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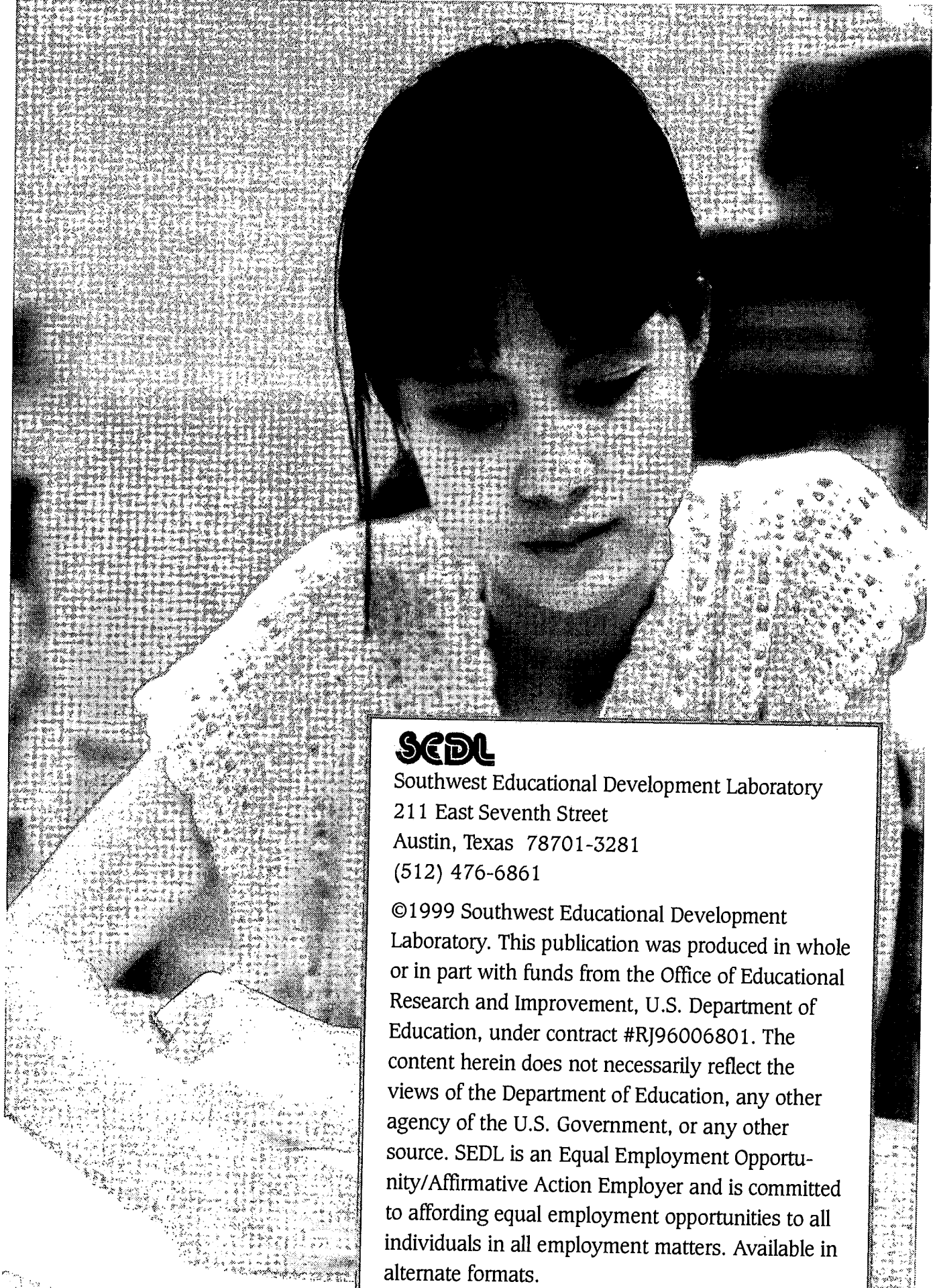
ABSTRACT

This guide provides suggestions for using technology (i.e., computers and anything that attaches to computers) as instructional tools in environments that support learning. Chapter 1 offers an overview of learning principles based on constructivist theory, including what constructivism offers the classroom, the role of the student, the role of the teacher, and changes in the classroom. Chapter 2 presents activities based on constructivism, without technology, in three learner-centered classrooms, including a story writing group, math estimation exercises, and a trial of Julius Caesar's murders. Chapters 3 and 4 examine ways computers can complement classroom instruction; initial steps for introducing technology into the classroom are provided, and examples of activities that employ several types of applications (word processing, database, spreadsheet, presentation, simulation, Internet, e-mail, and multimedia/hypermedia) are presented. Chapter 5 is a practical compendium of questions, answers, and considerations for introducing technology into the learning environment. A resource section provides more information on technology and constructivist theory. (Contains 30 references.) (AEF)

Connecting Student Learning & Technology

Technology Assistance Program • Southwest Educational Development Laboratory



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Connecting Student Learning & Technology

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Introduction

Winds of change are blowing through American classrooms from several directions. Schools are serving a more ethnically, linguistically, and culturally diverse student body than ever before. From our universities and research institutions, studies about education, cognitive psychology, and neurology have offered new insights on how humans learn. And from the marketplace, the infusion of technology has redefined work skills and society's expectations about what it means to be an educated person.

In more and more classrooms, teachers are using technology to help them meet the challenges posed by these changes. Constructivism, a theory of learning, provides a valuable framework for using computers and other technology in productive, interesting ways. Technology can enrich students' use of a variety of resources and help them gain understanding about their world. Assisted by teachers and peers in their growth as individual learners, students can use technology to enhance their work and increase their connections with resources outside school walls. However, computers are not inherently instructional tools, and most teachers need suggestions for using them. This guide provides such suggestions. It is not a nuts-and-bolts manual, but a discussion about using technology in environments that support learning. The definition of "technology" is limited here to

include only computers and anything that attaches to computers. Beginning with an overview of learning principles based on constructivist theory in Chapter 1, Chapter 2 presents classroom activities without technology. Chapters 3 and 4 examine ways computers can complement classroom instruction to support learning. Chapter 5 is a practical compendium of questions, answers, and considerations for introducing technology into the learning environment. A resources section is provided for those wishing more information on technology and constructivist theory.

Learning as a Personal Event

A Brief Introduction to Constructivism

Constructivism, a learning theory informed by cognitive psychology, educational research, and neurological science, views learning as the product of experience and social discourse. Constructivists consider learning to be an individual and personal event. The following principles[1] are based on the work of various constructivist theorists and are offered as a framework for this discussion.

- *Learners bring unique prior knowledge, experience, and beliefs to a learning situation.* Every learner has experiences that influence his or her understanding of the world. Those unique experiences are the foundation for learning; they provide opportunities for personal connections with new content.
- *Learning is internally controlled and mediated.* Learners take in information, process it to fit their personal frameworks, and build new understanding. That knowledge construction occurs internally, in the private domain of each individual.
- *Knowledge is constructed in multiple ways, through a variety of tools, resources, experiences, and contexts.* Constructivist learning theory tells us that we learn in a variety of

ways. The more opportunities we have, and the more actively engaged we are, the richer our understanding. Good teachers have always used experience as a valuable instructional tool; that is why we arrange field trips and hands-on projects. It is why an internship or apprenticeship is essential to the completion of most vocations, including teaching.

Constructivist theory tells us that we learn in a variety of ways. The more opportunities we have, the richer our understanding becomes.

- *Learning is a process of accommodation, assimilation, or rejection to construct new conceptual structures, meaningful representations, or new mental models.* Every person is surrounded by an infinite variety of images, ideas, information, and other stimuli that provide raw material for thought and understanding. If new information matches the learner's existing understanding, it is easily assimilated. If it does not match, the learner must determine how to accommodate it, either by forming new understanding, or rejecting the information.

- *Learning is both an active and reflective process.* Learners combine experience (action) and thought (reflection) to build meaning. Both parts must be present to support the creation of new knowledge.
- *Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning.* In many situations, learning is enhanced by verbal representation of thoughts—it helps to speak about an idea, to clarify procedures, or float a theory to an audience. The exchange of different perceptions between learners enriches an individual's insight.

What Constructivism Offers the Classroom

Constructivism is a theory of learning, but it does not dictate how that theory should be translated into classroom practice. It is up to teachers and other educators to provide environments that support the ways students learn—learner-centered classrooms. Lessons that allow little opportunity for student response or discussion are not learner-centered; the focus is on the text or on the teacher. Such teacher-centered classrooms are often described as "traditional," although there are many time-honored instructional strategies that do not fit the teacher-centered model. To contrast the differences between a teacher-centered ("traditional") classroom and a learner-centered classroom, let's visit two seventh grade social studies classes studying U. S. geography.

Traditional Classroom

The teacher begins the unit by having the students read aloud from their textbook's chapter on the Great Lakes states. As they read, the teacher writes new vocabulary words on the chalkboard. Using their textbook, the students identify these words and answer questions from the end of the chapter. The teacher checks for student understanding by asking short-answer questions ("Jim, what is the primary product of the Great Lakes area? Jackie, what is the difference between spring wheat and winter wheat?"), and by giving the students a blank map to fill in the state names in the region. Students check each other's homework, which is the completion of moderate-length sentences from a worksheet (How has state legislation recently affected commerce in Wisconsin?). During one class period, the teacher shows a film about the history of the railroad and its impact on Chicago. Students are reminded they will be tested on the content of the film and they should ask any questions they have about it. There are no student questions. As a review, the students play a game based on important facts and vocabulary, and a written test completes the unit.

Learner-Centered Classroom

The teacher[2] begins by asking the students what they know about the Great Lakes region ("Chicago, Cleveland, Lake Michigan? Are any of these names familiar?") from trips, readings, TV programs, or stories. Before assigning the chapter, the teacher tells the students that they will be taking a road trip to one of the cities in

the region and they should be thinking about where they would like to visit as they read the text. Students then write to the Chamber of Commerce for information on that city; interview people who have been to or are from that city; calculate their budget for gas, food, and lodging; plan the route of the trip; and make daily journal entries about the geography, culture, economy, and people of that city. All information is assembled in a portfolio and shared with others in the class. The portfolio includes such information as the travel budget, the length of time to drive from the student's home to the city, photos, descriptions of noteworthy people and places, and the ways the city resembles and differs from the student's hometown.

Comparisons

On the surface, the difference may not be immediately apparent. Both classrooms cover the required curriculum, they both include reading from the text, and they both include teacher-led discussion. However, if we look closely we see that instructional strategies in the second classroom are based on what we currently know about the ways people learn.

- The teacher asks the students to tap into prior knowledge, first by sharing their experience with the content ("What do you know about this region?"), then by the structure of the activity itself. The learners must use memories of a previous trip to plan this one.
- With the trip as a guide for thinking about the content, the textbook becomes a source for

relevant information that can be applied to the students' plans. They can assimilate the information that fits into that framework. If they discover information that does not match their understanding of the region ("I didn't know Chicago was on a lake."), they must decide to accommodate that new information, or reject it as irrelevant or wrong. Teachers must be able to uncover these internal decisions. While tests help teachers monitor student understanding, there are other effective methods which include encouraging explanations of student work or strategies, allowing presentation of student products, and listening to conversations in small groups or large group discussions.

Relying on their prior knowledge, students can evaluate new data from authentic sources, actively pursuing information relevant to their own journey.

- Authentic sources (letters from correspondents in the region, information gleaned from interviews) supplement the content presented in the text.
- Students actively pursue information about their destination and the journey along the way, and they also reflect on their efforts by keeping daily journals.
- Presentation of the student portfolios allows a formal opportunity for social interaction. It lets the learner present the work and lets others discuss it. While not mentioned in this scenario, informal conversations are equally important ways of letting students talk about their projects. A teacher may want to structure small group activities that provide time for the students to share their work.

- By putting students in charge of their projects, offering an interesting, relevant context for the work, and providing a recognizable structure to build on, the teacher has increased the likelihood that the students will connect with the curriculum. Since learning is internally controlled, the student must make the connections and build his or her individual understanding.

In classrooms where teachers do all the work, students may be a captive audience, waiting for the end of class.

Looking back at the first classroom, we realize that most of the curriculum content is controlled by the teacher—the students are not participants, they are observers. A film, which can be an interesting way to present content, is still a passive medium. Games can be valuable tools for helping students explore content, but games that require only recall of simple facts and definitions (word search puzzles, trivial fact scavenger hunts) do not foster higher level thinking.

It has been said that the person doing the work is the person who learns. Teachers can structure lessons so they have done most of the work, and students are robbed of the opportunity to discover. Many of these teachers, exhausted at the end of the day, wonder why they receive so little response from their students. Truth be known, the teacher has done all the work and the students are a captive audience, waiting for the end of class.

There are brilliant lecturers who spark a connection with students by presenting content in ways that are relevant and rich. We have all experienced such teachers in our student careers. However, the majority of classrooms will be much more supportive of learning when students are allowed to pursue their understanding of content through discovery, conversation, and completion of intellectual products.

The Role of the Student

Students are the stars in learner-centered classrooms. They bring knowledge and information gained from past experiences, things they've read and seen, things they have heard and talked about. Their previous understandings are the foundation of whatever learning they will glean in the classroom. Just as detectives are responsible for solving a crime, students are responsible for solving problems. Detectives start with what they know and build upon these clues through a variety of sources—fingerprints, DNA evidence, and witnesses. Students undertake all sorts of research from a variety of resources—newspaper articles, interviews with experts, books, and videos—to solve their problems. Just as detectives need more than one type of evidence to solve a crime, students can use multiple tools (computers, text, interviews, etc.) to approach a problem. And like police detectives who work in teams, students need colleagues and mentors for discussion, reflection, and dispute to help them work through solutions to their problems.

The Role of the Teacher

Since most adults have experienced classrooms with the teacher as the lead instructor, it is difficult to envision the teacher's responsibility in a learner-centered classroom. If the student is a self-sufficient detective, what does the teacher do? In a short answer, the teacher serves as the class instructional leader. While the teacher doesn't provide all the answers or control all the content, she establishes the structure that launches student exploration. That structure includes setting and keeping curricular goals, assessing students to ensure that learning is occurring, managing classroom activities in a

way that balances a variety of student abilities, and sparking the initial stages of exploration to start the students on their work. Teachers in these classrooms rely on skillful questioning, monitoring student discussions and establishing rules that allow conversation and collaboration. They model reasoning and thinking, identify and restate student beliefs and understandings, support student-teacher and student-student dialogue, and provide feedback.

Changes in the Classroom

Student learning is affected by many factors—the physical and social environment, the curriculum, personal understanding and initiative, and the teacher's style and skill, to name a few. A teacher's challenge is to create a classroom that supports, rather than hinders, students' inherent ability to learn. Teachers in traditional classrooms may find that change will be necessary in some key areas.

Curriculum

Since students bring personal knowledge to the classroom, how can teachers help them connect their experiences and understanding to lesson content? A thematic, interdisciplinary curriculum that presents a larger picture is more recognizable and more meaningful than are isolated facts. A complex, overarching theme (such as growth, revolution, native people, or community) offers a scaffold to support student contributions. If students are encouraged to construct relationships and create metaphors for their understanding, they are more likely to make personal connections to the content. Challenging them to use higher order thinking skills—asking them to analyze, create, or synthesize ideas—helps to broaden their view of the content.

How can teachers lure students to the natural world when their interest is captured by video games?

Linking that broad view to direct student experience, however, can be difficult. How can a teacher lure student imaginations to the natural world if their interest is captured by video games? Skilled practitioners begin with their students' interests and build upon them. The social studies teacher in the previous example let the students choose a city for their trip. There is no assurance that all the students will want to plan a trip, but offering them an option gives them a start toward making the activity their own. If a current event has captured the class mind for the moment, the teacher may consider altering the day's lesson to follow that avenue of exploration.

One strategy for lesson or unit planning is to cast the intellectual challenge in the form of a problem for students to solve—this recalls our metaphor of student as detective. Individuals or

teams of students may work through meaningful problems that reflect their interests or comment on their lives. How many problems presented in the first classroom example had any connection to students' everyday life?

Classroom Interactions

A major idea in constructivist thought is that learning is affected by social interaction. Discussions, conversations, explanations, listening—all these are ways we learn by interacting with others. Encouraging social interaction among students is not common in classrooms—even classrooms of excellent teachers. If social intercourse is, indeed, an essential part of learning, our students need more opportunities for discussion to develop their understanding. Classrooms that reflect this concept allow the flow of ideas among the teacher and students. Furniture is arranged in ways that encourage students to work together; class discussions allow time for thoughtful responses and talk about answers; assignments are designed so students have interdependent roles for completion of the work.

Skillful questioning techniques are important teaching tools in these classrooms. Teachers allow enough time after questions so students can think about their answers and provide thoughtful responses. Some of the questions are open-ended and require higher level skills. Students are asked to comment on each other's answers and check for understanding. Misconceptions or mistakes are used as opportunities to present inconsistencies or contradictions that require further thinking.

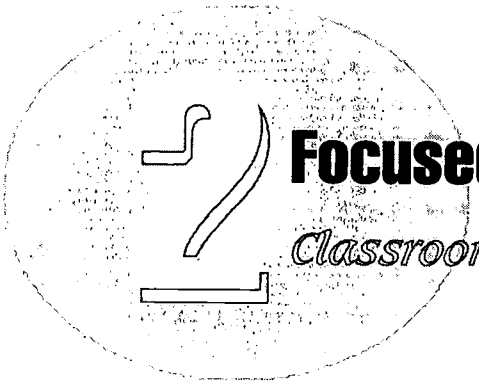
A learner who thinks through a mistake and understands its fallacies is more likely to construct a new and better understanding.

Assessment

Assessment should be linked to learning and should relate to performance and understanding.

Changes in the classroom's curriculum and interactions demand changes in assessment. Assessment should be linked to student learning and relate to performance and understanding.[3] Tacking a test onto every learning activity will not reflect the rich variety of work being accomplished.

Multiple forms of assessment provide opportunities for different learners to demonstrate their understanding. Classroom discussions offer recurring opportunities to check for understanding, but more permanent evidence can be captured in products from projects, papers, journals, photographs, drawings, and tests. These can be gathered in portfolios that let the students view their own progress. The importance of teamwork and dialogue in the classroom deserves attention as well, and student growth in areas of cooperation and interpersonal skills should be documented through teacher observation and products of teamwork.



Focused on Learning

Classroom Activities Based on Constructivism

In this chapter we explore three learner-centered classrooms. While the focus of the activity is on the student, the teacher establishes the lesson context and provides the tools and structure to complete the activity.

Story Writing Group

As part of the fifth grade language arts strand, students met twice a week to explore folktales from around the world. First, each student found a folktale to read, learn, and tell to the class. Some of the stories came from the school library, some from talking with their family or from stories the students already knew. Some were from the local area, but others were from around the world. The student marked the tale's country of origin on a world map posted in the class. While they listened to the various stories, the students talked about what they liked about them, how they thought the story had originated, and how some stories were like others. As the tales continued, a class list of different story characteristics emerged from their comments.

After all the stories were completed, the teacher divided the class into working groups of three students and asked each student to write a two-page tale, remembering the characteristics from the class list. Members of the working groups read each

other's tales, provided feedback and suggested additions, which the author could use or not. The working group also illustrated the tales, providing at least one picture for every story. By the end of the unit, the class had a collection of stories and illustrations bound in a class booklet.

A constructivist lesson is based on students' own interests and allows them to work together to construct a unique understanding.

The lesson, while presumably adhering to the curriculum, was based on student interests. Students chose a folktale that held particular interest or meaning for them and the teacher encouraged them to critique each folktale. Through reflection (discussion) about each folktale and collaboration (peer editing), students could construct their own understanding of folktales and gain another perspective on interpretation through the comments of fellow students.

Estimation: Building Math Power

Students enter school with estimation skills, aware of their approximate height or age, for example. By building lessons around this prior knowledge, teachers can help students develop a personal understanding of mathematics. In real life we estimate all the time—for example, when determining the number of hours to reach a destination or when figuring out how much money to leave for a tip.

In this activity for a fifth grade classroom[4], the teacher breaks the class into several small groups and introduces three estimation exercises. First, students are given a cluster of ten dots. They must estimate several other clusters as "fewer than ten," "more than ten," or "about ten." Students discuss "good" estimates—how close the estimate must be

to the exact number—and then emphasize that in some situations, an estimate is just as good as the exact count. Students estimate the number of candies in a jar and pencils in a box, documenting how they arrived at their estimate.

Next, students choose strategies to respond to the problem "What is the sum of 243 + 479?" One group adds hundreds and tens to produce an approximate sum of 700. Another estimates a sum of less than 750 by rounding 479 up to 500 and 243 up to 250.

Estimation exercises encourage numerical flexibility, mastery of a certain level of mathematical computation, and reflection about spatial and mathematical concepts.

Finally, students estimate the dimensions of classroom objects. To calculate the height of the door, one group places their tallest member against the doorjamb. He knows that he is five feet tall and reaches slightly more than halfway to the top of the door, so the door is about nine feet. One girl, measuring the teacher's desk, recalls reading that a child's hand is about five inches. Her group decides that two "hands" equal a foot and estimates the desk length to be four and one half feet.

These estimation exercises encourage numerical flexibility, mastery of a certain level of mathematical computation, and reflection about spatial and mathematical concepts. Such skills are especially important when using calculators or computers, since students must have an estimate available for comparison with the calculator's answer.

By posing problems that demand reflection and self-generated meaning, teachers can help students build their own understanding and gain a better sense of what the numbers represent. In the above example, students draw upon their pool of knowl-

edge (the boy as five feet tall, the size of a hand) to create a way to solve the problem.

Let's examine what the learners and teacher did in this activity. First, the estimation exercise provides students the opportunity to use their prior knowledge to solve real world problems. Second, students accessed a variety of tools (clusters of dots, candies in a jar, and classroom objects) to construct their own understanding of the mathematical principles involved. Finally, by posing problems that demand activity, reflection and self-generated meaning, the teacher helped students build their own understanding and gain a better sense of what the numbers represent.

Trial of Julius Caesar's Murderers

The following example was a three-week exercise, originating in a Latin class, that could also be used for an interdisciplinary literature, government, or history class.

Most students at some point or another study the death of Julius Caesar or read the play by William Shakespeare. The death of Caesar raises still-relevant questions about political, personal,

and national ambitions. Because all societies, 2000 years after the fact, still wrestle with such issues, the class decided to engage in a mock trial of Caesar's murderers, Cassius and Brutus.

To prepare for the trial, students watched and read the play *Julius Caesar* and viewed parts of the film *Cleopatra*. Through a weekly Roman history class, they learned about events leading up to 44 B.C. Based on their points of view about the murder, students formed a prosecution team (those representing Rome) and a defense team (those representing Brutus and Cassius). Each group voted for its lawyer, produced a set of witnesses (e.g. Marc Antony, Cleopatra, Caesar's widow), chose witness roles, and began planning its legal strategy.

The trial is a good example of how learning can reach beyond the content area to help students gain academic life skills.

Since the trial was modeled on the American legal system, two lawyers from the community provided in-class consultations about various legal and courtroom procedures and placed themselves on call after school. Students were very excited at having such "real-life" expertise at their disposal and approached the exercise with tremendous seriousness.

All additional necessary library research was conducted during and after class. Groups presented daily research findings and witness questions to the teacher. She returned them the next morning with questions to encourage further research or to refocus those who were off track. In class, the teacher circulated between the groups, listening to their strategies, and through her questions guided students to a particular strategy or issue that they may have missed. On the days of the trial, students from a seventh grade English class served as jurors. One

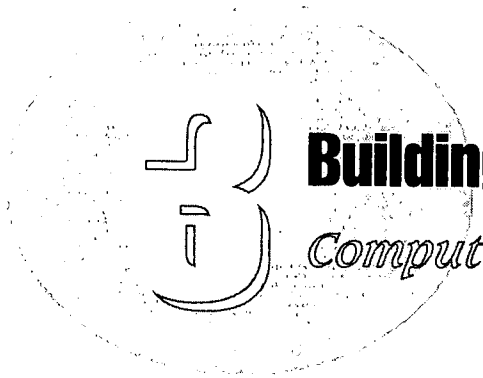
teacher gave up her planning period to serve as the judge; another videotaped the trial.

The trial is a good example of how learning can transcend content area mastery toward the development of a set of academic life skills. Students gained content knowledge of Latin legal phrases and historical information about the last days of the Roman republic. They learned the nuances and complexities of reasoning and how to anticipate and address opposing arguments. Most important, they were excited about the authenticity of the exercise and felt that history had come alive for them.

Each team of student lawyers constructed its own belief system through interactions with outside resources, use of class materials, and evaluation of the information presented each day of the trial.

All the students participated in the evaluation of this activity by critiquing themselves and their peers. Students were forthright about their efforts and the efforts of their group members. Their grade was based on the process (group cooperation, communication, preparation, and individual effort) and a final product (their performance in the videotaped trial).

As with the other learner-centered examples presented in this chapter, several constructivist ideas are evident in this activity. Each team of student lawyers constructed their own belief system about Brutus's and Cassius's actions based on their interaction with resources (the two lawyers, the teacher and their team members), materials (class lecture notes, film, Shakespeare's play, historical documents) and their accommodation or rejection of the information presented each day. By reflecting on the day's trial and by interacting with their peers, students developed a greater understanding about both subject area content and legal procedures.



Building on Technology's Promise

Computers and Constructivism

Learner-centered environments support independent work as well as collaboration among learners. These classrooms provide students opportunities to connect prior learning with current experience. Learners have access to a variety of tools and resources with which to work. Teachers can design such classrooms, and computers can help. In this chapter and the next, we will illustrate the link between the use of technology and the constructivist principles presented in Chapter 1.

Technology in Support of Learning

Computers can support the variety of ways learners construct their own understanding. Students who gather information from the Internet can be self-directed and independent. They can choose what sources to examine and what connections to pursue. Depending on the parameters set by teachers, the students may be in complete control of their topics and their explorations.

Knowledge is constructed uniquely and individually in multiple ways.

Students can work through a computer-based activity at their own pace. Rather than 25 individuals working together on one activity, technology allows independent completion of work. Those who begin to fall behind can receive an instructor's

individualized attention while others can begin to tackle more complex tasks.

Learners bring unique prior knowledge, experience, and beliefs to a learning situation.

Computer software can mix text, pictures, sound, and motion to provide a variety of options for learners. Multimedia software will not be the only classroom resource, but it can contribute richness and variety to student work.

Students can build on their own understanding by using computers as resource tools, as work stations for individual learning, or as communication channels to share their ideas with other learners. Individual understanding and experiences must be shared and compared to curriculum content. By uncovering students' individual understandings, teachers can determine the influence of students' prior knowledge and further their education through new experience.

Learning is internally controlled and mediated by the learner.

Computers can be used to assist active experiences—gathering data and resources, conversing with colleagues, struggling through a challenging puzzle or application—or they can assist in reflection. For example, while an on-line conversation through e-mail is an active event, such discussions usually prompt reflection. They help us think about ideas and check our understanding. In another reflective application, teachers can enlist computers as authoring tools for students' journals which are excellent vehicles for thoughtful examination of experience.

Learning is both active and reflective.

Introducing technology into the learning environment can encourage cooperative learning and student collaboration. If they are allowed to converse, most students like to talk about their computer work and share their strategies.

Social interaction introduces multiple perspectives.

Classroom activities that are structured so that computers encourage collaboration build on learners' desire to communicate and share their understanding. It takes planning and intervention to build successful cooperative groups with or without computers, but groups that use computers as teamwork tools have a better start toward collaborative work.

Beyond the classroom, computer networking allows students to communicate and collaborate with content experts and with fellow students around the globe. Communication tools like e-mail, listservs, bulletin boards, and chat groups allow teachers to exchange lesson plans and teaching strategies and create a professional community.

Knowledge is constructed through a variety of tools, resources, experiences, and contexts.

The use of real world tools, relevant experiences, and meaningful data inject a sense of purpose to classroom activity. Part of the mission of educational institutions is to produce workforce-ready graduates who can, among other things, manipulate and analyze raw data, critically evaluate information, and operate hardware and software. This technological literacy imparts a very important set of vocational skills that will serve students well in the working world.

Technology has allowed schools to provide greater assistance to traditionally underserved populations. Assistive technology such as voice recognition systems, dynamic Braille displays, speech synthesizers, and talking books provide learning and communication alternatives for those who have developmental or physical disabilities. Research[5] has also shown that computer-mediated communication can ease the social isolation that may be experienced by those with disabilities. Computers have proved successful in increasing academic motivation and lessening anxiety among low ability students and learning disabled students, many of whom simply learn in a manner different from that practiced in a traditional, non-technological classroom.

The Student's Role

Students in technology-supported classrooms are armed with powerful tools to help them gather information, consult with colleagues, and present their findings. Their autonomy and confidence increase as they rely less on their teacher and more on their own initiative for knowledge-creation. Technology enables students to manipulate information in a manner that accelerates both understanding and the progression of higher-order thinking skills. As students gather more real-world data, share their findings with learners beyond their school, and publish their findings to the world, their role broadens from investigators of other products to designers, authors, purveyors, and publishers of their own work.

The Teacher's Role

Technology amplifies the resources teachers can offer their students. Rather than relying on the textbook for content, computers can provide on-line access to content experts and up-to-date information from original sources. Reference materials on CD-ROMs and curriculum assistance from high quality software offer many more resource opportunities than most classrooms or school libraries could provide.

The depth and breadth of such information poses its own challenge. Internet content is less structured and manageable than material outlined by a textbook. Students will need to question and evaluate the information they find. There are many Internet sites that offer raw data—pictures from space, numbers from the census, text from court testimony. These kinds of resources need context to provide meaning, and lessons should include components that help students use the information wisely and productively.

Information from the Internet is more dynamic than the printed word. Teachers who understand the medium will use its currency and authenticity to their advantage. Along the way they will find an added bonus from such an environment—they become learners as well.

Where Do I Start?

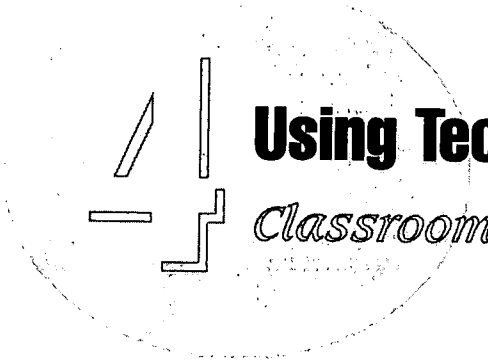
It may seem daunting to begin incorporating computers into your classroom. Yet many teachers have done so with great success. Although there is no blueprint for getting started, the following suggestions may serve as useful initial steps for introducing technology into the classroom.

Maintain modest goals. Although a powerful learning tool, technology is not a panacea for all that ails a classroom. When introducing computers in your classroom, start with a small task such as supplementing research with some Internet resources or having students word process (rather than handwrite) a report. As you begin to feel comfortable you can increase your repertoire of computer-supported classroom activities.

Have a backup plan. Backup plans, always a necessity, are even more crucial when using technology. What can you do if the Internet site is down or the CD-ROM drive gets stuck? How can such glitches be used as learning experiences?

Ask for help. For many teachers who started their careers before the dawn of the Information Age, understanding computers seems difficult. Learning technology, however, is easier than it appears. It just takes time. Don't let difficulties with software get you down or deter you from tapping technology's true potential. There are lots of experienced educators around. Ask for their help!

Learn from and with your students. Many students have grown up around technology and feel comfortable with it. Don't be embarrassed that they may know more about technology than you do. Welcome opportunities to learn from them.



Using Technology to Enhance Learning

Classroom Technology and Constructivism

Teachers should consider lesson goals before deciding to use technology!

Not every lesson needs technology. While there may be opportunities to attach technology to many activities, teachers must consider lesson goals before deciding to use technology. If computers enrich, extend or facilitate learning, they should be used. If not, they shouldn't.

The following examples employ several types of software most often found on a classroom computer: word processing, database, spreadsheet, presentation, and simulation software, in addition to the Internet, e-mail, and multimedia CD-ROMs. You'll notice that most use a variety of these applications. In the first example, we extend the language arts lesson presented in Chapter 2.

Story Writing Group

This exercise[6] was a collaborative effort between fifth grade social studies and language arts classes from a number of schools. The students met together biweekly in groups, searching the Internet for fairy tales or folktales from around the world. Whenever students located a tale, they marked its country of origin on the world map with a colored pin. Based on their findings, students began writing and illustrating their own

tales, using Claris Works™ (now AppleWorks™). Hand-drawn illustrations were also encouraged. Students e-mailed their compositions to their partners in another school, who then provided feedback and added to the tale.

Upon completion of their stories, students and teachers listed the names of all participating countries on the chalkboard. Students divided into groups and adopted a country to research. Using the Claris Works™ graphics library, they included maps and flags of the country, or hand-drawn versions of both in their reports. Students e-mailed their preliminary drafts to their partners for feedback and additions. Final stories and reports were published on the Internet.

Assessment for this exercise examined a variety of skills: students' writing and editing abilities, working together in face-to-face and electronic groups; conducting research, meeting deadlines, and manipulating such word-processing mechanics as spell check, graphics, and page layouts; incorporating feedback from their electronic partners; and preparing a final report.

This lesson is a good example of a learning activity enhanced by technology. Students were able to choose their favorite story and create a similar tale based on their own interests. Cooperative groupings allowed for collaboration as students brainstormed, dialogued, and critiqued

Word Processing

Basic word-processing programs allow students to become independent publishers of ideas and opinions. When supplemented by other applications, word processing becomes a particularly powerful learning tool. Using graphics allows authors to illustrate their stories. E-mail provides opportunities for "peer review" and group editing, and the Internet allows students to publish their stories and to share results of their research or problem-solving. (Harris, 1995, pp. 157, 165, 168).

their products. The interdisciplinary nature of the exercise provided a window on the culture of a chosen country. The word-processing program made for easy revision and reflection on the writing process. Finally, through e-mail and the Internet, students were able to connect with their counterparts in other schools and to publish their work to a broader audience.

A Fauna Database

This exercise[7] was carried out in a geography class in an urban school but could also be employed as a science project. The teacher began the unit by asking his ninth grade geography class to list the various birds and animals they noticed in the vicinity of the school. After students listed what they knew, the teacher mentioned several other species that were found in the neighborhood, none of which the students had ever seen. Students were then given the task of creating a database, complete with text and photographs, of all fauna within a five-mile radius of the school.

Databases

Databases allow users to store, organize, and query information by keywords. Database construction requires classification and organization skills, and encourages students to think relationally and with careful attention to details.

Through newspapers, phone interviews, and the Internet, students contacted such organizations as The Audubon Society, the Nebraska Parks and Wildlife Department, and local conservancy groups. Once they had assembled their list of fauna, the students again used library and Internet resources to come up with characteristics and photographs of these birds and animals. After gathering all of their information, groups were reassigned according to

the parts of the database (birds, mammals, reptiles) they wanted to construct. The database was developed and put on-line: <http://www.ops.org/north/curriculum/socstudies/ecosystem/ecoframes. html>. The class as a whole discussed their new birds and animal findings and the importance of cataloguing such information.

This technology-rich project cast the students as explorers. The lesson focused on an area that held meaning for them—their school's neighborhood—and built upon the students' prior knowledge about the urban ecosystem. Once the exercise was completed, students could see where they had begun and how much they had learned in their construction of knowledge about the urban animal ecosystem. The use of such technology as the telephone and Internet allowed greater access to real-world resources and experts, such as local nature groups, while the database software and the Internet allowed student information to be disseminated to a much broader audience than their immediate classmates.

Charleston Housing Market

Ninth and tenth grade students in a Charleston Algebra I class[8] learned about linear equations by examining housing prices in Charleston, South Carolina. Students accessed on-line census data and real estate information, such as sales prices of existing homes, square footage, and the median price of housing. Using spreadsheets, they plotted these data on a coordinate plane, found a line of best fit, and decided how these graphs would help them with home-buying information. With this

mathematical information, students answered teacher-posed questions about housing prices.

Spreadsheets

Spreadsheets are software packages that enable users to organize numbers in rows and columns, which allow for automatic calculations and creations of charts and graphs.

Next, in groups, students chose a city in which they wanted to live and conducted the same research for a report comparing the Charleston housing market to that of their city. They began to observe trends in median-price housing sales and created charts comparing the trends in the two cities. This quantitative information, coupled with real estate information about economic and housing conditions in the two cities and their knowledge of their own city, resulted in the creation of a housing market report.

Assessment was based on the successful completion of the process (the ability to answer a set of algebraic questions and work with partners) and on a number of products (the creation of a linear graph, their success in gathering information, their broad conclusions about housing markets, and on the quality of their finished report). With the information they gathered, students constructed and authored their own knowledge about causes and effects of rising and declining housing prices.

This activity illustrated to students the real-world applicability of linear equations. Because of the technological component, students could "travel" to San Francisco, for example, and access timely housing and economic data that would have been harder to retrieve in its printed form. The use of electronic spreadsheets made for easy data manipulation and analysis and the creation of charts that could be imported into their reports.

Tropical Rain Forest Research

Following a textbook study of biomes, this eleventh grade environmental science class[9] began an Internet research project on two of the biomes discussed—the rain forest and another of their choice. Pairs of students accessed Microsoft's online travel site, Mungo Park <http://mungopark.msn.com>, "traveled" to a rain forest and another biome and maintained a journal on each contact. The teacher photocopied all daily journals and distributed them to the entire class. Working in pairs, the students used daily journals, as well as other research sites and non-Internet sources, to develop a word-processed research paper on two biomes.

This exercise again illustrates ways technology is a natural fit in learner-centered classrooms. By structuring the lesson around a big theme—biomes—and permitting pairs of students to research a biome of their choosing, the teacher encouraged student autonomy and initiative. Through the journal-writing component, students reflected on and recorded their impressions about both the information gathered and the information-gathering process. The classification, analysis, and synthesis of raw data into a refined report modeled the progression of higher-order thinking skills. Finally, the timely, real-world data from primary sources needed for such an exercise would have been impossible to gather without the Internet.

Internet

Because of its versatility and the timeliness of its information, no other computer application holds as much educational promise as the Internet. Because they can easily access and manipulate massive amounts of open-ended data found on the Internet, students can make decisions about how to process and display data, just as they will have to do in future work environments (Ellsworth 1994, p. 392).

Water-Quality Project

This parallel problem-solving activity involved the creation of learning communities in which students from three different countries, along with university professors, teachers, and scientists, shared information about water-quality issues in their towns. Students accessed information via the Internet, used e-mail to gather information from experts, and wrote reports on methods to improve water quality and water management. Students then e-mailed their reports to professors, scientists, and urban planners for immediate feedback.[10]

Since many individuals, quite interestingly, tend to be more responsive to e-mail solicitations than to surface mail or telephone inquiries, many teachers encourage students to contact professionals (lawyers, engineers, university professors) in order to increase the authenticity of a certain exercise. Many Internet sites, such as The Electronic Emissary <http://www.tapr.org/emissary/index. html> and Ask Dr. Math <http://forum.swarthmore.edu/dr.math/dr-math.html>, have been established for the purpose of establishing on-line mentorships and fielding student inquiries.

This exercise focused on an issue that was relevant to students—their community—and encouraged them to create their own solutions to community environmental issues. Because of

E-mail

Because it is a communication tool, e-mail yields a number of opportunities for social interaction.

- Parallel problem solving (posing the same problem to one or more classes, which can then communicate with one another through the Internet)
- Sequential creations (producing papers, poems, and reports collaboratively in several classrooms)
- Electronic process writing and peer tutoring (publishing work and receiving feedback from other students) (Harris, 1998.)

E-mail contacts with professionals involved in water quality issues added to the authenticity of the activity.

the ease and immediacy of e-mail, students could communicate instantly and frequently with content experts and student colleagues from around the globe. Additionally, by permitting student consultation and sharing with professionals involved in water quality issues, e-mail added to the authenticity of the activity. Such interactions provided students with additional information and new perspectives that enriched their understanding of local environmental issues.

An Urban Planning Exercise

SimTown™, a scaled-down version of its more powerful software counterpart, SimCity™, allows users to create a town. In so doing, they deal with such urban-related issues as protecting natural resources, designing a city layout, providing infrastructure and services, and maintaining the balance among residential, public, and commercial establishments. Based on user input, the program provides feedback on the town's progress in the form of the front page of the town newspaper.

This exercise was carried out by a group of ten- to thirteen-year olds in a colonia along the Texas-Mexico border. (Colonias are rural subdivisions characterized by inadequate housing and a dearth of jobs, services, and infrastructure.[11])

Students were introduced to SimTown™ through a combination of exploration time and directed lessons. Both they and their teacher discussed such urban planning issues as the physical layout of this particular community and the problems it faced, examples of "good" and "bad" cities, and such terms as "urban planning," "town planning principles," and "amenities."

Simulations

Simulations are excellent constructivist learning tools, since users can negotiate environmental constraints, solve simulated real-world problems, and witness the effects of changes in variables. These interactive multimedia packages can simulate complex work experiences through games and serve as critical tools to evaluate the kinds of skills that are so often difficult to measure in tests (Maddux, Johnson, and Willis, pp. 29, 223–225).

Armed with pencils and notebooks, students conducted a physical survey of the community's two main streets, recording the number of residences and businesses and noting areas of trash dumping, poor road quality, and vegetation. They then used SimTown™ to construct a model of the two most densely populated streets in the community from which they documented some of the community's problems. These student urban planners discovered that their town was at great risk for fire and they presented this information, along with fire mitigation suggestions, to the town council. The result was a very animated discussion between councilors and students about the need for a community fire-safety awareness program. Many of the students volunteered to help in this campaign.

Technology can complement constructivism to support increased student engagement, learning, and achievement.

The above lesson provides another illustration of how the blending of technology with learner-centered approaches supports increased student engagement, learning, and achievement. Students examined and surveyed a geographic area that held real meaning for them—their community—and ascertained its very real physical problems. The simulation package allowed for a real-world, hands-on learning experience that would not have been possible with textbooks alone. Students actively recreated their physical landscape by inputting real-world data and made observations from which they could draw their own conclusions. The presentation of such information transformed learning from a cloistered academic exercise to one that held community-wide importance.

My Favorite Works of Literature

This exercise[12] was used at the end of the school year by an eighth grade reading class. The teacher asked the students to discuss their favorite stories of the year and what they liked about them. Both she and the class decided that they would give the seventh graders a preview of upcoming eighth grade reading attractions by presenting synopses of some of the eighth graders' favorite stories.

Students divided into groups according to their favorite stories. Group members could present a synopsis of the entire story or their favorite chapter in the story. The teacher explained that most professional presentations were brief and that student presentations had to be under ten minutes. As a result, students had to focus on distilling the story to its most essential parts. Once condensed, students used a presentation program, PowerPoint™, to display synopses of their favorite story or chapter, in flow chart, outline, or bulleted format.

Presentation Programs

Presentation programs allow users to present information in outlined or bulleted form and to save it as slides or transparencies. Users can also add charts, graphics, pictures, sound and video to supplement written information. Information in this format is often used in professional presentations at meetings and conferences. It can be an excellent tool for display of student projects.

Assessment of this exercise took a number of forms. Students were evaluated on their ability to work together, their ability to distill the story to its main elements, their success in creating PowerPoint™ slides, the quality of the slides, their oral presentation, and on their coordination of the correct slide with the scene being recounted. The presence of a visual medium combined with the oral presentation addressed more than one learning style, while the presentation to another audience replicated a "working world" scenario.

Students were in charge of this activity. They chose a story that was meaningful to them, reconstructed the story according to their own interpretations, and shared these interpretations with students and teachers. The presentation software served as a powerful visual organizer allowing eighth grade students to distill and convey their understandings and interpretations to their seventh grade colleagues.

Timeline: My Life, My Community, My Country

The purpose of this unit was to familiarize students with major national and community events of the past fifteen years by examining these events within the context of the students' lives. All of the information compiled would be organized into a timeline supplemented with text, photos, and video.

The unit was divided in three parts. In My Life, students recorded ten of the major highlights of their lives (e.g., the birth of a sibling, a fun trip somewhere) and the years in which each occurred. They collected and scanned photos of themselves at various ages as well as other scannable prized mementos (e.g. an award, a CD cover of their favorite musical group) for their timeline and touched up these objects using PhotoDeluxe™, a photo editing software tool.

Compiling photos and other archival materials with videotapes of oral interviews, students created a timeline about their community and then looked at it in a larger historical context.

In the second part of the unit, My Community, students gathered information about their community since 1982. The class decided that videotaped oral interviews of their parents and other community members would provide the best vehicle for recording information about their community. Students developed a list of ten questions, learned how to use the video camera, divided themselves into groups with assigned roles (camera operator, interviewer, scribe) and conducted their interviews. The teacher digitized the videotaped interviews into the computer.

In part three of the unit, My Country, students used Time/Warner's 20th Century™ multimedia CD-ROM to examine some of the major national events of the past fifteen years. This

multimedia application contains video and audio clips, as well as photos and text of all national and international events of the twentieth century, arranged by categories and organized along a timeline. Students chose one major development from each year of their life in either politics, medicine, sports, entertainment, science, or business and recorded the major event and the year it occurred.

Students compiled all information into their own multimedia timelines using the Claris Works™ paint program. Timelines included major national, community, and personal events, organized chronologically and supplemented by photos, mementos, and audio and video clips (the latter tasks undertaken by the teacher). This information was eventually organized onto a Web site.

The unit began with an issue that was meaningful to students—themselves— and folded their lives within a local and national context. Thus, students were able to see themselves as part of a larger community. The use of the multimedia CD-ROM, with the sounds and sights of Selena's music, cheering 1986 World Series fans, and tanks rolling across Kuwait, made history more interactive and engaging than is possible with a textbook or video alone. In turn,

Multimedia & Hypermedia

Both hypermedia and multimedia are useful tools because they:

- Are highly interactive. Materials are organized and presented so that students can draw their own conclusions rather than have conclusions imposed upon them.
- Structure learning as an active exploratory exercise in which the user sequences and controls his/her level and pace of learning.
- Allow for greater learner autonomy, since students can use different modes of inquiry and extend their activities based on their interests.

by constructing their own timelines using a variety of text-based, visual, aural, and hyperlinked tools, students shared their own understandings of local and national history in creative and interactive format.

Making It Work

A Few Considerations

Bringing technology into a classroom and basing instruction on constructivist learning theory requires a different dynamic from teacher-centered, textbook-driven classrooms. Anyone thinking about making changes in the classroom will have many questions.

Questions About Classrooms

With so much student activity and autonomy, will chaos ensue and learning collapse?

Changing to a learner-centered classroom does not demand the abdication of the teacher's classroom authority. While responsibility for learning is shifted to the student (something most teachers welcome), the teacher is still the leader, organizer, arbiter, planner, and classroom manager. Indeed, these roles are intensified since a structured environment must be in place for student learning to occur. Noise and activity levels may be higher, but they should be the products of students who are engaged in and excited about learning.

Can our students do it? Do they have the self-discipline, the interpersonal skills, or the desire to direct their own learning?

It is tempting to inventory students and conclude that they have neither the interest nor the ability

to be successful in such a classroom. However, performance in a traditional classroom is not an indication of the way students will react in a different setting. In fact, the academic problems and boredom of many students may indicate that traditional instruction is failing to reach them. Just as teachers will need time to learn new techniques, students will also need models for different ways of thinking about school. Some students will quickly recognize their new role, but others will continue to look to the teacher for all instructional authority. Collaboration is difficult for some students and a teacher will need to reserve some time at the beginning of the school year to train the class in their roles as team members.

Matching instruction with the natural inclination to learn should support better understanding of the curriculum.

Can I cover the curriculum, and will my students pass the state test?

Teachers can and do cover the curriculum, successfully preparing students for external tests, while teaching in learner-centered classrooms. To do so demands a firm connection to the goals of the curriculum, assuring that student activities result in skills that accomplish those goals. Matching instruction with students' natural inclination to learn should support better understanding of the curriculum.

How much work will it take to change my teaching?

Shifting from a traditional, teacher-centered classroom setting to a learner-centered one is time- and labor-intensive. We do not advocate a sudden dramatic shift to this type of classroom

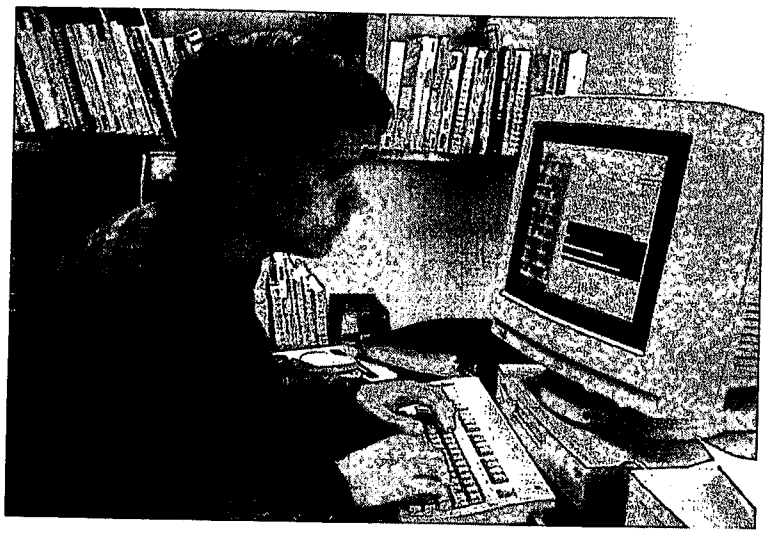
but suggest taking the initial steps that feel most comfortable. Change must be gradual, incremental, and self-paced.

Thoughts about Computers

Computers are dynamic learning tools. They can offer students a variety of real-world and interactive learning experiences that cannot be replicated by other classroom tools. Such an observation does not suggest that books, microscopes, or other classroom tools be subordinated to computers. Rather it is an invitation to use computers in concert with other resources to engage students in active construction of knowledge and authentic problem-solving. Only then will the environment truly support learning while integrating technology.

The value of computer technology is that it allows students to transcend "2 x 4 learning"—learning confined to what's between the two covers of the book and within the four walls of the classroom. With software that allows exploration and replication of real world tasks, students can glean information and learn in ways not supported by textbooks alone. Despite the potential of educational technology, however, several qualifiers must be kept in mind.

First, computers in and of themselves will not make a student learn. There is always the danger that administrators, teachers, and students will fall victim to the "gee whiz" aspect of computers and let the computers become both the instructor and the curriculum. Such a scenario may result in more harm than good for students. For computers to



fulfill their promise, educators must establish environments that prompt reflection and discussion. Activities are focused on problem solving and students are involved in knowledge creation. The deployment of the computer as an electronic textbook or babysitter does not harness the power of the medium.

Using the computer as an electronic textbook or babysitter does not harness the power of the medium.

Second, books and other learning materials should not be abandoned in favor of computer technology. Like computers, books, maps, paint brushes, microscopes, and other nontechnological tools are valuable real world tools that enhance and make learning possible. Multiple resources—technological and non-technological—must be used to address multiple learning styles and curricular goals.

The introduction of computer technology demands a tremendous amount of physical and organizational restructuring—for administrators, teachers, and students. Schools must determine

their educational goals and the ways technology can help them realize such goals. Teachers need high quality professional development and access to on-site technical assistance. They must be offered the flexibility, support, resources, and time to carry out the changes required by a technology-rich environment that supports learning.

Conclusion

No one knows exactly what the future holds, but there is little doubt that computing technology will be a large part of it. Young people will take their places in work environments that need independent thinkers who have skills in problem solving, analysis, communication, and teamwork. Some of them will be using technology directly as a basic part of their employment. Beyond the workplace, as citizens they will need to understand technology's products, interpret information, and choose from ideas that inundate their lives. Skilled use of technology is an important part of their future, but more important is the skillful use of their minds.

Constructivism provides valuable insight for classroom teachers who want to use technology to support student learning. Computers offer opportunities for enhancing intellectual growth and learner-centered classrooms can help students connect the curriculum with their personal experiences and innate abilities to learn. These classrooms have the most promise for successful technology integration.

Resources

Suggested Additional Readings

The following resources have been provided for those wishing to learn more about technology-integrated constructivist approaches.

Brooks, J., & Brooks, M.G. (1993). *In Search of Understanding: The Case for Constructivist Classrooms.* Alexandria, VA: Association for Supervision and Curriculum Development.

This is a well-written overview of constructivism and strategies for implementing constructivist approaches in the K–12 classroom.

Caine R., & Caine G. (1991). *Making Connections: Teaching and the Human Brain.* Menlo Park, CA: Addison-Wesley Publishing Company.

In addition to addressing several assumptions that teachers hold about education and citing facts and theories about the human brain, the authors discuss twelve principles of brain-based learning and the implications of those principles for educators. They directly challenge the reduction of learning into left- and right-brain modes.

Interactive Educational Systems Design. (1997). *Report on the Effectiveness of Technology in the Schools, 1995–1996.* Washington, D.C: Software Publishers Association.

This is an overview of research studies concerning the successes and limitations of educational technology in the K–12 classroom. Findings are summarized and presented within overall teaching strategies and classroom structure. A new report is issued annually.

Maddux, C.D., Johnson, D.L., & Willis, J.W. (1997). *Educational Computing: Learning With Tomorrow's Technology.* Boston: Allyn & Bacon.

Maddux, Johnson and Willis offer an excellent grounding for those wishing an overview of different types of hardware

and software and their utility in the classroom. The authors focus on each type of software application (e.g. word processing software, databases) and the specific skills each can facilitate. Although only one chapter deals exclusively with constructivist uses of educational technology, the majority of activities described occur within student-centered and constructivist settings.

Southwest Consortium for the Improvement of Mathematics and Science Teaching. (1995). Constructing Knowledge in the Classroom. *Classroom Compass* (1)3. Austin, TX: Southwest Educational Development Laboratory.

Classroom Compass is an information bulletin published by SEDL that presents essays, recommends electronic and print resources, and suggests classroom activities for K–12 math and science teachers. This issue focuses on constructivism and constructivist applications in mathematics and science classrooms.

Technology Assistance Program, Southwest Educational Development Laboratory (SEDL). <http://www.sedl.org/tap/>

Applying Technology to Restructuring and Learning, a project serving more than 150 teachers in six schools, is part of SEDL's Technology Assistance Program. The SEDL staff work with these teachers to create technology-enriched constructivist classrooms. This website was designed for K–12 teachers who are embarking on a path toward such learning environments. The site provides information on both constructivist theory and educational technology, as well as subject area resources that could be used to supplement constructivist approaches.

Endnotes

1. These six principles are distilled by staff of SEDL's Technology Assistance Program (TAP) from a variety of sources on constructivism, brain research, and education research, as well as staff members' experiences as teachers, learners, and observers in classrooms. Many of the resources used can be found in TAP's literature review, *Constructing Knowledge with Technology* (Boethel & Dimock, 1999).
2. This classroom example was modified from a unit developed by Sharon Roy, Michelle Garza, Jayne Kennesson, John Schwertner, and Trish Leal of Kealing Junior High School in Austin, TX.
3. See Perrone, p. viii.
4. This mathematics activity, based on examples from the National Council for Teachers of Mathematics's *Curriculum and Evaluation Standards for School Mathematics* (page 37), was presented in the fall 1994 (Vol.1, #2) issue of *Classroom Compass,* an information bulletin of the Southwest Consortium for the Improvement of Mathematics and Science Teaching (SCIMAST), a SEDL project.
5. See Wissick. Also Interactive Educational Systems Design, pp. 9, 14, and 35.
6. Adapted from a Winnipeg (Canada) school. For more information, contact <dfalk@minet.gov.mb.ca>.
7. Used with the permission of Harrison Payne, geography teacher, Omaha North High School, Omaha, Nebraska. See "The Hidden Ecosystem in Omaha" on the Omaha Public Schools website: <http://www.ops.org/north/curriculum/socstudies/ecosystem/ecoframes.html>.
8. Adapted from Susan Boone's lesson, "A Functional Housing Market," available on the Internet at <http://www.crpc.rice.edu/CRPC/GT/sboone/Lessons/Titles/lphouse.html>.
9. This lesson was authored and conducted by Dwayne Carlock at Block (Louisiana) High School. It is used with

his permission. For further information, contact him at <dcarlock@cath.nls.k12.la.us>.

10. McDaniel, p. 75. Grade level and subject area are unavailable.
11. Definition furnished by the U.S. Department of Housing and Urban Development: <http://www.hud.gov/whatcol.html>.
12. Adapted from Gottfried and McFeeley, p. 10.

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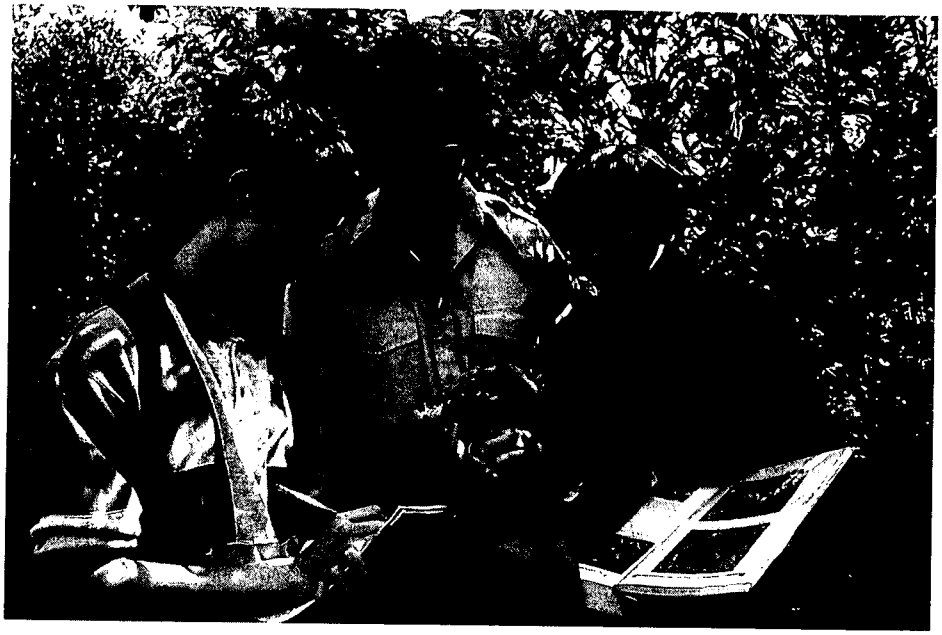

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SEDL's Technology Assistance Program

Engaged Discoverers: Kids Constructing Knowledge with Technology

SEDL's Technology Assistance Program staff

Elementary, middle school, and high school students are using classroom technology in innovative ways, and this video captures them in the midst of their exploration. The 16 schools portrayed in this film are located throughout the SEDL service region: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. Their classrooms exemplify the diverse ways technology can expand the local setting by bringing in voices, data, and projects from around the world. (31:08 minutes)

Putting Technology into the Classroom: A Guide for Rural Decision Makers

Martha Boethel, K. Victoria Dimock, and Lin Hatch

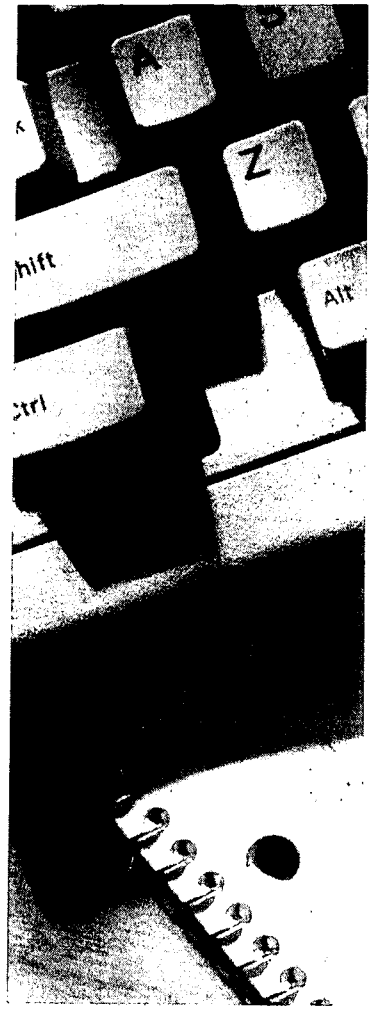
This booklet outlines the issues that face superintendents, boards of education, principals, and other decisionmakers who want to integrate technology into classroom instruction. Some issues addressed include: How can we fund technology? How should we provide staff development? Why should we spend the money on technology? and How do we keep our systems up-to-date? (42 pages)

Planning Into Practice

Jeff Sun

A step-by-step guide for school technology planning, this publication offers assistance for activities that range from determining a school's vision for technology to the nitty-gritty of using technology to improve learning. Developed from work with SEIR*TEC sites. (Approximately 100 pages; to be released in spring 1999)

Please call 1-800-476-6861 for pricing information.



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