is the one constant. Change—and the need to offer students the best tools with which to learn.

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Many Paths, One Goal: Real-World Networking Tales

By Jean Shields

When it comes to building a network, there are as many different approaches as there are school districts. But as these networking case-studies demonstrate, the common denominator is careful planning based on an analysis of the district's resources, problems, and aspirations—both instructional and administrative. Then a flexible design can be drawn up that alleviates immediate pressures and accommodates future plans.

Cincinnati Public Schools first concentrated on the administrative applications of a district-wide network.

Problem-Solving Networks

Sometimes a specific problem offers a way to conceptualize a network. This approach worked for the Cincinnati Public Schools, where a key consideration in developing its networking plan was the 42 percent mobility rate of its student population. The planning team believed that by instituting a network-based student tracking system, the district would be better able to serve the community and make more efficient use of the resources at hand.

While this mobility rate is about average for large school districts such as Cincinnati, it still meant that the first three weeks of the year were spent figuring out where the enrolled students really were. In the meantime, one school had too many teachers for its students, while another across town was short-staffed and frazzled. One school had more hot lunches than it could use. Others faced hungry students empty-handed.

"We chose to concentrate on the administrative side first," says Dave Hickey, network administrator, "because if you don't know where the kids are, you can't teach them, no matter what your network can do."

Over a period of two years, the district installed a fiber backbone with Ethernet LANs in the high schools and middle schools. Elementary schools each had one workstation connected to the administrative network to start, with LANs to be added in the second phase of the implementation. Compaq servers form the network's foundation, with 3Com switches and hubs providing high-speed connections between the different LANs.

The network has increased efficiency dramatically. For instance, because of information from the new student tracking system, the district now uses smaller vehicles to serve lightly populated bus routes, rather than more costly full-sized buses. In fact, Hickey estimates that in the first year alone the district saved more than $1 million through better teacher and resource allocation.

Hickey believes Cincinnati's decision to concentrate first on administrative applications was the right choice. "Some districts build networks as a hodge-podge, part instruction, part everything else," he says. "And they end up spending more because they're trying to do everything at once."

The Two-Pronged Approach

The New Haven Unified School District saw things differently, however. Like many school systems, the northern California district had a hard time justifying the network on purely administrative grounds, believing that kids and teachers need to incorporate computer networks into their work as quickly as possible. New Haven made two goals central to its planning process—improving both instruction and administrative functions.

"We felt it was essential to provide information processing skills to our students," says Modesto Muniz, network architect for the district. "For instance, the science department at the high school won a grant to develop

Internet-based curriculum. They need cutting-edge tools now."

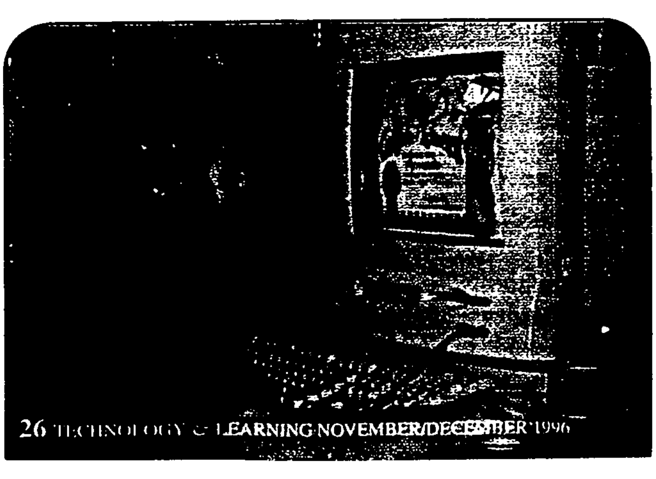
To meet these dual goals, Muniz and his staff are installing two networks at each school site—one for instructional use, and one that carries administrative information. Students can log onto the instructional side, where many have e-mail accounts, but the administrative line is blocked to them. The network is built from Bay Networks Ethernet components, and uses a combination of fiber, ISDN, and T1 connections.

Another aspect of the New Haven network is a document management system, which the district hopes will ultimately replace paper and microfiche files. With it, users will be able to access curriculum materials, submit forms, and retrieve student portfolios. "Information isn't useful if people can't get to it," observes Muniz, "whether it's our own student information or the latest research from the Internet."

A Customized Solution

It's easy to think that networking is best suited to implementations in large districts. That's not so, says Renald Hallee, co-director of data and network services for the Lexington Public Schools. Although the Massachusetts district has just nine schools in all, over the last four years, the district has upgraded to an Ethernet network with 200 workstations. The key for Lexington has been a customized database that the district puts to use in many different ways.

The database began as a tape and keypunch system. Over the years, the district has expanded what it includes in the database, building it into a flexible information warehouse. Data such as college applications and acceptance profiles, athletic awards, and health information are now part of the gathered information, in addition to the usual administrative functions such as accounting and scheduling. This customized database has also whittled down the budgeting process from over two months to just three weeks. Remote access has something to do with that dramatic change, as administrators can now work on the budget from home or while away.



New Haven students can log on to the instructional network, but are blocked from the administrative line.

A networked teacher training session in the New H[...] Unified School District.

Like their big-city counterparts, educators in Lexington find setting a time to hash out curriculum and other policy issues difficult. The network's e-mail system facilitates these exchanges, becoming the main communications tool in the process. Now faculty and staff members can look over key documents at their convenience and report back to a project coordinator. Student progress reports are handled in a similar fashion. From their workstations, teachers enter comments into student records, and the system automatically prints them up and sends copies to the necessary personnel.

Hallee believes the Lexington network has enhanced operations because he and his staff take a flexible approach to it. "The computer database does not set policy," he explains. "If administration wants to change something, we adjust the system to reflect those needs."

Room to Grow

Networking is a technology prone to change, usually for the better. Engineers are perpetually finding new ways to squeeze more information through old wiring, or developing new "pipes" with ever-greater capacities. Planners for the Kent School District didn't want to miss out on what might be down the road, so they took a "future-proofing" stance to designing a network for the Washington district's 28 schools.

"Our schools are wired for Ethernet," says Ann McGlone, a technology specialist at Grass Lake Elementary. "But realistically, only one computer in ten can even connect. We felt it was important to get the wiring in.

Hub Hub-bub

A hub is an essential network building block, where all the wires and cables from computers, servers, and peripherals come together to get the network talking. These new 10Base-T Ethernet hubs have recently come to our attention.

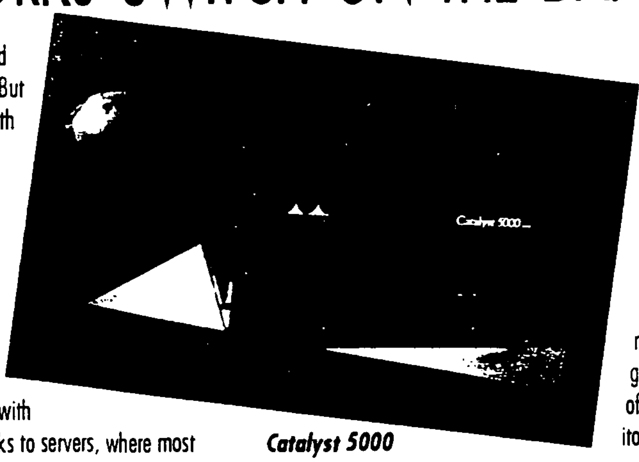
• **3Com** (Santa Clara, CA; (800) 638-3266; http://www.3com.com/) has a full line of hubs, including the ONLine 10Base-T modules, which let you connect PCs, terminals, printers, or modems to your LAN with built-in load-balancing and disaster recovery features. You can also hot-swap modules to reduce downtime when you want to expand.

• **Focus Enhancements** (Woburn, MA: (800) 538-8864) offers several hub models including the EtherLAN Hub, available with 16 or 32 ports. Both support PCs, Macintosh, and workstations, and offer auto-reconnection should a particular port go down. The EtherLAN Hub 16 V offers similar features in a vertical configuration.

• **Onan Corporation** (Minneapolis, MN; (888) 662-6267) has copper and fiber versions of its Workgroup Hubs for either eight or 16 attached devices. The 8600 Series is for use on copper networks, while the 8700 Series is for fiber-based networks, and supports longer link segment distances.

FAST NETWORKS SWITCH ON THE BANDWIDTH

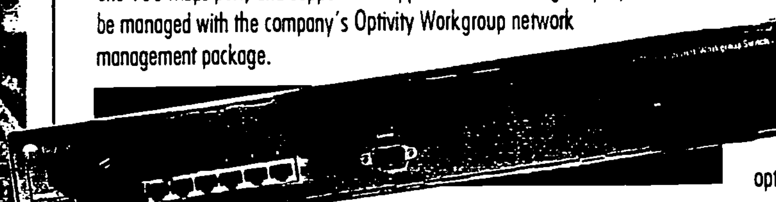
You've built a fine Ethernet network, and the school staff has been enthusiastic. But lately you've noticed some lagging. With CD-Towers, voice on the network, video-conferencing, and other multimedia applications hogging bandwidth, the standard-bearer 10 megabits per second (Mbps) Ethernet doesn't deliver the way it used to. That's where fast networking switches come in. Whereas a standard Ethernet hub shares a 10 Mbps "ring" among all connected workstations, these new "fast" hubs combine each individual port's 10 Mbps capability into a single unit with 100 Mbps or more of data capability in their uplinks to servers, where most bottlenecks occur. Because each "switching hub" connects to individual workstations or sub-networks using standard 10BaseT Ethernet connections, these devices can painlessly replace your main hubs while greatly increasing the throughput (and life span) of your Ethernet network investment.



Catalyst 5000

• **Asante** (San Jose, CA; (800) 662-9686; http://www.asante.com/) is now shipping its 5216 segmentation switch for medium to large networks. It has 16 10BaseT Ethernet ports and two 100Mbps uplink ports. The 5216 supports remote monitoring and includes a port mirroring feature, allowing any of the 10Base-T ports to be used to analyze traffic.

• **Bay Networks** (Santa Clara, CA; (800) 231-4213; http://www.baynetworks.com/) has new addtions to its BayStack family including the BayStack Ethernet Workgroup Switch (below). It features six 10 Mbps ports, one 100 Mbps port, and support for copper and fiber wiring. Bay's products can be managed with the company's Optivity Workgroup network management package.



• **Cisco Systems** (San Jose, CA; (800) 336-8957; http://www.cisco.com/) recently introduced the Catalyst 2900 switch, which features 14 ports, for small- to medium-sized networks. The Catalyst 5000 Group Switching Ethernet Module is for larger networks. It features easy integration into existing systems, and offers managers a variety of monitoring functions.

• **Compaq** (Houston, TX; (800) 888-3224; http://www.compaq.com/) offers many switches, including the Netelligent 5000 10/100 series, which feature congestion management control features for prioritizing packets, and shared memory for faster performance.

• **Farallon** (Alameda, CA; (510) 814-5000; http://www.farallon.com) offers several fast Ethernet products for Macintosh networks including the Fast Startlet 100TX/8 hub, with eight ports, plus an expansion slot for the company's Fast Startlet Bridge when you want to increase your network's capacity.

• **Focus Enhancements** (Woburn, MA; (800) 538-8864) offers the Lightning Series of switching hubs. The Lightning 4100 Hub S provides both 10 and 100Base-T capabilities. The Lightning 8100 Hub offers high performance 100Base-T speeds, and is well suited for networked multimedia uses.

• **Standard Microsystems Corporation** (Hauppauge, NY; (800) 762-4968; http://www.smc.com/) has theTigerSwitch, which offers high-speed switching capabilities for small work groups and LANs capability to handle 260 Mbps for 17 ports, this switch provides only intra-hub switched connectivity, but also several 100 megabit options to connect to high-speed backbones.

Later we can upgrade the individual computers."

The network uses Cisco routers and is built on a fiber backbone with T1 lines connecting the schools. Mac Pluses currently make up the majority of student workstations, but most classrooms have at least one higher-end computer as well. Still, the district felt it was important to provide headroom into which the technology program could grow.

Kent's network planners also made a special effort to get participation from the full spectrum of the school community. Teachers were involved in decisions such as where to place the network drop in their classrooms. High school students did much of the actual wiring.

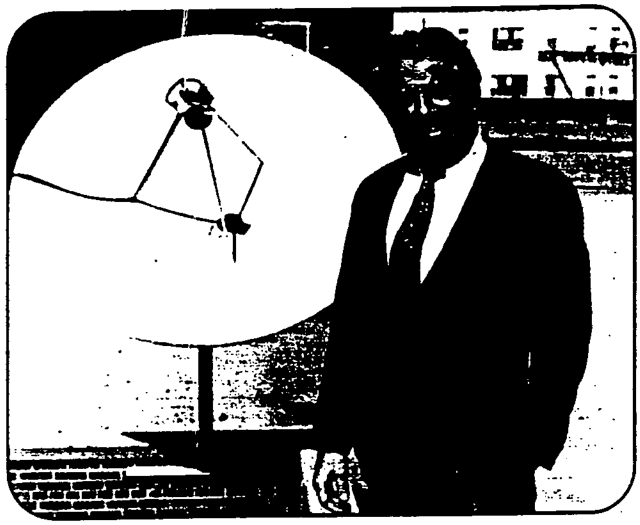
This year, the district is piloting a new system for tracking student records at five schools. While initially people have been a bit overwhelmed by the change, McGlone comments that "once you get used to it, it really does save time." On the instructional side, teachers are using the network for e-mail exchanges—both to collaborate with other teachers and to take part in "key-pal" projects on the Internet. The district's World Wide Web server has also been busy, as each school has its own Web page. Another popular network application is *CU-SeeMe*, a low-cost video conferencing program. McGlone has used it with small groups, including special needs students who find it especially reinforcing to make a visual connection with far-flung companions.

Making the Most of the Least

Like most school systems, the districts profiled here all have small staffs to service increasingly complex networks. For instance, in Cincinnati, Dave Hickey has just five technicians to manage the 1000-workstation network currently in place, and plans call for it to grow by 150 servers over the next two years.

Rather than hoofing it to each campus, he and his staff rely on network management tools to handle much of the maintenance. They can install software, upgrade operating systems, and even demonstrate procedures to users by "taking over" their computers right down to the mouse clicks. "It would take us a month to get to every school," Hickey says. "Now, if problems arise, we can troubleshoot from our desks."

For New Haven's Muniz, network management tools had to be part of the bid submitted by vendors, or the district would not consider the proposal. "These tools provide a lot of flexibility in configuring networks to reflect how they're used, not just physical proximity," he says. "So if the science department and the English department decide to work together on some projects, we can accommodate them pretty easily."



Troubleshooting from a distance is one of the benefits of Cincinnati's network management tools.

Where Do We Go From Here?

Building an educational network is a never-ending job. Older systems become overextended, new technologies emerge, and the cycle begins again. Most of the districts we spoke with are looking to high-speed switching as a logical next step, while some are moving up to asynchronous transfer mode (ATM) networks.

This fall, Cincinnati began installing 16 ATM networks to connect classrooms to the network and ramp up Internet access. "The infrastructure in some of our buildings is pretty awful," Hickey says. "ATM will allow us to get the file servers out of those environments and into a newer facility without sacrificing performance."

A network capable of transmitting simultaneous video and audio signals was number one on most districts' wish lists. The Kent School District, for instance, is already involved in a distance learning video project run jointly with a local community college. ATM promises to deliver some of these capabilities. Still, some are taking a wait-and-see attitude.

"We'll give it three or four years before we move to ATM," says New Haven's Muniz. "By then, the price will have dropped and the bugs will be worked out." And more than likely, a new technology will beckon on the horizon.

Jean Shields is Senior Editor for Technology & Learning.

SERVERS SERVE IT UP

The file server provides a central storage area for LANs where shared applications and files are housed. They can also be the holding tank for documents heading to networked printers, as well as provide other network functions. Here are some recent models to consider:

• **Compaq** (Houston, TX; (800) 888-3224; http://www.compaq.com/) recently added the ProLiant 5000 to its line of network servers. The 5000 has four 166 MHz Pentium Pro processors and a total storage of 700 GB.

• **IBM** (Atlanta, GA; (800) 426-4338; http://www.solutions.ibm.com/k12) has the AS/400 line of servers which offer up to 520 GB of storage and customizable features including support for multiple storage media. A new version of the AS/400 operating system is scheduled for release this fall, adding support for Windows NT, Unix, and Macintosh clients.

SAFEGUARDING YOUR SCHOOL'S INTERNET ACCESS

Amending the Bill of Rights might be easier than trying to suppress student access to some of the "free expressions" available on the Internet. But fundamentally changing our freedoms isn't necessary when intelligent software and thoughtful community standards can eliminate better than 95% of offensive Internet content. (For more on this topic, see *Technology & Learning*, September 1996). Here are some solutions we've recently learned about:

• **InterGo Communications** (Plano, TX; (972) 424-7882; http://www.intergo.com/) offers a suite of mail editing, web browsing, news reading, and file transfering programs that incorporate censor-ware within the actual applications. This approach affords tighter integration between filtering and browser functions.

• **Raptor Systems** (Waltham, MA; (800) 932-4536; http://www.raptor.com/) has integrated Microsystem's *CyberNOT* Internet screening system directly into its Eagle 4.0 and EagleNT firewall technology. This allows a single point of control for all Internet screening and security issues. By blocking the address and name of "local" machines from the Internet and allowing only authorized access to Internet resources, this firewall greatly reduces the risk of unauthorized access to the school's LAN from the Internet.

New Tools for Managing Networks

Networks have never been easy to manage. Yet now, with increasingly complex demands being placed on systems, a new generation of management tools is making it much simpler to perform such tasks as updating operating systems, analyzing network traffic, and resolving bottlenecks. Here are some recent releases.

• **3Com** (Santa Clara, CA; (800) 638-3266; http://www.3com.com/) offers *Transcend Network Management* software to work with Windows, Novell, Unix, and TCP/IP networks. Features include the ability to zero in on each port for troubleshooting, and a virtual grouping capability that lets you manage PCs based on user-defined relationships rather than physical connections.

• **Apple** (Cupertino, CA; (800) 800-2775; http://ed.info.apple.com/) recently brought out its Network Administrator Toolkit, which includes *At Ease for Workgroups 4.0, Apple Network Assistant*, and *Apple User and Group Manager*. Key new features in *At Ease* include file access and preference settings that can be associated with a given student regardless of what PC on the network he or she uses. The user management system has also been improved to allow printer and disk storage quotas for shared resources. The *Network Assistant* allows the system administrator to inspect workstation and server RAM and hard-drive usage remotely.

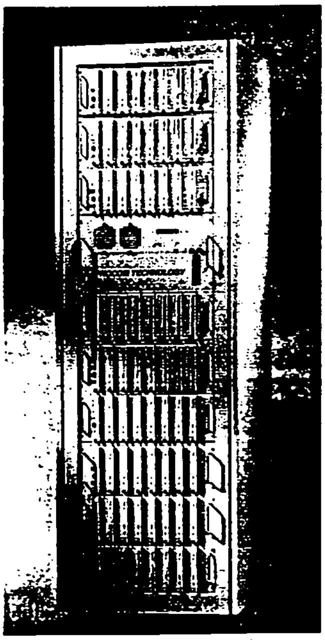
• **The AG Group** (Walnut Creek, CA; (800) 466-2447; http://www.aggroup.com) has *Etherpeek 3.0*, a Power Macintosh version of its Ethernet traffic and protocol analyzer. The package displays network traffic and packet information graphically, and automatically maps network IDs to corresponding machine names. It also notifies the network administrator when problems arise.

• **Compaq** (Houston, TX; (800) 888-3224) recently released version 3.0 of its *SmartStart* and *Insight Manager* network management tools. *SmartStart* now lets you distribute and configure system software on a network. *Insight Manager 3.0*, now a 32-bit application, lets network administrators manage servers and desktops centrally, or designate management to specific LANs. *Insight Manager* also works more easily with inventory control systems, a plus for multi-campus school systems.

• **Intel** (Santa Clara, CA; (800) 628-8686; http://www.intel.com/) offers version 2.5 of its *LANDesk* network management tool. Its features include software distribution, inventory functions, printer management, and a variety of reporting options.

• **Neon Software** (Lafayette, CA; (800) 334-6366; http://www.neon.com) released version 3.0 of *LANsurveyor*, an AppleTalk mapping and management tool. New features include MacTCP support, remote query of AppleShare settings on a network Mac, and PowerTalk and PageNOW! integration, which notifies the administrator through a pager when devices disappear from the network.

Towers for Networked CD-ROM Access



Procom Technology's HyperCD

CD-ROM towers house a series of CD-ROM drives and connect them to a network. They're growing in popularity because they can deliver information from the same CD-ROM to multiple locations on a network simultaneously. The new CD-ROM towers take advantage of the new "Fast/Wide SCSI" interface to connect up to seven drives per interface to a network server. Here are some to consider:

• **Procom Technology** (Irvine. CA (800) 800-8600) announced three new CD-ROM towers for Macintosh networks that allow access not only to Macintosh CDs. but also to Kodak Photo CD and High Sierra disc formats.

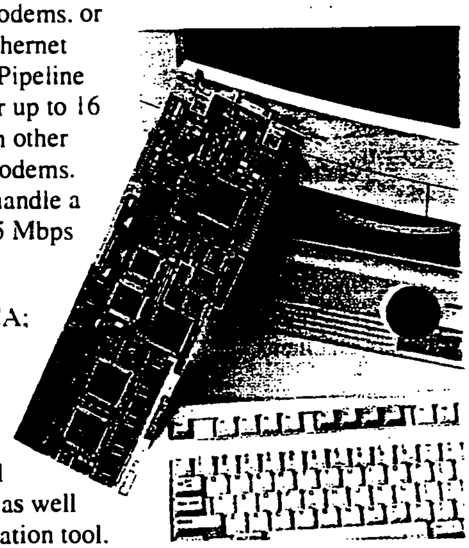
• **TACSystems** (Huntsville, AL; (205) 721-1976) recently announced a rack-mount version of its CD-ROM tower for use in Compaq equipment racks. This horizontal 19" rack-mount "tower" features up to four separate SCSI connectors for seven networked drives. allowing the user to configure the drives into several different SCSI chains as required.

• **Celerity** (Knoxville, TN; (800) 558-1901) recently announced the Mediator, which manages CD-ROM towers and jukeboxes (which play a single CD at a time) for Windows NT, Novell. or UNIX networks. It allows network administrators to set up towers without taking down the entire network, and supports towers and jukeboxes from different vendors on one system.

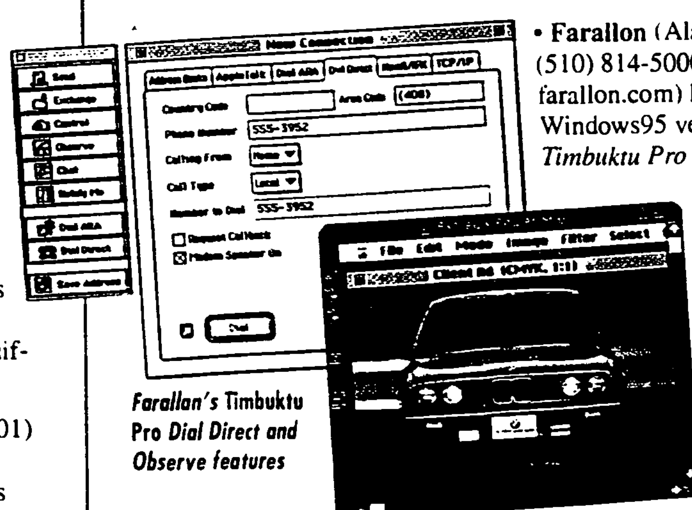
Remote Access Solutions That Deliver

Accessing networked information from home or when attending meetings away from school is increasingly important for educators. It provides teachers and administrators with tools for planning and analysis. and can help parents and the community stay informed as well. Here are some solutions to consider:

• **Ascend Communications** (Alameda. CA; (510) 769-6001) has the Pipeline series of remote access hardware. With the Pipeline 25 and an ISDN Basic Rate Interface (BRI). a user can connect two devices such as telephones. analog modems. or fax machines as well as an Ethernet network to remote sites. The Pipeline Max 1800 provides access for up to 16 ISDN channels dialed in from other Pipelines or remote analog modems. The Pipeline Max TNT will handle a total of 696 connections or 45 Mbps of dial-up connectivity.



• **Cisco Systems** (San Jose. CA; (800) 336-8957: http://www.cisco.com/) has introduced the AccessPro Router card (right). It slips into a PC card slot and provides the full suite of Cisco router features as well as a Windows-based configuration tool.



Farallon's Timbuktu Pro Dial Direct and Observe features

• **Farallon** (Alameda. CA: (510) 814-5000: http://www.farallon.com) has Mac and Windows95 versions of its *Timbuktu Pro* remote access software, which lets users do drag-and-drop file transfer. collaborate on projects from remote locations. and connect to a network as a remote node.

• **Shiva** (Bedford. MA: (800) 977-4482) offers the Netmodem/E and LanRover/2E for up to 20 remote users to dial in to an Ethernet LAN. or the LanRover/E PLUS for connecting larger groups. The units support a variety of connectivity options including ISDN.

Networked Display Systems

These products make sharing with the whole class a snap—great for modeling technology and Internet skills.

- **Intel** (Santa Clara, CA; (800) 628-8686; http://www.intel.com/) has LANSchool version 4.0, which works with NetWare and allows an instructor to broadcast his or her computing session to any number of student Windows 3.1 or DOS workstations on a network.
- **Minicom** (Holland, MI; (800) 922-8020) has introduced Classnet Lite, a video networking system that allows a teacher to access and display the content of individual student monitors in a laboratory situation. Classnet Lite uses a Windows interface or the Classnet keypad, allowing the teacher to preview work on student PCs and even switch the screen to a large screen or projector to share with the full class.

Networking Resources Online

The Internet, being after all a network of networks, is home to a great many resources on the subject—from basic beginners' guides to discussions of the latest technical standards. We've gathered a cross section to help you learn more.

Cisco Education Archive (CEARCH)
http://sunsite.unc.edu/cisco
This site brings together a wealth of education-oriented links, including the Network Operation Center, where you'll find background information on building networks, case studies of successful implementations, and product information.

Consortium on School Networking (CoSN)
http://cosn.org/
Though under construction, this site is worth a bookmark, as CoSN is a leading organization concerned with school networking, particularly Internet use.

The Ethernet Page
http://wwwhost.ots.utexas.edu/ethernet/ethernet-home.html
All things Ethernet, including links to FAQs, Usenet newsgroups, basic info, and expert schematics.

The Future of Networking Technologies for Learning
http://inet.ed.gov/Technology/Futures/index.html
A collection of white papers by leading thinkers in the field of educational technology—all concerned with networking. This is the place to hone your network rationale.

A Guide to Networking a K-12 School District
http://choices.cs.uiuc.edu/schools/lamont/thesis/toc.doc.html
An excellent overview of networking, specifically tailored to K-12 settings.

Introduction to ATM
http://iquest.com/~nmuller/atmintro.shtml
This page provides a solid introduction to asynchronous transfer mode (ATM) networking. The author does a good job pointing out the benefits of the technology, but the language tends toward the techie.

Introduction to Networking
http://w3.fwn.rug.nl/itgeheer/nwdoc/networe_info/NetWare_introduction.html
Excellent beginners' guide to networking topologies and specifications.

Network Administrator's Survival Handbook
http://tampico.cso.uiuc.edu/nas/nash/nash.html
Originally written as a guide for University of Illinois network administrators, this survival guide has valuable information for anyone involved in building a network.

Network Vocabulary and Acronyms
http://toucan.iecs.fcu.edu.tw/doc/vocabulary/voc.html
Don't know your CSMA from your FDDI? This is the place to sound it all out.

INTRANETS:

Time for a Web of Your Own?

By Peter Weinstein

They're the rage in the business world, but what exactly *are* Intranets and do they make sense for schools?

Perhaps you've heard non-educator friends all abuzz about a new system they refer to as the "Intranet" recently installed at work. You politely correct them, trying not to be smug, since you've been online for some time already: "Oh, you mean the Internet!" In the ensuing discussion, you discover that they are indeed referring to a unique information system, with exciting applications and possibilities.

As a teacher at Brookside School Upper Campus (grades 3-5) in San Anselmo, California, I have seen a similar scenario played out many times this past year, ever since we developed our own school-wide Intranet and began telling people about it. While Intranets are spreading rapidly through corporate America, they are just beginning to seep into the consciousness of educators. The term itself is still foreign to most teachers. The questions that arise when people first hear of Intranets are not surprising: What's the difference between the *Internet* and an *Intranet*? Why are Intranets becoming so popular? What are their implications for education? How do you set one up?

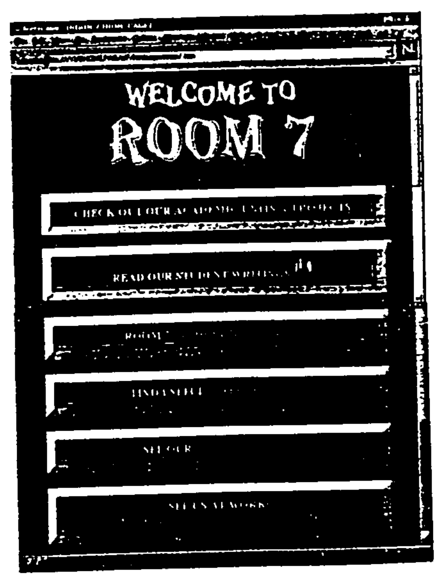
Why the Excitement?

While the Internet has been around for nearly 30 years, the term "Intranet" has been in use only since mid-1995. It was coined by vendors of networking products to refer to the use of Internet technologies within private networks. An Intranet, therefore, is simply a *private* computer network based on the data communication standards of the *public* Internet. The most important of these standards is TCP/IP (Transport Control Protocol/Internetworking Protocol), a networking protocol that enables computers to address and send data reliably to one another.

One of the main advantages of using TCP/IP to extend the capabilities of a local network is that it allows members of your school community to use a "Web browser" not only to navigate on the Internet's World Wide Web, but also to access files created and shared locally. In the few short years since the introduction of the original Web browser, *Mosaic*, browsers have become incredibly popular for many reasons. Browsers are intuitive and graphically elegant, making it easy to navigate through large amounts of text and multimedia. They unify a number of network capabilities (file transfer, e-mail, and so on) through a single interface. Browsers themselves are inexpensive (often free) and the costs of compatible software are kept low thanks to open standards developed in committee by multiple vendors and institutions.

Another strength of TCP/IP is that it is "platform independent." Just as it's possible to access the Internet through a variety of different hardware and software setups, an Intranet can overlay virtually any network wiring (e.g., coaxial cable, Category 5 copper cable, or fiber-optic cable); transmission hardware (e.g., Ethernet or TokenRing); network operating system (e.g., Novell NetWare, AppleTalk, or WindowsNT); and computer system software (e.g., Windows, MacOS, or UNIX).

Creating this sort of "mini-Internet" for your school or district has some advantages over plunging unguided into the vast world represented by "the 'Net." While the Internet is global in scope, open to everyone with no regard to content, an Intranet serves a well-defined and bounded user community, such as a single business or a school. A school can organize its text and multimedia in a relevant way that makes sense to its user community, while still providing access to the unlimited, but



A Brooknet Class page

somewhat chaotic. resources on the Internet. An Intranet is usually configured to provide its users with access to the Internet. but prevents Internet users from accessing the local Intranet for reasons of security and privacy. It offers relief for parents who want their children to publish and be present on a network, but don't want their children's pictures and names distributed freely around the world.

On another front. the fact that Intranet information is carried over a LAN (a Local Area Network within a single site) or a WAN (a Wide Area Network integrating resources in different buildings within the user community), rather than over public communications channels. offers a major speed advantage. Data transmission speeds within an Intranet are limited only by the speed of your network, not by the bandwidth of your Internet hookup. While a modem connected to a standard phone line transfers information at no more than 28.8 kilobits per second. and a "fast." high-cost T1 line operates at approximately 1.5 megabits (or about 1,500 kilobits) per second. the typical LAN carries data at ten megabits per second. If you've ever experienced the frustration of waiting for graphics or other large files to download from the Internet. this speed increase will be a major relief.

A Day on the Intranet

What does it feel like to use an Intranet on a regular basis? First. it's important to understand that today's Intranet does not displace your main network operating software. Rather. as a separate interface. it coordinates many of the information management needs of the network.

Like the Internet, the Intranet's main function is to read and display HTML (Hyper Text Markup Language) files. These files might be ones students and teachers have created and saved in HTML. With assistance from the sorts of "helper applications" that are common in the Internet world today, an Intranet can also offer viewing access to files in a variety of other formats. Helper applications are readily available for reading desktop-published documents saved as PDF files, digital movies in QuickTime or other formats, X-WAV audio files, and much more.

E-mail and simple interactive programs are functions of some Intranets as well. For the time being, however, everyday programs like word processing, desktop publishing, spreadsheets, or multimedia applications are still accessed directly with the regular network operating system. With an Intranet in place, users will often

Intranet Basics

In building an Intranet for your school, here are the main components you'll want to plan and budget for.

Infrastructure
- wiring (purchase and installation)
- network cards (purchase and installation)
- network operating system (licensing, installation, and technical support)

Intranet server setup
- server CPU (purchase and technical support)
- Internet connection (setup and access fees)
- Web server software (licensing, installation, and technical support)

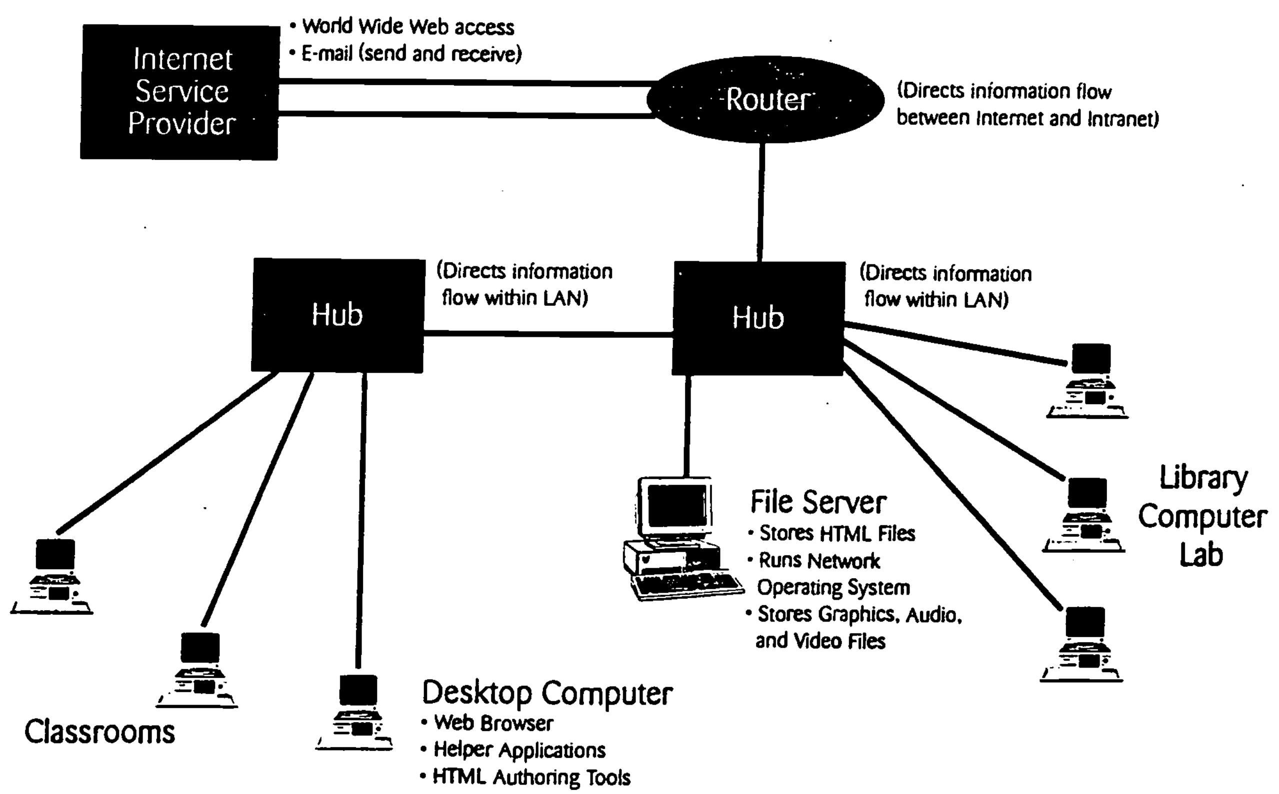
Client setup
- desktop computers (purchase and technical support)
- TCP/IP software (licensing, installation, and technical support)
- Web browser* (technical support)
- helper applications* (technical support)

Authoring tools
- HTML editors (licensing and technical support)
- graphics editors (licensing and technical support)
- input devices such as scanners and video frame grabbers (purchase)

Training, Development, and Maintenance

*For the moment, most of these are either shareware or otherwise free to schools.

FILE SERVER MODEL FOR AN INTRANET



bounce back and forth between the regular operating system and the Intranet. The original LAN is still there as the backbone of the system; the Intranet simply offers a superior information-access interface. As Intranet technology evolves, more and more actual applications will be handled directly by the Intranet. For example, eventually tools should be widely available that enable schools to collect attendance data and student grades right through their Intranet browser without having to launch separate programs.

In just the first six months of its implementation, we have found many uses for Brooknet, as our Brookside School Upper Campus Intranet is affectionately known. For example:

• Individual class home pages have helped create a sense of classroom community. These Intranet Web pages include class pictures, class descriptions, and even some individual student home pages. They use eye-catching backgrounds and other publicly available graphics scavenged from around the Internet. These have also helped to extend each child's experience beyond one classroom's walls to the greater school.

• Online publishing makes a great contribution to our school culture. Students' writing and art work can be accessed from any class at any time. For starters, there are watercolor paintings of endangered rainforest animals, descriptions of California Missions, and a variety of interesting poetry.

• The Intranet makes it easier for teachers to share academic units, projects, and curriculum ideas. For example, we have a series of linked pages, completely developed and authored by students, describing a science unit on scale and structure. Many teachers have begun to describe academic projects on their class home page. More than ever, our teachers are getting ideas from other classrooms.

• Hot links to the Internet make us all more efficient. As it turns out, there are ways of making the vast resources of the Internet less daunting. When a teacher or student discovers something useful, there's no need for others to reinvent the wheel every time that Internet resource is needed. We have created pages of links to share which relate directly to a particular academic unit or subject.

Besides these practical uses of Brooknet, we're experiencing inklings of the potential to transform the school as a physical entity, by expanding the culture of the classroom to the level of the school site. An Intranet allows for individualism and creativity, while helping us discover what's happening in other parts of our school community. We look forward to expanding the uses of Brooknet even more in the future. Possibilities include storing multimedia student portfolios, collecting data for school-wide science experiments, and even giving families direct access from their home computers.

BUILDING YOUR INTRANET

Setting up an Intranet from scratch involves three main phases: building the network infrastructure, setting up the network operating system, and placing the Intranet as an "overlay" on the network operating system. The first two steps in the process are beyond the scope of this article (see "Building Your Infrastructure: The Basics of Cabling and Connecting," *Technology & Learning*, April, 1996, for more on the issues involved). The third phase—adding the Intranet overlay—involves installing several key tools on the server CPU and the client workstations that make up the network.

For starters, every client desktop computer will need TCP/IP drivers; a Web browser and helper applications that allow the browser to read the types of text and multimedia files students plan to create; and authoring tools for the creation of home pages and other shared files. Your network consultants can advise you on the acquisition and installation of the proper TCP/IP drivers. The most popular browser is *Netscape Navigator*, but *Microsoft Internet Explorer* has been gaining fans in recent months. Helper applications are almost always available as shareware on the Internet, and often come with network software packages.

Important HTML authoring tools include an HTML editor (such as Adobe's *PageMill*, Sausage Software's *Hot Dog*, Soft Quad's *HoTMetaL Pro*, Microsoft's *Front Page*, or Claris's *Home Page*) and a graphics manipulation program (such as Adobe *Photoshop* or Micrografix *Picture Publisher*). Advanced users can add programs capable of 3-D rendering, creating real-time animation, or scripting data manipulation features for your Intranet.

Learning HTML basics and how to use an HTML editor is important for anyone who wants to place content on the Intranet. This includes teachers, administrators, parents, and students. (At Brookside we find that students in grades four and up are able to do quite well with HTML authoring.) Technology leaders within the school can be responsible for handling graphics capture, graphics manipulation, and any advanced applications the school community deems necessary.

It is important to note that there are two distinct structural models to the implementation of an Intranet. The smaller-scale approach, the one undertaken at Brookside in our first year, is the *file server* model. Brooknet is simply a set of carefully linked HTML and graphics files stored in organized subdirectories on our network file server. It

Intranet Resources on the (Other) Net

Here are some excellent Intranet resources located on the World Wide Web:

- **The Intranet Journal (http://www.brill.com/intranet/index.html).** This information site for Intranet users includes news items, a moderated newsgroup, opinions, links, a frequently asked question (FAQ) section, and an expert's corner.
- **The Complete Intranet Resource (http://www.lochnet.com/client/smart/intranet.htm).** You'll find questions and answers, case studies, articles, news, links to hardware and software vendors, event information, and even a daily Intranet cartoon.
- **The INTRAnet Handbook Page (http://www.ntg-inter.com/ntg/intra_hb/handbk.htm).** A handy resource for Intranet developers, the handbook covers publications, training, case studies, news, resources, and available commercial services.
- **Intranet Resource Centre (http://www.infoweb.com.au/intralnk.htm).** This site contains hundreds of links to articles, Intranet product vendors, and other online resources.

is an "access only" setup, in which the primary function of the browser and helper applications is to view shared files. With the help of an Internet connection, it is also fairly simple and common to send and receive e-mail using the file server model. This system is affordable for most schools and relatively easy (though still time-consuming) to maintain.

The second approach, the *Web server* model, goes one step beyond file sharing; it lets the Intranet more closely resemble the full-fledged Internet. The difference lies in the addition of HTTP (Hyper Text Transfer Protocol), the hypermedia information protocol which is central to the World Wide Web. This is accomplished with the installation and configuration of Web server software such as Microsoft's *Internet Information Server*, Novell's *Web Server for NetWare*, or Apple's *MacHTTP*. A Web server allows for many sophisticated HTTP operations including data manipulation, search and retrieval, and using interactive forms.

The Web server model allows students and teachers to share files of a more interactive nature. For example, their home pages might include simple online games or surveys in which visitors are prompted for input. It's also possible to install a customized search engine on a Web server for locating key words in your own Intranet files. If your school decides to set up a full-fledged Internet site (as opposed to a home page housed on somebody else's server), the same Web server can be used for both purposes. Unfortunately, taking advantage of these added capabilities requires additional support software, knowledge of one or more HTTP scripting languages, and considerably more human resources for managing the network than many schools have.

The actual nuts and bolts of getting any Intranet up and running can be complicated and expensive. As always, the biggest roadblocks are time and money—not only for hardware, software, and technical support, but also for training and the actual work of page design (see sidebar on page 51). However, don't let this scare you away. With small grants, donations of used hardware from local businesses, volunteer help, and the advice of qualified consultants, a simple Intranet can be set up on a shoestring budget. If, like many schools, you have already installed a LAN for Internet access, then you are most of the way there. Yes, it's wonderful to connect your students with peers all over the world, but do they know everything they should know about the rich resources and interesting people to be found in the classroom across the hall?

■ *Peter Weinstein is an elementary school teacher and educational technology consultant in the San Francisco Bay area. He is happy to answer questions and inquiries at: PeterW@microweb.com.*

THE 1996-97 TECHNOLOGY & LEARNING SOFTWARE AWARDS

NAME	TYPE	COMPANY	GRADE	CURRICULUM
THE TOP SIX				
HIP Biology 1 & 2	Mac CD	Center for Image Processing in Education	9-12	Science
Hollywood	Mac CD/Multi PC	Theatrix	5-Up	Creativity Tools
Little Planet Literacy: Glowbird & Ribbit Collections	Mac CD/Multi PC	Little Planet Publishing	K-4	Creativity Tools
Logical Journey of the Zoombinis	Mac CD/Multi PC	Broderbund	3-6	Math/Critical thinking
Tenth Planet Explores Primary Math: Geometry	Multi PC/Mac CD	Tenth Planet	K-3	Math/Geometry
World War II	Multi PC	FlagTower	7-Up	History
ADDITIONAL AWARDS OF EXCELLENCE				
Alphabet Express	Multi PC/Mac CD	School Zone Publishing	Pre-K-2	Presch/Readiness
Dr. Seuss's ABC	Mac CD/Multi PC Win 95	Broderbund	Pre-K-1	Presch/Readiness
Trudy's Time & Place House	Multi PC/Mac CD	Edmark	Pre-K-2	Presch/Readiness
Sheila Rae the Brave	Mac CD/Multi PC	Broderbund	Pre-K-4	LangArts
Of Mice and Men	Multi PC	Penguin Books USA, Inc.	7-Up	LangArts
CampOS Math: Numbers & Number Theory	Mac CD	Pierian Spring	5-8	Math
CornerStone Mathematics	Multi PC	Skills Bank	3-8	Math
Graphers	Win/Mac floppy	Sunburst	K-4	Math
Peter Rabbit's Math Garden	Multi PC/Mac CD	Mindscape	Pre-K-3	Math
Snootz Math Trek	Multi PC/Mac CD	Theatrix	1-5	Math
Astronomy Village: Investigating the Universe	Mac CD	NASA Core	9-12	Science
Message in a Fossil	Multi PC	Edunetics	2-8	Science
One Small Square: Backyard	Mac CD/Multi PC	Virgin	3-6	Science
Rainforest Researchers	Mac CD/ Multi PC	Tom Snyder Productions	5-8	Science
Exploring the Lost Maya	Multi PC/Mac CD	Sumeria	6-Up	Social Stud/History
Pilgrim Quest II	Multi PC	Decision Develop. Corp.	4-Up	Social Stud/History
STV: Maya	Videodisc/Mac floppy	National Geographic	7-12	Social Stud/History
Vital Links	Mac CD/Multi PC	Davidson	5-12	Social Stud/History
World Discovery Deluxe	Multi PC/Mac CD	Great Wave	3-Up	Social Stud/History
World War I	Multi PC	FlagTower	7-Up	Social Stud/History
Let's Go	Mac CD/Multi PC	DynEd	K-4	ESL
A History of Medicine	Multi PC	FlagTower	7-Up	Reference
Encarta 96 World Atlas	Win 95 CD	Microsoft	6-Up	Referemce
Encyclopaedia Britannica Online	Internet access	Encyclopaedia Britannica	6-Up	Reference
SIRS Discoverer	Mac/Dos CD Multi PC	SIRS, Inc.	1-8	Reference
Wide World of Animals	Multi PC/Mac CD	Creative Wonders	5-Up	Reference

Research Summary
Educational Electronic Networks

Virtual field trips to Central American rain forests, global grocery price comparisons, NASA Hubble telescope images, community Web pages. Electronic learning networks are changing what happens in the classroom. What does the research say about ways to make sure network learning is meaningful to students?

Electronic learning networks provide access to the riches of the world. Students in remote rural locations can reach the Library of Congress, classes in towns without museums can visit the Louvre, and students and teachers anywhere can communicate with content-area experts from around the world.

Networks also have made new forms of local and worldwide collaborative learning possible. They have helped to create writing communities (Bruce and Rubin 1993, Scardamalia et al. 1992), science communities (Learning Through Collaborative Visualization Project 1993, Newman and Goldman 1986–87, Ruopp et al. 1993), mathematics communities (Klotz 1996), problem-solving communities (Levin et al. 1987), and teacher education communities (Levin et al. 1994, Thurston et al. 1996).

These electronic communities bring together students, teachers, and adults from outside the education arena. For example, students have worked in communities to analyze and predict weather, to exchange measurements of the sun's shadow to figure the circumference of the earth, and to develop new solutions to local problems based on similar approaches used in distant places. Teacher education students have worked in communities to find or develop, evaluate, and electronically publish curriculum resources.

Students do most of their work off the network, and in many cases off the computer. Network-based learning, unlike word processing or programming, does not require vast numbers of computers and unlimited connection time. It can motivate students to become involved in a wide range of learning activities. And the computer and network infrastructure can be expanded as needed to allow for ever more powerful uses.

Research on the uses of electronic networks often starts with the exploration of innovative uses. Researchers then develop conceptual frameworks for such uses and look at barriers that may lead to difficulties and failure. Educators can use this information to make decisions about networks in their own settings.

One set of studies focused on the InterCultural Learning Network (Levin et al. 1987), where students collaboratively tackled water shortage problems in their communities, engaged in network-based analyses of cultural differences in holiday celebrations around the world, and contributed to a network-based newswire. According to researchers, this kind of student writing is much more effective educationally than the electronic pen pal projects commonly advocated by network novices (Levin et al. 1989).

BEST COPY AVAILABLE

Cohen and Riel (1989) reported that writing for remote peers over a network produced better quality writing than writing for the teacher. This "audience effect" of network-b[illegible] [illegible]eractions can provide a [illegible] context for learning in many different areas. Researchers have found similar effects in science (Cervantes 1993, Ruopp et al. 1993), mathematics (Thalathoti 1992), and social studies (Levin et al. 1989).

Sharing Information with Society

Electronic networks are highly interactive. Information can flow in many directions. The research suggests that in the long term, the most significant impact of networks on education may prove to be the flow of information from educational institutions to the rest of society.

Many recent curriculum reform efforts have focused on problem-based and project-based learning. Networks allow students and teachers to draw from many fields, not just from education. And networks allow students and teachers to share their findings with the world at large. Thus, student work—while primarily oriented toward optimizing learning—can have a secondary benefit beyond the immediate learning context.

For example, networked students helped design recreational activities for space station astronauts (Cervantes 1993, Levin 1992). They developed concepts for transforming everyday sports and for creating new sports. NASA professionals had not tackled this task because the space shuttle is too small for such activities.

Students can, as part of their learning activities, contact adults in their communities to identify problems and challenges. They can use networks to access resources anywhere in the world and make them available to community members. For example, students in California, Illinois, Japan, Mexico, and Israel used a network to study a local water problem (Levin and Cohen 1985, Waugh et al. 1988). They used local resources to learn the specifics of the problem and the actions taken to solve it. The students relayed questions developed by local authorities to the distant students, who in turn asked their own experts. They exchanged information, and they analyzed it to identify actions that local authorities had not yet considered.

Barriers to Using Electronic Networks

Much of the research to date has focused on overcoming the difficulties of using networks successfully in education. These barriers include lack of access and appropriate infrastructure, separation of telecommunications from the curriculum, lack of support for teachers attempting to work with innovative approaches, and lack of teacher expertise in telecommunications.

Infrastructure and access. A number of studies indicate that it is important for teachers to have equipment in their classrooms (Harris 1994, Levin 1995, U.S. Office of Technology Assessment 1995). The Apple Classroom of Tomorrow research indicates that teachers should return from training sessions to classrooms equipped with the hardware and software on which they received their training (Ringstaff and Yocum 1994). Ideally, they should have access to telecommunications equipment at home and at school (Harris 1994).

Infrastructure—which includes wiring, modems or high-speed connections, and computer hardware and software—is a critical component of an effective network. Current estimates are

Networks allow students and teachers to draw from many fields, not just education. And networks allow students and teachers to share their findings with the world at large.

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Photo courtesy of James Levin

that only 9 percent of the nation's classrooms are connected to the Internet (West 1996). In our experience with the Teaching Teleapprenticeships model, student teachers emphasized the importance not only of having hands-on training, but also of being "hooked up" or "wired" in their own classroom (Thurston et al. 1996).

Telecommunications and curriculum. A second barrier to effective implementation of networks is the gap between network use and the curriculum. Studies show that networks are most effective when they are tied to the curriculum (Levin 1995, Thurston et al. 1996). Training is essential if teachers are to see telecommunications as a means to an end, not as an end in itself. For example, a high school French teacher developed a project where a large number of sites contributed recipes via the Internet. Her students then translated the recipes from French into English, which involved math as well as language skills. Then, they used desktop publishing software to create and illustrate a cookbook based on the project.

Lack of support. Another barrier to teacher implementation of networks is a lack of technical and/or administrative support. Very few schools have a full-time, on-site computer coordinator available to help teachers. *The Learning Connection* (Benton Foundation 1995) indicates that 60 percent of schools have no one to help, and it estimates that only 6 percent of elementary schools and 3 percent of high schools have a full-time computer coordinator.

The newly released Carnegie Report, *Breaking Ranks* (National Association of Secondary School Principals 1996), says such support is critical. In its "Priorities for Renewal," the report recommends that "every high school designate a technology resource person to provide technical assistance and to consult with staff to assist them in finding the people, information, and materials that they need to make best use of technology." Administrative support is as important as technical support (Harris 1994, Levin 1995, Ringstaff and Yocum 1994). In fact, the Apple Classroom studies show that the principal has a key role to play. The principal can control release time, provide access to hardware and software, promote team teaching or interdisciplinary study, and acknowledge efforts and provide recognition.

Lack of effective training. Research shows that many teachers have little or no experience with telecommunications or with technology in general (Benton Foundation 1995, Thurston 1990, U.S. Office of Technology Assessment 1995). In fact, lack of teacher expertise is probably one of the most significant obstacles to the effective implementation of networks. Teachers need appropriate infrastructure and access, opportunities to integrate technology into the curriculum, and technical and administrative support; but they also need effective training. And effective training requires hands-on experience and follow-up support (Benton Foundation 1995, Ringstaff and Yocum 1994).

Many experts believe it is a mistake to mandate telecommunications training for all teachers. Schools should support and recognize those teachers who are ready to move forward and learn (Foa et al. 1996, Harris 1994). Training should incorporate modeling or coaching in effective uses of technology (Benton Foundation 1995, Harris 1994, Ringstaff and Yocum 1994). The training should include face-

Photo courtesy of James Levin

Much of the research to date has focused on overcoming the difficulties of using networks successfully in education.

to-face sessions followed by practice, then a return to follow-up coaching (Harris 1994). Teachers should work in pairs or small groups (Harris 1994, Ringstaff and Yocum 1994), so they have peer support when they return to their classrooms.

Studies show that districts should allocate 30–40 percent of their technology budget to teacher training (Benton Foundation 1995, Foa et al. 1996, Marshall 1995, U.S. Advisory Council on the National Information Infrastructure 1996, U.S. Office of Technology Assessment 1995). Typically, however, school districts allocate less than 15 percent for training (Benton Foundation 1995), and many have no budget at all.

Changing the Nature of Teaching and Learning

In summary, research has shown that the use of telecommunications in the classroom has the potential to change the nature of teaching and learning (Foa et al. 1996, Means 1994, Wilson et al. 1995). It can shift the focus from whole-group to small-group interaction; it can mark a shift from lecture to coaching; and it can enable teachers to do more one-on-one work with students. It can help shift the focus from test performance assessment to assessment based on products and progress (Wilson et al. 1995). And it can encourage teamwork, collaborative inquiry, and individualized instruction (Means 1994, U.S. Office of Technology Assessment 1995). ■

Using Networks Successfully

- The "audience effect" of network-based interactions can provide a powerful context for learning (Cervantes 1993, Ruopp et al. 1993, Thalathoti 1992, Levin et al. 1989).
- Teachers need to have telecommunications equipment in their classrooms (Harris 1994, Levin 1995, U.S. Office of Technology Assessment 1995).
- Networks are most effective when they are tied to the curriculum (Levin 1995, Thurston et al. 1996).
- Technical and administrative support is critical if teachers are to implement networks (National Association of Secondary School Principals 1996, Harris 1994, Levin 1995, Ringstaff and Yocum 1994).
- Teachers need appropriate and effective training, including hands-on experience and follow-up support (Benton Foundation 1995, Ringstaff and Yocum 1994).
- Districts should allocate 30–40 percent of their technology budget to teacher training (Benton Foundation 1995, Foa et al. 1996, Marshall 1995, U.S. Advisory Council on the National Information Infrastructure 1996, U.S. Office of Technology Assessment 1995).

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73

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Teachers need appropriate infrastructure and access, opportunities to integrate technology into the curriculum, and technical and administrative support; but they also need effective training.

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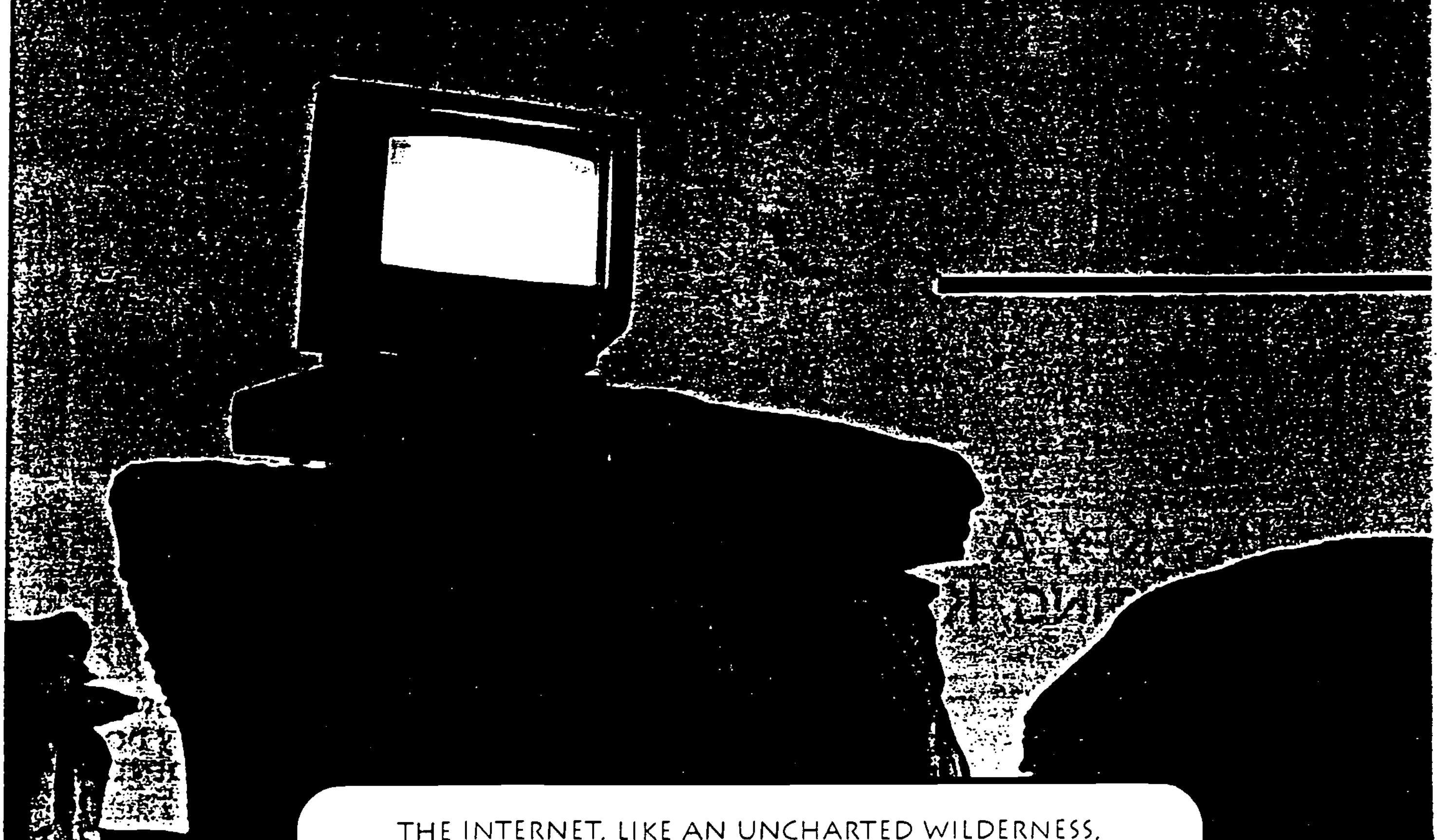
EXPLORING THE INTERNET SAFELY



THE INTERNET, LIKE AN UNCHARTED WILDERNESS, PROMISES VAST RESOURCES AND THE SPACE TO CREATE NEW COMMUNITIES. BUT NOW, PARENTS AND TEACHERS ARE WONDERING WHETHER LURKING DANGERS OUTWEIGH POTENTIAL BENEFITS.

HERE'S A LOOK AT STRATEGIES FOR SAFE EXPLORATION.

When it comes to letting students use the Internet, inevitably the discussion turns to safety. Educators are justifiably concerned about giving students unrestricted opportunities to indulge their *curiosities*, shall we say. (What did *you* used to look up in that huge dictionary in the library?) And just as troubling as kids accessing inappropriate materials is the potential for inappropriate people to access kids.

But how do schools ensure that students get the educational advantages without the unwanted dangers? Some advocate guiding students to educational treasures and engaging (or developing) their common sense along the way. Others believe that software or server-based controls are essential. The most effective approach may well be a combination of both.

Filtering With Software & Servers

While businesses worry about outsiders breaking into their computer systems, schools focus their concerns on insiders getting "out"—that is, students accessing inappropriate text, images, and people on the Internet. "In our area, a school system would be tarred and feathered if they risked having a child find something inappropriate on the Web at school," says Libby Helseth, a teacher in Florida.

With the stakes so high, many schools choose to install filtering software on each workstation with access to the Internet. These utilities block sexually explicit material from FTP

What Schools Can Do

By Mary Anne Mather

archives, Telnet, Usenet newsgroups, and the Web. Some also exclude sites condoning violence, illegal activities, bigotry, or drug use. Others are capable of scanning e-mail. All let a designated user add or delete specific sites at the user's discretion.

Filtering software works by maintaining databases of blacklisted sites and objectionable terms found in Internet addresses and site descriptions. The more sophisticated programs evaluate objectionable terms in context, allowing access to sites that contain a blocked term but no objectionable material. Some products rate sites by age appropriateness, while others let the system administrator assign a password to each user, and set graduated levels of access.

In addition to filtering, some products keep a user log of Internet activity and access attempts. These "monitoring" devices provide a designated user with an overview of all computer activity, much as a telephone bill lets you see a listing of phone numbers called. Some products also let users capture screenshots of any computer activity at predetermined intervals.

Proxy servers and network-based filtering provide a more global level of Internet management. Proxy servers, configured to receive and send Internet [illegible]s, sit between the individual at [illegible]orkstation and the Internet at large. Think of it as a stop-off before a message or request exits or enters. The server screens material according to standards set by the system administrator. Thus, selected materials can be prohibited from ever reaching your network.

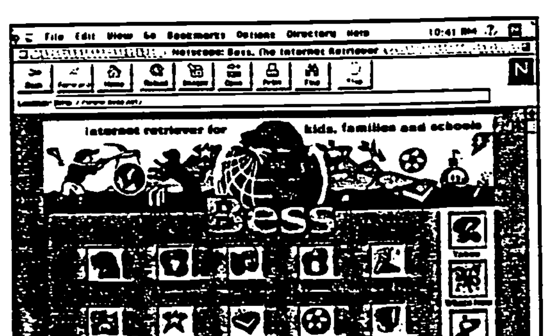
Because of the dynamic nature of the Internet, no filtering solution can guarantee that children will be protected from all offensive material. Sites number in the millions, and addresses change frequently. Even with filtering software and devices installed, educators and parents need to share responsibility for protecting children by thoughtfully planning and supervising their access to the Internet. No software can replace common sense and adult guidance.

It Takes a Village to Write an AUP

Acceptable Use Policies (AUPs) are local policy documents that state a school or district's Internet usage plan. This may include instructional strategies and rationales, but an AUP needs to offer, in concise, clear language that students at all levels understand, guidelines for what is and isn't appropriate when online. They also spell out the repercussions when violations of the policy occur.

AUPs accomplish other objectives as well. They teach students to act responsibly and develop good judgment, and they help protect the educational organization from liability issues. For these reasons, many educators, librarians, and technology media specialists believe they are the cornerstone for defining and controlling Internet use in schools.

Actively involving parents in the creation of a school's AUP is essential. "Patently unsuitable material" in one community might be educationally valid in another. The AUP must reflect the values of the population it hopes to influence in order to be effective. And,



Some products balance filtering by providing appropriate sites for kids.

76

when parents become involved in the decision-making process, they then share responsibility for the Internet activities of their children. For the same reason, both students and parents should sign the agreement. (For more on AUPs, see sidebar, page 46, and *T&L* January 1996, "The Online Connection.")

Providing Safer Havens on the Net

Another strategy teachers use to limit Internet access is to steer students to the "right" places. Hyperlinked bookmark lists and topic-specific homepages linked to selected sites provide students with a path to follow when online, and model the kinds of uses a school deems appropriate.

Ragen Tiliakos, a K-12 technology programs coordinator in Massachusetts, explains how this works: "If we are going to allow students to use Net resources in the classroom, they need to make appropriate decisions. To facilitate correct usage, I supply bookmarks specific to our curriculum and special classroom projects. Children are not allowed to wander. If we search, we might have choices to make, but I am there to facilitate."

The Scholastic Network, which this fall moved to the Web, also uses this technique. The network's staff of educators serve as Website evaluators and create hotlists relevant to topics being covered in curriculum activities, and others of interest to teachers and students.

Commercial online services are another option for schools experimenting with cyberspace. CompuServe, Prodigy, and America Online are smaller worlds with their own policies for dealing with offenders. They have defined education areas, and offer parental control functions that restrict where students can go. Some provide filtering software free to subscribers for forays beyond the system out onto the Internet.

Rating Online Content

In 1996, the passage of the Communications Decency Act (CDA) made it a crime knowingly to use a telecommunications device or computer to send an indecent communication to a child or display an indecent communication in a manner accessible to a child. Although this legislation is now being contested, it has prompted Internet content providers to establish self-rating mechanisms, rather than face government regulation or censorship.

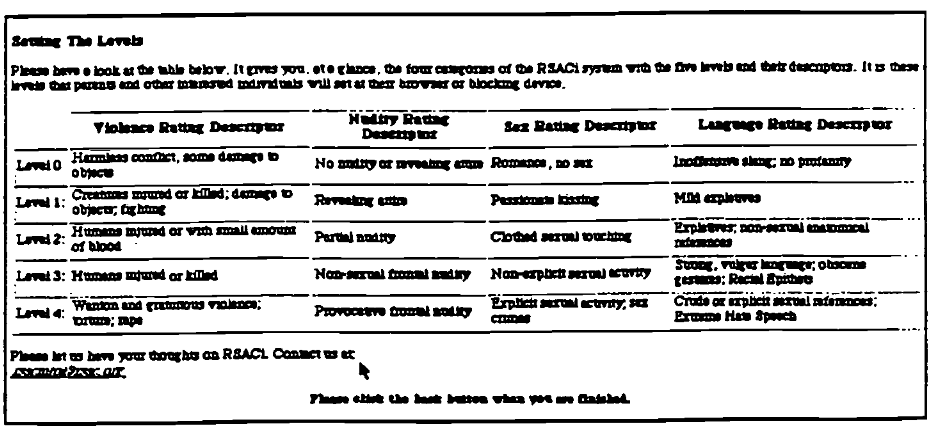
RSACi (http://www.rsac.org) is a new rating system for the Internet developed by the Recreational Software Advisory Council (they also rate software). Webmasters assign ratings to their own sites according to the RSACi standards (see below). Educators, parents, and students can use these standards to make informed choices for access, much the same as movie ratings.

In conjunction with rating systems, a Platform for Internet Content Selection (PICS—http://pics.microsys.com) technology has been developed. PICS technology allows Webmasters and third-party rating bureaus to embed rating labels, like the RSACi, into the HTML code of Web documents. PICS-compatible software can then implement selective blocking in various

BEFORE YOU BUY...

If you decide to purchase filtering software, these questions can help you select the best product for your needs:

- Is it compatible with my computer system(s)?
- Does it work with the browser I will be using?
- Does it block URLs (Universal Resource Locators for Web addresses), as well as the IP (Internet Protocol) numbers for each site address?
- Does it work with news readers, chat, FTP, telnet, and e-mail programs?
- Does it prevent students from divulging personal information while using chat software?
- How comprehensive is the blocking list?
- How often is the list updated, and what is the subscription charge?
- Does it evaluate objectionable terms in context?
- Does it offer a list of "good" sites for students?
- Is it an economical solution for the number of workstations I need to protect?
- Does it allow multiple users?
- Is it easy to deactivate or reconfigure?
- Does it support the PICS standard, including the SafeSurf and RSACi rating systems?



Setting The Levels

Please have a look at the table below. It gives you, at a glance, the four categories of the RSACi system with the five levels and their descriptors. It is these levels that parents and other interested individuals will set at their browser or blocking device.

	Violence Rating Descriptor	Nudity Rating Descriptor	Sex Rating Descriptor	Language Rating Descriptor
Level 0	Harmless conflict, some damage to objects	No nudity or revealing attire	Romance, no sex	Inoffensive slang; no profanity
Level 1:	Creatures injured or killed; damage to objects; fighting	Revealing attire	Passionate kissing	Mild expletives
Level 2:	Humans injured or with small amount of blood	Partial nudity	Clothed sexual touching	Expletives; non-sexual anatomical references
Level 3:	Humans injured or killed	Non-sexual frontal nudity	Non-explicit sexual activity	Strong, vulgar language; obscene gestures; Racial Epithets
Level 4:	Wanton and gratuitous violence; torture; rape	Provocative frontal nudity	Explicit sexual activity; sex crimes	Crude or explicit sexual references; Extreme Hate Speech

Please let us have your thoughts on RSACi. Contact us at [illegible]

Please click the back button when you are finished.

The RSACi rating system will work with browsers to set levels of access for users.

77

AUPS—RESOURCES FOR LEARNING MORE

You don't have to reinvent the wheel when it comes to Acceptable Use Policies. Here are some valuable resources online:

The Internet Advocate
http://silver.ucs.indiana.edu/~lchampel/netadv.htm

Acceptable Use Policies—Defining What's Allowed Online, and What's Not
http://www.classroom.net/classroom/aup.htm

TENET AUP & Other Samples and Resources
http://www.tenet.edu/tenet-info/accept.html

The Internet Explorer
http://silver.ucs.indiana.edu/~lchampel/netadv.htm#Part3

Web66: Part of U of MN Mustang Project
http://mustang.coled.umn.edu/Started/use/Acceptableuse.html

Indiana Department of Education's List of State Requirements for Public School Internet Acceptable Use Policies and Guidelines
http://ideanet.doe.state.in.us/LearningResources/aupreg
The Indiana guidelines reach beyond student access to appropriate Internet sites to address copyright, intellectual property, and personal safety issues.

WEB RESOURCES WITHOUT WEB CONNECTIONS

These are alternative resources if you don't have an Internet connection or are not ready to let students loose on the Web. They provide access to selected sites from the local desktop.

iCD Educator's Internet CD Club
http://www.classroom.net/ICD/
Wentworth Media, Inc.; (800) 638-1639
One-year subscription of four CDs filled with actual Web sites organized by subject. CDs also include lesson plans, activity sheets, and teaching tips. $79.

WebWhacker
http://www.ffg.com/whacker.html
ForeFront, Inc.; info@ffg.com, (713) 961-1101
"Whacks" single pages, groups of pages, or entire sites from the Web and stores them on your hard drive. Students can surf from the local desktop without an Internet connection. $49.95.

ESTABLISHING A MINDSET FOR INTERNET USAGE

These sites can help schools take a thoughtful approach to Internet safety for their students.

12 Reasons Why Schools Should Avoid Filtering
http://www.pacificrim.net/~mckenzie/mar96/whynot.html

Child Safety on the Information Superhighway
http://www.larrysworld.com/child_safety.html

Information Filtering Resources
http://www.enee.umd.edu//medlab/filter/filter.html

Information Highway Parental Empowerment Group
http://www.realaudio.com/contentp/rabest/IHPEG.html

Parental Guidance
http://www.pguidance.com/

The Internetworked School: A Policy for the Future
http://www.covis.nwu.edu/Papers/Fishman&Pea1993.html#Introduction

What's a (Teacher, Parent, Administrator) to Do?
http://sunsite.unc.edu/cmc/mag/1995/jun/stratford.html

ways. One is to build it into the browser, a solution both Microsoft and Netscape have announced they will support. A second method—used in filtering software products—is to perform this operation as part of each computer's network protocol stack. A third possibility is to perform the operation somewhere in the network itself, for example at a proxy server.

Each option can affect efficiency, ease of use, and security. For example, a browser solution could be circumvented by installing a different browser. The network-level control may be the most secure, but could create a performance bottleneck if not implemented carefully.

Where to Head From Here

Even to discuss filtering and controlling the Internet requires references from myriad Web sites. There isn't a more accessible or current library of information anywhere to help us think about and develop solutions—which will need revision as technology changes.

Cyberspace is a work in progress, a frontier with boundaries that are yet to be glimpsed, let alone defined. Proceed with determined caution and good sense, but do proceed—and enjoy.

■ *Mary Anne Mather is a former classroom teacher who serves as an educational consultant for technology and life-long learning. She is a frequent contributor to* Technology & Learning *magazine.*

The Educator's *Ultimate* World Wide Web Hotlist

By Odvard Egil Dyrli

The World Wide Web offers plenty for you and your students, but do you know where to find what you need? Here,* T&L*'s telecommunications columnist shares his "ultimate hotlist" for enriching and extending your curriculum.

Imagine this: You're an American history teacher, trying to awaken your students to the devastation caused by the Civil War. Wouldn't it be great, you think, if the soldiers could speak directly to the students. What you really need is some letters home written by the men who served....

Those letters are a click away on the Internet's World Wide Web. After only a few short years, the Web has become the premier place online for finding multimedia resources and connecting students to real-world events. Teachers have discovered that the Web makes possible new levels of individualization. and encourages collaborations that take students far beyond the classroom (see "Surfing the World Wide Web to Education Hot-Spots." *Technology & Learning*, October, 1995).

But what's needed is a guide that points the way to the extensive resources already available online—the documents, photographs, maps, video clips, sound bites, references, and teaching materials for every level and content area. That's where this article comes in. It's called the educator's "ultimate" hotlist because it represents a comprehensive compendium of online educational resources including lesson plan collections; curriculum resources from schools, colleges, government agencies, and commercial organizations; cooperative online projects; and Web-based libraries, museums, and communications media. Plus, we've included the URLs of powerful tools you can use to search the Web on your own. We hope you will use this article as a continuing reference.

Sites, of course, can appear, move, or disappear suddenly. Fortunately, many valuable educational materials are linked to online "centers" that are comparatively stable. To ensure accuracy, all addresses have been verified, and the sites were selected based on the quality of their offerings.

Lesson Plan Sources

While you can find lesson plans at a variety of Web sites, including some listed in other categories, the following locations have particularly strong lesson plan collections.

- The AskERIC Virtual Library (http://ericir.syr.edu)
- Columbia Education Center's Mini Lessons (http://youth.net/cec/cec.html)
- Connections+ (http://www.mcrel.org/connect/plus)
- E-Link, Environmental Education on the Internet (http://nceet.snre.umich.edu)

Search Engines

Search engines scour the Web based on content words or phrases that you specify. Each of the choices below has unique search area strengths, so it is good to try several.

- Alta Vista (http://altavista.digital.com)
- Excite (http://www.excite.com)
- InfoSeek (http://www.infoseek.com)
- Lycos (http://www.lycos.com)
- WebCrawler (http://www.webcrawler.com)
- c|net search.com (http://www.search.com)
- MetaCrawler (http://www.metacrawler.com)

Information Indexes

Information indexes use topic menus and submenus to narrow searches until you find resources of potential interest. Yahoo is by far the most comprehensive and well-known information index, but there are other options such as Kids Web, which is tailored for students.

- Yahoo (http://www.yahoo.com)
- Yanoff's Internet Services List (http://www.spectracom.com/islist)
- Cool School Tools (http://www.bham.lib.al.us/cooltools)
- Kids Web (http://www.npac.syr.edu/textbook/kidsweb)
- Yahooligans, The Web Guide for Kids (http://www.yahooligans.com)

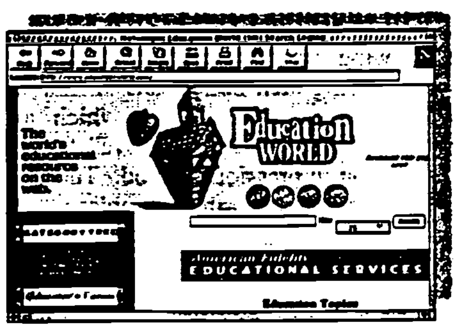
Curriculum Resource Centers

There are many curriculum centers maintained online by various organizations including professional associations, foundations, government agencies, colleges, and universities (see the next two sections for centers maintained by K-12 schools and commercial companies). Some of these are collections of general educational resources, but others are specialized by content area or teaching level.

The curriculum centers listed below are grouped by general content area emphases—note that several sites combine math and science resources—or may contain links to Web sites of value to a broad range of K-12 teachers. Those listed under "general curriculum" include resources in several content areas, and are usually divided by subject.

General Curriculum

- Curricular Resources and Networking Projects (http://www.ed.gov/EdRes/EdCurric.html)
- Education World (http://www.education-world.com)

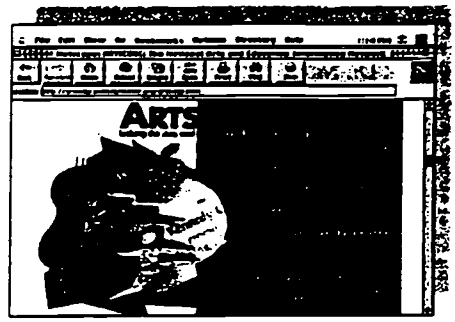


Education World

- EdWeb (http://edweb.cnidr.org)
- Internet Connections (http://mcrel.org/connect)
- LiveText Educational Resources (http://www.ilt.columbia.edu/k12/livetext)
- The Schoolhouse (http://www.nwrel.org/school_house)
- Web Sites and Resources for Teachers (http://www.csun.edu/~vceed009)
- World Education Exchange (http://www.hamline.edu/~kjmaier)

The Arts

- ArtsEdge (http://artsedge.kennedy-center.org/artsedge.html)
- ArtsEdNet, an online service for K-12

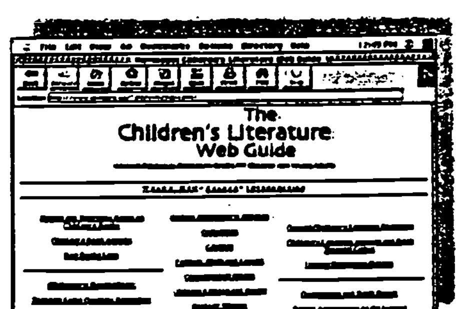


ArtsEdge

arts education (http://www.artsednet.getty.edu)
- Dance Directory (http://www.cyberspace.com/vandehey/dance.html)
- Music Education Online (http://www.geocities.com/Athens/2405/index.html)
- The Music Educators Home Page (http://www.athenet.net/~wslow)
- The Puppetry Home Page (http://www-leland.stanford.edu/~roseage/puppetry/puppetry.html)

Language Arts and Literature:

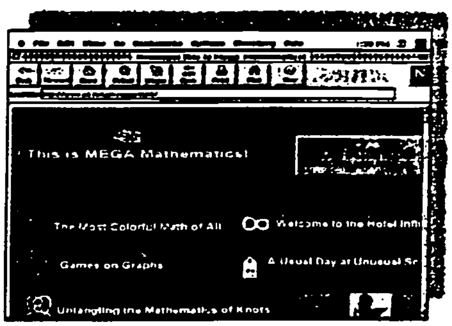
- The On-Line Books Page (http://www.cs.cmu.edu/Web/books.html)
- The Children's Literature Web Guide (http://www.ucalgary.ca/~dkbrown/index.html)
- The Complete Works of William Shakespeare (http://the-tech.mit.edu/Shakespeare/works.html)
- Multicultural Book Review (http://www.isomedia.com/homes/jmele/homepage.html)
- Poetry (http://english-www.hss.cmu.edu/poetry)
- Resources for English Teachers (http://nickel.ucs.indiana.edu/~lwolfgra/english.html)



The Children's Literature Web Guide

Mathematics

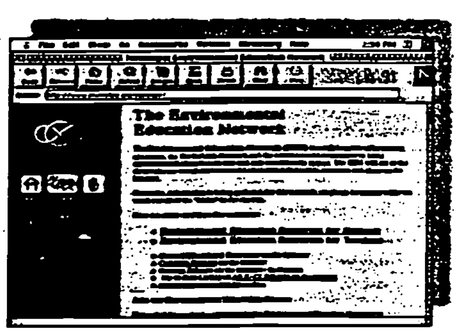
- Ask Dr. Math (http://forum.swarthmore.edu/dr.math/dr-math.html)
- Calculators On-Line Center (http://www-sci.lib.uci.edu/HSG/RefCalculators.html)
- Cornell Math and Science Gateway for High School (http://www.tc.cornell.edu/Edu/MathSciGateway)
- The Geometry Center (http://www.geom.umn.edu)
- The Math Forum (http://forum.swarthmore.edu)
- MegaMath (http://www.c3.lanl.gov/mega-math)



MegaMath

Science

- Eisenhower National Clearinghouse (http://www.enc.org)
- The Environmental Education Network (http://www.envirolink.org/enviroed)
- Health Resources (http://www.kent.wednet.edu/curriculum/health/health.html)
- SciEd: Science and Mathematics Education Resources (http://www-hpcc.astro.washington.edu/scied/science.html)



The Environmental Education Network

- Science Learning Network (http://www.sln.org)
- Space Educators' Handbook (http://tommy.jsc.nasa.gov/~woodfill/SPACEED/SEHHTML/seh.html)

Social Studies

- American History Archive Project (http://www.ilt.columbia.edu/k12/history/aha.html)
- History/Social Studies Web Site for K-12 Teachers (http://execpc.com/~dboals/boals.html)
- Lesson Plans and Resources for Social Studies Teachers (http://www.csun.edu/~hcedu013/index.html)
- Online Resources (http://socialstudies.com/online.html)
- Social Studies (http://www.kent.wednet.edu/curriculum/soc_studies/soc_studies.html)
- Social Studies Sources (http://www.halcyon.com/howlevin/social.studies.html)

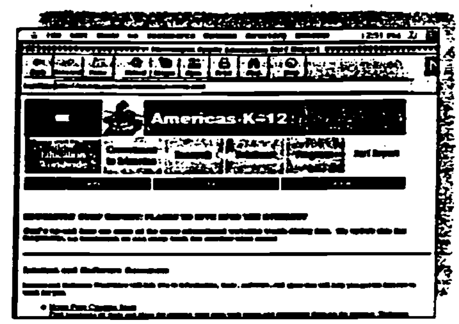
K-12 School Curriculum Collections

Growing numbers of K-12 educators are sharing their collections of links to Web resources, many of which are maintained as "labors of love" for the common professional good. The following are noteworthy examples.

- Armadillo's K-12 WWW Resources (http://chico.rice.edu/armadillo/Rice/K12resources.html)
- Carrie's Sites for Educators (http://www.mtjeff.com/~bodenst/page5.html)
- Integrating the Internet (http://www.indirect.com/www/dhixson)
- Jan's Favorite K-12 Resources & Projects (http://badger.state.wi.us/agencies/dpi/www/jans_bkm.html)
- Lane's Homepage (http://www.ebicom.net/~lane)
- Kathy Schrock's Guide for Educators (http://www.capecod.net/Wixon/wixon.htm)
- Vose School Education Resources Page (http://www.teleport.com/~vincer)
- Web Site for Busy Teachers (http://www.ceismc.gatech.edu/BusyT)

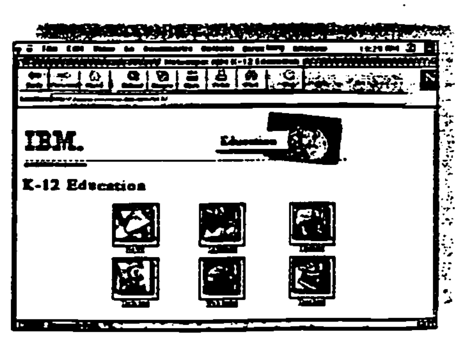
Commercial Curriculum Collections

Many companies that provide goods and services to schools now offer links to curriculum resources—their own and others—at their Web locations.



Apple Education Worldwide Surf Report

- Apple Education Worldwide Surf Report (http://ed.info.apple.com/education/surfrep.html)
- Cisco's Virtual Schoolhouse (http://sunsite.unc.edu/cisco/schoolhouse.html)
- Classroom Connect on the Web (http://www.classroom.net/cgi/rofm/eduFind.html)
- Educational Software Institute Online (http://www.edsoft.com/esi)
- Discovery Channel School (http://school.discovery.com)
- Global Schoolhouse (GSH) (http://www.gsh.org)
- Global Network Navigator (GNN) K-12 Education (http://gnn.com/gnn/wic/wics/ed.teach.html)
- Houghton Mifflin Education Place (http://www.eduplace.com)
- IBM K-12 Education (http://www.solutions.ibm.com/k12)
- Internet Learning Sites (http://www.



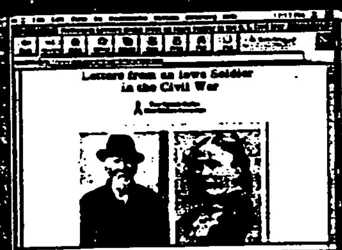
IBM K-12 Education

81

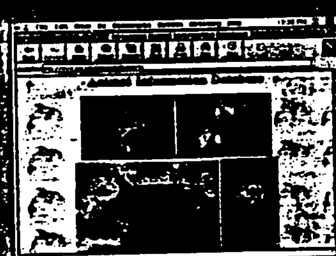
What Makes the Hottest Hot?

The following examples, drawn from the sites in this article, illustrate the range of high-quality materials available to enhance your curriculum.

- **23 Peaks Expedition** (http://www.23peaks.com). Through journal entries and photographs, follow a team of explorers as they climb the highest peak of each nation in North, Central, and South America.
- **Benjamin Franklin: Glimpses of the Man** (http://sln.fi.edu/franklin). Review the work of one of our Founding Fathers—as a scientist, inventor, statesman, printer, philosopher, musician, and economist.
- **Cap Web, A Guide to the U.S. Congress** (http://policy.net/capweb/congress.html). Explore our government via links to the Senate, House of Representatives, and the Library of Congress, with additional resources on the executive and judicial branches of the federal government.
- **Electronic Field Trip to the United Nations** (http://www.pbs.org/tal/un). Tour the UN at its half-century mark, with background history, and the "UN in action"—major achievements, world trouble spots, daily press summaries—with classroom activities and links to related resources.
- **Gallery of Interactive Geometry** (http://www.geom.umn.edu/apps). Put theory into action at this site where math decisions affect geometric models on the screen.
- **Letters From an Iowa Soldier in the Civil War** (http://www.ucsc.edu/civil-war-letters/home.html). Read three years' worth of letters written by an army clerk describing rich details of the war and living conditions in Union camps—with maps and links to related Civil War sites.



- **The Nine Planets** (http://seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html). The sky's no limit at this illustrated tour of the planets and moons of the solar system, with links to sites on planetary research.
- **The Pelagic Shark Research Foundation** (http://www.ugraf.com/pelagic/index.html). "Everything you want to know about sharks...and more" you'll find right here—current research on their biology and history, plus links to shark sites throughout the world.
- **The New South Polar Times** (http://205.174.118.254/nspt/home.htm). Discover the Antarctic through photographs and experiences shared by members of the Amundsen-Scott South Polar Station.
- **Sea World/Busch Gardens Animal Information Database** (http://www.bev.net/education/SeaWorld). Talk with the animals—or at least learn more about them—at this site, with links to related educational resources and information on zoological careers.
- **Volcano World** (http://volcano.und.nodak.edu). An explosion of volcano-related information, this site lets you learn about different types of volcanoes, visit volcanic parks, and study active volcanoes throughout the world.
- **WeatherNet** (http://cirrus.sprl.umich.edu/wxnet). All the weather information you need is here, including thousands of forecasts and images, and links to weather maps, storm centers, and live weather cameras.



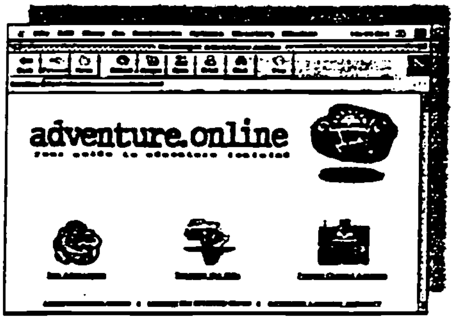
pierian.com/oasis/gazette/gazette.html)

- Latitude28 Schoolhouse (http://www.indy.opennet.com/schoolhouse)
- Macmillan/McGraw-Hill Schoolhouse (http://www.mmhschool.com)
- Pitsco Technology Education (http://www.pitsco.com/wel.html)
- School.Net (http://k12.school.net)
- *...hnology & Learning* (http://www....learning.com)

Sources for Online K-12 Projects

Cooperative projects give students the opportunity to study a topic with participants from around the world—and hone telecommunications skills at the same time. The following are the major Web sites for finding and proposing online educational projects of all sorts.

- Academy One/National Public Telecomputing Network (http://www.nptn.org/cyber.serv/AOneP)
- Adventure Online (http://www.adventureonline.com)
- Electronic Emissary Project (http://www.tapr.org/emissary)
- Electronic Schoolhouse (ESH) (http://town.pvt.k12.ca.us/Collaborations/e-school/e-school.html)
- Global SchoolNet Foundation (GSN)



Adventure Online

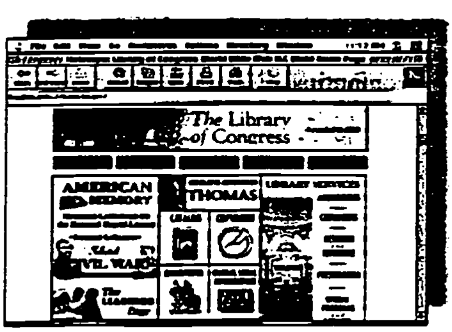
(http://www.gsn.org)

- Hilites (http://www.gsh.org/tch2tch/hilites.htm)
- Intercultural E-Mail Classroom Connections (IECC) Projects (http://www.stolaf.edu/network/iecc)
- International Education and Resource Network (I*EARN) (http://www.iearn.org/iearn)
- Internet Projects Registry (http://www.gsn.org/gsn/proj/index.html)
- KIDLINK/KIDPROJ (http://www.kidlink.org/KIDPROJ)
- Online Class (http://www.usinternet.com/onlineclass)
- Quest, The NASA K-12 Internet Initiative Page (http://quest.arc.nasa.gov)
- NASA SpaceLink (http://www.spacelink.msfc.nasa.gov)
- NASA SeaWiFS Projects—including the Jason and Ocean Planet Projects (http://seawifs.gsfc.nasa.gov)

Libraries and Museums

The Web allows teachers and students to visit libraries, museums, and exhibits throughout the world, and do research electronically.

- Exploratorium ExploraNet (http://www.exploratorium.edu)
- Expo, WWW Exhibit Organization



Library of Congress

(http://sunsite.unc.edu/expo)

- Franklin Institute Science Museum (http://www.fi.edu)
- Hands On Children's Museum (http://www.wln.com/~deltapac/hocm.html)
- Hands-on Science Centers Worldwide (http://www.cs.cmu.edu/~mwm/sci.html)
- Internet Public Library (http://ipl.sils.umich.edu)
- Library of Congress (http://lcweb.loc.gov)
- National Air and Space Museum (http://www.nasm.edu)
- On-Line Exhibitions and Images—note that the address is expressed numerically (http://155.187.10.12/fun/exhibits.html)
- Planet Earth Home Page (http:// www.nosc.mil/planet_earth/info.html)
- The Smithsonian (http://www.si.edu)
- United States Holocaust Memorial Museum (http://www.ushmm.org)
- Virtual Tourist (http://www.vtourist.com)
- WebMuseum Network (http://sunsite.unc.edu/louvre)

Communications Media

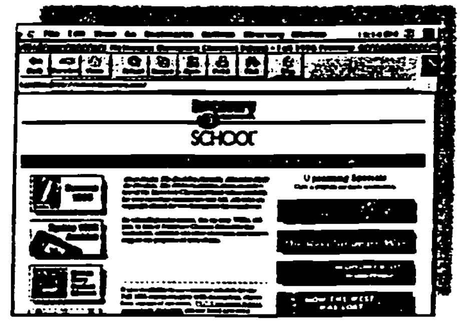
Valuable channels for investigating topics in depth are the online links to communications media including book publishers, magazines, newspapers, and television programs.

- CNN Interactive (http://www.cnn.com)
- Discovery Channel (http://www.discovery.com)
- Hotlinks (online newspapers) (http://www.naa.org/hot)
- National Geographic Society (http://www.nationalgeographic.com)
- PBS Online (http://www.pbs.org)
- Publishers' Catalogs Home Page (http://www.lights.com/publisher)
- Books A to Z (http://www.booksatoz.com)
- The Nando Times (http://www2.nando.net)

Especially for Kids

The following sites were developed specifically for children, and offer a variety of educational resources, as well as recreational materials including interactive stories, games, and puzzles.

- Berit's Best Sites for Children (http://www.cochran.com/theosite/KSites.html)



Discovery Channel

- Book Nook (http://www.schoolnet.ca/english/arts/lit/booknook)
- Cool Places for Kids (http://www.alaska.net/~steel/coolpls.html)
- Global Show-n-Tell (http://www.telenaut.com/gst)
- KidNews (http://www.vsa.cape.com/~powens/Kidnews.html)
- Kid Pub (http://www.en-garde.com/kidpub)
- Kids on Campus (http://www.tc.cornell.edu/Kids.on.Campus/WWWDemo)
- MidLink Magazine (http://longwood.cs.ucf.edu:80/~MidLink)
- The Kids on the Web (http://www.zen.org/~brendan/kids.html)
- The Kids Web (http://www.lws.com/kidsweb/links.htm)
- Uncle Bob's Kids' Page (http://gagme.wwa.com/~boba/kidsi.html)

Schools on the Web

A valuable way to see how K-12 teachers are using online resources for assignments, projects, teaching units, and even courses, is to visit school Web sites. The following indexes will link you directly to schools on the Web throughout the United States and abroad.

- HotList of K-12 Internet School Sites (http://www.sendit.nodak.edu/k12)
- School.Net Navigator (http://school.net/go/go.g_na_us.html)
- Web66—Schools on the Web (http://web66.coled.umn.edu)

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Getting Equipped and Staying Equipped, Part 1: Grappling with Obsolescence

By Gregory Jordahl

As you take stock of the computers you have on hand, does it look like a retrospective on the history of computing? Are older computers taking up precious closet space? Have you been wondering which ones you can use and which to let go of? Read on for the lowdown on how to get the most from all your computers, and how to get rid of the ones you just can't use any longer.

You're charged with preparing your students for the Information Age. Yet. emerging computer technology continues to gallop ahead of the tools your school district has already purchased for this crucial and demanding task. The latest educational programs all seem to require more memory. larger hard disks. and everything from sound cards and stereo speakers to CD-ROM drives and high-speed modems. However. instead of expanding to meet these accelerating demands. your school's computer budget has most likely declined over the past few years. Under such conditions. how do you keep your technology program from lapsing into obsolescence?

In this article. the first of two parts. you'll learn strategies for maximizing the hardware you have on hand through specialized uses. upgrades. and inexpensive supplements. You'll also find resources to help you sell. donate. or trade in those computers you're ready to replace. Finally, we'll begin looking at leasing options for acquiring new technology in a way that postpones obsolescence.

Upgrading Older Computers: Is It Worth It?

Upgrading various computer components so that they perform more like newer ones is one method for leveraging the investment you've already made in technology. There are several ways to upgrade older computers. representing a spectrum of performance improvements. from increasing the random access memory (RAM), a relatively inexpensive method; to adding accelerator cards; using an external CD-ROM or hard drive; or the more radical replacement of central processing units (CPUs), chips, and motherboards. But there's more to consider than swapping one part for another.

Schools should carefully evaluate several cost and performance issues before considering upgrades. While the price of upgrade products might seem inexpensive when compared to the cost of a new system, analyze how many components you'll need to upgrade to realize significant gains. Many new applications, for example, require not only a fast processor, but also a great deal of RAM, a fast CD-ROM drive, state-of-the-art graphics, and so on. If it comes to upgrading all of these components at once, you may find yourself paying almost as much as you would for a new system. In such cases, it may be better to spend a few hundred dollars more to purchase a new computer and find a less demanding setting for the older models (see section below).

On the other hand, if adding some extra RAM or upgrading the CPU in a relatively recent model is enough to turn it into a state-of-the-art machine, then it may make sense to upgrade instead of buying new systems. Be sure to find out if the upgrade product you're interested in is compatible with your computers and with your classroom applications, as few upgrade suppliers are likely to have tested their products with every educational software title on the market.

New Uses for Old Machines

Even if you decide not to upgrade your older computers, you may be able to put them to work in new ways. While they may not run the newest software you plan to buy, many of these machines have life in them yet. Gahanna Lincoln High School in Gahanna, Ohio, grappled with this issue when they installed new 486 computers in their computer labs, bumping out a host of 286s.

It didn't take long for the displaced ... find new homes. A dozen

UPPING THE PROCESSOR

Considerations in Upgrading PCs

Many, though not all, 386 processors can be upgraded to 486 status. (Note: 386SX processors built before 1991 cannot be upgraded.) Before you upgrade, find out about your computer's video subsystem and RAM, as these can limit the effectiveness of a CPU upgrade. The upgrade candidate should have at least four megabytes of RAM, an 80-megabyte or larger hard drive, and reasonably up-to-date subsystems.

If your school is buying new 486 computers advertised as being "Pentium upgradable," be aware that an upgrade chip was not yet available at press time, although it is planned for later this year. Factors such as bus design (the path across which data travel in a computer) and memory will influence the effectiveness of such an upgrade.

Many 486 computers use older ISA bus technology instead of the faster PCI bus used by Pentiums. For an upgrade, this means that even though the processor will be operating at a higher speed, the bus will still be handling data at the slower 486 speeds. The way in which memory is installed in the 486 also affects its upgradability. Most 486s have four slots for inserting SIMMs (memory modules). So if the SIMMs in a four-megabyte 486 are each one megabyte, there's no space to add the additional four megabytes needed to bring the machine up to Pentium standards. Your only choice will be to replace the one-megabyte SIMMs with two-megabyte SIMMs, increasing the cost of the upgrade.

Companies With PC Upgrade Products

Prices for upgrades generally range between $250 and $400. A few of the companies currently offering 486 processor upgrade products include the following:

- Cyrix Corp. (Richardson, TX; (800) 848-2979)
- Compaq (Houston, TX: (800) 345-1518)
- Evergreen Technologies (Corvalis, OR; (800) 733-0934)

From Mac to PowerMac

Apple has made it clear that the PowerMac is the Mac of the future, and many of Apple's newer LC and Quadra models have upgrade paths available.

Mac LCs are upgrade candidates if they have a 68040 processor. With Apple's own upgrade card, available for about $560 (800-800-2775), the 040 chip is pulled off the logic board and plugged into the upgrade card, which is then plugged into the 040 slot, turning the machine into a dual-processor machine. Both processors are not active at the same time, but you can switch between them depending on the application you're using. Processor upgrades for the LC are also available from DayStar Digital (800-962-2077).

If you're using a Quadra, you may have a choice between upgrading the CPU or the entire logic board—an approach which gives you a greater overall performance boost. The logic board costs from $1,048 to $1,897, depending on the model you choose, and works only with some Quadra models.

Since the minimum RAM requirement for the PowerMac is eight megabytes, an upgrade may also involve buying additional RAM.

went to the social studies department, where they were networked and put to work helping students learn about their world. "We put software such as *PC Globe* and *PC USA* on the file server and showed students how to use the network as a geography database," says district computer coordinator Randy Allen (who was *Technology & Learning*'s first-ever Teacher of the Year).

Another 25 were installed in a vacant classroom that became home to the school's highly successful writing lab. The lab is open throughout the school day for teachers to use with classes, or for individual students who want to complete assignments during study hall. An additional lab equipped with both 286 computers and older Macintoshes is staffed every hour by an English teacher who is available to help students with their writing projects, regardless of the class in which they were assigned.

"The teachers in the English department have told us that the difference is like night and day in terms of how much the kids write and how well they write," says Allen. "And since all the students have access to word processing technology, most of our teachers will no longer accept papers that are hand-written."

Apple II computers also lend themselves to this kind of niche usage. If at least some of the machines have 3.5" disk drives it's quite easy to set up a word processing lab, using the Apple IIs for the actual writing and adding in a few Macintoshes dedicated to page layout. If you're determined to do it totally with Apple II technology, there are products to help make it more attractive to students. Inkjet printers, for example, instead of dot-matrix models, provide more polished-looking results and make the room a quieter place in which to work. (Schools interested in that approach might consider using *AppleWorks 4.0*, which features built-in Apple II support for the Hewlett-Packard Deskjet, but for best results you'll need to add RAM.) A printer sharing device is another writing lab enhancement well worth considering, regardless of the computers being used. It eliminates long lines of students waiting to print their assignments by queuing documents and printing in the background.

Inexpensive Technology Supplements

In addition to repurposing older computers, you can supplement your program with less costly "special use" technologies, allowing you to use the money you save for emerging systems that expand your program. Ramona Middle School in Ramona, California, is using this strategy to guide its purchase decisions as the school faces replacing its Apple II computers, which are wearing out after several years of nearly constant use.

"The disk drives in particular are getting very unpredictable," says assistant principal Susan Brooks. "Students are getting frustrated because their work isn't always being saved properly."

In searching for a solution, Brooks realized that the budget probably wouldn't allow for replacing the Apple IIs with new Macintosh or PC systems. Besides that, since the computers were being used primarily for word processing, buying full-featured computers didn't seem to be the most cost-effective answer anyway. If the school could find an inexpensive way to provide students with reliable word processing systems, Brooks reasoned, there likely would be funds left over with which to buy more advanced equipment for multimedia applications and desktop publishing. With this goal in mind, the school is looking at laptop word processors.

Such devices, which cost about $300, look like keyboards with very small display screens above the keys.

(continued on page 35)

RESOURCES FOR CLEARING OUT THE OLD MODELS

If you need help figuring out how much to charge for your older computers, try shareware recently released by the American Computer Exchange Corporation (Atlanta, GA; (404) 250-0050). Available in both Macintosh and Windows versions, this program will estimate the value of any used Macintosh or PC after basic configuration information has been entered. The program is available from America OnLine, CompuServe, and many local bulletin board systems. The Exchange also maintains a database of buyers and sellers, and serves as a "middleman" for transactions as well.

The Boston Computer Exchange (617-542-4414) will buy your school's old equipment and then re-sell it. For those districts hoping to get rid of machines that are only a few years old, IBM provides a similar service with help from a partner called IBC. Any organization that has ten or more units (IBM or other brands) with current market value can call for a bid request form. Fill out the number of units, and the model and configuration information, and IBC within 48 hours will make a bid that stands for ten

Students enter text but can't do much manipulation or editing. Some systems let students save work, while others store it only temporarily before it gets ported to a computer's hard drive. These systems extend the usefulness of Macs or PCs by letting more kids write, while saving the "real" computers for text formatting and page layout, functions which the dedicated word processors cannot accommodate.

One community that has already taken this approach is the Boulder Valley Public School District in Boulder, Colorado. They've acquired over 800 laptop word processors, and school personnel there say that the volume of student writing has since increased by between 50 and 70 percent. According to Len Scrogan, the district's technology coordinator, getting the most per-student impact out of limited financial resources was a primary reason the district chose this approach. They've chosen the AlphaSmart word processor from Intelligent Peripherals, but there are several other options as well. (See sidebar.)

days. IBC will also bid for computer parts, and can tailor contracts to the needs of larger accounts. For details, contact IBC at 908 Providence Highway, Dedham, MA 02026; (617) 320-0123.

Schools with a link to the Internet might consider selling their used technology through the Global Recycling Network, a worldwide information service set up to help organizations buy and sell used goods of all types. Subscribers to this service pay $30 per month to post unlimited "sell" or "buy" requests and to browse for buyers or sellers using keyword searches. For information, send e-mail to info@grn.com or write 2715A Montauk Highway, Brookhaven, NY 11719; (516) 286-5580.

The National Cristina Foundation is a not-for-profit organization that uses donated computers to train disadvantaged populations, students at risk, and people with disabilities. The foundation will accept any IBM or Apple system that is in working order. Many of the early intervention programs that the foundation works with are particularly interested in Apple II models. For more information, write to 591 West Putnam Avenue, Greenwich, CT 06830 or call (800) 274-7846.

The East West Development Foundation is a non-profit agency that distributes used computer hardware to charities within the United States and to developing countries throughout the world. The group is primarily interested in IBM (286 and above) and Macintosh (SE and above) systems. For more information, write to 55 Temple Place, Boston, MA 02111; (617) 542-1234.

Getting Rid of What You Can't Use

When you finally do decide that your older machines have outlived their usefulness, you have essentially two choices: to sell or to donate. While it's important to avoid the ill will that can result if you sell or donate outmoded equipment to an unsuspecting audience, there are many recipients who truly are interested in what your school can no longer use.

The Hicksville Union Free School District, in Hicksville, New York, for example, finds willing buyers for its old equipment at a garage sale held every spring. "We put all the items in a shed behind the school," says Hicksville's superintendent, Stuart Opdahl. "The computers usually sell within a couple of hours." Such an approach can generate much-needed money for new purchases while clearing out your school storage closets. A note of caution however: Before you plan the sale, look into any constraints imposed by your district, or by funding mechanisms such as Chapter I. If you purchased the computers with specially targeted funds, selling them may not be permitted, or only within certain parameters.

Besides selling equipment, schools can also donate it to local organizations. Carefully considering what you have to give and how it can be matched to the community's needs is a key first step in planning your donation. For example, you might determine that a local social service agency, such as one that serves the elderly, could use machines for specialized purposes, such as word processing, telecommunications, or even computerized chess or checkers. Or consider organizations that serve the disabled, the homebound—or any other group for whom an older computer could serve as an important communications link to the outside world. Students could serve as teachers, showing new users how to work with donated software or how to connect to the Internet. In this way, not only do you clear out the machines, you also create a learning opportunity that reaches beyond the students.

The Allure of Leasing

Once you're ready to put whatever money you've saved from careful disposition of older computers into the purchase of new equipment, leasing is one way to get up-to-date technology quickly, and to keep it current—at least for the duration of the lease.

Savvy schools use leases as a means of minimizing obsolescence. For instance, many schools are able to add new equipment throughout the leasing period with help from the equity built up through payments. "The amount that a school has paid on the lease principal during the first year can be used to purchase a portion of the equipment and to add new equipment to the lease," explains Suneet Paul, who manages the Apple Education Finance Program. "For example, if the school signed a three-year, $100,000 lease, by the end of the first year they would have built up approximately $31,000 equity. They could buy a third of the equipment at that point and add another $31,000 worth of hardware to the lease, which would then be extended for another year, keeping their payments the same. In this way, the school could annually update their technology without increasing their annual budget."

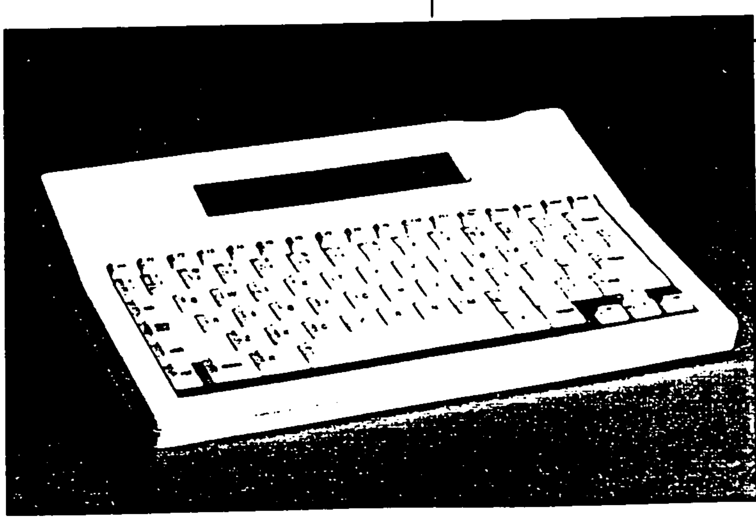
Another option is to negotiate for a "lease to replace" option, like a car lease, where at the end of the term, you do not own the equipment at all, but instead roll over into a new lease, with new hardware. This is particularly appealing if you can negotiate a good deal based on the fact that the original equipment reverts to the leasing company at the end. While the leasing company may have little desire to own the older models, the likelihood of keeping your school on as a long-term partner might be enough to convince them to cut you a good deal.

■ *Gregory Jordahl is a freelance writer who specializes in new technology for education and business.*

Words Are Cheap

Here are some laptop word processors to consider:

- The AlphaSmart Pro, from Intelligent Peripherals (Cupertino, CA; (408) 252-9400), works with Apple IIGS, Macintosh, and IBM-compatible computers, and can save up to 64 pages of text. It sells for $279.
- The Laser PC4 from Perfect Solutions (West Palm Beach, FL; (800) 726-7086) stores up to 15 pages of text and can transfer files to IBM, Macintosh and Apple II systems. It sells for $239.
- The $299 DreamWriter from NTS Computer Systems (Maple Ridge, B.C., Canada; (800) 663-7163) stores up to 30 pages of text and is IBM- and Macintosh-compatible.



The AlphaSmart from Intelligent Peripherals is a low-cost keyboard word processor that works with the Macintosh.

Editor's Note: Next month, as *T&L* helps you continue to plan your technology purchases, look for more on leasing, as well as other ways to stretch your technology dollars. Additionally, we'll explore a variety of approaches to fundraising and partnering with businesses to bring technology resources to your school.

Standards for School Networking

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To assure the interoperability, reliability and maintainability of a school district's network, certain standards should be established and followed. This article categorizes these standards and provides a list for designers and implementers. The standards were developed expressly for, and adopted by, the Pittsburgh Public Schools as district policy.

> A prudent recommendation is to use Category 5 Twisted Pair wire.

The goal of this article is to provide a simple and concise set of standards that school districts can use to facilitate the process of designing and implementing electronic data networks. Such networks are likely to be in increasing demand as new resources and educational applications are developed for the global Internet and as wide area networking increasingly permeates the society at large.

In planning the physical connectivity of a school district it is important to develop a broad view of the district's network architecture, including not only the infrastructure of the local area network and Metropolitan Area Network (MAN), but also the set of applications that will initially operate over the network. This ensures that the network will have adequate bandwidth for proposed applications, that these applications will be interoperable, and that sufficient funds will be available for all necessary hardware and software.

The Layered Approach

Network design can be greatly simplified if one thinks of the network as a set of levels, with each level isolated from those above and below it, and communication to adjacent levels is through a well-defined interface. This architecture allows one to design elements of the network without having to worry about unexpected interactions, incompatibilities or inefficiencies.

The idea of a layered architecture has been carried to a formal extreme in the International Standards Organization's (ISO's) definition of seven layers of network structure. Since the ISO definition is more formal than we need in this article, we simplify it by referring to three layers, each of which represents several ISO layers. The three layers are as follows:

- **Physical Layer.** This refers to the physical medium through which signals are carried, be it copper wire, fiber optic cable or wireless transmissions.
- **Protocol Layer.** This refers to protocols used to encapsulate information and present it to applications running on devices attached to the network. These protocols define a set of rules that enable different entities on the network to communicate with each other.
- **Application Layer.** This refers to programs that run on computers attached to the network and provide specific tools or services to users of the network.

Physical Layer

Currently, computer applications that operate on LANs in the school environment can be handled with inexpensive copper wiring. Present technology allows for operation at speeds of 10 million bits per second, and it is possible to install wiring capable of transmitting data at much higher speeds. A prudent recommendation is to use this type of wiring, known as Category 5 Twisted Pair wire. This choice combines economy of hardware and ease of installation with a reasonable allowance for future expansion.

The wiring plant should be a structured one, with a central wiring closet to which classroom or office runs return. Large sites will require multiple closets connected by backbones, which can be constructed from either Category 5 copper or fiber optic cable. Sites of intermediate size may also be served economically with coaxial cable runs in some network segments.

Each classroom should have a minimum of three network drops. These drops can accommodate three devices, including classroom telephones as needed. Rooms requiring more devices can use fan-out hardware to accommodate as many devices as might be desired. The choice of three drops is a compromise between convenience and cost and is based upon experiences with this wiring architecture in Pittsburgh and elsewhere. Some redundancy is desirable for ease of expansion, flexibility and added network integrity.

> **one should plan to accommodate a mix of technologies at the physical layer of a MAN**

The preceding paragraphs refer to premise (building) wiring or to the structure of the local area network within a given school. To connect schools together and provide access to central resources and the Internet, one needs a Metropolitan Area Network (MAN). Neither the precise needs in terms of bandwidth nor the precise solutions in terms of services can be specified at the present time with any great degree of confidence, but graphical applications require a minimal bandwidth on the order of 56 kilobits per second. Services that can provide this bandwidth include:

- Striped (parallel) modems over multiple voice-grade phone lines
- 56 kilobit leased lines
- Frame relay
- ISDN
- Fiber optic lines.

The layering concept allows one to mix these technologies at different sites in a network so as to obtain the required performance at the most economical cost. Unless one single technology can be obtained at a cost significantly lower than any competing technologies, one should plan to accommodate a mix of technologies at the physical layer of a MAN, with the choice at each site matched to that site's needs and accessibility.

Graphical and video applications will eventually require higher bandwidth for many school sites. Here, too, there is a multiplicity of choices:

- Frame relay (speeds up to 1.5 megabits)
- SMDS
- 1.5 megabit leased lines
- Cable TV

If one technology proves much cheaper than the others, it could provide a suitable choice for districtwide adoption. Otherwise one should anticipate a mix of technologies to form the fabric of the metropolitan area network.

■ Protocol Layer

This layer includes those protocols that define transport along the physical medium and protocols that present data to applications running on devices attached to the network.

Transport over the LAN described in the previous section is conveniently provided via the Ethernet protocol. Atop this protocol sits another protocol that is independent of the physical medium. The choice of protocol at this level is simplified by the fact that the Internet is based upon a common public protocol known as TCP/IP. If students and teachers are to have access to resources on the Internet, then the MAN and LANs in the schools must support TCP/IP. This is the only commonly used protocol that is suitable for application to Wide Area Networks (WANs), and one can anticipate an evolution of popular proprietary protocols for LANs to coincide with TCP/IP in the future.

Among the popular proprietary LAN protocols are IPX, used by Novell, and AppleTalk, used by Apple. While both protocols may be of use in specific LAN applications, they should not be extended over wide area connections, except through encapsulation in TCP/IP.

To isolate applications from the raw TCP/IP protocol, vendors have developed standards through which their applications receive data from the network. On the Macintosh platform the standard interface is provided through MacTCP, while on Windows machines the standard interface is known as Windows Sockets (WINSOCK). By enforcing these standards for each of these platforms, one can insure the interoperability of all network applications running on any given machine.

■ Application Layer

Standards issues at this layer have to do with how applications handle data. We presume the existence of a networked environment, with all computers and peripheral devices connected to it. Standard applications are available via file servers and maintenance of commonly used software can be provided remotely. Local software can be added to individual classroom machines or installed on school-based servers. Virus-checking utilities protect individual machines and the file structures for these machines can be rebuilt from the servers if their integrity is severely compromised.

Applications that support native-mode standard file formats can exchange data and interoperate across the networked environment. This is an evolving area, as new applications are continually being developed, but one can discuss a few general issues and several specific issues that presently apply.

Among the general issues is that of how multimedia is handled. This question applies to e-mail, news and various network applications. The most widely employed standard is known as MIME (Multipurpose Internet Mail Extensions). It is reasonable to demand that mailers, news readers and network applications that support multimedia should all adhere to this standard. The MIME standard is extensible, since it specifies external programs or "viewers" for any given multimedia file type. This enables it to accommodate a variety of text types, graphics formats, video and sound, as well as such specialized elements as databases and spreadsheets.

Specific issues relate to the user interface and file formats. For the first, a standard user interface can be specified in terms of utilizing a graphical display with a keyboard and a pointing device such as a mouse or trackball. Such interfaces are provided with all current commercial devices. Specialized interfaces, such as voice synthesizers and mechanical assists, should be provided for users with special needs.

For the second, interoperability demands either that applications use a common file format or that they have file conversion capabilities. The lowest common denominator for file exchange is that of ASCII text and all programs should support this format. One level up is a standard known as Rich Text Format (RTF), which allows for the specification of font information and attributes. This, too, should be supported wherever possible.

At a basic level, user frustration can be reduced if a single product is deployed districtwide for each of the most common computing tools: word processing, databases and spreadsheets.

> ... the only ... used ... table for ... to WANs.

Not all available software meets all of our standards at the present time. In order to provide students with access to products found in the typical commercial workplace it is therefore necessary to make some compromises in strict adherence to these standards. A convenient mechanism is to develop a districtwide list of currently supported products. This list should further indicate the extent to which the products meet the standards as well as the reasons for relaxing standards in certain cases.

■ Attached Hardware

Specific devices to be attached to the school network also have minimum "standards." Personal computers, for instance, should have a monitor/video card combo capable of running a windowed environment, an Ethernet interface and the processing power to run commonly needed applications. These requirements can be met with any of a number of models of Macintoshes, IBMs or IBM-compatibles running Microsoft Windows, OS/2, etc. Prudent recommendations for a minimal configuration of such machines are as follows:

- 8MB internal memory (RAM)
- 200MB hard disk
- 800 × 600 pixel display with 256 colors
- 14" display screen
- Intel i486, Motorola 68040 or PowerPC processor

In addition, there are several other components required to make the network and its attached information resources function. These can be listed as follows:

- **Servers.** These machines provide file service, print service, information resources and mail. A true *multi-tasking* operating system is required to support this range of services. Typical devices for this task are RISC-based workstations running the UNIX operating system. Other processor platforms may be adequate for smaller sites; other operating systems (notably Windows NT) may prove suitable for this purpose as their installed software base increases in size.

Standards

• Routers. These devices provide connectivity to a metropolitan area network. The choice of TCP/IP for MAN connectivity requires that the routers support this protocol. Multi-protocol support, including IPX and AppleTalk, can be a useful option but increases the maintenance required.

Standards should be reviewed on a regular basis

• Peripherals. This category includes printers, scanners, CD-ROM drives, tape drives and other devices. Where standards exist in terms of file formats, these should be respected in most school district purchases. Relevant standards in this area include PostScript (a page description language for printers), Kodak's Photo CD format (for CD-ROM drives) and TWAIN (for joining together scans made on a flatbed graphic scanner). Networkable devices are preferred for reasons of economy and flexibility. A high-volume, networked laser printer can, for example, serve a classroom more conveniently than multiple impact printers attached to individual computers. As with application software, this is an area in considerable flux, and standards should be reviewed on a regular basis. ■

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Court TV in Our Nation's High Schools

A nationwide survey of high school educators has revealed that Courtroom Television Network (Court TV) is considered to be highly valuable in classrooms as a curriculum tool for educating students about the workings of the American justice system, with teachers who actually watch the network praising it as even more valuable than those who have only heard of it.

The survey was conducted by Malarkey Taylor Associates, a well-known national market research company. In May of 1994, Malarkey Taylor interviewed 203 public and private high school social studies teachers in 32 states. Virtually all the respondents had access to TV and VCR equipment. Three-fourths of the teachers had access to cable television, including Court TV. Nearly half (46%) of the teachers had viewed Court TV at least once.

■ Key Finds

Among key finds, 90% of respondents who indicated that they had viewed Court TV (vs. 84% of all respondents) stated that the network helps students understand many aspects of the law.

In addition, 85% of respondents who viewed the network (vs. 62% of all respondents) said they believe Court TV presents current issues of social interest, such as free speech, crime and violence, in a constructive manner.

Perhaps the most relevant and timely finding among 87% of Court TV viewing teachers (vs. 72% of all respondents) is that the network's trial programming focuses on resolving social disputes in a civilized and fair manner, as compared to many television programs which show violence and violent outcomes in public and individual disputes.

The results indicate that of all the teachers surveyed, 77% are in favor of Court TV being available for educational instruction. And 75% of the respondents would recommend their students watch Court TV on their own.

■ Educational Outreach

The survey was undertaken as part of Court TV's educational outreach program, which includes: active participation in the industrywide Cable In The Classroom program; telecasts of the National High School Mock Trial Championship, which familiarize over 60,000 students and 12,000 teachers with the judicial system and how courts attempt to resolve disputes; the multimedia Casemaker CD-ROM educational product for schools; and distribution of "Trial Story," special report videocassettes and study guides made just for classroom use.

Court TV is distributed to 15+ million basic cable subscribers in the 48 states, D.C., Puerto Rico and the Virgin Islands, in addition to satellite dish receivers nationwide. The service is a joint venture of American Lawyer Media, L.P., Time Warner Inc., NBC, Cablevision Systems Development Corp. and Liberty Media.

Source: Trylon Communications, Inc.

Architecture and Costs of Connecting Schools to the NII

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Universal connection to the National Information Infrastructure (NII), it is presumed, will facilitate educational reform within schools and communities. Several developments suggest this:

- The federal government is committed to having every classroom in the U.S.A. connected to the NII by the year 2000;
- A number of telephone and cable companies have announced plans to connect schools in their service areas at low or no cost;
- Modern, high-speed networks have been installed at a number of progressive, pioneering K-12 schools;
- The Internet, a global network of networks that connects to an abundance of educational resources, is experiencing phenomenal growth.

However, to date, there is relatively little known about the costs for connecting schools to the information infrastructure. Even though exact costs are unknown, they are expected to be significant. To reduce these costs, a variety of approaches are being tried.

Some states have implemented the cost-saving strategy of purchasing telecommunications equipment and services for all schools in the state. For example, North Carolina has saved its schools 20% - 50% on certain items. Some states have passed legislation permitting the state Public Utility Commission to set preferential or fixed intra-state rates for educational institutions.

Our research suggests that a number of programs would have a significant impact on the total costs of connecting to the NII. For instance, if all schools coordinate purchasing at the state level, cost savings will exceed $2 billion. Colleges and universities often have the resources to provide technical support to K-12 schools. If a nationwide program were instituted, potential savings would be $800 - $1,800 million.

Our research suggests that a number of programs would have a significant impact on the total costs of connecting to the NII.

If schools were given free Internet connectivity, the total annual costs for school Internet connections would be reduced from $150 - $630 million. But costs for telecommunications lines and services represent only 11% of the total costs, and hence reductions will have a limited impact.

Finally, as the costs of networking schools is better understood, a new question arises: How will these costs be financed? Many states have programs to fund networking in schools. The federal government has a role, although it must become more flexible and coordinated. However, as Vice President Gore continues to state, the NII will be built by the private sector. A number of states have initiated cooperative ventures between businesses and schools. An expansion of these programs may be the key for successfully connecting K-12 schools to the NII.

But connection alone is not enough: we report below on our finding that support and training together comprise 46% of the total costs of networking schools.

Scope of K-12 Networking

The model of school networks presented follows the Internet-networking model, by which schools have digital, data connections that transmit and receive bits of information. The models do *not* include analog video point-to-point networks or voice networks and voice-mail systems. Audio and video functions are possible in digital format over the Internet, but many schools will still use separate video and voice networks. Costs for these systems are important, but are not covered in this article.

It should also be noted that although voice and video networks have been separated out from this report, schools should not consider these three types of networks to be wholly distinct. Some schools have integrated their voice and video networks with their data network. Sharing resources between the multiple networks can be effective in providing significant cost savings. At a basic level, it must be understood that as a school installs a LAN and puts computer data connections in every classroom, there are little added costs to also concurrently install other types of connections, including telephone lines.

■ Technology Standard for Connecting to the NII

As described in Information Infrastructure Task Force (1994), the NII "promises every ... school ... in the nation access anywhere to voice, data, full-motion video, and multimedia applications... Through the NII, students of all ages will use multimedia electronic libraries and museums containing text, images, video, music, simulations, and instructional software." The following requirements outline what the model presumes is needed in order to have full connection to the NII:

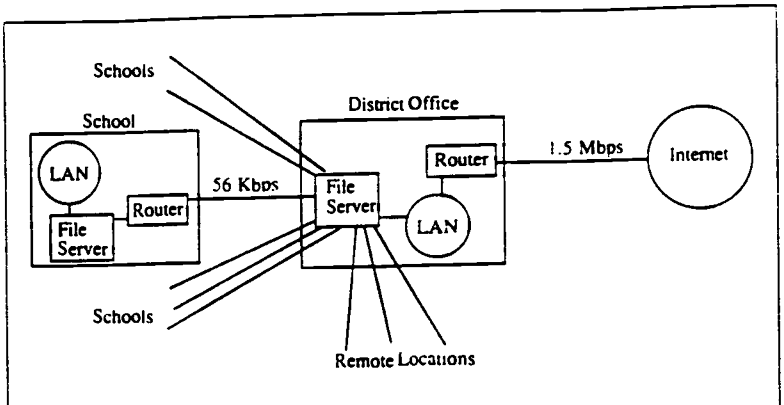
• *A LAN within the school with connections to multiple machines in every classroom.* The power of the network is greatly enhanced with more access points throughout a school. A classroom with one connection is not conducive for use of network applications in a class of 20 or 30 students. Telecommunications will not be a tool for systemic educational reform until network connections are replete throughout a school.

• *A connection from each school to a community hub.* From two to ten schools should connect to a single hub, depending on the size of the schools. In most cases, the hub will reside at the district office. However, where there are many schools in a single district, then schools should be clustered into sets of four to six. Each of these school-clusters will have a group hub, probably at the district office, which will contain the center of the network for those schools. The rationale for the use of this architecture is described below.

• *A connection between the school LAN and the district office hub.* With this configuration, every classroom has a connection not only to every other class in the school but also to the central district office.

• *A connection from the school district office to a community-, state-, or nationwide Wide Area Network (WAN).* This link will allow all schools to connect to the WAN. The Internet is a good example of such a WAN and will be used throughout this report as a model and precursor for the NII.

• *Sufficient bandwidth for these connections.* With a high-bandwidth connection, users in schools can make use of graphical applications (like Mosaic) and limited video service (like CU-SeeMe and MBONE). For most districts, the minimum bandwidth, or bit-speed, that will support these services is 56,000 bits per second (56 Kbps). Thus the connection between the school and the hub ~~must~~ be at or above this level. For the con-...on from the district office to the Internet, a broader pipeline is r essary becau all of the schools in th group conn to the Intern through this line. The sug gested mini- mum band- width for th connection i 1,500,000 bit per second (Mbps), also known as a "T1 line."



SOURCE: U.S. Department of Education, 1994

Figure 1. LAN with Local Server and Dedicated Line Model

• *Symmetric, bi-directional access to the WAN/Internet.* It is important that the connection to the school allows information tc flow both in *and* out at the same rates. In this way, students can become both consumers and providers of information over the network.

• *Adequate remote dialup facilities.* With a sufficient number of modems and phone lines, faculty, students and parents can gai access to the school system remotely on weekends and after school hours.

• *Use of established and tested technologies.* Schools have benefited most from mature technologies that have been well tested in the marketplace. Cutting-edge technologie have not been as successful in schools due to their inherent instability and the large amount of resources required to support them. The models assume the use of matur technology and transmission media. Newe technologies such as wireless and coax-fibe hybrid systems are not considered in this study. However, given the rapidity of technological change and marketplace evolutio for networking products and services, wireless and cable alternatives should be evaluated in future research.

■ Architecture of the District Network

The basic network architecture for these models follows the "star" configuration, similar to that used in the nationwide telephone network. In the phone network, residential telephone lines in an area are directly connected to a single district office. In the school network, each school building is connected to the school central hub. In most cases, the district office will serve as the central hub. However, in cases where there are very few or many schools in one district, then alternative sites must be chosen.

The rationale for adopting this architecture is that when many schools are connected through a single hub, then costs can be aggregated among them. This gives schools stronger purchasing power as equipment purchases are aggregated by the school district for volume discounts. It also allows schools to share resources—such as the data line to the Internet, training programs and full-time support staff—that each school might not be able to afford individually. Thus, there are costs both at the school and at the district level for networking schools across the country.

A second rationale for adopting a star architecture is that it is confluent with the administrative/bureaucratic design of the school system. Individual schools report to a school district office, which in turn reports to state education offices. In the network design, schools connect to the district office hub, which in turn connects to a statewide (or national or global) network.

Cost Areas

The cost models presented in this article include four types of costs: hardware, training, support and retrofitting. Items included in these categories are summarized:

- *Hardware* – Wiring, routers, servers and PCs, including installation, maintenance and service of the hardware and telecommunications lines.
- *Training* – Training of teachers and other school staff to use the network.
- *Support* – Technical support of the network.
- *Retrofitting* – Modifications to the school facility to accommodate the telecommunications infrastructure. This may include costs for asbestos removal (where applicable), electrical systems, climate control systems, added security (locks, alarms, etc.) and renovation of buildings to accommodate network installation and operation.

A cost area *not* included in the models is educational software. "Freeware" versions of many popular Internet applications exist, however, other educational software may be desired by particular schools. Economic analysis of such software costs and their evolution in network scenarios is needed.

Four Different Technology Models

Following is a brief description of four ways to achieve connectivity to the NII. Inherent costs are noted; details are provided later in this article.

Model One: Single PC Dialup

This model represents the most basic connectivity option for a school. The school has no internal LAN within the building. There is a single connection to the district office over a modem and standard phone line. Only one person may use the connection at any time.

Model Two: LAN with Shared Modem

The difference between this model and the former one is the existence of the LAN within the school. By connecting the modem to the LAN, every computer on the network has access to the Internet. However, this model supports only a few users at a time, since it is limited by the number of phone lines going out of the school. As in the first model, users of the system can only utilize text-based applications over the Internet (e.g. e-mail, telnet, gopher).

In this model, there is now a cost for the LAN. This model assumes the use of copper wire (category 5) as the medium for the network since it is the most affordable and scaleable option for schools in 1994. The costs for the wiring and network cards run \$100 - \$150 per PC connected. Including costs for the accompanying hardware and labor, costs per PC are \$400 - \$500. Therefore, for the school model with 60 - 100 connected PCs (3-5 PCs per classroom @ 20 classrooms), the total LAN costs are \$20,000 - \$55,000.

Model Three: LAN with Router

The main difference between this model and the former one is the existence of a router in place of the modem. With the router, multiple users of the LAN may access the Internet concurrently. Again, people can use text-based applications over the Internet, but have no real-time access to video or graphics.

Since the router allows multiple users of the system, there is an opportunity to expand the entire network infrastructure. With this infrastructure, it is reasonable to support one PC in every classroom. Therefore, there is a requirement to purchase 15 additional PCs for the average school to use in addition to its small initial stock of TCP/IP-compatible machines. It is assumed that the purchasing of these PCs is done at the district level in order to negotiate better rates (\$1,000 - \$2,000 per PC).

Support and training costs are higher since there are additional users of the system. There are additional dialup lines required to accommodate remote access. There are also significant retrofitting costs for the electrical system, climate control system and enhanced security.

Model Four: The Preferred Strategy LAN with Local Server & Dedicated Line

The primary difference between this model and the former one is the existence of a file server at the school. (See Figure 1.) The on-site server allows much of the information to reside locally at the school instead of at the district office. This feature provides better performance since more data does not need to be fetched over the network. Additionally, the local server allows school administrators to exercise greater control over the information flows in and out.

> Total one-time costs for Model Four represent **3% - 7%** of total national educational expenditures.

Higher speed links from the school enable the use of limited video, graphical and text-based network applications.

In this model, virtually the entire school is supported on the network. As a result, the training program is extensive and the support team is well staffed. Costs of the connection to the Internet are also higher due to the larger bandwidth. Significant retrofitting costs are incurred for the electrical system, climate control system and better security. A range of costs for an average size school to attain this level of technology is listed in Figure 2's table.

■ Using the Models to Estimate Costs

These four models are representations of the network technology used in schools. While a level of complexity and detail is omitted, the simplicity is helpful because they encompass broad cross-sections of network and school configurations. The models provide a clearer view of the costs and choices for networking K-12 schools.

Using this model as a baseline for connecting to the NII, these figures then become indicative of the costs of connecting K-12 schools across the country to the NII. These numbers indicate that there will be $9.4 - $22 billion in one-time costs, with annual maintenance costs of $1.8 - $4.6 billion. At the per-pupil level, this is equivalent to $212 - $501 in one-time installation costs and an ongoing annual cost of $40 - $105.

In this model, hardware is the most significant cost item for schools. However, most of the cost is for purchasing PCs. The value of PCs in schools goes well beyond their use as networking devices. Therefore, the "real" costs for PC purchases should be allocated across other parts of the technology budget, and not only to the networking component. If this is done, then hardware costs for connecting schools to the NII drop considerably.

If the high startup costs are amortized equally over a five-year period, then the breakdown of costs during the first five years, excluding PC purchases, is as shown in Figure 3's pie chart.

	Low	High
SCHOOL COSTS		
One-time Installation Costs		
Local Area Network	$20,000	$55,000
Personal Computers (60 machines)	$60,000	$120,000
File Server	$4,000	$15,000
Connection to Hub/District Office (56Kb)	$500	$2,000
Router and CSU/DSU	$2,600	$5,000
Retrofitting (major)	$10,000	$25,000
Total:	$97,100	$222,000
Annual Operating Costs		
Replacement of equipment	$3,000	$8,250
Connection to Hub/District Office (56Kb)	$1,000	$5,000
Total:	$4,000	$13,250
DISTRICT OFFICE COSTS		
One-time Installation Costs		
File Server	$2,000	$15,000
Router	$2,000	$5,000
District Local Area Network	$2,000	$5,000
Data line to WAN/Internet (1.5 Mbps)	$1,000	$5,000
Dialup Capabilities (20 lines)	$16,000	$32,000
Training (40-50 staff per school)	$50,000	$150,000
Total:	$73,000	$212,000
Annual Operating Costs		
Internet service (1.5 Mbps)	$10,000	$42,000
Dialup Lines	$3,000	$5,000
Support (2-3 staff per district)	$66,000	$150,000
Training	$15,000	$35,000
Total:	$94,000	$232,000
TOTAL U.S. ONE-TIME COSTS	$9.35 B	$22.05 B
One-Time Costs Per Student	$212.47	$501.14
TOTAL U.S. ANNUAL COSTS	$1.75 B	$4.61 B
Annual Costs Per Student	$39.77	$104.69

SOURCE: U.S. Department of Education, 1994

Figure 2: LAN with Local Server and Dedicated Line Model Costs

Costs for support of the network represent about one-third. Support is a vital part of any successful implementation of a school network and its costs *must* be factored into the budget. Support and training together comprise 46% of the total costs of networking schools.

Finally, it is important to note that the costs for telecommunications lines and services represent only 11% of total costs. This amount is *lower* than those assumed by much of the technology community, including telecommunications service and equipment providers.

To put all of this into perspective: Total U.S. expenditures on K-12 education in 1992-93 totaled $280 billion. Total one-time costs for the fourth model described above represent 3% - 7% of total national educational expenditures. The ongoing annual costs represent between 0.6% - 1.6% of total national educational expenditures.

■ Potential Impact of Initiatives on Costs

Much more can be done by the government and the private sector to significantly mitigate the costs that schools face in order to connect to the NII. This section examines some possible programs and their impact on the costs to schools.

Preferential telecommunications tariff rates are instituted for schools.

Estimated savings: $89M - $218M (One-Time)
(30% reduction) $39M - $150M (Annual)

Estimated savings: $179M - $435M (One-Time)
(60% reduction) $78M - $300M (Annual)

All technology purchasing is done at the state level. Figures are based on an average of 30% discount across all 50 states.

Estimated savings: $1.9B - $4.1B (One-Time)
$45M - $189M (Annual)

Universities or other institutions provide technical support to schools. It is assumed that schools will be able to function with 80% less support staff than would be required without university support.
Estimated savings:
$790M - $1.8B (One-Time)

Teachers trained on their own time. If teachers agreed to attend classes on their own time, the only cost would be for the trainer.
Estimated savings:
$0 - $1.5B (One-Time)
$0 - $300M (Annual)

LAN installed by volunteers. If groups of parents and community members offer to provide labor at no cost, schools would reap significant savings.
Estimated savings:
$1.1B - $3.1B (One-Time)

Personal computers are donated to schools. The success of a donation program depends on the quality of the equipment given. Schools will require fairly modern machines to run networking software. Donations of obsolete or incompatible equipment may be very costly to schools.
Estimated savings: $5.1B - $10.2B (One-Time)

Network routing equipment are donated to schools. This program is similar to a PC donation program. The savings are lower, however, since the routing equipment is less expensive.
Estimated savings: $221M - $425M (One-Time)

Network servers are donated to schools. Again, this is similar to the PC donation and router donation programs.
Estimated savings: $370M - $1.5B (One-Time)

Internet connectivity is free to schools. This could be arranged either by provision from an Internet service provider or from a local university or community college that has its own Internet connection.
Estimated savings:
$150M - $630M (Annual)

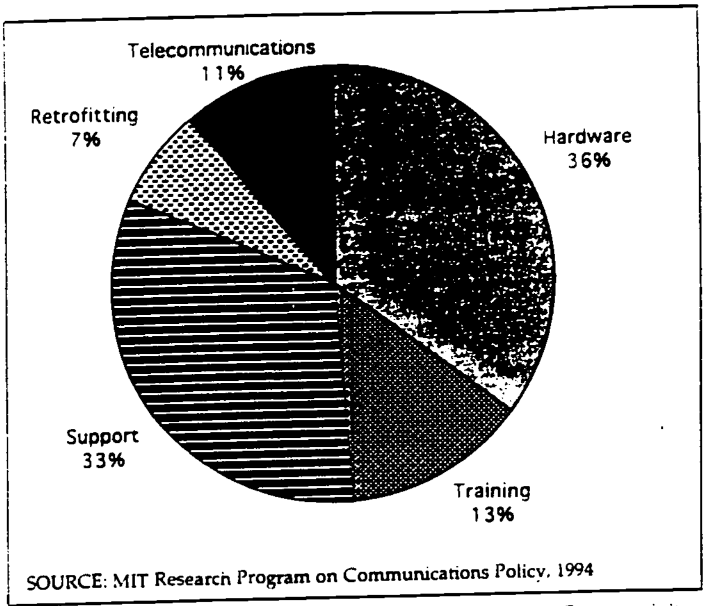


Figure 3: Breakdown of Costs for Baseline NII Connectivity

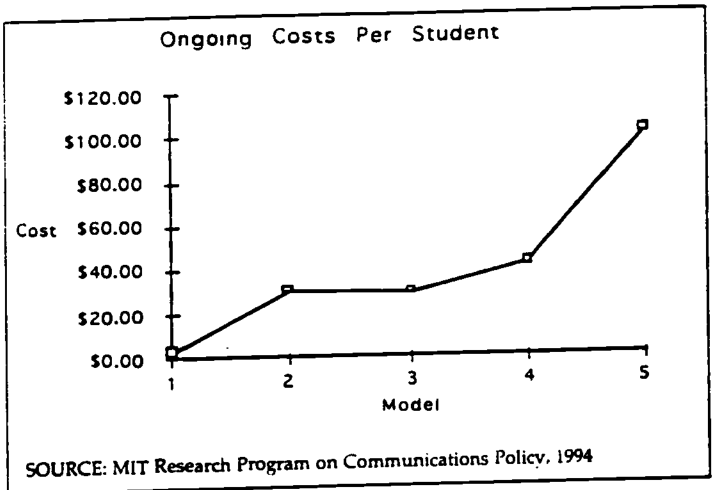


Figure 4: First Jump in Costs

Conclusions

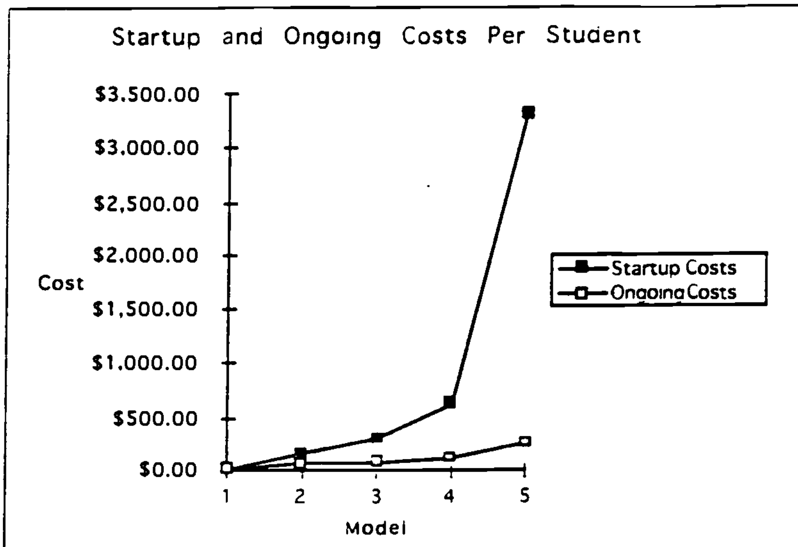
With a clearer picture of the costs for connecting schools to the NII, a number of conclusions may be drawn:

- **The costs to network a school are complex.** It is not simple to estimate the costs for a particular school. Costs for most schools will fall into a bounded range, but each particular school will vary greatly depending on its individual needs and characteristics. While this article seeks to put bounds on cost figures, the numbers are rough estimates at best.
- **Network hardware cost is only a small fraction of the overall costs for connecting to the NII.** Initial training and retrofitting are the largest one-time costs for starting the network. Costs for the wiring and equipment are typically not as high. Support of the network is the largest *ongoing* annual cost that schools must face.
- **There are two major jumps in the costs to network a school.** The first jump in cost arises when the school installs the LAN (see Figure 4). At that point the school and district must pay for installation ($20,000 - $55,000 per school) and employ full-time support staff ($60,000 - $150,000 per district).

The second jump arises if and when a school decides to purchase computers for all students to use. The number of networkable PCs in 1994 is inadequate for most schools; hundreds of thousands of dollars would be needed to provide multiple PCs in every classroom. Also, many schools will need major electrical work (possibly $100,000+) to support the increased number of PCs. In the intermediate stages between these jumps, the costs are incremental and relatively small.

- **Startup costs for the network increase at a faster rate than the annual ongoing costs as the network complex increases.** In the less complex models, the one-time startup costs are 2-3 times the annual ongoing costs of the network. However, for the more complex models (models four and five,) the one-time costs are 5-15 times the costs to start the network. These differences are illustrated in Figure 5's graph.

The divergence indicates that the most significant hurdle that a school will face is the initial investment costs in the network and computers. Dispensers of educational funding should be aware of this trend, so that they can help schools overcome this initial barrier. Schools should be given flexibility to amortize initial costs, in order to spread the burden over a number of years.



SOURCE: MIT Research Program on Communications Policy, 1994

Figure 5: Second Jump in Costs

• **Costs are significantly reduced when aggregated at the district and state levels.** Schools stand to save a lot of money by pooling resources and purchasing power with other schools in the district and at the state level. When schools share a high-speed data link, or support staff, the per-school costs drop considerably. Schools in North Carolina and Kentucky, for instance, have saved 20% - 50% by purchasing services and equipment at the state level.

• **Education initiatives of telephone and cable companies will have a small impact on the total costs to schools.** The free telecommunications services currently offered by these companies are only a small piece of the total cost for successfully networking schools. However, schools would greatly benefit from the establishment of state trust funds or other cooperative efforts, as included in some plans. The benefits of these programs are more difficult to quantify, but are significant, nonetheless. They have the potential to garner support and consensus for connecting schools to the NII. In contrast, the highly touted free connections and free telephone services are not as valuable to schools.

Further research on the costs of wireless and cable Internet access methods for schools is recommended to elucidate the costs and benefits of these approaches. In addition, the issue of software and equipment cost accounting require further analysis. We hope that this preliminary assessment of the costs of connecting schools to the NII can provide a point of departure for analysis of these and other more detailed models of NII connectivity for schools. ■

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7

RESOURCES

C) PEOPLE INFRASTRUCTURE

BY GWEN SOLOMON AND STAN SOLOMON

Technology and Professional Development—10 Tips to Make It Better

BEST COPY AVAILABLE

In the United States, we are anxious about our schools. Since *A Nation At Risk* was published in 1984, we've tried to reform education. The concern is pragmatic: Will our young people be prepared for the demands of the future? Will they get jobs when they graduate? Graduates find that a college degree is no guarantee of gainful employment or a future as lucrative as their parents'. One challenge for schools is to prepare students with the technological skills that businesses need and give young people the thinking skills for a new kind of workplace. Yet when we put technology into schools, we use a Field of Dreams approach: Put it there and it will be used. Ten years ago, we put computers into classrooms and found that they became drill machines and were used as rewards for good behavior. Now, we want to implement networking and hold our collective breath that it will be used well. However, a key to ensuring effective use is the knowledge of the person at the front (okay, these days it's more often at the side) of the room. But how do we get more teachers to use technology well? When teachers believe that technology addresses a need, solves a problem, makes life easier, or offers information they can't get otherwise (or as easily), they will use it. When it is easy to use (really easy), they will use it. How do we get the critical mass of teachers to give technology a chance in their classrooms?

The answer lies in improving professional development. Oh, yes, we've stopped calling it teacher "training"; "professional development" sounds much better, but has our understanding of it changed? To begin with, we can't develop something that doesn't exist, and schools don't encourage teachers to be professionals—to read professional literature; to collaborate with colleagues who teach the same grade, subject, or students; or to think of themselves as professionals. We still offer the same one-day workshops and quick inservice courses. So what should we do? While there are never surefire methods for success, here are 10 suggestions that may work and, even better, may inspire you to improve on them.

1. Offer Training

Training (oops, didn't we get rid of that word?) means offering the classes, workshops, and seminars professionals need. (Businesses offer training during the work day so that their employees learn new skills and stay current.) If we're talking technology here, it means offering the ongoing hands-on sessions teachers need to learn and refine their computer use. And it means offering the courses they need to determine how, when, and why technology makes a difference for student learning. Other industries have compelling applications that have changed the way they operate. For example, spreadsheets changed business, word processing and desktop publishing changed publishing, and computer graphics changed entertainment. There is no comparable compelling application for education, and there may never be. But educators can benefit from the broad spectrum of tools that exist—if we offer ample opportunities for teachers to learn what to do with them.

2. Give Educators Technology They Can Take Home

Would we ever require teachers to teach a book or a mathematical concept without taking the text home to develop lessons and materials? Then why don't we find the resources to give teachers computers for use at home, where they can practice in private? We can't expect teacher learning to just happen. Before educators can use technology in their classrooms, they should use it themselves. If they can borrow educational software to take home, they'll learn how to use it and find the best classroom uses for it. An integrated package of basic applications with a single interface is least intimidating at the start.

3. Provide On-Site Technical Support

It's inevitable that technology fails us just as we're doing a presentation or getting students started on a project. Technology failures convince teachers not to try. Again, if it doesn't work when they need it to, they won't use it; they look foolish and lose the class' attention. Thus, on-site support people are essential to ensure that everything is running well and that teachers figure out what to do and how to do it. In some future utopia, when technology doesn't have glitches and adults are as comfortable with it as young people seem to be, we won't need such support. But today it is essential.

4. Encourage Collaboration With Colleagues

Unlike most professionals, teachers seldom confer about their work. They have little or no opportunity to work and plan with colleagues who teach the same grade or content area, or even who work with the same students. Few schools encourage staff reading groups in which individuals can debate and share ideas gleaned from professional literature. This is one place technology can help. Telecommunications makes collaboration possible, especially if there is access to a network from teachers' homes. Modems are inexpensive, and community bulletin boards and proprietary networks (especially those with Internet access) offer a way for teachers to communicate. For example, LabNet (a TERC project for science teachers around the country) provides a two-week summer institute and an online forum that focuses on how teachers are implementing hands-on science projects. Thus, teachers can share ideas and get help from one another. The fact that they may not be geographically near one another may actually help promote self-analysis without self-consciousness.

5. Send Professionals to Professional Conferences

Attending conferences is a great way for educators to learn about the latest things, have contact with others who care about the same issues, and feel like professionals. Like the creatures on Noah's Ark, educators should go to conference in pairs (at least). Conferences generate excitement and new knowledge; however, a single representative from a school often comes back feeling like a lone voice. When two individuals share the experience, they reinforce one another back at their school and more quickly spread the word about what they have learned.

6. Stretch the Day

Prisoners of Time, a report from the National Commission on Time and Learning, stated, "Our schools and the people involved with them—students, teachers, administrators, parents, and staff—are prisoners of time, captives of the school clock and calendar." One of the report's recommendations was to "give teachers the professional time and opportunities they need to do their jobs." Technology can help the educational community extend time by providing the opportunity for discourse on demand. Active online discussions take place on electronic networks. For example, the Consortium for School Networking hosts online forums on many topics, including professional development, curriculum, and electronic publishing. Such discussions are accessible at any time from home or school.

7. Encourage Research

Educators are natural ethnographers. They have ample opportunity to observe successes and failures in their classrooms, and, if they keep track, they can provide the educational community with valuable sources of both raw data and synthesized observations. Yet, teachers are seldom encouraged to report on what they see. If they are encouraged to think and write about their work—about the effectiveness of new methods, about the implementation of new technologies, and so forth—they will not only provide valuable information but also think more deeply about their work. We have little quantitative research that proves the effectiveness of technology integration in classrooms, so we take it on faith that technology will work well. However, qualitative research provides ample evidence that students are engaged in learning in new ways. Qualitative research may be the only natural source of accurate information on technology's effectivess in the classroom, and who better to provide it than teachers? Of course, how will others learn what these teachers observe? Again, technology, with its potential for allowing electronic publishing, is an answer. Information published on a network is timely, open for discussion, and useful for the entire community.

8. Provide Online Resources

Electronic publishing offers many sources of information for teachers and by teachers. With a modem attached to their phone line at home and

a subscription to a community or proprietary network, teachers can fi... online information on the Internet. Many software tools for accessi... World Wide Web, Gopher sites, WAIS databases, and other sources are free. In some cases, 800 numbers and other advanced services are available. Some good examples of free sources of information for teachers are those provided by the federal government. The U.S. Department of Education, for example, has both Web (http://www.ed.gov) and Gopher (gopher.ed.gov) sites, with resources like the "Teachers' Guide to the Department of Education," program information, press releases, and transcripts. AskERIC (http:\\ericir.syr.edu) offers teachers hundreds of lesson plans for all subjects and grades. In addition, teachers who connect directly to the Internet can create World Wide Web pages to provide visually pleasing information about their schools and to demonstrate what their students can do. This ability to publish information electronically can be a very effective and popular way for teachers to share their work.

9. Influence Preservice Education

One way to integrate technology into instruction is to rely on the younger generation of teachers. Because they were raised with technology and are more familiar with its uses, they are more likely to use technology in their classrooms. Of course, they will still need to learn what's available for education, how to use it, and how to evaluate its worth. The best place to begin is where they first learn about teaching—in schools of education. Many colleges already require students to have comp

Continued on page 71

- There is a lack of inservice support for teachers.
- The state Board of Studies' refuses to view teachers as curriculum professionals who can give worthwhile input.
- There has been a problem in promoting a process-oriented skill-development curriculum in which learning is assessed through traditional tests for entry into the employment sector or higher education institutions.

Involving teachers more and giving them due credit as well as the required training and responsibility would be a good way to start meeting the real demands of a change in educational policy.

The debate about the VCE is an example of the problems administrators must confront when converting an examination-centered system to a student-centered system. The successes of the information technology courses show what can be achieved within the VCE framework. Paul called for teachers and school systems to keep a strong focus on learning and to ensure that curriculum change occurs only when it improves the quality of learning. The VCE, and information technology in particular, have done that. The VCE's weakness lies in catering to university selection requirements based on output grades rather than focusing on developing a wide range of skills acquired through coursework.

The solution? Communication and debate are good starting points, although I feel that Paul's valuable input is not representative of the university leadership because most educators at the university level seem unwilling to discuss educational issues with secondary school teachers and administrators. Teacher inclusion and the development of new paradigms are required. Pendulum swings help no one in the long term, but collaboration may move us forward. ■

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Essentials for Telecommunications Staff Development

Behind every successful implementation of classroom telecommunications stands an excellent staff development program. Here are six tips from a workshop veteran for doing it right.

■ By Odvard Egil Dyrli

If you've ever been to a staff development workshop concerned with online skills, you may well have encountered presentations by "online acrobats" who dazzle with rapid-fire screen calisthenics: "First I click here, then there. I make this menu choice. I answer this dialogue box, click there, then here." While such a presentation can be fun to watch, it rarely produces lasting results, and may even turn off participants who feel intimidated by it all.

However, staff development is crucial to the success of telecommunications in schools, and needs to be done right. No matter how powerful the hardware in your school, or how fast your connection to the Internet, teachers need proper training to use these exciting resources to their best advantage. But while it may seem expensive to do staff development well, in the long run it will cost more to do it poorly, and much more to skip it altogether.

ESSENTIAL ELEMENTS

In recent years I have conducted many professional development programs, in formats ranging from hour-long and one-day presentations to full-semester courses. I have also participated in my share of workshops developed by others. As a result, I recommend the following key elements for successful staff development:

1. Offer a Variety of Options. Ideally, telecommunications staff development should continue throughout the year, in contexts that include large-group presentations, curriculum-specific small-group workshops, and individual online sessions. Additionally, teachers can extend their skills if optional instructional experiences and materials are available. Area conferences and workshops fit the bill, as do print and multimedia materials.

2. Emphasize Skill Development. While inspirational workshops have their place, teachers will benefit more from workshops that focus on learning practical techniques and mastering sometimes arcane online routines. Examples include signing on to education-oriented discussion groups, downloading files, and participating in online collaborative projects.

3. Provide Hands-On Experiences. Staff development presentations should

(continued on page 6)

include live online demonstrations, and model how to deal with problems that can arise. However, teachers also need opportunities to try out for themselves what has just been shown, whether in classrooms or in small-group lab settings.

4. Tailor Programs to Local Realities. This is particularly important when using outside presenters. Teachers will feel frustrated learning to do things that they can't do in their classrooms because they haven't the proper equipment or connection levels. Emerging technological developments should be touched on in staff development workshops, but the program will be most successful when it focuses on making the most of the telecommunications technology currently available to participants. Similarly, presenters should introduce examples and skills that are appropriate for the teaching levels, content specialties, and experience of the participants.

5. Use Genuine Teaching Examples. Hypothetical examples abound for using online resources to enhance the curriculum. However, participants will get more from programs that show how real teachers have used telecommunications for specific educational purposes, perhaps including examples of student work. Drawing on any local "pioneers" in this area can be particularly motivating.

6. Provide Supporting Materials. Every staff development experience needs to include take-away materials that help teachers apply what they have learned when they go it alone back in the classroom. These can include background articles, step-by-step instructions for doing the online activities demonstrated, and copies of presentation slides or outlines that make note-taking easier.

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Planning for Staff Development and Technology

BY CONNIE FEIL, TIES

When it comes to technology implementation, the two most critical issues are no longer time and money. According to a survey of over 600 teachers and administrators conducted by TIES in December, 1995, the leading technology issues are **staff development** and **support.** These now represent the main considerations in planning for the integration of technology in the classroom.

Too often, respondents said, computer training is an end in itself. Instead of showing teachers how to actually implement technology in classrooms, the focus is often on hardware or software. While many teachers are still learning to feel comfortable with computers, others have a high level of technical literacy. The missing link common to both groups is knowledge of how to significantly improve instruction through the use of technology.

Even among those teachers most proficient with technology, many classrooms are still teacher centered; to the disadvantage of the learner, roles are not changing. In many cases, this is because teachers do not have a vision of life in the approaching century. Administrators and curriculum coordinators who traditionally have been sources for staff development leadership are challenged to lead teachers through a transitioning process in new roles. When technology is involved, a student-centered learning environment brings the best results.

Our survey indicates, however, that more and more teachers are sharing leadership roles. A new form of leadership is surfacing within teams of technology implementors who are committed and willing to share their technical knowledge and their classroom successes. Among a team of teachers, it is now common to find a wide range of abilities with respect to technical proficiency.

Still, most teachers prefer formal training experiences at the very beginning, whereby a new technology or application is introduced. Then, upon mastering the basics, teachers often find that open exploration along with support from fellow teachers is a good way to develop instructional applications. After teachers are comfortable with the basics of a system, they are less intimidated about learning from students, the survey indicates. Students who are eager to share their own proficiency are increasingly responsible for motivating teachers to acquire additional skills.

A support network, collaborative planning time, peer coaching, project centered curriculum, community and parental support, and plenty of public relations were also mentioned as being important to technology implementation teams. E-mail, whether a local system or through the Internet was praised as being the tool which has had the most significant impact on teachers and their ability to work collaboratively. Even those teachers "forced" to use Internet by district or building policies quickly become believers in the tool as a means of communication, as a time saver, and as a curriculum planning tool.

When asked "What has been your most successful staff development experience relating to technology?" the top item on the list is hands-on training sessions from instructors who have classroom teaching experience and a high level of technical knowledge. Responses were mixed as to the best site for training; some indicated that off-site experiences afford more focus than on-site classes can provide. However, survey feedback indicates that at the implementation stage, teachers prefer short after-school working sessions. These project-based sessions should be led by teaching peers, requiring team imput.

Also highly rated were summer sessions lasting two or more days with hands-on practice for planning, discussion and project work. Many expressed an interest in receiving graduate credit for this type of summer work. The most requested courses are those that emphasize integration of technology into the curriculum, (rather than introductory computer classes), and word processing.

Technology fairs, especially those focusing on what's new in the field are still popular activities with teachers. The "Taste of Technology" concept has taken many forms, including events sponsored by vendors, by students for their parents and community members, or by teachers for other district staff members. Teachers also identified hands-on activities as being their best learning experiences.

Both teachers who are experienced with using technology and those who are not indicated that technology conferences were effective and stimulating forms of technology staff development. Technology conferences were considered most effective when teachers attend the conference in teams, immediately discuss new ideas and strategies, and informally plan implementation.

Conferences also provide the most efficient method of viewing a wide variety of products in a short amount of time. The opportunity to preview software products and to personally ask questions of vendors were also cited as important. Teachers inexperienced with technology indicated that conferences can be overwhelming unless the program clearly recommends sessions for beginners, or unless they receive guidance from someone better able to interpret session descriptions.

The wide variety of responses received through this survey indicates that technology and staff development issues are more complex than ever. Ability levels, the pace of technological change, networking, and the unlimited number of options now available require that a coordinated technology staff development plan be in place well in advance of each school year. A good technology staff development plan will balance scarce resources among the varied ability ranges of teachers to ensure that in-house expertise is used but not exhausted. It should spark new ideas among the staff "pacesetters," while moving the larger group of technically literate teachers toward full implementation of technology across the curriculum.

Let staff development activities vary and grow with the experience base of the teaching staff. While local initiatives are important, regional/ national training and conferences supply critical growth opportunities and bring fresh ideas into the system.

Bellingham Schools
Course Outline:
Information Literacy
and the Net

This eight hour staff development course emphasizes student investigations as vehicles to explore the information available over the Internet. The course engages participants in learning the **Research Cycle**, several types of literacy, Gardner's **Seven Intelligences** and much more.

This course is primarily about Information Literacy and Information Problem-Solving. Learning to use the software is secondary.

Module 1

Question: What is Information Literacy? How many other literacies exist?

Achievement Targets: Construct a working definition of the concept "information literacy" and gain an overview of class goals and content.

Delivery Strategy: This an opportunity for small group discussion and the introduction of "learning journals" which participants will keep open throughout all the sessions on a word processor.
Go to Module One

Module 2

Question: What is Visual Literacy?

Achievement Targets:
1) Construct a definition of visual literacy
2) Explore some visual resources on the Net
3) Learn to save graphics
4) Learn to navigate: the Back button, the Go menu, the Stop button

Delivery Strategy : Visit the Library of Congress site and explore its great collections of photographs, stopping to analyze one photograph in considerable depth. For this lesson go to Visual Literacy

Module 3

Question: What is Textual Literacy?

Achievement Targets:

1) Construct definition of text literacy
2) Explore electronic text resources on the Net
3) Learn more about how to navigate with Netscape: parts of the URL (address)
4) Learn to save text files by copying and pasting text or saving a file to the "H" drive

Delivery Strategy: Participants will visit Project Bartleby at Columbia in order to see how electronic text differs from hard copy. For this lesson go to Textual Literacy

Module 4

Question : What is Numerical Literacy?

Achievement Targets:
1) Construct definition of numerical literacy
2) Explore some numerical resources on the Net
3) Learn how to save and then use datasets with a spreadsheet
4) File Management: anticipating the need for directories

Delivery Strategy: Visit the U.S. Census site and compare two counties in Connecticut using the data found there. For this lesson Go to Numerical Literacy

Module 5

Question: How might we use the Research Cycle to achieve literacy and build insight?

Achievement Targets: Review the steps of the **Research Cycle.**

Delivery Strategy: Readings and (ultimately) a video showing students working through the steps.

For this lesson go to: Research Cycle!

Module 6

Question: In what ways do we gather information?

Achievement Targets: Gather information from the Web in order to make a decision on Which City is Best?

Delivery Strategy: Compare and contrast parks and recreation information about three cities using Mapquest

For this lesson go to: Gathering Information

Module 7

Question: How might we Sort, Analyze and Synthesize Information most effectively?

Achievement Targets: Experience the challenge of creating an answer from the information gathered.

Delivery Strategy: Synthesize findings recorded in Works during Module 6

For this lesson go to: Sorting, Analyzing and Synthesizing Information

Module 8

Question: How do we provide the social foundations and group skills needed to make this kind of research work? How will we measure student progress with literacy?

Achievement Targets: Work with ESL's and various documents for information literacy and assessment throughout the research cycle.

Delivery Strategy: Review and consider use of assessment documents

For this lesson go to: Assessment, Teamwork, and Essential Student Learnings

Module 9

Question: In what ways could this type of learning support multiple intelligences and different learning styles?

Achievement Targets: Brainstorm strategies for different learning styles and intelligences.

Delivery Strategy: Explore a page of definitions outlining and explaining Gardner's **Multiple Intelligences**.

For this lesson go to: Multiple Intelligences

Module 10

Question: Where are the good curriculum resources on the Web and how might I use them?

Achievement Targets: Bookmarks

Delivery Strategy: Visit sites on District Curriculum Pages. Go to Curriculum Page lesson.

Module 11

Question: Where are the good teacher resources on the Web and how might I use them?

Achievement Targets: Bookmarks (continued)

Delivery Strategy: Visit, evaluate and consider the value of teacher sites. Go to Teacher Sites lesson.

Module 12

Question: Where are the good information sites for virtual field trips, weather and daily news? How might I use them?

Achievement Targets: Bookmarks (continued)

Delivery Strategy: Visit, evaluate and consider the value of virtual field trips, weather and daily news sections of the district home page. Go to Real Time Research Resource lesson.

Module 13

Question: Now that I've visited a variety of good sites, how will I use this information to design an effective learning experience for students?

Achievement Targets: Importance of using pre-selected sites

Delivery Strategy: Pick one site that has potential to develop the research cycle, and create a lesson involving an essential question to use with a specific group of students.

Module 14

Question: How do we use indexes and search engines to find information efficiently on the Web?

Go to lesson.

Achievement Targets: Search Engines, Indexes

Delivery Strategy: Participants will test the features of two different search engines in order to see which one returns the best information in the top ten "hits." They will also learn how indexes differ from search engines.

Module 15

Question: How do I connect globally using Telecommunications and Mail?

Achievement Targets: Global activities, Mail

Delivery Strategy: With you and your partner's classroom needs in mind, review five or more activities from each of these groups: Problem Solving Projects, Information Collections, and Interpersonal Exchanges. During the second half of the module, in small groups, explain how you could use the lessons effectively with your students. Internet Projects

Module 16

Question: How does your lesson plan support the district policy?

Achievement Targets: Familiarity with the Bellingham School District Board Policy as it pertains to Internet Policy and Procedures for Students.

Delivery Strategy: Scan the District Policy to see its main components. Relate the policy to lesson plans.

Go to the Policy lesson . . .

Credits: This class was invented by the following Bellingham staff members: Tara Felder, John Schick, Carolyn Hinshaw, Linda Lamb, Eileen Andersen, Dar New, Jamie McKenzie, and Mary Gilson.

Return to Bellingham Schools Home Page

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8

RESOURCES

D) TEACHING & LEARNING

■ THE QUESTION IS...

BY DR. DAVE MOURSUND

The Basics Do Change

Q. How do you respond to people who argue against computers in schools by speaking about the importance of the "basics"?

I begin by agreeing that the basics are really important. Many people agree about what constitutes the basics in education. and a number of the basics can be combined into an overall goal for education such as the following:

> All students should gain a working knowledge of speaking and listening, observing (which includes visual literacy), reading and writing, arithmetic. logic, and storing and retrieving information. All students should learn to solve problems. accomplish tasks. and carry out other higher order cognitive activities that make use of these basic skills.

There are three important ideas here. First, the list is often summarized as "the three Rs," even though it contains more than three items. Second, the goal has an emphasis on performance at a level requiring higher order skills. Third, *all* students should achieve the goal.

Ten thousand years ago, the basics of education were quite different. Reading and writing had not been invented. Information was stored and passed on mainly through a combination of oral tradition and artifacts such as tools. The development of reading and writing clearly brought with it a significant addition to the basics.

Thus, the basics themselves can and do change. However, they do not change very often. The three Rs have been with us for thousands of years. We have no indication that they will suddenly disappear.

The higher order thinking skills associated with the basics have also stood the test of time. When we say "read and write" we mean that there should be intelligent, higher order processing of information through reading and writing. Indeed, we mean that people should be able to meet contemporary standards in the use of these basics. For example. a few thousand years ago nobody was expected to be able to read a bus or train schedule. Now, however, a lack of high performance on such a task is taken as evidence that our schools are failing. The emphasis is on performance—on being able to read and process the information in order to meet contemporary standards.

The idea that all students should master the basics is an important part of our educational goals. If we were to go back just a few hundred years, we would find ourselves in a time when many people received no formal education in reading and writing. Of those who did, the highest proportion received fewer than three years of formal instruction. Contemporary standards were not very high. Standards do change.

Tools and Contemporary Standards

There is another dimension to the basics: the tools we use. The tools and the basics are so intertwined that in many cases we do not attempt to separate them. For example, the abacus has been used for about 5,000 years. Over the past few hundred years, paper-and-pencil arithmetic replaced the abacus in many educational systems. Both the abacus and the paper and pencil are tools—they are physical artifacts developed by people. Other artifacts that have proven very useful in arithmetic and mathematics include the slide rule, the calculator, and the computer.

Similarly, consider writing. At one time students had to learn how to select an appropriate quill, cut its point properly, and gather and mix the ingredients for ink. These were part of the basics of writing. Later, pencils were developed—and then the typewriter and then the ball point pen. Still more recently, the word processor was developed.

We have nearly universal agreement that arithmetic and writing are essential basics in education. However, we lack agreement on which tools should be embedded in the basics and how those tools should affect the basics.

Obviously, there is no single right answer. It is both appropriate and desirable that people should argue about which tools to embed into the definitions of the basics. These discussions need to include a focus on contemporary standards of expected performance in using the basics.

To take a simple example, when I was in high school all students taking algebra learned to calculate square roots by using a paper-and-pencil technique that bears some resemblance to long division. This is a rather laborious process, and it is easy to make mistakes. Now, however, this computational technique has largely disappeared from the curriculum. It has been replaced because students now have easy access to hand-held calculators. The hand-held calculator can calculate square roots much faster and more accurately than students doing the calculations by hand. Moreover, it does not take very long to learn to use a calculator to calculate a square root. The learning time that is saved can be devoted to other tasks.

The point is that the calculator supports an increase in contemporary standards in arithmetic and mathematics. To a large extent, contemporary standards in education are based on levels of performance expected of people working in business and industry. Business and industry are less constrained by the weight of history than are schools, and people working in business and industry select tools that help them solve problems and carry out tasks. Thus, business and industry set contemporary standards based on the use of available, effective tools.

This type of analysis should help us to understand the nature of the basics issue. I strongly support the importance of the basics. But I want students to learn to meet contemporary adult standards of performance, too. Thus, I strongly feel that students need to be educated in the environment of the tools that adults use as they define their own contemporary standards. Computers are now part of the basics! ■

[Send your questions for this column to Learning and Leading With Technology, *International Society for Technology in Education. 1787 Agate Street, Eugene. OR 97403-1923; fax 503/346-5890; e-mail iste@oregon.uoregon.edu. You can e-mail Dr. Moursund directly at moursund@oregon.uoregon.edu.]*

From Now On
Vol 6|No 2|October|1996

The Post Modem School

by Jamie McKenzie

New Ideas
New technologies

The Net is for everyone

The Internet, variously called "the Information Highway," "the Net," the "Web," etc., is creating dramatic changes in the ways people communicate, learn, play, do business and solve problems - changes which require an appropriate program response from schools, given their charge to prepare young people for this electronically networked global village and workplace.

The Internet has changed from a network of scientists and computer buffs to an increasingly vital communications medium for the workplace and a rapidly growing number of households. The user friendly visual format makes it easy for anybody to enjoy and explore. Its use will become widespread regardless of the actions of schools, especially among the more affluent families who can afford home computers with adequate RAM and speed. As the much publicized ***Internet Machine*** *materializes at $500 - and Sony has introduced and is advertising one already, the* ***WebTV Internet terminal*** *- we may even see the Net as broadly available as* ***NinTendo Game Boys*** *and satellite dishes which manage to find their way into homes pretty much regardless of income levels.*

The Web offers information treasures

The Web offers rich potential for accessing information treasures . . . anything which can be digitized . . . great paintings, sculpture, photographs, and drawings from the museums of the world . . . great manuscripts and books from the leading libraries of the world . . . fresh and accurate statistics from government agencies and international agencies such as the World Bank . . . as well as information of interest to the family . . . to guide the purchase of a car, the selection of a movie, the choice of a vacation spot, the investment of family savings, the tracing of a family tree or the pursuit of a hobby.

One of the most dramatic examples to emerge in recent times is an offering from the San Francisco Fine Arts Museums. ***The Thinker*** *(http://www.thinker.org) is a* *collection of some 60,000 images which the museums have decided to share with the general online public. They mention with considerable pride that they are committed to sharing their entire collection while most museums can only show five per cent of their holdings. For most museums, the rest remain stored away in basements and warehouses.*

The decision to share can be seen as a phenomenal breakthrough in the development of the Net as the San Francisco museums join the ***Library of Congress*** *in creating a great digital splash. The combined effect of these institutional investments is something on the order of an earthquake. While* ***Negroponte*** *has been talking of a digital age (Being Digital), the images and the text must move off the shelves and out of the basement if we are to realize the full promise of digital exchange.*

Fundamental to widespread use has been the recognition by leading entertainment and communications companies that the Net will become as basic to the world as telephones and television. This is not a narrow playground for a small, privileged segment of the population. The Net is for everyone.

Schools must wake up and take this new responsibility seriously or they will find themselves failing to prepare students for learning and thinking in the next century and an Age of Information.

Information=Power

In this new landscape, Information=Power. The layperson gains independence from "authorities" as one is now able to find one's own answers. No more middlemen and middlewomen getting in the way. Buying a car, deciding treatment for a disease, arranging a mortgage, all of these are transformed. No more ***buyer beware****. The buyer now has information as an ally.*

"That car's book value is two thousand dollars less than what you're charging!"

What is an appropriate program response from schools?

What does it take to prepare young people to enjoy the full benefits of the Internet . . . this new information landscape? What is an appropriate program response from schools, given their charge to coach young people for this electronically networked global village and workplace? What is the role of teachers in delivering such a program?

The Goal: Developing Information Literacy

We might begin by providing students with the skills to manage these rich information resources: investigating, researching and making meaning from data.

In times of rapid change, the ability to create fresh meanings and novel solutions to problems becomes paramount. As states meet with educators and business leaders to ask what our students must bring in the way of skills to the workplace of the next century, reasoning, problem-solving and decision-making come out on the top of the list.

Teachers may employ an array of new technologies such as the Internet, databases and CD-ROM disks to support the development of strong research and thinking *skills. For staff development strategies to develop teaching skills in these areas, check out <a href="http://www.bham.wednet.edu">the lesson plans</A> on the Bellingham School District's Web site.*

The Advent of Post Modem Research

There is a substantial difference between ***descriptive research*** *(pre modem) on the one hand, which was nothing much more than "word moving" and* ***explanatory research*** *(post modem) on the other hand, which requires real digging to answer how and why things are related, how and why things happen, as well as just what we might do about what we learn.*

In pre-modem schools. the teacher had the answers. The job of students was to commit memory. Pre-modem, "go find out about" research projects required nothing much more from students than moving words from an encyclopedia page to index cards while changing one word in each sentence. Little thinking was required by such topical research. Go find out about Dolly Madison! Go find out about Molly Pitcher! Go find out about the Battle of Bunker Hill!

The copyright dates of a typical school library's books on science, American states and foreign nations are pretty discouraging. Example from an affluent private school

The old technology has not keep up with the times. Pre-modem education sent children to learn about countries, states, products and economies which no longer exist.

In post-modem schools, students make the answers. Teachers show students how to navigate through vast databases so as to locate information which will provide the basis for new insights. Information is hot, fresh, current and rich.

Why do we call such schools "post modem?" It is because they are linked classroom by classroom to a WAN (wide area network) and to the Internet at large by a direct connection. The modem is a rapidly obsolescing product of the analog age, translating the computer's digital messages for analog telephone connections.

In a post modem school, teachers provide students with the "technology of questioning."

essential questions
unanswerable questions
provocative questions
divergent questions
subsidiary questions
curiosity

Questioning is the primary technology to make meaning(s). Questioning converts data into information and information into insight.

The Learning Strategy: Practicing Information Literacy

Teachers show students how to move

from data
-------------*to information*

Learning Strategy: launching student team investigations with new technologies

Real time research is often project-based research which requires students to work in teams on problem solving or decision-making questions using a combination of new technologies (the CD-ROM encyclopedia and the Internet) with older ones (the book). Students may employ the Research Cycle:

Questioning
Planning
Gathering
Sorting and Sifting
Synthesizing
Evaluating
------Reporting

Which of the following three cities in New England shall we move to?

Portland, Maine?
Cambridge, Massachusetts?
Hartford, Connecticut?

Previous issues of From Now On and a series of articles published in Technology Connection have described this research process in some depth. The series is available in the book, **Net Profit in a Post Modem World.**

Curricular Goal: Interpersonal and Cooperative Learning Collaborating, Communicating and Problem-Solving in Groups

The workplace and the society rely increasingly on telecommunications to carry on the daily business of the "global neighborhood" with teams working to create answers to issues. Schools must prepare students for this present world (and their future) by involving them in challenges which engage teams across local boundaries.

The "global neighborhood" also offers teachers a chance to step outside of the isolation which too long characterized the life of teachers in smokestack schools, communicating with colleagues across town, across state lines and across national boundaries on how to achieve the best results for students.

Electronic publishing offers new possibilities for learning and communicating. As traditional publishing shifts to electronic forms and the Internet, schools may engage students in publishing the findings from their research, the fruits of their creative production and the best of their thinking.

Learning Strategy: launching global problem-solving, investigations and exchanges with e-mail and Web sites

Judi Harris, a professor at the University of Texas has collected and organized several hundred of the best Internet projects involving students in global partnerships and investigations.

She has grouped these projects into three major categories:

---------------------------to insight

Students must learn at least three kinds of literacy (the ability to make meaning from data).

Text Literacy

Good teachers have always taught students to be critical readers, but the task of finding meaning in thousands of pages of electronic text is a new challenge requiring new skills. (Internet Example: key word searching at Project Bartleby - an online collection of classics - Dickinson, Shakespeare, Frost, etc.) For staff development lesson on text literacy, go to Bellingham Schools

Numerical Literacy

Understanding the modern world requires some ability to think mathematically, analyze databases and crunch numbers. Once students have the vast databases of the US Census available on their desktops, they must know how to ask powerful questions about relationships and use a spreadsheet to find answers. (Internet Example: understanding data about crime and infant mortality at The US Census) For staff development lesson on numerical literacy, go to Bellingham Schools

Visual Literacy

While most young people learn more than half of what they know about the world through visual information, few schools teach them how to probe the information critically.

> *We're in the middle of a major communications shift from print to imagery.*
> *Politicians are aware of it, but I don't think educators are.*
> *------------Mary Alice White*

Teachers can show students how to look below the surface to grasp the content of a photograph, the strategies of an advertisement or the emotions of a painting. (Internet Example: analyzing turn of the century photographs at ***Library of Congress****). For staff development lesson on visual literacy, go to Bellingham Schools*

This is not about Surfing!

Information ATMs

Electronic information resources now provide the equivalent of information ATMs in many homes and across the classrooms of networked schools. Information is everywhere and available 24 hours a day. You can access the Net from an airplane 40,000 feet off the ground or an elementary classroom far from any metropolis.

Students can now do ***real time research*** *. . . exploring questions as they appear in the here and now with fresh data right in the class room.*

The new tests of information are speed of access, currency and quality. is it fast and easy? Is it hot? Is it accurate and reliable?

From Collaborative Problem-Solving Projects, Save the Beaches (http://ednhp.hartford.edu/WWW/Nina/Beaches2.html) as an example of a social action project.

COLLOQUIUM
The 4 Rs

By Jason Ohler

DIRECTOR, EDUCATIONAL TECHNOLOGY PROGRAM,
UNIVERSITY OF ALASKA

About 10 years ago, I had an experience that changed me irrevocably. I was teaching a class for K–12 teachers about using telecommunications in the classroom. After I described the expectations for the final project for the course, a student raised her hand and asked," May I submit a video instead of a paper ?" What followed in reality lasted only a few seconds. But in my mind, an indeterminably long confusion unfolded as old thinking and new paradigms chafed against each other like psychic tectonic plates. I couldn't just dismiss the student's request. After all, as director of one of the most rapidly evolving disciplines at my university, namely, educational technology, I was making a living teaching others how to incorporate the swiftly moving information age into their lives and classrooms. "Sure," I finally squeaked halfheartedly. I was just stalling as I tried to figure out what that moment meant.

I would eventually understand that this moment marked the beginning of my realization that a new world was upon us in which the written word, whether on screen or on paper, was no longer the primary way to present information or facilitate communication. This student was unique at the time because she was one of the few who had access to expensive, sophisticated video equipment. But now, with relatively inexpensive, easy-to-use multimedia-authoring technology becoming available in many U.S. schools, students combine words, pictures, sound, and movies in unified presentations. Because of the emergence of multimedia technology, we are being forced to expand one of the cornerstones of our academic culture. The 3 Rs are becoming the 4 Rs: Reading, 'Riting, 'Rithmetic, and *a*Rt.

Multimedia technology is commonly understood to be all that cool "stuff" used to create the desktop equivalent of glitzy television. But it is much more than that. Multimedia technology is assistive technology for those who might consider themselves "artistically challenged." In much the same way that the world of writing prior to word processing had been limited to those who came to feel at home with the often laborious mechanics of penmanship or typing, the artistic world had been reserved for those who spent countless hours learning how to draw, paint, play musical instruments, and manipulate media. We became a two-tiered culture: those who created art and those who appreciated what others created.

Then along comes multimedia. Want to draw a straight line? Make orchestra sounds? Create a movie? Write a rap song? The tools of multimedia can make it all possible. Those who gave up trying their hand at creating art because of the work involved finally get a chance to express themselves in ways they had only dreamt about. Artists used to working with traditional media have whole new palettes of tools with which to work.

Nowhere has the popularity of multimedia grown as much as on the World Wide Web, which offers many contributions to paradigm evolution. It allows the creation of distributed learning communities. It facilitates associative learning through the use of hypermedia (media that are linked). And it provides the first truly interactive form of mass media in which almost anyone can become a publisher. Yet its largest contribution goes largely unnoticed: it requires students to communicate as designers and artists. The citizens of the Web, who number in the many millions, employ the multimedia presentation as their Esperanto. The effect is to spread the language of multimedia throughout the international networked world. In retrospect, it seems inevitable that World Wide Web users would move away from language-dependent text and towards more universal languages like pictures to facilitate communication.

With the growing popularity of multimedia comes a proportional increase in the need for workers skilled in the language of multimedia. Thanks to our struggle to use multimedia effectively, the language of art is taking center stage.

There are three major components of this language: an understanding of the "grammar" of aesthetic presentation, loosely referred to as "design"; a grasp of the skills needed to manipulate media in meaningful ways; and the ability to use these skills to express a vision in terms others can appreciate. The three components are fully integrated within the domain of art, a field that, unfortunately, is currently considered outside the scope of an essential education. For years, art has been viewed as a skill only for the hobbyist and the hopelessly romantic, to be cultivated after mastering Reading, 'Riting, and 'Rithmetic.

Because of the emergence of multimedia technology, the 3 Rs are becoming the 4 Rs: Reading, 'Riting, 'Rithmetic, and aRt.

The age we live in has changed this forever. The rapidly growing domain of employment, in which presentation, media, entertainment, and education converge, now embraces the Arts out of necessity. Each of the 500 inevitable channels of video, the millions of incipient CD-ROMs, DVDs (Digital Video Disks), and World Wide Web home pages, as well as the new media we can't even conceive of, will be a cooperative effort, involving musicians, videographers, graphic designers, script writers, choreographers, creative consultants, and hundreds of other positions commonly associated with the Arts. In an equation: Art = Jobs.

During the inevitable transition period from text to multimedia, teachers will experience a loss of control. They will not be able to guide and evaluate student multimedia projects nearly as effectively as the text-based projects they are used to. I see art teachers working across the curriculum, teaching others the language and skills of art. The "writing across the

119

curriculum" movement of the past decade will be followed by a similar movement in which art is infused across the curriculum. There will be a long transition as the text-based culture that dominates the educational structure retires and makes way for one based on multimedia. But in time, students and teachers will be expected to communicate with a number of media in much the same way that they are currently expected to read and write effectively, regardless of their field of study.

Thanks to our struggle to use multimedia effectively, the language of art is taking center stage.

At present, the most pressing need is for graphic literacy: using pictures to communicate and present information. There are two primary reasons for this. First, the creation of graphics has been within our grasp longer than other non-text media and is, therefore, more commonplace. After all, expanding mass literacy to include graphics was the meta-message of the Macintosh revolution. Second, the transmission of graphics typically requires less memory, bandwidth, and other technological support than sound and video, which is why graphics and text currently dominate the Web.

But once video, sound, music, and animation are better understood in terms of their ability to communicate ideas and information effectively, and the technology that supports them becomes cheaper, more pervasive, and less specialist-oriented, art literacy will embrace all of these media and more. New media are certain to evolve, including holography, virtual reality, and others that we cannot presently discern, and promise to assume positions of pedagogical importance. Regardless of their forms, they will be folded into a multimedia context and learning the language of art will be essential for those who seek to use new forms effectively.

What will happen to the written word? As art and design begin to challenge the primacy of text, which has dominated our culture since Gutenberg, we should not fear that we will lose text. Instead, we will rediscover it. We will emerge from the current Age of Presentation with a better understanding of when text offers the best vehicle for communication, the ultimate goal in using any medium. Is all this a "good" thing? In trying to make sense of a world changing at an unprecedented rate, we need to remind ourselves that print only seems conservative because we have had half a millennium to get used to it. True, books seem to be a stabilizing cultural force. They offer inexpensive, readily accessible sources of information that don't break down or need 110 volts to work. But they have also created caste systems of literates and illiterates, wreaked havoc on indigenous, non-text-based cultures, and, in general, caused considerable social upheaval.

Similarly, multimedia technology and the new literacies offer us much, but for a price. Even though multimedia tools are relatively cheap, they are still presently expensive enough to be out of the reach of the information underclass that already exists, further separating the empowered and the disenfranchised. Also, using these tools demands new, technical skills that will perhaps blur the lines between commercial and fine art more than we would like. And while we routinely expect our students to develop an argument with text to convince the reader of a particular viewpoint, when they do so with multimedia, it looks suspiciously like advertising.

While many respond to the coming Age of Art with excitement when I talk about the 4 Rs, it is precisely the power of multimedia to overwhelm our senses and manipulate our emotions that worries discriminating consumers. Already sensitive to an entertainment industry that values special effects and battle scenes over dialogue and thematic substance, they want to know: Will using multimedia take the place of learning an artistic craft? Never. Will the general public come to accept technical dexterity in lieu of artistic vision? Perhaps. But, as the saying goes, while you can fool some of the people some of the time, you can't fool all the people all the time. While multimedia can act as assistive technology, it cannot take the place of vision, talent, or skill, whether developed or inherited. However one views multimedia, this new age of technologically driven communication makes clear the need for a critical analysis of the relationship between people, technology, and ethics in new and urgent ways.

But these are the concerns of the cognoscenti. Back in the real world, parents dominate the discussion of education in simple terms. They stick with the very understandable bottom line that I have heard them espouse since I entered education more than a decade ago: I want my kid to be able to get a good job. As education works to become more responsive to preparing students for the world of work, we must keep in mind that one of the true growth areas in the future will be the Arts. The literate, knowledgeable person will be expected to be well versed in the 4 Rs. If we are to be proactive and give our kids the skills they need, then art and design should become staples of K–12 literacy. ◀

Jason Ohler is director of the University of Alaska's Educational Technology Program which offers a master's degree, credential endorsement, and preservice and inservice training in the effective and creative use of technology in education. In his off hours he uses the technology to compose music and write for theater. The Educational Technology Program's home page is at h'tp://www.jun.alaska.edu/edtech/.

Computers in the Classroom of the Future

By Charlotte N. Carter, Nancy A. Childress, Sarah L. Mullican, and Lindsay D. Sheubrooks

IN THEIR SEARCH FOR THE CLASSROOM OF 2016, A TEAM OF FOURTH-GRADERS FOUND TODAY'S CUTTING-EDGE TECHNOLOGY, A COMPUTER-CENTERED CURRICULUM, AND AN INNOVATIVE IDEA FOR CONNECTING AGING CLASSROOMS TO COMPUTER TECHNOLOGY.

Our vision of a fourth-grade classroom in the year 2016 begins in a school that, at first glance, looks much like ours. While many newer schools will be built between now and 2016, most of the current school facilities will still be in use, so they will have to be upgraded to meet expanding technology needs. Once inside those classrooms, however, many dramatic changes will be apparent.

You will quickly notice there are many computers in every classroom. Each student has a notebook-size computer on his or her desk. The laptop computers of the 1990s have become the desktop computers of the twenty-first century. These computers are small, but powerful. They are easy and fast to use, and they connect to a variety of other electronic learning tools throughout and beyond the classroom and even beyond the school. The classroom's computers are networked into the teacher's master computer, which acts as a file server and a massive storage device. The computers are also connected to the library where thousands of CD-ROM disks can be "borrowed" to the laptops. CD-ROM disks in 2016 are made in the classroom. They hold text, color, sound, video, and camera-quality graphics.

The increased use of computer technology in the classroom of 2016 will change the way that classrooms are structured.

To activate their computers, students reach up and pull down coiled cables that plug into their laptops. The teacher loads software onto the server, and all the students can begin working. The server is very powerful and can run several CD-ROM disks at the same time so that each student can work on materials that fit his or her needs, abilities, and interests. This server also helps do the record keeping for the teacher so she can tell at what level and on which skills each student is working. If a student has some difficulty, the server will both alert the teacher and provide the student with remediation and practice until a predetermined mastery level is reached.

The teacher in this classroom has to play many roles. She is part computer technician and part information highway tour guide. A big part of her job involves record management, thus her computer is larger and more expensive than the students' laptops. Although the computer has made her job easier, it has not replaced the teacher. She is still the resident expert on curriculum, learner behavior, and motivation.

Computer-Centered Curriculum

In our 2016 classroom, the computer plays a larger role in the learning process. Although there are still some books in use, more and more textbooks are on disks. These electronic texts include a broader range of materials than was available in printed books. The pictures, or graphics as they are now called, have sound, color, and motion. Some are three-dimensional and give the "reader" a virtual reality experience. The student plays an interactive role with this material, scanning barcodes to access options that can enhance learning with music, animation, charts, graphs, and simulations. The student can take notes, do calculations, or write questions for follow-up study while the books-on-disk are on the screen. The computer is a true multimedia workstation allowing the user to access related materials that include videos, laser discs, CD-ROM encyclopedias, online newspapers, and a full range of reference materials in the school's library.

Utilizing the modem, fiber optic cables, and a communication satellite, the student can reach beyond the walls of the classroom and contact other people on the Internet. The student can both hear and see the person to whom he is connected if he sits at the teacher's computer which has the necessary auditory and visual devices. Global communications on the World Wide Web enable the student to join with other students and mentors around the globe to discuss issues, share ideas, and solve problems. This gives the student nearly unlimited and immediate sources for data. More importantly, it connects the student with experts and leaders in the topic of most interest to the student. The flexible curriculum allows students to make choices about what and how they will learn.

The teacher is still the resident expert on curriculum, learner behavior, and motivation.

The increased use of computer technology in the classroom of 2016 will change the way that classrooms are structured. Although students begin each day in homeroom grades, most of their time is spent in multi-age cooperative teams. Some teams include members from other schools within the district; a few teams connect students across the country. Students come together for instruction according to their needs and interests. These teams of students are flexible and change as the students make progress. There are greater opportunities for individualization. Adaptive devices allow special-needs students to participate on an equal footing with their peers.

When a student is home sick or hospitalized, a special laptop computer is lent to the student to keep him or her connected to the classroom as much as possible. The student dials the school on the modem and inputs a special code that provides access to the classroom's file server. From there, the student can access all books-on-disk, workgroup members, assignments, and notes. The teacher can activate both sound and video exchanges between this student and the classroom. During class discussions, the missing student is visible on the teacher's monitor, or an infrared beam can project the student's image onto a giant television screen set on the classroom wall. The student can ask questions or contribute ideas as if he or she were actually in class.

The increased use of computer technology in the classroom of 2016 makes other significant changes in the lives of the students. They do their homework on computers and download their work to the file server in their classroom. If the work isn't received at school by a certain time that evening, a warning message is sent to the student's home computer. If there are major errors in the home assignment, the file server may immediately ask the student to redo the task and resubmit it, or it may program remedial activities for the student and have these waiting on the laptop when the student arrives at his or her workstation the next day.

Parents can download progress reports, assignments, school bulletins, and teacher messages by calling the school from their home computers. They can even view their child's CD-ROM Portfolio, a collection of the student's work samples, video clips from musical and dramatic performances and grades and test scores.

Students still have to do paper-pencil tasks, but most tests, essays, reports, and worksheets are done on their laptops. Fast and accurate keyboarding is advantageous for the student. However, in some lessons, the student uses headphones and voice-entry responses. Other lessons are "hands-on," and the student participates by touching selected areas on the screen. Finally, the power and flexibility of the computer make it the focal point of most lessons, rather than just a machine to use when the main work is done. Curriculum is written and teaching materials are selected to take full advantage of the multimedia capabilities of computers.

Breakthroughs

A number of developments and changes need to occur before our advanced computer classroom of 2016 can become a reality.

A Note from the Teacher

The four coauthors in the front row appreciated the advice and encouragement of their 17 classmates, shown here with their teacher, Mary Finch.

I was teaching the process of writing a research paper to my fourth-graders and found that Charlotte, Nancy, Sarah, and Lindsay had already mastered this skill in their gifted and talented experiences. I asked them to design a task that would be more appropriate. They decided upon a collaborative project that focused on computers, an area of interest to them all. When we learned about Toshiba's ExploraVision competition, the girls really went to work! Frustrated in their search for materials on computers in the classroom of the future, they wrote to leaders in the field and asked for their thoughts [see "Letters," TECHNOS 4:4 and 5:1].

Working together was a real challenge, but the students discovered areas of strength in each other, and the research was divided accordingly. The girls worked at home and at school, often giving up recess and coming to school early. The rest of the class took great interest in the girls' vision of the classroom of tomorrow. They patiently shared my time, attention, and assistance. Everyone listened and critiqued each topic as the research paper developed. The long process of revising and polishing the final draft was a wonderful lesson for all of the fourth-graders. Even our principal helped the girls proofread.

Toshiba also wanted a 10-frame storyboard for a brief movie the students might make about their project. When the class was unhappy about having a substitute while I was on duty, the idea developed to parody a popular children's book, *Miss Nelson Is Missing*, by Henry Allard and James Marshall [see page 31]. When the last picture was colored and the last paragraph was printed, our class celebrated a job well done!

—Mary Finch, Fourth-Grade Teacher,
Timberwilde Elementary School, San Antonio, Texas

Nearly all of the needed advances in computer technology are already developed and are available on the business-world market today. There are smart phones like BellSouth's "Simon." a combination cellular phone. fax. video. and pager. There are talking modems and keyboards that speak and respond to voice. such as "Vocalyst" by Compaq. Every computer manufacturer is racing to put the latest models on the market. and each model is faster. more versatile. smaller. and more portable than last year's favorites. Many of these have related handheld information and communication devices like Apple's "Pippin" and "Newton."

Why doesn't this level of technology exist in schools today, and particularly, in a fourth-grade portable classroom like ours? Money!

Multimedia display devices and digital connectivity are essential features in the competitive retail market. The growing range of peripherals includes photo-quality printers. color copiers. scanners. digital cameras. LCD panel viewers. big screen digital television. massive memory storage systems. and towers that access dozens of CD-ROM disks. Fiber optic cables carrying sound. video. and digitized signals can hook all these devices into a powerful and elastic communications network.

Why doesn't this level of technology exist in schools today, and particularly. in a fourth-grade portable classroom like ours? Money! In a survey of the 100 largest American districts. lack of funding is the most frequently mentioned obstacle to school reform and technological development (32.7%) (1994 National Survey for Education Reform. SIMBA). Insufficient time to plan and organize (28.8%) and lack of training (5.8%) were other factors that directly impacted technology acquisition. In a 1990–1994 study of the cost of network technology in its schools. the Tucson Unified School District in Arizona reported that the per-unit cost was $4.350 (with $250 for maintenance. $2.750 for capital. and $1.350 for training). Salary and energy costs were not included in the figures (see "Three-Year Cost of Educational Computing" by Daniel Kinnaman in the May/June 1995 *Technology and Learning*).

When technology funds are available. they reach high schools long before they filter down to the elementary classrooms. It will be 20 years before the cutting-edge devices of today's workplace appear in our classroom. and these devices will only appear if they are more affordable and we have access to funds. Enrollments are soaring in public schools and budgets are tight. Achievement in math and reading is stagnant. Administrators are looking for new ways to boost productivity and quality without raising costs. Maintenance is being deferred. More and more students are housed in portables. Unfortunately. the technology budget is caught in a squeeze play between the high costs of investing in technology and increased demands on the overall school budget.

Another breakthrough related to funding is meeting the high cost of retrofitting existing school buildings to support evolving technology systems. It will be very expensive to install the wiring. cables. phone lines. and network connections in every school so that all students can use this technology to its fullest. We think there is a market for prefabricated linear panels that contain all the needed wiring. We call our idea "Media-Links." Our product would be cheap. lightweight. and durable. It would come in a variety of lengths. curves. and angles. or could be made-to-order. It would snap together like toy train tracks. and could be attached at ceiling level to interior or exterior walls. Connectors would punch into classrooms. where smaller Media-Links would distribute the wiring around the rooms using the acoustical ceiling supports. Laptops would connect to these cables using pull-down bungee cords.

Media-Links would snap together like toy train tracks, and could be attached at ceiling level to interior or exterior walls.

Finally, there must be a breakthrough in what and how students are taught. Our classroom in 2016 isn't designed for 25 students all doing the same thing at the same time! The technology we envision requires major changes in education. It can't just be an add-on to the way things are done today. Teachers and students will need to make more choices as they utilize the diversity of information the computers provide. The screens will be windows on the world. and because the media will be interactive. the students will have a global audience. The Internet will be the field trip bus of 2016. Parents. technologists. and educators will need to rewrite the curriculum so that it makes the best use of this dynamic technology. Then our equipment. in the hands of wonderful teachers. will work education miracles.

Consequences and Challenges

The use of computers in the future will have many positive consequences and present a number of serious challenges. Computers make learning fun. easier. and more interesting. The variety

Continued on page 32

Today's Classrooms

Many of the computers at Timberwilde Elementary School are hand-me-downs from local high schools. Nearly all of our software is on 5-inch floppy disks; the newest program among those is dated 1989. The story is frequently the same in the 105,952 public and private schools in the United States (Quality Education Data).

The number of antiquated machines that cannot run the most up-to-date software is high. The picture is bleakest in elementary schools. where 60% of the machines are old 8-bit terminals like Apple IIs. Intermediate machines, like IBM 8088s, account for 23%; only 14% of elementary computers are up-to-date and capable of supporting CD-ROM drives (Software Publishers Association).

Ten years ago, there was one computer for every 125 students, K–12. Today, there is one for every nine students. But if the installed base is significantly outdated, those nine students are being shortchanged (QED).

—Mary Finch

Mary-Lee Finch has taught in regular, special, and gifted education positions for more than 25 years. A teacher and campus technology facilitator at Timberwilde Elementary School , she is also training to become an Effective Teacher Practices mentor for the Northside Independent School District in San Antonio.

Sarah, Lindsay, Nancy, and Charlotte: The four coauthors are gifted fourth-grade students in the Timberwilde Elementary School in San Antonio, Texas. Sarah Mullican is interested in the stock market and plans to be a special education teacher. Lindsay Sheubrooks loves animals and wants to be a veterinarian. She hasn't decided yet on Texas A&M or the University of California at Davis. Nancy Childress wants to be a lawyer or a nurse. She is interested in her Korean heritage. Charlotte Carter is the athlete of the group, and a killer soccer player. She plans to play as a professional and then be a lawyer.

Continued from page 30

of software programs available encourages students to explore special interests and work at their own pace. Computers can save you time, and they allow you to access information from sources far beyond the school, the home, and the community library. Distance learning in cyberspace connects the classroom to the whole world, making the student-user a part of the global village. Computers with adaptive devices like touch screens and voice entry allow physically challenged students to participate more advantageously in regular classroom activities. As more and more computers become available in schools, other learning tools like books, televisions, videodisc players, cameras, and telephones will be modified to connect with this technology, allowing the creation of multimedia learning experiences. Ultimately, students working with computers will be better prepared for the workplace of the future.

The use of computers in the future will also pose numerous challenges. Even though computer costs are decreasing, they are still too expensive for all students to have adequate access to them. The expenses involved are not just for the hardware and software. Classrooms have to be modified to handle this equipment. Training people to use the computers takes time that people may not have, and it also costs money. The community that pays for increases in classroom technology will also expect proportional increases in student test scores, and this may not occur.

People may find computers to be too advanced for them. Some parents may not be able to keep up with their child's knowledge of educational technology. Many districts may not be able to afford this technological growth, and the public school system could break down along socioeconomic lines. Low-technology school systems might face legal actions on the grounds that they are failing to provide equal educational opportunities for their students. There could be a challenge to privacy as people make unauthorized entries into files. We will have to deal with the sensitive issue of censorship. Not everything in cyberspace is appropriate in the classroom, so guidelines for access will need to be set and enforced. Finally, there is a health issue. If students spend hours in front of a computer screen, what impact will that have on their fitness, vision, and social development?

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- Andy Reinhardt, "New Ways to Learn," *Byte* (March 1995)
- *Report on the Effectiveness of Technology in Schools*, 1990–1994, Washington, DC: Software Publishers Association (1994)
- Judy Salpeter, ed., "Where We're Headed: Teaching, Learning and Technology in the Future," Special Issue, *Technology and Learning* (Summer 1995)
- Alan Trussell-Cullen, *Beyond 2000*, Hong Kong: Shortland Publications Limited (1988)

Jamie McKenzie

Making WEB Meaning

Students can triumph over the information overload of the Internet by contributing to virtual museums on their school's Web sites, using annotated Web curriculum lists, and conducting research in cooperative teams.

The once popular "surfing" metaphor is now pretty much discredited as the Internet reveals itself as the greatest yard sale of information in human history. Poorly organized and dominated by amateurs, hucksters, and marketing gurus, the net offers INFO-GLUT, INFO-GARBAGE, and INFO-TACTICS. Schools that plunge students into this INFO-SEA with nothing but mythical or metaphorical surfboards are courting disillusionment, chaos, and what

In building a Web site or conducting research, books are still important to Fairhaven Middle School students and teachers.

beach folk call "Wipeout!" Good planning and staff development can convert the chaos into treasure.

Before schools invest millions of dollars to provide access to the World Wide Web (WWW), they would be wise to stop and ask "Why?"

Bellingham, Washington, Public Schools spent nearly half of its $6 million technology bond on infrastructure to connect all 1,500 desktops across 18 schools to the Internet and each other—in a wide area network. After a year and a half of robust access to the Web, we have found three strategies to make the learning experience most meaningful to the 10,000 students in our 18 schools (12 elementary, 4 middle, and 2 high schools):

- Virtual museums
- Curriculum pages
- The research cycle

Virtual Museums

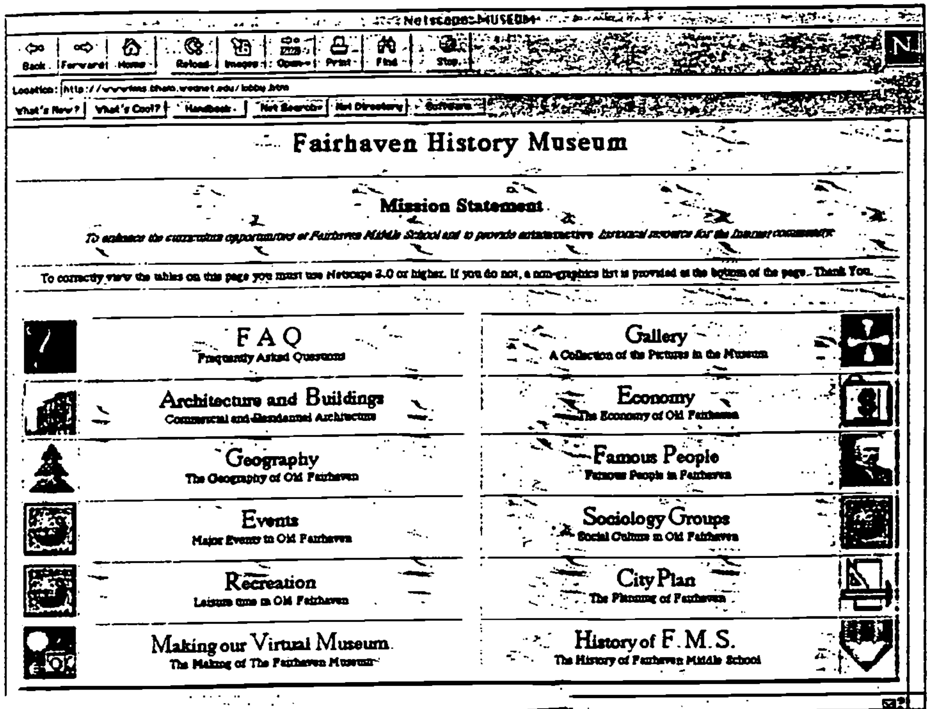
Because our schools are all connected to the Internet, it was a simple matter to create Web sites (home pages) at each school. We began by asking "Why bother?" in February of 1995.

A quick scan of several hundred school Web sites revealed little of consequence. We found pictures of principals and pictures of buildings. Here and there we found examples of student work. There were lists of Internet sites, but we found little substance, little content, and little utility.

The several dozen staff members—many of whom were library media specialists—who joined in these "virtual field trips" were quick to call for something better. Entranced by the vivid graphics and superb information provided by adult virtual museums such as the Web Museum (http://sunsite.unc.edu/louvre/) and the Franklin Institute (http://sln.fi.edu/), they seized on virtual museums as a centerpiece for Web site development.

Our virtual museums are student-constructed collections of digitized artifacts that illuminate some major aspect of the curriculum. Ellis Island, for example, is one elementary school's virtual museum devoted to diversity, national origin, and immigration. Students (half of whom are first-generation Americans) share the stories of their families' voyages to America from Laos, Cambodia, Vietnam, Greece, and Russia. Another museum, the Fairhaven Turn of the Century Museum, concentrates on local history. (See the next page for Fairhaven's home page.) The students include scanned photos and documents, as well as short video segments, to welcome visitors. For a full listing of Bellingham's museums, go to http://www.bham.wednet.edu/bpsmuse.htm=Bellingham; for a global listing of school museums, go to http://www.pacificrim.net/~mckenzie.

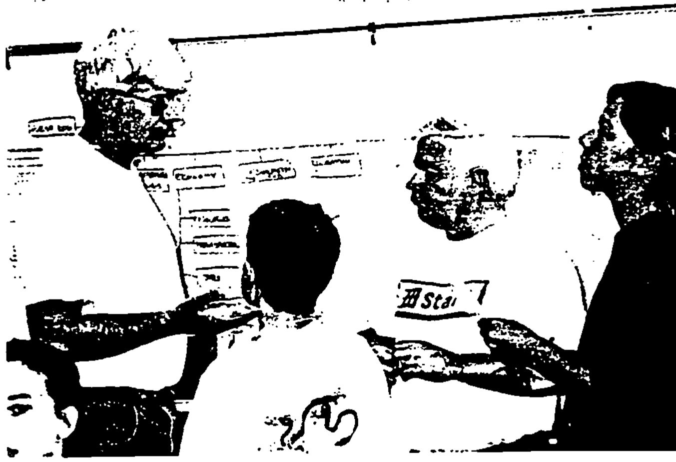
Students act as curators under the tutelage of teachers who help them learn the special coding necessary for Web page design (called HTML, or hypertext markup language), as well as the skills of gathering and interpreting artifacts and information. Virtual museums are a great way to engage students in "making meaning" while publishing globally. They challenge students to learn in a fully constructivist manner, building meaning into cyberspace.



Curriculum Pages

The second way we helped our students find good content was through building our own lists of curriculum-related sites—curriculum pages. In our Web searches, we found that many of the lists available did not point us to quality. The typical user had to visit dozens of sites and pass through many levels of menus before finding solid content relevant to the curriculum question at hand.

For example, only about 10 percent of *Yahoo's* (http://www.yahoo.com) lists of curriculum-related sites had rich content. Our "curriculum page" team saved dozens and potentially thousands of other teachers the trouble of visiting those "empty" sites by publishing our annotated selections on our Web site.



Fairhaven Middle School staff and students meet to plan the Fairhaven turn-of -the-century virtual museum, with a focus on local history.

To examine examples of such lists, visit the Bellingham Public Schools at http://www.bham.wednet.edu.

Because Web lists rarely include annotations and because many of the people who name sites or build lists seem to know little about categorization or labels, it is difficult to identify from simple lists the sites worth visiting. The solution is to add annotations that warn and inform the explorer regarding the site's offerings. These annotations can include comments about whether the site has large graphics (which take a long time to access or download) and can provide a sketch of the content.

To protect explorers from unnecessary and wasteful passages through menu levels, our Web page designers and their student helpers used HTML coding to link the content at useful sites to our page. We would often bypass the introductory pages of these sites and go directly to the heart of the information.

Good curriculum resource lists also offer a healthy alternative for districts concerned about students coming into contact with controversial materials. Staff and students may visit sites on the list (and stay on them) without risk. Such guidance seems preferable to censorship and site-blocking software.

The Research Cycle

Our third strategy to enrich students' learning experiences involved new approaches to research. We learned quickly that old approaches to student research were inadequate to meet the essential learning goals set by the district and were ill-suited to the information-rich environment we had created with our 1,500-computer network. With all those computers and all those classrooms connected to great information on CD-ROMs and the Internet, we needed to reinvent our concept of research, upgrading the questioning and elevating the reasoning required while encouraging students to work in teams.

Our teachers now participate in a staff development course titled "Launching Student Investigations." This course is based on the *Research Cycle*, first published in *Multimedia Schools* (McKenzie 1995). We teach teams of students to move repeatedly through each step of the research cycle: *questioning, planning, gathering, sorting and sifting, synthesizing, evalu-*

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126

ating, and *reporting*. After several repetitions, these steps lead to *insight*. (For a detailed description of these phases, see a six-part series of articles published by *Technology Connection* [McKenzie, April 1995 through December 1995].)

Questioning. Most research done for school projects is topical. Students must "go find out about" Dolly Madison or Connecticut. These assignments turn students into simple "word movers."

Virtual museums are a great way to engage students in "making meaning" while publishing globally.

New technologies make word moving—cutting and pasting—even more ridiculous. We now emphasize research questions that require either problem solving or decision making. Examples: How might we restore the salmon harvest? Which New England city should our family move to?

Planning. The student teams now carve up the questions into subsidiary questions. They ask: Where might we find the best information? What sources are likely to provide the most insight with the most efficiency? Which resources are reliable? How will we sort, sift, and store our findings? (For example, should we use a database or a word processing file?)

Gathering. If the planning has been thoughtful and productive, the team swiftly and efficiently finds good information sites, gathering only relevant and useful information. Otherwise, teams might wander for many hours, scooping up hundreds of files that will later prove frustrating and valueless. Students must structure findings *as they gather them*. Putting this task off until later is dangerous when coping with INFO-GLUT. In addition, teams need to be aware that they should use the Internet only when that source is likely to provide the best information. In many cases, books and CD-ROMs will prove more efficient and useful.

Sorting and Sifting. The more complex the research question, the more important the sorting and sifting that provides the data to support the next stage—synthesizing. While the teams must select and sort during the previous stage—gathering—now it must systematically scan and organize the data to set aside what is most likely to contribute to *insight*. (McKenzie 1993, 1994).

Synthesizing. In a process akin to working jigsaw puzzles, students arrange and rearrange the information fragments until a pattern begins to emerge. Synthesis is fueled by the tension of a powerful research question.

Evaluating. At this point, the team asks whether more research is needed before proceeding to the *reporting* stage. For complex and demanding research questions, evaluation often requires several repetitions of the cycle. The time to report and share insights is determined by the quality of the information revealed during evaluation.

Reporting. As multimedia presentation software becomes readily available to our schools, our students are increasingly making more persuasive presentations. The research team, charged with making a decision or creating a solution, reports its findings and its recommendations to an audience of decision makers (simulated or real).

Two excellent additional print sources to expand the reader's understanding of information problem solving are Michael Eisenberg's *Big Six* model (Eisenberg and Berkowitz 1990) and Jacqueline and Marty Brooks' 1993 ASCD book, *In Search of Understanding: The Case for Constructivist Classrooms*. An electronic source is the WWW page devoted to constructivist learning (http://www.ilt.columbia.edu/k12/livetext/webcurr.html).

On the Horizon

At Bellingham, our students are developing more information literacy as the information landscape shifts with powerful new technologies. For the same reason, the importance of library media specialists has been growing dramatically, particularly as research becomes central to student-centered, constructivist classrooms. The journey will probably take a full five years of staff development, team planning, and invention—but it is a journey well worth undertaking. The payoff for this investment is the graduation of a generation prepared to make their own meanings in an often confusing, rapidly changing world. ■

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TELEHUNTING TELEGATHERING TELEHARVESTING

Information-Seeking and Information-Synthesis on the Internet

More than a year ago, the Internet offered you approximately 2.5 mil- ' hosts, or computers to which you could connect to access information (...atrix Information & Directory Services, 1995). The Internet has been growing at a rate of 80%–100% per year for more than six years now (Quartermann & Carl-Mitchell, 1995). One estimate says that a new Internet host is added about every 30 minutes (Calcari, 1994). Obviously, there is a lot of Internetworked information to which you and your students have access, and that amount is growing quickly.

But, as I suggested in October's Mining the Internet column, merely accessing information should not be confused with constructing knowledge. The making of knowledge is an active, holistic, and idiosyncratic process for each learner that can be greatly enhanced with a teacher's guidance. Information accessed using the Internet can become some of the elemental substances learners use to create knowledge, much in the same way as a plant uses air, water, and light in the process of photosynthesis. Unlike the production of chlorophyll, though, the production of knowledge often benefits from direct, interpersonal assistance. As teachers, we know it is our responsibility to provide this guidance to our students. Yet, with most of us being newcomers to the overwhelming amount and variety of information available online, how can we know how to do this?

Information-Seeking

The usual answer to this question is technological ... and insufficient. ...ormation-searching programs, such as *veronica* in Gopherspace and ...riety of search engines (such as *WebCrawler*) on the World Wide Web, are certainly powerful, useful tools that can help our students locate large numbers of diverse and timely documents. In schools with the luxu- ...asy access and flexible class schedules, students (and teachers) "surf the Internet," and are often impressed with the range, amount, and appearance of all that can be found that is related to a particular area of inquiry. In a sense, we become Information Age hunters and gatherers in cyberspace, sharing news of the richest locations by exchanging addresses and URLs with members of our virtual clans. Yet it is here, at the point of information access, that many current knowledge-creation efforts falter. We find ourselves confronting a much more important educational issue: what students *do* with the information once they locate it. This is the step at which mechanical assistance cannot replace human interaction. (Specific instructions for use of Internetworked information-searching tools are included in *Way of the Ferret: Finding and Using Educational Resources on the Internet* [Harris, 1995]).

In prehistoric terms, how can the fruits of the hunt be turned to food for the clan? Part of the answer to this question lies in the plan for information-seeking itself. If students know clearly how they will use the information they eventually locate, their chances for purposeful searching, rather than aimless surfing, increase. As teachers, we can help our students formulate and enact these plans. My virtual travels on the Internet have revealed five purposes that students seem to have (often at the apparent suggestions of their teachers) when engaged in such "virtual foraging." I share them with you now with hopes that these categories will assist your online activity planning.

1. Students can practice information-seeking skills.

During the spring of 1995, Brian Callahan, a teacher working with public television station WHRO in Norfolk, Virginia, organized several grade-level divisions of the Great Computer Challenge Internet Scavenger Hunt to help his students collaboratively hone their Internet information-seeking skills. Here is Brian's introduction to the Scavenger Hunt and some of the rules for joining in on this team-oriented competition:

On Your Marks...Welcome to the first ever Great Computer Challenge Internet Scavenger Hunt! There are three parts to the Scavenger Hunt: The Questions, The Log and The Team Defense. Although this is a competition, we're much more interested in helping students learn about the Internet. Please keep teacher involvement to a minimum.

You will have a little over two weeks to answer the questions. Please pay close attention to the submission deadlines on page 2.

The Questions (please see attached page)
Each question has a different point value.Please try to answer every question, but remember: we're interested in not only the right answer, but how you get the answer.

The Log
Each team is required to keep a detailed Log telling us how you got your answers. There is no set format for The Log - just make sure it tells us everything. The more detailed The Log, the better. Even if you don't get the right answer, you'll probably get partial credit for trying.

The Team Defense
On the day of the competition each team will be asked a series of questions by the judges. Team members will be judged on the quality of their responses.

Several of the questions posed to the Division 2 teams (grades 3–5) were:

2. What is the phone number for VA.PEN? (2 points)
3. What does VA.PEN stand for? (5 points)
7. What are the complete lyrics to "Won't You Be My Neighbor?" (7 points) [Hint: Mr. Rogers sings the song and makes his home on Learning Link.]
10. Who is Linda Berry? Send her an e-mail message. (10 points)

Bonus Question
13. What month and year, according to the NASA Fleet Manifest, is flight 63 scheduled for? (10 points)

As you can see, the purpose for participation in this activity is for students to practice, reflect upon, and share their Internet-based information-seeking strategies. (We should also hasten to mention, as did Brian in his directions to the eight teams in Division 2, that an additional requirement for the activity was to "HAVE FUN!")

Information Synthesis

Honing information-seeking skills is an important prerequisite for much of what students will do online that is related to their curricular studies. It should not be forgotten, though, that developing these skills is but a means to an end. The synthesis and evaluation of multiple types, formats, and sources of information are truly at the heart of knowledge construction. Why might a student apply information-seeking skills? The four purposes for teleresearch that follow are possible answers to this question.

2. Students can become informed about a topic of inquiry and/or answer a question.

Much online information-seeking serves this purpose. For example, from March through May of 1995, William Gathergood coordinated a well-conceived activity that he called The Geography Project - 4. (Please note Mr. Gathergood's surname is *not* a topically referenced, clever writing technique. Had I created a fictional name for this creative teacher, I would have chosen, of course, Gather*well* <grin>.) According to Gathergood's online message, the primary learning goals for this activity were to:

A) hone students' skills in researching scientific and social information and map interpretation.

B) [encourage] students to communicate with others in other countries.

C) help students to develop an understanding of the differences between scientific fact, presumption, and errors based on misinformation based upon stereotypes and prejudice.

Participants were paired with student partners from different countries and then asked to to get to know their keypals by sending introductory letters and responding to 30 "icebreaker interview" questions. At that point, the project took on an interesting and powerful dimension. In Mr. Gathergood's words,

After sending this to their partner, the students will then be instructed to learn as much as possible about the other student's country through research. They may look at maps, books, magazines, and any computer-generated data they can find. After the research is complete, each student must write "A Day in the Life" of the other student. The paper should include what each student thinks the other student's life is like. What are schools like? What do the students do for fun? What kind of work/ responsibilities do they have outside of school? What is family life like? What are most students' attitudes about the future?

These questions should be answered to the best ability of the student who has researched the other country. So if John Smith, of Central Ohio, is working with a student in Japan, he would communicate with a student from there and then begin research using as many sources as are available to him. He will then write a paper entitled "A day in the life of ______." The student in Japan will do the same thing, studying the American student.

When the papers are finished, they are sent to the student in that country. When students receive the paper about their lives, they will critique it. Obviously, they will discover mistakes. John Smith may not understand how Japanese life has become modernized while the Japanese student may have false assumptions about what Americans do with their leisure time.

In the critique, each student should point out which observations are correct and which are wrong. Then each will write about what his or her day-to-day life is really like.

In this way, students will use research tools to learn about real people in other cultures and have the opportunity to separate myth from fact - stereotypical prejudice from actual social behavior.

Please note that information-hunting and information-gathering often complement telecollaborative activity, as we see in this keypal project. (Other educational telecollaborative activity structures are described in

MIDS does not stop with their own edification. Instead, they share the fruits of their new understanding with other students by producing instructional multimedia packages for younger students and by using computer conferencing facilities to directly assist these students in their learning. This points to an important goal for use of information collected online: to publish syntheses and critical appraisals of the content from the full range of located resources. In this way, the results of students' explorations can become the information "crops" that other students can harvest.

5. *Students can publish synthesized and/or critiqued information overviews for other students to use.*

Perhaps the single most important trend in the evolution of online resources is the development of a technologically simple way for Internetworked explorers to share the fruits of their seeking and synthesis labors worldwide. The most common way to do this is with a locally maintained but internationally accessible World Wide Web (WWW) server. In late August 1995 there were more than 450 K–12 schools in the world with such WWW servers, and this number promises to grow rapidly by the turn of the century. (For more details on how to create WWW servers, see last month's Mining the Internet column.)

Several teleresearch projects incorporate such publication efforts into the structures of the students' activities. The previously mentioned SECs project, coordinated from LBJ High School in Austin, is one example. The 1995–96 Earth's Crust and Plate Tectonics Project, a multidisciplinary, interdisciplinary, international effort organized by Hannah Sivan and David Lloyd from Sde Boker, Israel, requests that students create databases and WWW pages that summarize their discoveries of how phenomena related to plate tectonics appear in their daily lives. And in Project Population, organizer Martha J. Harris from Wayland, Massachusetts, requests that participants examine local historical census data to identify, and eventually explain, "[time] periods of rapid growth or decline." By publishing these local analyses on the Project Population Web Page, participants from all over the U.S. will soon be able to deduce common patterns (and perhaps causes) of population rate changes across sites.

Examples of publishing synthesized online information for educational use are impressively numerous. Exploring only a few of the many K–12 servers online will give evidence of this trend. Fortunately, "Internet angel" Gleason Sackman has made such exploration easy for us. Just use your Web browser to open this URL:

```
http://www.sendit.nodak.edu.k2/
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This useful Web page contains links to all known K–12 servers, plus sites set up by other organizations to benefit precollege students and teachers. It is updated frequently and supports use of any WWW browser, including *Lynx*.

Teleharvesting

Those of you raised in urban environments might be surprised to learn, as I was, that crop harvesting is not comprised primarily of the collection and bundling of mature plants. Instead, it involves mostly the *processing* gathered crops—getting them ready for sale or consumption.

The same is true for *teleharvesting*. (I am indebted to my friend and colleague, Cathy Gunn, a faculty member at the University of Northern Arizona, for her creation of this insightful concept and term.) Teleharvested information has been remotely cultivated, perhaps by groups of K–12 students and their teachers. The effective processing of Internetworked information—that is, its use by learners in the construction of knowledge—is a principal challenge to learners and teachers in the Information Age. Like the ancient farmers who invented agriculture, we have much to learn, and ultimately share, about the art and practice of "infoculture." ■

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the March, April, and May 1995 Mining the Internet columns, as well as in *Way of the Ferret: Finding and Using Educational Resources on the Internet* [Harris, 1995].) In fact, we could argue that information-seeking and information-synthesis as primarily independent activities have limited educational benefit for most of our students. Therefore, it is important to consider ways in which located information can be collaboratively examined and critiqued.

3. Students can review multiple perspectives on an issue.

Students can seem to be convinced that there are discrete and simply stated answers to many questions. Fortunately, the world is much more complex and interesting than that. Online information-seeking can help students consider multiple perspectives upon issues they are exploring. For example, Kay Corcoran, a middle school teacher in Mendocino, California, helped her students form questions to ask historians who contribute to a number of scholarly discussion lists about ancient history. According to Ms. Corcoran, this was a culminating activity, helping sixth- and seventh-grade students to "extend their research ... on ancient history topics."

The basis for this project is rich and educationally sound. As Ms. Corcoran stated in her project summary:

> To enliven and engage the middle school learner, project-based units based on guided research are a popular feature in the History/Social Science curriculum. Typical research projects utilize the resources of school and community libraries, and students need to learn to read information closely and thoughtfully. With the availability of telecommunication resources for research on chosen topics, they soon discover that "historical fact" is open to interpretation, contradiction, and occasional controversy.
>
> As a culmination activity to their research project presentations, those students who have been "critical readers," who have recorded inconsistencies, who have exhausted their resources, and who have unanswered questions may utilize listservs to provide clarification.
>
> A variety of history listservs abound, and the discussions cover a wide range of topics. Not only will sixth and seventh graders see that ancient history is alive and well, but that "historical fact" is open to interpretation based on evidence. History listservs provide an excellent opportunity for middle school students to observe the give and take of inquiry and to dialogue with the experts.

Alternative perspectives can also be discerned from files of information stored on Internet-accessible servers. Din Ghani, the organizer for KIDLINK's 1994–95 What's in a Name? project, for example, posted a list of helpful Internetworked genealogical resources to assist participants worldwide with their online and offline explorations of the etiologies, similarities, and differences among related groups of surnames and naming conventions in different parts of the world. Mr. Ghani, who moderated this richly conceived, telecollaborative "information search" project from Newcastle-upon-Tyne in the United Kingdom, also provided a list of offline resources to help participating students locate information about the names or naming practices they were researching. In this way, he illustrated an important and often-overlooked aspect of the educational use of Internetworked resources. Information accessed online might be more recent, more varied in form, and perhaps more plentiful than information available locally; but online resources, no matter how much they are hyped by technocentric advocates, should not replace offline resources. Instead, *all* kinds of information should be used in combination, and according to the requirements dictated by each learning situation.

4. Students can solve authentic problems.

Advocates of constructivist notions of learning and teaching stress the importance of having students explore and find solutions to real-world, complex problems. Online information-seeking can greatly assist these efforts. This year, for example, Martha McPherson's students in Fort Worth, Texas, used information culled from existing Internet resources, data generated through surveys written and administered by students, and information available via electronic discussions with subject matter experts to discover why the horned lizard is endangered. She provided the following overview of the project.

> Students will use online research and survey instruments to collect data throughout the United States, Canada, Mexico, and Central America on the Horned Lizard. This information will be pooled and analyzed to discover reasons why this species is now endangered. Electronic mentoring will be provided by scientists from Texas A&M.

Greg Rawls' junior high school students in Conroe, Texas, used online resources to both identify and explore local and larger scale social problems. Here is his description of his project:

> The "Problems" program is a student-based problem-solving project in which students focus on the process involved in determining interdiciplinary, real-world solutions to local and societal issues. Students use online resources to research a topic, send out surveys to collect additional data, and exchange e-mail with experts and content specialists for guidance. It is expected that the project will be ongoing throughout the year with students producing a technical paper as a result of their research.

Gail Carmack's high school biology students used Internet resources via TENET, the Texas Education Network, to explore the scientific and social challenges presented by AIDS and other immuno-suppressive diseases through a well-constructed project entitled Students Exploring Cyberspace (SECs). She posted the following description:

> Project SECs will allow biology and social studies students to study AIDS and other current topics in a multinational, interdisciplinary fashion. Students will use TENET resources such as Gopher, Veronica, Archie, Telnet, and FTP to research current information about AIDS pathology, epidemiology, treatment, and social implications. Additionally, they will communicate with students from other countries through e-mail to find out how AIDS impacts other societies. They will then produce multimedia packages that can be used to teach [about] AIDS at feeder junior high schools. High school students will use TENET newsgroups to mentor junior high students who are also studying AIDS.

Note that the culminating activity for these students' exploration of

Changing Teaching With Technology

I first began thinking seriously about the impact of computers on learning environments while directing a computer camp during the summer of 1988. I remember watching about 15 middle school students working on the several different types of computers I'd been able to scrounge for the project. The students moved easily between different platforms, building cities using *LogoWriter* on IBMs, creating cartoons with *HyperCard* on Macs, and exploring the beginnings of multimedia using an Amiga. Wow, those kids looked bright. But when I asked a couple of students how they were doing in school, they told me about the Ds and Fs they were getting. Why had these students, who seemed so bright and motivated to learn when working with technology during the summer, failed in their schools?

The Need for Teacher-Centered Reform

Odvard Dyrli and Daniel Kinnaman (1995) set the stage for this month's Research Windows column when they suggested in a recent article that if technology is to be a powerful and positive force in our schools it will be necessary to design a new curriculum. They also suggested that teachers take the lead in this process. The curriculum they imagine is not the sort that comes in a box and often sits unused on shelves. Rather it is a curriculum that evolves through teachers' thoughtful integration of technology tools with those teaching strategies that get students more involved in their own learning.

In a comprehensive review of the science education reform movement, Marcia Linn (1992) echoed Dyrli and Kinnaman's concern for teacher involvement and leadership:

> Collaborative efforts to reform science education depend more and more on the participation of teachers. ... However, such benefits are likely to arise only if all members of the collaboration are equally respected. Frequently the rhetoric surrounding science education reform suggest that new approaches be teacher proof, rather than being informed by insights from teachers. (p. 836)

Linn continues, "Teachers are often the recipients of a knowledge-telling approach to educational reform rather than partners in efforts to improve science instruction" (p. 831). The rest of Linn's article discusses the role of technology in science education reform both in terms of breaking down the professional isolation of teachers and in providing students with tools they can use to improve their thinking.

Technology-Rich Environments and Changes in Teaching

We know that when teachers teach for several years in technology-rich environments, there are significant changes in the way they teach and in the way students learn (Dwyer, Ringstaff, Sandholtz, & Apple Computer, 1990; Sheingold & Hadley, 1990). O'Connor and Brie (1994) reported on a three-year project funded by the U.S. Department of Education to empower high school mathematics and science teachers to improve their curricula by using technology. These researchers concluded that technology had made a significant change in the classroom environment. Specifically, they reported "less lecturing and more doing of science and math, improved feedback to students, more problem-solving, more hypothesis generating and testing, more performance-based assessment, increased student creativity, increased student motivation, and increased teacher productivity" (p. 27).

This month's Research Windows column looks at research on how technology can be used to support innovative teaching, ranging from thematic teaching to the use of technology to support cooperative learning and provide authentic audiences and tasks.

Thematic Teaching Using Technology

Theory has it that one of the ways to get students interested in science is to get them involved in doing science and to present it in a way that relates to their interests. Valerie Bristol and Susan Drake reported on a study in which technology was used to link language arts and the learning of science content.

Bristol, V. & Drake, S. (1994). Linking the language arts and content areas through visual technology. *T.H.E. Journal, 22*(2), 74–77.

The integrated science and reading project described by Bristol and Drake is currently in the last year of a five-year longitudinal study. The project was conducted in an urban school district in Florida. Three fourth-grade classrooms with average and above-average students took part during the first two years. In the third and fourth years, fourth- and fifth-grade at-risk students were also involved in the project. The science/language arts program replaced the traditional reading/language arts instruction with a daily two-hour time block of in-depth science instruction. Students were involved in hands-on science, writing and discussion, and the use of visual technology materials, including instructional television, laserdiscs, and computers. The authors describe how several teachers in the project used visual media to connect language arts with content-area learning.

Christy Bradford, who teaches a drop-out prevention class of fifth graders, used cable television for many learning activities. Her students learned economics by taking part in a 10-week competition centered on the stock market. Eulalee Burke's fourth-grade at-risk students watched Reading Rainbow's *Hill of Fire* to learn about volcanoes. Her students pretended to be on-the-scene reporters who witnessed the eruption of a volcano in Mexico in 1943. They then gave reports in front of the classroom video camera. A student teacher, Karen Lasagna, began a social studies lesson by showing the "land grab" scene from the movie *Far and Away*. The movie brought to life the race for free land in the early West.

Analysis of data in this project showed that those students participating in the reading/science program showed significantly higher levels of achievement in both reading and science than students who received instruction through their regular basal reading and science programs. The researchers reported that the students in the project also displayed more positive attitudes toward reading and science.

Technology and Cooperative Learning

Uslick and Walker provide an interesting overview of a teacher-driven educational innovation in which technology is used to support cooperative learning. The authors describe the evolution of a four-year project, the Lighthouse Education Enhancement Project, in which there were significant changes in the way students learn and teachers teach mathematics.

Uslick, JoAnn, & Walker, Carole. (1994, April). *An evaluation of an innovation: Standardized test scores were not valid indicators of success.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED 372 099)

The Lighthouse project is a collaborative effort among an urban school district and two suburban districts in which 74 teachers in six elementary schools are making an effort to implement mathematics reform as suggested by the National Council of Teachers of Mathematics (1989). Specifically, the goals of the project were to "improve elementary math teacher effectiveness and student competencies in critical thinking, cooperative learning, problem solving, and the use of technology" (p. 2). The project also intended to demonstrate that a technology-enhanced mathematics curriculum would significantly improve student performance on standardized achievement tests. This second goal turned out to be problematic.

The teachers were assisted in improving mathematics learning through ongoing staff development in mathematics teaching, cooperative learning, and the integration of technology and instruction. They also received five computers for each of their rooms. After four years, it was concluded that the project was successful in changing beliefs, curriculum, instruction, and assessment in mathematics. Positive factors influencing this success centered around technology use and cooperative learning. Some of the reasons teachers gave for believing that the goals of the project could not have been accomplished without technology included the following:

1. With computers, math makes sense, math has meaning, math is fun.
2. The computer reinforces the understanding of math concepts.
3. Technology makes us aware that change in attitudes towards mathematics is necessary.
4. Technology provides both individual and small group emphasis.
5. Technology is multisensory.
6. The computer is there to respond immediately to errors as well as successes.
7. Children develop self-esteem by using technology and helping others. (p. 17)

One teacher also commented on her "new and different role as a teacher." She said that her "ability to make a child think … and to find and create those situations for that, or those children, has added life to teaching!" (p. 17).

Teachers also described how cooperative learning is facilitated using computers. As one teacher explained:

> Just walk through any classroom that has more than one child on a computer and your question will be answered. There is no doubt that two minds are better than one when you see this happening. God gave children such inquisitive minds which they use for asking incredible questions, and for justifying answers. There is no need to justify an answer if there is no one to question it. Peers certainly question! (p. 14)

In addition, many teachers mentioned that they were learning to use the computer along with their students and that many of their low-achieving students were often the most skilled with the computer. One teacher commented that "students are aware of the power of the group to solve problems. Certainly the computer enhances cooperative learning. Since I'm learning too, the students help me learn and grow as well" (p. 15).

With the help of cooperative learning and computer support, the teachers began to spend more time asking questions, looking for patterns, and encouraging mathematical thinking. They moved from a dependency on textbooks to the use of a problem-solving approach to mathematics in the context of cooperative, computer-based learning.

Assessment Issues

As the project continued with growing observational evidence of the effectiveness of the intervention, frustration grew with the original goal of evaluating the project using the district's standardized test. Teachers began to realize that the test was not measuring what they were teaching. In fact, 30 of 36 teachers surveyed reported that the standardized tests and students' report cards did not adequately evaluate the type of learning that was going on in the Lighthouse project. In response, the teachers asked for staff development in alternative forms of assessment, such as portfolios or projects.

The project evaluators, using both qualitative and quantitative tests, found significant improvement in teacher and student attitudes and be-[?]iors toward mathematics, as well as instructional practices that aligned more closely with the recommendations of the NCTM. However, achievement scores, as measured on the one standardized test used by the district, were inconsistent and showed statistical significance only for students who began the program in kindergarten. The evaluators, administrators, and teachers who worked with the classrooms in the project became convinced that the test was not measuring the type of mathematics learning advocated by NCTM.

Other researchers have commented on the lack of emphasis on higher level thinking skills in standardized achievement tests (Meir, 1989; Romberg & Wilson, 1992). A study supported by the National Science Foundation found that "only 3% of the questions on standardized mathematics exams test conceptual knowledge and only 5% test for problem-solving and reasoning skills" (National Council of Teachers of Mathematics, 1993, p. 7). As educators begin to change teaching to involve more technology use, it may also be necessary to reform current assessment practices.

Authentic Tasks, Real Audiences

Research based on learning in natural settings suggests the importance of real tasks and audiences for learning. The following study examined the effects of a computer-mediated, networked learning environment on the writing of fifth-grade students who used word processing to write [?]r texts collaboratively over an eight-week period.

Allen, Gayle, & Thompson, Ann. (1994, April). *Analysis of the effect of networking on computer-assisted collaborative writing in a fifth-grade classroom.* Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED 373 777)

The 93 fifth-grade students, 45 males and 48 females, all had access to computers and were comfortable using technology for writing. Half of these students were randomly assigned to an experimental group that had access to a telecommunications network that allowed them to send their work via e-mail to an audience of readers, in this case, students in a college of education. The college students read the students' written work sent via e-mail and responded in a supportive fashion. The students in the control group had the same assignments as the experimental group and had equal access to computers for writing, but they did not have access to an audience via a network.

The researchers were interested in whether the students with the distant audience would write longer, higher quality texts, whether their attitudes about writing would change, and whether there would be any gender differences in writing when using the network. Three college writing instructors evaluated the students' writing by using a holistic writing scale. Each scorer read all texts, and the scores that occurred two out of three [?]es were used. Text length was calculated, and students were given an attitude survey before and after the eight-week experiment.

The experimental group had significantly higher scores on both the quality of the writing and the length of writing. There were no differences on the attitude survey, and both genders in the experimental group did better than their respective genders in the control group.

Conclusion

These studies have several common themes. First, they suggest that research in the field has moved beyond a focus on the machine or the test to an interest in developing learning environments and the complex interactions that make up these environments. Second, the research projects all began with the goal of improving instruction and then looked at how technology could become a partner in learning. They also involved teachers as essential partners for implementation, both classroom teachers and future teachers (the college of education students who responded to the fifth-grade students in the study described by Allen and Thompson). Teachers and their uses of technology to support new teaching strategies were inseparable, essential components that contributed to the success of each of the projects. Finally, these studies support the power of collaborative research in real-world settings in which teachers and researchers work together with the assistance of technology to improve learning. ■

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Note: We welcome your assistance in locating research related to teaching and learning with technology. Please send or e-mail your suggestions to Dr. Kärin Wiburg, New Mexico State University, Box 30001, Department 3CUR, Las Cruces, NM 88003; kwiburg@nmsu.edu.

Preparing an Instructional Lesson Using Resources Off the Internet

by DR. LAWRENCE A. TOMEI, Professor
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Take your students on a tour of the White House. Observe the Solar System without visiting the local planetarium. "Can't be done" you say? "Don't have the time or the funds?" is your response. Technology can provide the avenue for this exploration; actually, it can provide the Information Superhighway. An adventurous spirit is the key prerequisite, along with a little help to take those first tentative steps in preparing a classroom lesson using the Internet.

This article describes the step-by-step evolution of "Exploring the Holocaust on the World Wide Web," a highly successful lesson presented to students from a local high school Social Studies class.

■ Step 1: Design the Lesson Goals

Lesson development begins by resolving a specific Instructional Goal that should be identified before "surfing" the Web. The Holocaust lesson began with the following information:

Subject Area: Social Studies
Teacher's Name: Mr. Tim Plosnik
Grade Level: High School Juniors/ Seniors
Length of Lesson: 3.2 hours
Unit of Instruction: World War II and the Atrocities of War
Specific Topic: Holocaust — the Final Solution
Instructional Goal: Promote understanding of the Holocaust and its implications in our lives today.

■ Step 2: Conduct the Research — A Methodology for Searching Web Sites

Locating specific subject matter web sites has been made easier with search engines such as *www.webcrawler.com*. The key word "holocaust" returned over 240 potential locations, such as:

- Guidelines for Teaching About Holocaust *198.76.24.4/education/guidelines.html*
- Top Five Questions About the Holocaust *www.ushmm.org/education/5quest.html*
- Anne Frank's Amsterdam House *www.channels.nl/annefran.html*
- The Children of the Holocaust *198.76.24.4/education/children.html*
- The Cybrary of the Holocaust *www.best.com/~mddunn/cybrary*
- U.S. Holocaust Memorial Museum *www.ushmm.org/*

> Locating specific web sites has been made easier with search engines.

Bibliographic References. Lessons should not be based on data obtained from a single source — even if that source is as rich as the Internet. The volumes of appropriate books, magazine articles and other reference materials found during the online search appeared unlimited.

Other Materials. To augment the computer-based presentation, other materials were added to the session, including a videotape on the subject of racial discrimination, plus a Quick Reference Guide for Netscape Navigator and a list of selected Web Sites, all suitable for expanded learning opportunities outside formal classroom time.

■ Step 3: Write Specific Learning Objectives and Lesson Content

Learning objectives generally contain three components: behavioral terms, situations or conditions under which the behavior is to be performed, and the level of performance to be achieved. As an example, here are the Lesson Objectives, Content Items, Procedures and Assignments for the first objective in the Holocaust Exploration:

Objective I: Using a personal computer and Web address list (condition), students will: navigate the Internet (behavior) locating two specific educational Websites (criterion); explore selected sites (behavior) using two search engines (criterion); and, locate, download, and print (behavior) selected files from one site (criterion).

Content Item 1: Netscape Navigator Web Browser
Procedures: Identify Uniform Resource Locators (URLs), home pages, bookmarks;
Demonstrate the primary window icons (Back, Forward, Home, Print);
Demonstrate use of links (Blue and Red)
Assignment: None

Content Item 2: Internet sites of specific interest to Education
Procedures: Locate specific colleges and universities (*www.duq.edu*);
Locate Peterson's Catalog of Colleges/Universities (*www.petersons.com*)
Assignment: Students will visit a campus of their choice (e.g., Notre Dame)

Content Item 3: Internet search engines
Procedure: Locate WebCrawler search engine (*www.webcrawler.com*);
Locate Excite search engine (*www.excite.com*)
Assignment: Have students use search engines to locate subject areas (e.g., dinosaurs)

Content Item 4: Downloading selected files from the Internet
Procedure: Locate map of Washington, DC (*sc94.ameslab.gov/TOUR/tour.html*)
Assignment: Students will download and maps of the Washington, D.C. area

For brevity, look at the remainder of the objectives used in the session. Content Items, Procedures and Assignments have been omitted.

Objective II: After locating a given Web site, a student will review the information and answer the questions: "Why did the Holocaust happen? What were the world events that permitted such an atrocity?" The answer must contain information quoted and referenced from the Web site and be grammatically correct.

Objective III: After locating a given Web site, a student will review the information and answer the questions: "What was the true magnitude of the Holocaust? Were the Jews the only group targeted for extinction by the Nazis?" The answer must contain information quoted and referenced from the Web site and be grammatically correct.

Each student is given their own copy of the workbook and encouraged to cooperatively engage their fellow classmates in an ongoing discussion.

Objective IV: After locating a given Web site, a student will review the information and analyze the images presented of the Holocaust to support or defend the thesis that the Holocaust never happened.

Objective V: Using Internet search engines, a student will locate at least three additional sites pertaining to the Holocaust and select images, sound files and video clips of personal interest.

Step 4: Design Student Workbook

Student workbooks contribute significantly to the learning process. The questions posed in the Content Items, Procedures and Assignments portion of the Lesson Plan are compiled in the workbook to guide students through the lesson objectives. Critical components of the student workbook included:

Student Name. Self explanatory.

Date of Internet Exploration. Self explanatory.

Instructions. Each student is given their own copy of the workbook and encouraged to cooperatively engage their fellow classmates in an ongoing discussion as Internet exploration progresses. They are instructed, as a minimum, to visit the specific sites identified in the workbook. Problems should be reported immediately to the teacher.

Key Questions. Probing questions, along with targeted Internet site addresses where answers to those questions could be found, were added to this section of the workbook. Microsoft Word (or any integrated word processor) can incorporate the images and text found during the online research and produce a professional teaching product. An outline approach for capturing student responses facilitated the online exploration and promoted continued study.

Lesson Evaluation. The final question in the workbook provided an opportunity for a student to evaluate the lesson's effectiveness.

Step 5: Deliver the Lesson

Agenda. The length of a session will depend on many of the usual factors: scope of the material to be presented, manner of presentation, and available time (see (Figure 1 for a sample schedule). To present an Internet lesson, class time should be increased to accommodate the commute time to the location of the computers — be that across the hall to the computer lab or across the city to an available Internet provider.

Incidentals. Since this was a field trip for the high school, appropriate parental signatures were secured before the children departed campus. In addition, a one-hour lunch period was built into the schedule along with two breaks. With all the publicity surrounding "inappropriate" sites on the Internet, the research conducted prior to the presentation of the lesson ensured that students were not exposed to offensive material.

Delivery Format. The lesson began with a formal welcome to the School of Education. Students were acquainted with Duquesne's Multimedia Classrooms and received instruction in the use of their Power Macintosh 6100 multimedia systems, how to open and close files, and how to launch application programs.

Figure 1: Lesson Agenda Broken Down By Time

8:45am	Bus Departs High School for Duquesne Univ
9:30am	Bus Arrives Duquesne University
9:40am	Welcome and Introduction to the Lesson
9:45am	Navigating the Internet
10:10am	Break
10:15am	Why the Holocaust? The Nazi Party and Their Rise to Power
10:45am	The Magnitude of the Holocaust
11:15am	The Images of the Holocaust
11:40am	Lunch
12:15pm	Personal Exploration
12:35pm	Break
12:45pm	Videotape "Eye of the Storm"
1:00pm	Closure and Certificate Presentation
1:15pm	Bus Departs Duquesne University

Microsoft PowerPoint software was used with an overhead projection system to deliver the lesson. PowerPoint offers three other acceptable forms of presentation: printed copies of the slides, overhead transparencies and 35mm slides. Each of these formats supports a pedagogically sound delivery format for K-12 presentations.

Step 6: Evaluate Student Learning

Proper evaluation of an Internet-based lesson is critical because of its fairly recent adoption as a teaching methodology. The student workbook provided ample opportunity for the teacher to evaluate student progress towards satisfying lesson objectives. On the last page of the workbook, students were asked to complete a questionnaire describing their success with the new format. The teacher also conducted a quiz following the students' return to campus. A Certificate of Attendance was presented to each student.

Step 7: Conduct Follow-up Activities

Duquesne's Multimedia Classroom afforded the teacher additional opportunities apart from online Internet access. In the same teaching facility, students viewed a videotape entitled "The Eye of the Storm" and discussed its theme of racial discrimination in the United States. Could the Holocaust happen again? Readers are reminded that the entire Internet-based Holocaust lesson was merely one chapter in a semester-long and diverse Social Studies program. ■

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The complete package of "Exploring the Holocaust on the World Wide Web" is available either on diskette or a printed booklet from the author. The package includes: an unabridged version of this article; example resource materials obtained from the Holocaust search; a copy of the Student Workbook; complete set of Lesson Plans; a Quick Reference Guide for the Netscape World Wide Web Browser, a list of Selected Educational Web Sites; and the 10-slide PowerPoint presentation for $20 (postage include). Send requests to: Dr. Lawrence A. Tomei, Duquesne University, 600 Forbes Ave., Pittsburgh PA 15282. Please specify IBM-PC, Apple Macintosh, or printed Booklet format.

Computer Efficiency

MEASURING THE INSTRUCTIONAL USE OF TECHNOLOGY

By Christopher Moersch

Use the instrument described in this article to evaluate your computer efficiency in support of concept-based and process-based instruction, consequential learning, and the development of students' higher order thinking skills.

A local news station documenting the current status of computers in the schools recently provided a provocative comparison between the stereotyped "haves" and "have nots." At one school, parents, teachers, and students were viewed as trapped with aging Apple IIe computers collecting dust in some remote computer lab while their contemporaries on the other side of the tracks were seen enjoying the fruits of a recently passed bond levy that had brought them new Power Macintosh computers with full AV capability connected by an Ethernet network with unlimited access to the global Internet.

The reality of the situation is that kids are no better off in either an aging Apple IIe lab or a new Macintosh/Windows lab if a fundamental shift has not been made in the way technology is being integrated in the classroom. This shift involves recommissioning existing computers (yes, even those old Apple IIe, Macintosh SE/30s, and IBM XTs) as data analysis centers, probeware stations, multimedia publishing outlets, and research kiosks to prompt students to think, reason, make informed decisions, and communicate information based on the available data.

A myriad of research and conceptual papers have documented the modest impact technology has made toward altering the prevailing curriculum design based on subject matter and its emphasis on sequential instructional materials, traditional verbal activities, and expository teaching strategies (O'Neil, 1995; Stoddard & Niederhauser, 1993;). According to the Office of Technology Assessment, "the most common uses of technology today are the use of videos for presenting information, the use of computers for basic skills practice at the elementary and middle school levels, and the use of word processing and other generic programs for developing computer-specific skills in middle and high schools" (O'Neil, 1995).

The often-cited reasons for technology's meager performance are common to most educational change efforts: inadequate staff development, lack of teacher preparation time, insufficient equipment, and a basic lack of an overall vision.

An Instrument for Measuring Technology Use

Clearly, educational practitioners need to embrace a new paradigm that positions technology as a powerful catalyst in the school reform process. To aid in this process, I have developed an instrument that measures computer efficiency at the school site level. The term *computer efficiency* is defined as the degree to which computers are being used to support concept-based or process-based instruction, consequential learning, and higher order thinking skills (e.g., interpreting data, reasoning, solving real-world problems). The instrument is based primarily on my previous work (Moersch, 1995) and my identification of specific levels of technology implementation. A framework describing the levels of technology implementation (LoTi) is given in Table 1. The LoTi framework categorizes six levels of computer efficiency, ranging from Nonuse (Level 0) to Refinement (Level 6).

As a school site progresses from one level to the next, a corresponding series of changes to the instructional curriculum is observed. The instructional focus shifts from a teacher-centered to a learner-centered orientation. Table 2 shows three developmental levels and the changes that occur in instructional practices at each level as a school site changes its orientation.

It should be noted that this approach to measuring computer efficiency de-emphasizes the importance of (1) the brand, type, or age of computers at the school site; (2) the ratio of computers to students; and (3) the amount of funding allocated for infrastructure (e.g., modems, cable, networking configurations). Instead, primary emphasis is given to the degree that technology is used to support a constructivist orientation to classroom

Table 1. The LoTi Framework

Level	Category	Description
0	Nonuse	A perceived lack of access to technology-based tools or a lack of time to pursue electronic technology implementation. Existing technology is predominately text-based (e.g., ditto sheets, chalkboard, overhead projector).
1	Awareness	The use of computers is generally one step removed from the classroom teacher (e.g., it occurs in integrated learning system labs, special computer-based pull-out programs, computer literacy classes, and central word processing labs). Computer-based applications have little or no relevance to the individual teacher's instructional program.
2	Exploration	Technology-based tools serve as a supplement (e.g., tutorials, educational games, simulations) to the existing instructional program. The electronic technology is employed either for extension activities or for enrichment exercises to the instructional program.
3	Infusion	Technology-based tools including databases, spreadsheets, graphing packages, probes, calculators, multimedia applications, desktop publishing, and telecommunications augment selected instructional events (e.g., science kit experiments using spreadsheets or graphs to analyze results, telecommunications activities involving data sharing among schools).
4a	Integration (mechanical)	Technology-based tools are mechanically integrated, providing a rich context for students' understanding of the pertinent concepts, themes, and processes. Heavy reliance is placed on prepackaged materials and sequential charts that aid the teacher in the daily operation of the instructional curriculum. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processing) is perceived as a tool to identify and solve authentic problems relating to an overall theme or concept.
4b	Integration (routine)	Teachers can readily create integrated units with little intervention from outside resources. Technology-based tools are easily and routinely integrated, providing a rich context for students' understanding of the pertinent concepts, themes, and processes. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processing) is perceived as a tool to identify and solve authentic problems relating to an overall theme/concept.
5	Expansion	Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from business enterprises, governmental agencies (e.g., contacting NASA to establish a link to an orbiting space shuttle through the Internet), research institutions, and universities to expand student experiences directed at problem solving, issues resolution, and student activism surrounding a major theme or concept.
6	Refinement	Technology is perceived as a process, product (e.g., invention, patent, new software design), and tool for students to use in solving authentic problems related to an identified real-world problem or issue. In this context, technology provides a seamless medium for information queries, problem solving, and product development. Students have ready access to and a complete understanding of a vast array of technology-based tools to accomplish any particular task.

pedagogy based on the available hardware and software at the school site. By using the Computer Efficiency Rating Chart on page 55, school districts can reexamine their technology purchasing practices, staff development opportunities, and organization of the school day in light of a much broader goal—elevating the level of technology implementation systemwide.

Two Real-World Computer Efficiency Audits

Schools can use the Computer Efficiency Rating Chart to conduct a technology audit using the computer efficiency instrument. For example, the two schools identified in Tables 3 and 4 on page 56—Allendale Elementary School and Evergreen Elementary School—recently completed the audit, allowing them to assess their results in an objective, informed way.

Allendale Elementary School is equipped with a new Macintosh computer lab complete with Internet hookup and a local area network (LAN) connected to the district's wide area network (WAN). Most of the computers in the lab at Allendale are used as workstations where students develop their computer literacy (e.g., keyboarding) skills or as integrated learning system (ILS) terminals where they improve their basic math and communication skills. In the classrooms, the computers are used mostly for activities (e.g., students playing drill-and-practice games at the end of the class period, making simple movies using HyperStudio, and sending e-mail messages over the Internet). These activities supplement the teachers' instructional curricula. Fifteen percent of the computers are not used during the instructional day.

At Evergreen Elementary School, a "learning lab" is equipped with 10 Power Macintosh computers. The remaining computers are distributed in classrooms throughout the school. The learning lab has full Internet capabilities and is used exclusively for student informati...

searches, "purposeful" multimedia production, and data analysis. In the classroom, teachers use their Apple IIe and 286 computers as data analysis and "probeware" stations where students gather, tabulate, and graph data for various instructional activities. They also use the computers to solve pertinent and relevant problems related to an underlying theme or concept.

From this brief account of computer use at the two elementary schools, the following points emerge:

1. The level of computer efficiency is influenced directly by how teachers are using computers to develop students' higher order thinking skills.
2. Neither the age or type of computers nor the level of telecommunications infrastructure has an impact on the efficiency rating.
3. The differences in the socioeconomic status of the two schools was not a factor in the efficiency of their computer use.

These points closely parallel the findings from Becker's (1995) study of exemplary computer-using teachers. Using national survey data collected from teachers of academic subjects in grades 3–12, Becker identified roughly 5% (45 out of 516 teachers) as being exemplary computer-using teachers. (Exemplary computer-using teachers were defined as educational practitioners who engaged students in computer-based activities that involved higher order thinking. These activities included interpreting data, reasoning, writing, solving real-world problems, and conducting scientific investigations.) Contrary to expectations, the exemplary computer-using teachers Becker identified did not disproportionately teach classes of high-ability students, nor were they over-represented in high socioeconomic communities.

What's the Solution?

Unfortunately, changing classroom practices so that they unleash the potential of computer technology will never occur if purchase-order acquisitions of new hardware and infrastructure items take precedence over quality staff development opportunities. The billions of educational dollars that have already been spent during the past 20 years on hardware ranging from Commodore 64s to Power Macintoshes attest to this fundamental fact. As with any change effort, our investment needs to be in teachers and not exclusively in hardware. The Computer Efficiency Rating Chart described in this article was designed to help educational practitioners bridge this gap between computer acquisitions and computer use by providing valuable baseline data for a school's current computer efficiency profile. Such data can be instrumental in shaping future staff development interventions that target elevated levels of technology implementation. ■

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Table 2. Levels of Instructional Practices

	Level 1	Level 2	Level 3
Learning Materials	Organized by the content; heavy reliance on textbook and sequential instructional materials	Emphasis on science kits; hands-on activities (e.g., AIMS, FOSS)	Determined by the problem areas under study; extensive and diversified resources
Learning Activities	Traditional verbal activities; problem-solving activities	Emphasis on student's active role; problem-solving activities with little or no context; verification labs using science kits and related hands-on experiences	Emphasis on student activism and issues; investigations and resolutions; authentic hands-on inquiry related to a problem under investigation; focus on experiential learning
Teaching Strategy	Expository approach	Facilitator; resource person	Colearner or facilitator
Evaluation	Traditional evaluation practices, including multiple choice, short answer, and true/false questions	Multiple assessment strategies, including performance tasks and open-ended and problem-based questions	Multiple assessment strategies integrated authentically throughout the unit and linked to the problem/theme/topic; portfolios, open-ended questions, self-analysis, and peer review
Technology	Computer-based drill-and-practice programs (e.g., traditional integrated learning systems [ILS] computer games); little connection between technology use and overall theme or topic	Technology integrated into isolated hand-on experiences (e.g., the tabulation and graphing of data to analyze a survey or experiment); information searches using telecommunications	Expanded view of technology as a process, product, and tool to find solutions to authentic problems, communicate results, and retrieve information (e.g., use of spreadsheets, graphs, probes, databases, CD-ROM-based simulations, and telecommunications)

140