CHAPTER

4 Education

After completing this chapter, you will be able to:

- **Describe how multimedia computers provide a powerful environment for achieving the goals of the cognitive movement in education**
- **Understand how multimedia computers are being used across the curriculum in a wide range of subjects**
- **Sample demonstrations of state-of-the-art applications linked to the *Multilit* Web site**
- **Assess how up-to-date your local schools are in adopting multimedia technologies for teaching and learning**
- **Question whether technology will make any major difference in the structure of schooling**

As articulated by Brown, Collins, and Duguid (1989), skills and knowledge are too often taught out of context, as ends in and of themselves. To overcome this, teachers are using multimedia to bring into the classroom real-life examples of situations that provide the contextual framework so important for learning. Brown calls this use of multimedia **situated learning**. Multimedia gives teachers instant access to thousands of slides, videos, sound tracks, and lesson plans. These materials can be called up instantly, either for classroom use or as a networked resource for student exploration, discovery, reflection, and cooperative learning. Among educational researchers, the capability to demonstrate vividly and convincingly the real-world applicability of knowledge has become known as **anchored instruction** (The Cognition and Technology Group at Vanderbilt, 1990).

The benefits of multimedia are well documented by Professor James Kulik (1985, 1986, 1991, and 1994) and his associates at the University of Michigan. During the past 20 years, Kulik has analyzed hundreds of controlled experiments on the effectiveness of computer-based learning. Although the term *multimedia* did not exist then, many of the studies used graphics, sound, and video in a manner now referred to as multimedia. Overall, the findings indicate that average learning time has been reduced significantly (sometimes by as much as 80%), and achievement levels are more than a standard deviation higher (a full letter grade in school) than when multimedia is not used.

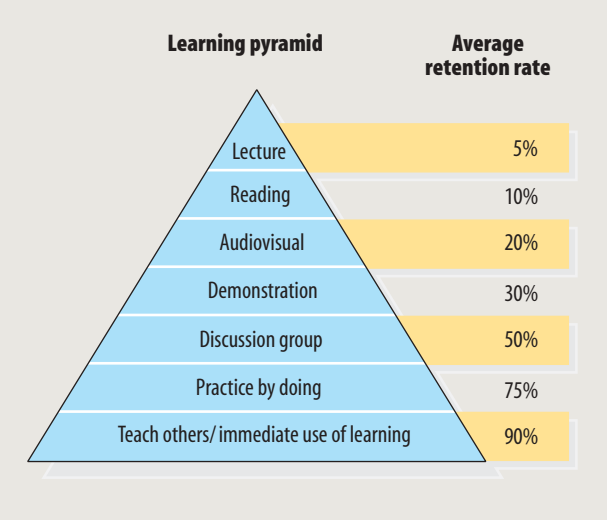

Figure 4-1 The learning pyramid.
Source: National Training Laboratories (NTL) Institute, Bethel, Maine.

The Kulik studies are classified according to grade levels. The Information Superhighway is linking universities, colleges, schools, and homes into a continuum that is helping to break down the distinctions between these grade levels. The Internet is enabling students of all ages to collaborate on worldwide projects, share discoveries, and develop strategies for acquiring knowledge in a social context. As the Learning Pyramid in Figure 4-1 shows, the more actively involved students are in the teaching and learning process, the more knowledge gets retained.

Cognitive Versus Behavioral Psychology

Much of what happens in the traditional classroom was influenced heavily by the behaviorist movement, which dominated American psychology from about 1920 to 1970. Chief among the behaviorists was Skinner (1938, 1953), who saw that human behavior is powerfully shaped by its consequences. Moreover, Skinner felt that psychology was essentially about behavior and that behavior was largely determined by its outcomes. Although Skinnerian methods have been effective in learning how to train animals and helping human beings modify their behavior, the behaviorists fell short of what is most important in education for most educators. To educate, you must do more than modify behavior. To educate, you must help the student learn how to develop strategies for learning. Such is the goal of the cognitive movement in education as defined by Bruning (1995: 1):

> *Cognitive psychology* is a theoretical perspective that focuses on the realms of human perception, thought, and memory. It portrays learners as active processors of information—a metaphor borrowed from the computer world—and assigns critical roles to the knowledge and perspective students bring to their learning. What learners do to enrich information, in the view of cognitive psychology, determines the level of understanding they ultimately achieve.

It is appropriate that Bruning borrows from the computer world in his definition of cognitive psychology. As you will see in the educational applications surveyed in this chapter, multimedia computers provide a powerful environment for helping achieve the goals of the cognitive movement in education. As articulated by Piaget (1969), students learn better when they can invent knowledge through inquiry and experimentation instead of acquiring facts presented by a teacher in class. It is difficult for a teacher to provide this kind of environment for each student in a traditional classroom. Since there is only one teacher for many students, it is physically impossible for the teacher to support each student's individual needs. Multimedia computers help by providing students with a world of interconnected knowledge to explore. The screen-capture and downloading tools you will learn in the tutorial section of this book enable students to collect what they discover and construct a framework for organizing and understanding. Thus, the student becomes an active processor of the information, and knowledge is the by-product.

Since the learner is portrayed as an active processor who explores, discovers, reflects, and constructs knowledge, the trend to teach from this perspective is known as the *constructivist movement* in education. As Bruning (1995: 216) explains, "The aim of teaching, from a constructivist perspective, is not so much to transmit information, but rather to encourage *knowledge formation* and development of metacognitive processes for judging, organizing, and acquiring new information." Several theorists have embellished this theme. Rumelhart (1981), following Piaget, introduced the notion of *schemata*, which are mental frameworks for comprehension that function as *scaffolding* for organizing experience. At first, the teacher provides instructional scaffolding that helps the student construct knowledge. Gradually, the teacher provides less scaffolding until the student is able to construct knowledge independently. For example, in the History of Flight tutorial in Part Six of this book, a lot of scaffolding is provided at first as an aid to learning how to develop a multimedia application; gradually, the scaffolding is removed until the student is able to create new multimedia works independently. Skinner and the behaviorists used related techniques known as *prompting* and *fading*. A hierarchy of sequential prompts firms up and reinforces a student's skill, and fading removes the prompts gradually until the student can perform a task independently.

Vygotsky (1978) emphasized the role of social interactions in knowledge construction. Social constructivism turns attention to children's interactions with parents, peers, and teachers in homes, neighborhoods, and schools. Vygotsky introduced the concept of the *zone of proximal development*, which is the difference between the difficulty level of a problem a student can cope with independently and the level that can be accomplished with help from others. In the zone of proximal development, a student and an expert work together on problems that the student alone could not solve successfully.

A challenge for software designers is to create programs that can function as the expert in the zone where learning and development take place. Software that succeeds can help transform the traditional teacher-centered classroom into a more learner-centered environment. Table 4-1 compares the teacher-dominated and cognitive perspectives. As you review the software surveyed in this chapter, keep this comparison in mind and reflect on the role multimedia computers can and should play in the contemporary classroom.

Table 4-1 Comparison of the Teacher-Dominated and Cognitive Perspectives on Education

Teacher-Dominated Perspective	Cognitive Perspective
Teacher centered	Learner centered
Teachers present knowledge	Students discover and construct knowledge
Students learn meaning	Students create meaning
Learner as memorizer	Learner as processor
Learn facts	Develop learning strategies
Rote memory	Active memory
Teacher structures learning	Social interaction provides instructional scaffolding
Repetitive	Constructive
Knowledge is acquired	Knowledge is created
Teacher provides resources	Students find resources
Individual study	Cooperative learning and peer interaction
Sequential instruction	Adaptive learning
Teacher manages student learning	Students learn to manage their own learning
Students learn others' thinking	Students develop and reflect on their own thinking
Isolationist	Contextualist
Extrinsic motivation	Intrinsic motivation
Reactive teachers	Proactive teachers
Knowledge transmission	Knowledge formation
Teacher dominates	Teacher observes, coaches, and facilitates
Mechanistic	Organismic
Behavioralist	Constructivist

Art

The ability to display more than 16 million colors lets computers exhibit artwork in true colors that rival those on the printed page. But unlike books, in which the pictures are static and unconnected, multimedia computers offer art educators all the advantages of hypermedia. For example, consider Softkey's *Leonardo*. Figure 4-2 shows how the user has instant access to every painting, invention, and writing of this Renaissance master. The biography chronicles the events that shaped da Vinci's life and contains hyperlinks that transport you to articles, paintings, videos, and models of his inventions. Figure 4-3 shows how the timeline correlates events in Leonardo's life to world history. Follow the *Multilit* Web site link for more information about *Leonardo.*

Now that graphics are available worldwide on the Internet, museums all over the world are making artwork accessible on the Information Superhighway. The Spring 1994 newsletter of The Getty Center for Education in the Arts discusses the role of the Internet in discipline-based art education:

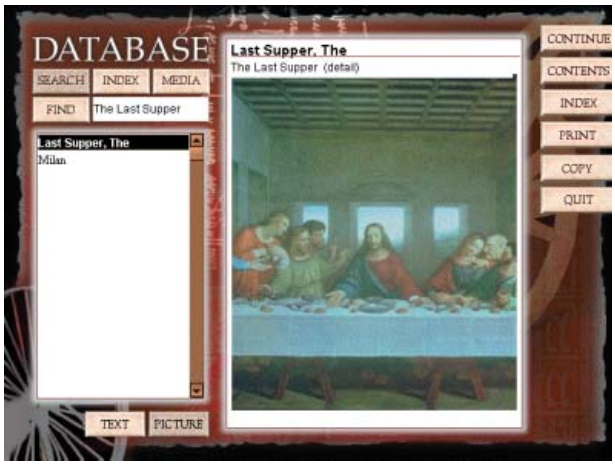

Figure 4-2 The database in Softkey's *Leonardo 2.0*.

Figure 4-3 The timeline in Softkey's *Leonardo 2.0*. The highlighted words are hyperlinks.

> Imagine a national network devoted to discipline-based art education (DBAE) in its myriad, evolving applications. This network would open communications between teachers, administrators, school board members, scholars, policy makers, students, artists, community arts groups, art associations, and parents. It would provide access to new ideas, products and research; innovative programs; opportunities for collaboration; current literature; discussions of ideas; and training techniques. Through print or electronic media it would offer forums for sharing, exchanging, informing, testing, discussing, learning, surveying, or advocating among an expanding community of practitioners, scholars, and advocates.

Getty has been working diligently to make this dream come true. To experience the wealth of resources available for art educators, follow the *Multilit* Web site links to Getty's art education site. Also linked to the *Multilit* Web site are:

- Archives of American Art—The Smithsonian Institute's easy-to-navigate digital art library
- ArtFul Minds—An art education Web site where teachers will find theoretical information and practical applications about brain research, arts education, technology use, and integration
- ArtMuseum.net—An Intel partnership with some of the world's leading art museums using Macromedia Flash and Shockwave, RealPlayer, and Live Picture Zoom to provide you with a virtual experience touring art exhibits online
- ArtsEdge—The Kennedy Center's online showcase including such titles as the African Odyssey Interactive, the Duke Ellington Centennial Celebration Site, and Look in the Mythic Mirror, an integrated mythology curriculum Web site
- National Gallery of Art—Virtual tours that use a free version of the Live Picture Zoom Viewer, which lets you move from room to room and zoom in to your favorite masterpieces

Biology

Biology teachers are taking advantage of multimedia's ability to bring classrooms to life with animations, full-motion video clips, and stereo sound. Multimedia curriculum resources include animals, dissection, genetics, heredity, and cell biology.

Animals

How We Classify Animals teaches taxonomy. Distributed by the Society for Visual Education (SVE), this multimedia CD begins by explaining the two broad groups of animals (vertebrates and invertebrates). Students examine the different types and categories of animal life such as sponges, animals with stinging cells, worms, jointed animals, soft-bodied animals, spiny-skinned animals, fish, amphibians, birds, and mammals. A HyperStax interface allows for fully interactive browsing and testing options with a scorekeeper. The teacher's guide features activities that make connections among a wide range of content areas, including language arts, health and nutrition, social studies, art, and critical thinking. For more information, follow the *Multilit* Web site links to SVE & Churchill Media.

Mammals: A Multimedia Encyclopedia is a multimedia CD from the National Geographic Society that covers more than 200 mammals, from aardvark to zorilla. There are 45 full-motion video clips, 150 authentic animal vocalizations, 700 captioned full-screen photographs, fact boxes, and range maps you access with your mouse. Essays about the animals provide the equivalent of 600 pages of text.

Oceans Below is a simulated CD-ROM scuba diving adventure by Amazing Media. After checking your gear on the deck of the ship, reading a small guidebook that turns into a slide show on topics like altered depth perception and ocean conservation, and selecting one of 17 dives (see Figure 4-4), you can view a fish chart like the plastic sheets real divers use (see Figure 4-5). Then, as you dive, the world beneath the waves emerges. You explore the depths with your mouse as many colorful images of sea creatures appear. For example, clicking on a picture of a lionfish lets you watch a video of it—within the frame of a face mask (see Figure 4-6)—and listen to a description.

Figure 4-4 The world map takes you to any one of 17 exciting dives in Amazing Media's *Oceans Below*.

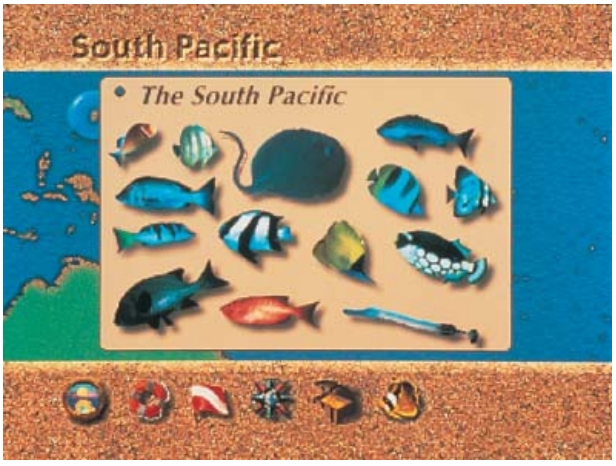

Figure 4-5 Narrated sea life charts identify the fish you encounter in *Oceans Below*.

Figure 4-6 Full-motion videos play inside the frame of a face mask in *Oceans Below.*

Dissection

The Curry School of Education has a frog dissection tutorial on the World Wide Web. The tutorial contains highly interactive activities in which the student clicks on a picture of a frog to mark the beginning and end of an incision. If the student is wrong, feedback is provided. When the student gets the answer right, the incision is made, and another picture shows the results. You can try this out by following the *Multilit* Web site links to the Interactive Frog Dissection Tutorial.

Genetics and Heredity

Exploring Genetics and Heredity is a multimedia CD from Clearvue that uses narrated diagrams and microphotographs to explain DNA structure, meiosis, mitosis, the nature and regulation of genetic material, and the basic patterns of heredity, including an extensive presentation of Mendel's law. Clearvue also publishes three separate CDs entitled *Genetics, Heredity,* and *Evolution,* treating these topics in more detail. For more information, follow the *Multilit* Web site links to Clearvue.

Virtual FlyLab (VFL) is an interactive Web site for genetics instruction. Developed by Dr. Robert Desharnais at California State University at Los Angeles, VFL enables students to conduct genetic experiments by "breeding" fruit flies over the Web and observing the patterns of inheritance in the offspring. Students can also formulate hypotheses and conduct statistical tests. You can find Virtual FlyLab online by following the *Multilit* Web site link to Virtual Courseware for Science Education.

Cell Biology

Clearvue's *Cell Biology* consists of two multimedia CDs that cover biological concepts and cellular processes. *Part I: Cell Structure & Function, Cell Cycle, Mitosis & Cell Division, Meiosis* compares prokaryotic and eucaryotic cells and presents the structure and function of organelles in plant cells. After outlining the phases of the cell cycle, stages of mitosis, and cell division, the CD introduces the basic mechanism of meiosis and examines the sequence of events, sources of genetic variability, cytology of meiotic cell division, and the differences and similarities between mitosis and meiosis. *Part II: Membranes, Cell Motility* describes how lipid and protein molecules assemble to form

cellular membranes and introduces the fluid mosaic model and supporting evidence, as well as major pathways for the transport of molecules through membranes. Cell motility is examined with respect to microtubules and microfilaments.

You can find out more about how multimedia computers are being used in biology teaching by following the *Multilit* Web site links to the National Association of Biology Teachers (NABT) and the Human Genome Project.

Chemistry

Illman (1994) reviews the work of several chemistry teachers who are using multimedia tools to make presentations in classrooms, publish electronic journals, illustrate the periodic table, develop animations of ions and molecules, and make multimedia chemistry instruction available on the Internet. Illman predicts that personal computers will become widespread in teaching chemistry due to the wide range of problems multimedia can solve.

For example, one of the most perplexing problems in teaching chemistry is that students do not get enough time in the laboratory to conduct experiments. Many schools cannot provide the quantity or quality of lab experience needed for a good education in chemistry. Students are no longer permitted to handle some important chemicals that have been found to cause cancer. Other experiments are too dangerous, expensive, or time-consuming. Enter the multimedia CD-ROM *Exploring Chemistry*. Published by Falcon Software, *Exploring Chemistry* is a comprehensive introductory chemistry course covering both inorganic and organic topics. Its 150 lessons provide 180 hours of instruction. The interactive lab design by Professors Stanley G. Smith and Loretta L. Jones (1993) uses full-motion video to let students conduct lab experiments repeatedly until the students master the material. Students can try experiments on the CD that would be too risky to perform in person, such as the grain dust explosion illustrated in Figure 4-7. The step-frame option lets the students view the explosion as it develops; each frame represents a thirtieth of a second.

Figures 4-8 and 4-9 show the equilibrium experiment, which lets you mix a variety of chemicals, observe the reactions, and learn from the results. The two chemicals used in the experiment, potassium chromate and potassium dichromate, have been widely used in chemistry education. Recently, they have been found to be carcinogens, so the only safe way to teach about them is through simulations like this. The simulations are so realistic that when you click a chemical with your mouse and see a hand pour the chemical into the beaker, it is as if your own hand poured it in. For more information about *Exploring Chemistry,* follow the *Multilit* Web site link to Falcon Software.

Figure 4-7 The grain dust explosion lasts only a quarter of a second; students view it in stages by stepping through each frame of video.

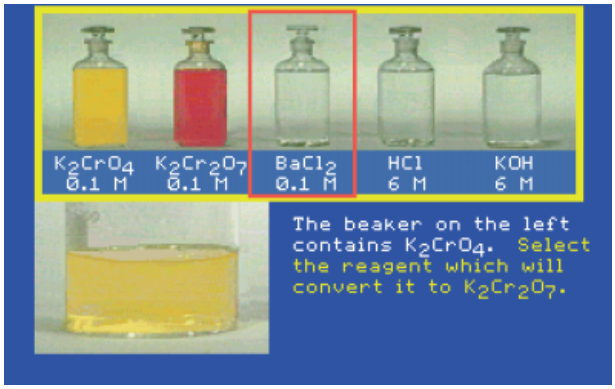

Figure 4-8 Students mix chemicals to find the one that changes potassium chromate into potassium dichromate.

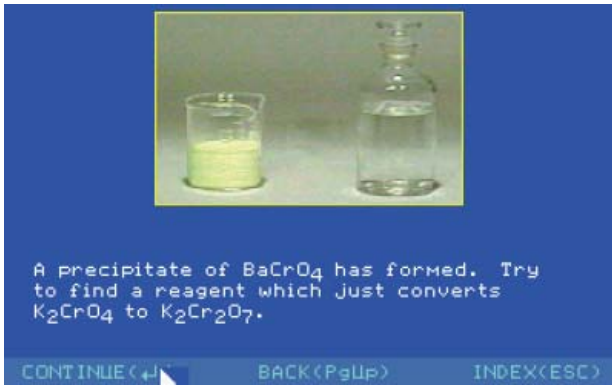

Figure 4-9 The result of entering a wrong answer in the equilibrium experiment.

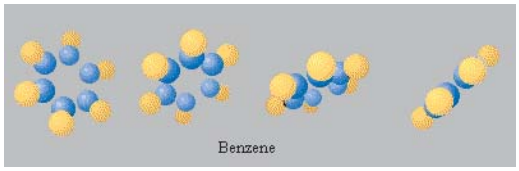

Figure 4-10 Java rotations of a model of a benzene molecule. Rotating the chemical model leads the user to discover that the centers of the six carbon atoms and six hydrogen atoms in benzene are coplanar.

Active technologies on the World Wide Web are helping solve another problem in teaching chemistry: visualizing the structure of chemical models. In a textbook, students are limited to a static photo that shows only one position. On the Web using active technologies such as Sun's Java, Macromedia's Shockwave, or Microsoft's ActiveX, students can rotate chemical models by clicking and dragging with a mouse. For example, Figure 4-10 shows different stages in the rotation of a model of a benzene molecule on a Java Web page. To try this and other chemical models on the Web, point your Java-enabled browser at http://www.udel.edu/fth/java/MoleculeViewer.

Speaking of textbooks, there is now a multimedia alternative to the best-selling introductory chemistry text *Chemistry and Chemical Reactivity*. Professor John Kotz, primary author of the text, has created a multimedia CD-ROM entitled *Saunders Interactive General Chemistry CD-ROM with Activchemistry*, which is distributed by Saunders College Publishing. The CD includes more than 600 screens with thousands of full-color photos and illustrations, video clips with narration and sound effects, animations, and 3-D molecular model rotations generated with CAChe Scientific software, which enables students to manipulate the models in real time. The multimedia materials contain content-sensitive hyperlinks to the complete textbook. Virtual Minilabs let students perform experiments on-screen, manipulate variables, and observe results. The CD-ROM comes packaged with a printed workbook in which students record their observations. For more information, follow the *Multilit* Web site links to Interactive General Chemistry.

Civics

Instead of teaching civics with textbooks that only describe it, multimedia lets teachers bring civics to life with multimedia CD-ROMs, live video feeds from Congress, and online access to government agencies and offices. The *Multilit* Web site has links, for example, to the White House, the U.S. House of Representatives, and the Senate. To find another agency, follow the link to the Louisiana State University Libraries' comprehensive *U.S. Federal Government Agencies Directory*.

To provide more of a historical perspective, Compton's NewMedia publishes *U.S. Civics*, a guide to U.S. history from the 1700s to the present. Biographies, government structure, reference manuals, and sample tests round out this educational database.

Economics

A big problem in teaching economics is the static nature of the charts and graphs printed in economics textbooks. Students need to be able to manipulate the data and view changes interactively to gain an understanding of complex economics concepts.

McGraw-Hill is addressing this problem with two multimedia CD-ROMs for the best-selling McConnell *Economics* textbook. The first CD is entitled *Microeconomics*. It covers supply and demand, elasticities, cost, pure competition, monopoly, and tax incidence. The second CD is called *Macroeconomics*. Topics include national accounts, the aggregate expenditure model, aggregate demand and supply, the Federal Reserve and monetary policy, inflation/unemployment, money, banking, and money creation.

If you compare Figures 4-11 and 4-12, you can see how the *Economics* CD-ROM brings economics to life. Figure 4-11 is one of the graphs in the textbook. The student sees only one view and cannot change anything. Figure 4-12 is the same graph on the *Microeconomics* CD. Buttons enable the student to shift the production possibilities and view the results in a table of data that updates automatically when the student changes the graph.

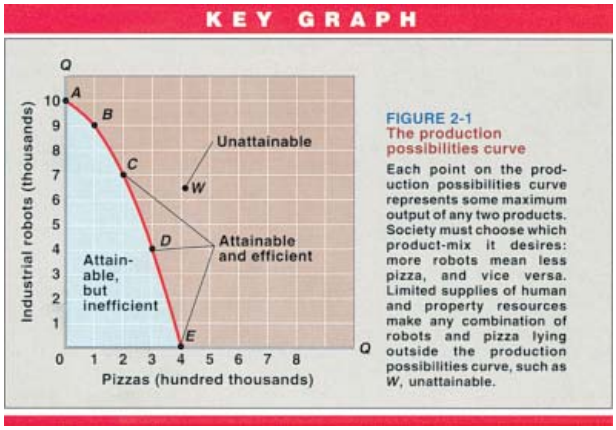

Figure 4-11 How the Production Possibilities curve appears in the *Economics* textbook. The student cannot interact with it.

Economics, 13E by C. McDonnell and Stanley Brue. Copyright © 1996 McGraw-Hill Companies. Reprinted by permission.

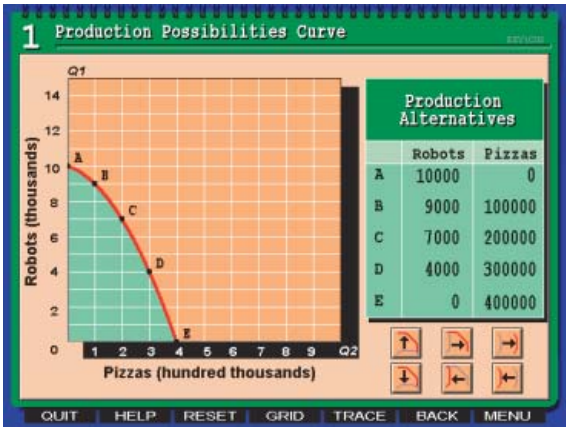

Figure 4-12 The multimedia version of the Production Possibilities curve lets the student manipulate the graph and study changes in the data.

Economics, 13E by C. McDonnell and Stanley Brue. Copyright © 1996 McGraw-Hill Companies. Reprinted by permission.

Foreign Languages

When abroad, try conversing in a foreign language you supposedly learned in school and you will quickly grasp the importance of multimedia in foreign-language instruction. Although books can teach grammar and vocabulary, they cannot interact with you the way people converse. Enter multimedia.

Multimedia computers are a natural for teaching language. Digital audio provides pronunciation capabilities, and full-motion video can put students in real-life situations. Exploiting these features, Syracuse Language Systems has teamed with Random House to publish the award-winning *Living Language Multimedia* series on CD-ROM. The series includes four products:

- *All-in-One Language Fun* contains instruction in Spanish, French, German, Japanese, and English—all on one CD. Designed for ages three to 12, the CD teaches hundreds of words and phrases through multimedia versions of familiar games, including bingo, jigsaw puzzles, Concentration, Simon says, and more. Digital audio of native speakers' voices helps users learn how to pronounce the words.

- *TriplePlay Plus* takes an important leap forward. It uses speech recognition software licensed from Dragon Systems to listen, analyze, and help improve your pronunciation. *TriplePlay Plus* is available in English, French, German, Hebrew, Italian, Japanese, and Spanish versions. Figure 4-13 shows how interactive comic strips depict everyday situations to build comprehension and conversation skills at a slow or natural rate of speech.

- *Let's Talk* uses Dragon speech recognition to teach on one CD more than 2200 words in each of four languages: French, German, Italian, and Spanish. Native speakers provide the model, and a "recognition meter" shows how well your pronunciation matched it.

Figure 4-13 An interactive comic strip in *TriplePlay Plus* from Syracuse Language Systems.

Figure 4-14 A conversational situation presented by *Your Way* from Syracuse Language Systems.

- *Your Way* is a language course based on branching conversations in six everyday settings: social engagements, dining out, hotels and accommodations, around town, travel, and medical needs. For example, Figure 4-14 shows a situation in a restaurant. Challenging games, extensive reference sections, and a multimedia glossary add to the richness of *Your Way*.

The Syracuse CDs have won many awards, including the Milia d'Or 1998 Reference and Education Award, the Family PC 1998 Family Tested Award, as well as a series of Consumer Electronics Show, Technology & Learning, and NewMedia INVISION awards. Highly praised is the use of speech recognition to teach pronunciation. According to Syracuse president Martin Rothenberg, "Using the automatic speech recognition games in *TriplePlay Plus*, language learners can develop a natural-sounding accent and confidence in their speaking skills. Learners will immediately know if they are saying words and phrases correctly, and will be able to practice and improve as they play. The games are also designed so that a native-speaker's voice is always available as a pronunciation model." Except for the specially designed dynamic microphone packaged with the software, no additional hardware is required. For more information about these and other products, follow the *Multilit* Web site link to Syracuse Language Systems.

Another award-winning CD called *Kidspeak* from XOOM aims to make learning a second language easy for grade-school children. Designed to take advantage of intuitive language learning abilities, *KidSpeak* combines animation with interactive games, puzzles, and songs. It has no drills, tests, or anything unpleasant. Instead, children believe they are playing with their animated friends as they acquire second language skills. To learn more, follow the *Multilit* Web site links to *KidSpeak*.

Geography

The highly visual nature of geography makes it a natural for multimedia. The National Geographic Society has pulled out all the stops with Xpeditions, a Web site developed in partnership with MCI WorldCom. If you follow the *Multilit* Web site link to the National Geographic Xpeditions, you'll find an interactive atlas that lets you see and print more than 1800 maps, take virtual tours delivered via Apple's QuickTime 3D technology, and browse an archive of the U.S. National Geography standards. Xpeditions won the 1999 Coadie award for best new education online product. It is part of MCI WorldCom's MarcoPolo project, which is bringing standards-based content online in subjects across the curriculum. To learn more about this exciting project, follow the *Multilit* Web site links to MarcoPolo. For more information about other multimedia products from the National Geographic Society, follow the *Multilit* Web site links, where you'll find the *Complete National Geographic*, a set of CD-ROMs containing every page of the magazine including the original photography.

A cleverly designed CD-ROM is Brøderbund Software's *Where in the World Is Carmen Sandiego?* Carmen and her gang of villains are stealing the treasures of the world. Sixty countries are involved, with hundreds of animations and thousands of audio clues, including 500 digitized in foreign languages. The student uses Funk & Wagnall's *World Almanac* to help solve the crime, doing research to find out where to go next to find the criminal and the loot. Figure 4-15 shows the high-tech on-screen tools. Clues include languages spoken, landmarks, and cultural sites. As you can see in Figure 4-16, places are illustrated with pictures from *National Geographic* and accompanied by songs from the Smithsonian. Thus, *Carmen* teaches geography in the context of world culture. The latest release offers an immersive environment in which the student can take a 360-degree walking tour, creating the illusion that the student actually is in the place being explored.

Although *Carmen* is so popular that hundreds of middle schools have held Carmen Sandiego Geography Days, some teachers have trouble figuring out how to integrate programs like *Carmen* into teaching, because it shifts the focus from teacher-centered to

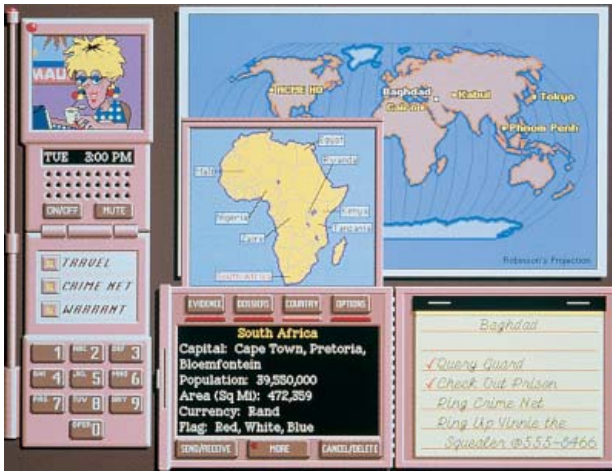

Figure 4-15 On-screen tools in *Where in the World Is Carmen Sandiego?* include the videophone (left), Dataminder (bottom center), and Note Pad (bottom right).

Figure 4-16 Dramatic photographs place players in 45 countries around the world.

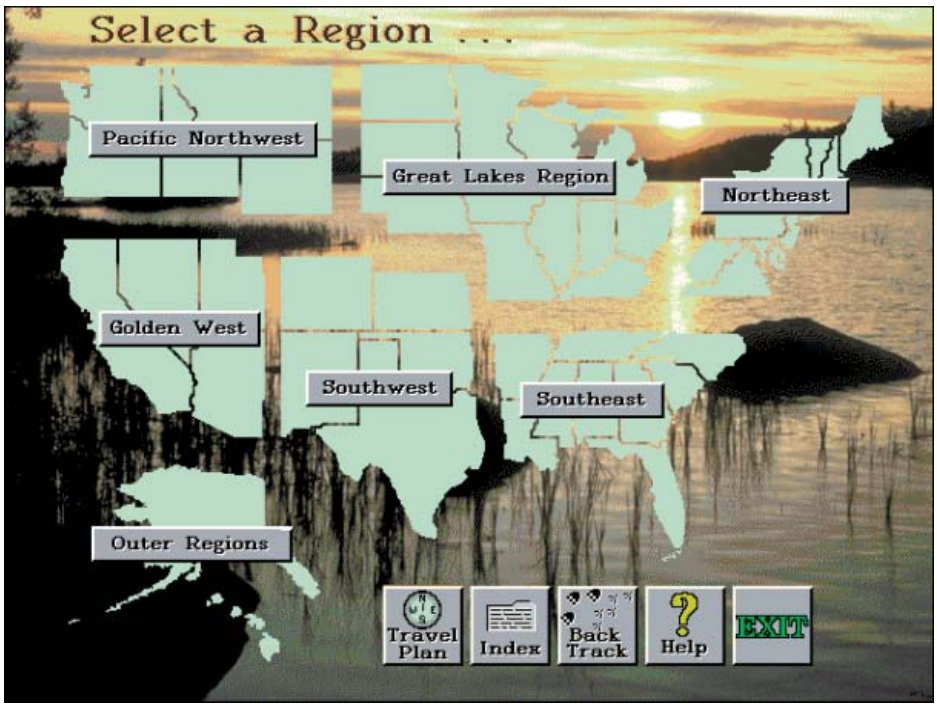

Figure 4-17 This map appears when you start the *National Parks of America* CD-ROM. Clicking the buttons lets you navigate down through Regional and State menus to individual parks.

student-centered instruction. As Neuwirth (1994) explains, "This game cannot be used in a classroom setting. It is not a very didactic tool as the teacher is not given any time for talking to the student during the game." Follow the *Multilit* Web site links to learn more about *Carmen* and other award-winning Brøderbund products distributed by The Learning Company.

National Parks of America by Multicom is more utilitarian. Figures 4-17 through 4-19 show how this multimedia CD uses the metaphor of a map to let you navigate to any park in the country and virtually tour it before deciding whether to plan an actual trip there. There are more than 900 photographs by renowned nature photographer David Muench. The CD lets you locate and select any one of 230 parks by name or geographic location or by specific criteria such as camping or hiking. You can research park background information or just tour through dramatic videos and the magnificent beauty of Muench's photographs, as shown in Figure 4-19.

Environmental Systems Research Institute's *ArcView* is a geographic information system (GIS) that lets you create and query geographically oriented databases. Using the combined power of the computer, geography, data, and their imaginations, students can develop hypotheses and test scenarios to develop an understanding of the world. For example, Figure 4-20 shows how you can query what countries produced more energy than they consumed in a certain year. Figure 4-21 shows a satellite plot of irrigated fields in part of Kansas. *ArcView* ships with six CD-ROM databases covering different aspects of the United States and the world. In addition, you can create your own databases and import data from dBase or plain text data files. For more information, follow the *Multilit* Web site link to *ArcView*.

Figure 4-18 At the state level, *National Parks of America* lets you view a map that locates each park in the state.

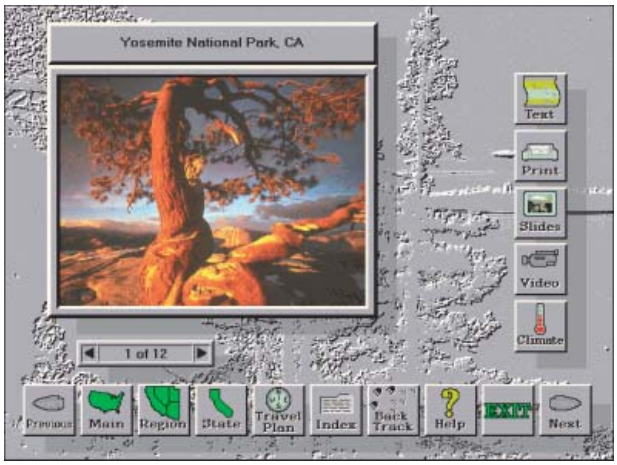

Figure 4-19 At the park level, *National Parks of America* lets you access detailed information about each park and view spectacular photos.

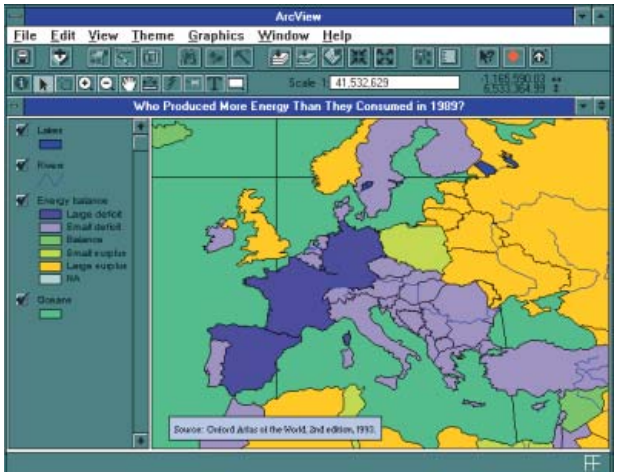

Figure 4-20 An *ArcView* plot answers the question of who produced more energy than they consumed in 1989.

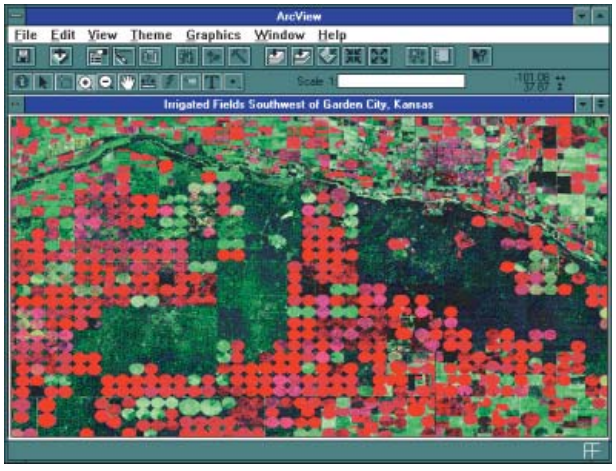

Figure 4-21 *ArcView* plots the irrigated fields southwest of Garden City, Kansas.

History

There are many ways multimedia brings history to life. CD-ROM versions of traditional history textbooks have audio and video with full-text search; multimedia has inspired the creation of new history resources on CD-ROM for which no prior book exists; and the Internet provides online access to source documents, newsletters, and discussion groups.

History Textbooks on CD-ROM

D.C. Heath and the Voyager Company have developed multimedia CD-ROM versions of established history textbooks. D.C. Heath has published the American history text *The Enduring Vision, Interactive Edition.* In addition to the text and photographs of the

printed version, the CD-ROM includes 3000 pages of historic documents, U.S. Census data from 1790 to 1990, and audio and video recordings that include footage of President Franklin D. Roosevelt's war message to Congress.

Who Built America? is a CD-ROM by Voyager. Developed by history professor Roy Rosenzweig at George Mason University, it covers the period from the centennial celebration of 1876 to the Great War of 1914. In addition to the text of the printed version, the CD contains historic documents, audio recordings, videos including *The Great Train Robbery,* and more than a thousand pictures.

Dorling Kindersley has created a multimedia CD version of its *Eyewitness Encyclopedia of World History.* The CD covers 10 historical eras from the earliest records of human habitation to Nelson Mandela's election as president of South Africa. Equal treatment is given to Europe, Asia, Africa, the Americas, and Oceania. Online references include Everyday Life, Culture, Inventions, and a Who's Who that provides biographies of historically important personalities.

Multimedia History Titles

Several history titles have been developed on CD-ROM without first appearing as a book. The National Geographic Society has published on CD-ROM *The Presidents: A Picture History of Our Nation,* which describes the personal and political lives of U.S. leaders. This encyclopedic reference tool for home, library, and classroom features historic moments on video, famous speeches, a historical perspective and commentary on each president, more than a thousand captioned photographs, election maps and essays, a political party index, a multimedia timeline that provides a social and historical context for each president, and photo essays on the presidency. The CD also has a narrated tutorial, a pop-up glossary, a game, and the ability to print captions, essays, and speeches.

Figure 4-22 shows The Ultimate Titanic Collection, which includes three CD-ROMs from CyberFlix that use multimedia to bring history to life. In *Titanic: An Interactive Journey,* you relive the story of the world's most famous luxury ocean liner and its catastrophic loss. In a game-like format, you discover thousands of amazing facts about the vessel, travel on its maiden voyage, witness the world-shattering events that led to the loss of more than 1,500 lives, and find out what happened in the aftermath. In the adventure game, *Titanic: Adventure Out of Time,* you play the role of a British secret agent who can change the course of history, depending on how you gather clues and solve puzzles as you navigate a 3-D reconstruction of the Titanic. A bonus CD contains seven more guided tours of the Titanic.

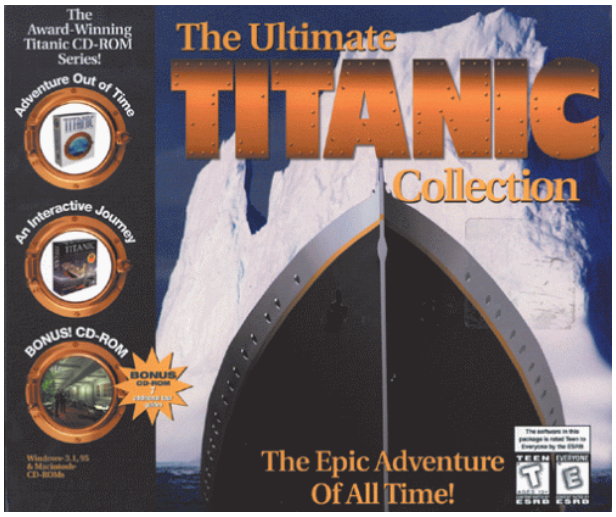

Figure 4-22 The Ultimate Titanic Collection contains three CD-ROMs from CyberFlix.

Wars

Quanta Press and Compton's NewMedia publish a series of war CD-ROMs. Titles include the *Civil War, World War II, Korea,* and *Vietnam.* In April 1991, Time Warner Interactive released *Desert Storm: The War in the Persian Gulf,* advertising it as "the first electronic magazine with

over 6000 screens of selectable documentation covering the Gulf War." Users follow the evolution of a Gulf War story from its origins to the actual article as it eventually appeared in *Time* magazine. The CD includes *Time* correspondents' files, exclusive audio reports, 300 full-color photographs, and every story report in its original, unedited form, organized chronologically and indexed by subject. There is a glossary of high-tech weapons and a photo gallery, as well as exclusive audio reports, including "as-it's happening" correspondent analyses and interviews. An active timeline of the war lets the user see and hear a synopsis of each week's key events.

Compton's NewMedia offers a competing product, *Desert Storm with Coalition Command*, which comes with a game that lets you deploy ground forces from a sophisticated command post, set policies for providing information to the media, and get vital feedback through direct hotlines to the White House and Pentagon.

FlagTower's *World War II* is a multimedia CD-ROM that presents the Second World War from the British perspective. The CD provides a broad perspective on the war from Germany in the 1920s through postwar reorganization efforts, with explorations of the war's six theaters, in-depth examinations of the impact of the Treaty of Versailles, and a powerful collection of first-person accounts of the Holocaust.

The Assassination of J.F.K.

A CD-ROM that fosters debate is the award-winning *The JFK Assassination: A Visual Investigation.* Published by Medio, it includes more than 20 minutes of narrated overview, video clips from five films documenting the assassination, and computer animations showing conflicting bullet angles. Also included is the complete text of the *Warren Commission Report*, Jim Marrs's best-selling book *Crossfire*, and *The J.F.K. Assassination: A Complete Book of Facts.* Figures 4-23 through 4-26 show how you review the evidence and decide whether there was a conspiracy and who was involved in it.

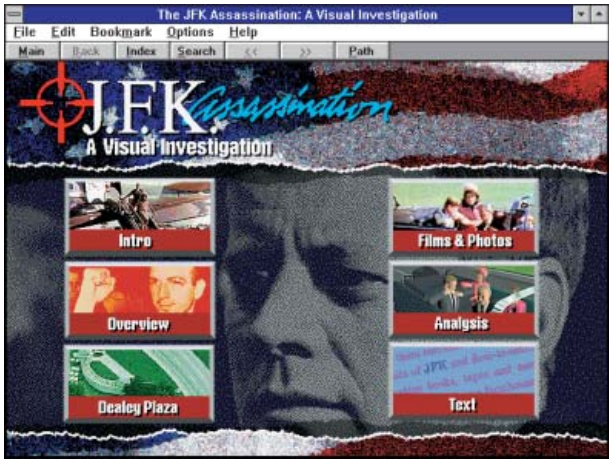

Figure 4-23 The main menu in *The JFK Assassination* introduces you to the background leading up to the assassination, lets you visit the scene in Dealey Plaza, and presents Text, Analysis, and Films & Photos buttons to help you determine whether there was a conspiracy.

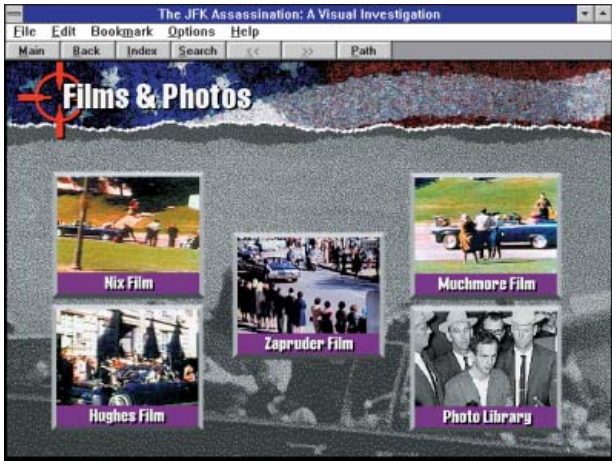

Figure 4-24 The Films & Photos screen from *The JFK Assassination* lets you view the Nix, Hughes, Zapruder, and Muchmore films.

Figure 4-25 Autopsy photo from *The JFK Assassination* refuting the *Warren Commission Report.*

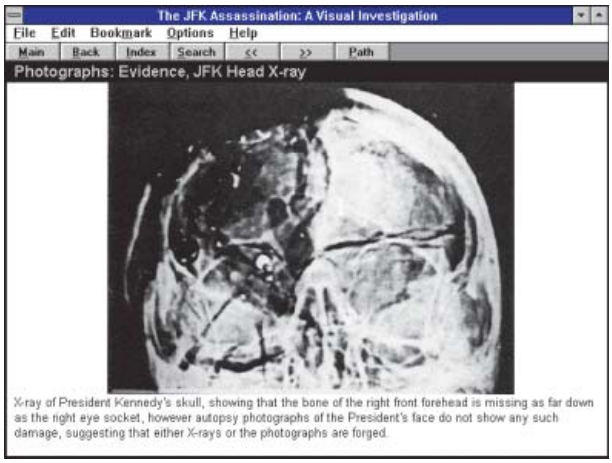

***Figure* 4-26** Evidence of forgery on *The JFK Assassination* CD-ROM.

Internet Resources for Historians

DeLoughry (1994) tells how the H-Net (history network) project at the University of Illinois at Chicago has set up 20 Internet mailing lists that have attracted more than 4500 subscribers in 47 countries. HNSOURCE at the University of Kansas provides historians easy access to historical texts and data located all over the network. The Historical Text Archives at Mississippi State University provide Internet users with such historical documents as the *Instruments of Surrender* signed by Japanese leaders at the end of World War II and *Up From Slavery*, the autobiography of Booker T. Washington. Cromohs, the *Cyber Review of Modern Historiography*, is an electronic journal that provides Web access to research on the principles and methodologies of historical research. The History Channel's speech archives provide full text and use RealAudio to let you listen to famous speeches ranging from the Reverend Martin Luther King's "I have a dream" speech to astronaut Neil Armstrong's commentary as he walked on the moon.

To learn more about these online history resources, follow the *Multilit* Web site links to H-Net, Cromohs, the University of Kansas History Group, the *Historical Text Archives*, and the History Channel.

Mathematics

Mathematics is one of the most highly developed multimedia application areas. Due to the computational nature of mathematics, computers can model the content, monitor student progress, and help students master educational objectives. The National Council of Teachers of Mathematics (NCTM) has issued a set of guidelines that rely heavily on computers as an agent for change in the way mathematics is taught. The NCTM guidelines encourage the teaching of math in real-world contexts in which students investigate problems that have meaning.

For example, Scott Foresman teamed with ABC to produce *Wide World of Mathematics*, in which video footage from ABC News and ABC Sports broadcasts is used to demonstrate how mathematics is used every day, in virtually every field of endeavor. Well-known runner Marty Liqouri takes students step-by-step over the New York City marathon course, using mathematics to compute the length of the course, the runners' rate of travel at different checkpoints, and the combined weight of the runners

as they cross the Verazzano-Narrows Bridge. The Hubble space telescope provides a real-world setting for a treatment of very large and very small numbers. The construction of the Chunnel that connects France and England beneath the English Channel introduces dimensions and units. Hurricane Andrew situates prediction techniques with footage from forecasters at the National Hurricane Center. An NFL football game uses a playing field as a number line on which students learn addition and subtraction. To get a copy of a preview of the *Wide World of Mathematics*, call (800) 554-4411 and ask for the videotape demo (code number 37520-X) or the CD-ROM demo (code number 37521-8).

Multimedia is also being used to give a fresh look to classic math software such *Math Blaster* from Davidson. *Math Blaster: Episode 1—In Search of Spot* uses dazzling graphics, digitized speech, sound effects, and music to present more than 50,000 problems in addition, subtraction, multiplication, division, fractions, decimals, percents, number patterns, and estimation. *Math Blaster: Episode 2—Secret of the Lost City* builds on the skills learned in episode 1 by presenting problems that contain two and three operands, up to three-digit numbers, whole and negative numbers, decimals, fractions, and percentages. *Math Blaster Mystery—The Great Brain Robbery* builds prealgebra and word-problem skills as students explore a mysterious mansion. *Math Blaster Algebra* teaches algebra for grades 7 through adult.

Academic Systems markets a series of mathematics CD-ROMs that link students to the instructor's PC, so the teacher can monitor each student's progress and step in for individual assistance when needed. California State University (CSU) at Northridge reports a higher percentage (70%) of students are passing math than before (only 50% pass without the programs). "Before this I've always felt I never met a technology that didn't ultimately just cost me more money," says CSU Northridge's vice president for academic affairs (*Wall Street Journal* 4/3/96: B6). Follow the *Multilit* Web site link to Academic Systems for case studies on the use of *Interactive Mathematics.*

For more information on the NCTM standards, follow the *Multilit* Web site link to the Eisenhower National Clearinghouse. IBM publishes a booklet that keys math software to the standards. The title is *A Directory of Educational Objectives and IBM Elementary Mathematics Courseware.* To peruse this and other IBM K-12 support services, follow the *Multilit* Web site link to IBM K-12 Education. While you are visiting the *Multilit* Web site, be sure to check out TERC's expanding list of hands-on math and science learning materials.

Music

The music industry has been so totally transformed by multimedia technology that accreditation guidelines require that every music student learn about computer music applications, including music recording, editing, arranging, and printing. Midisoft's *Studio* is an example of the kind of software musicians are expected to know how to use. *Studio* is very easy to use because of its graphical tape-recorder controls. Anyone who knows how to work a tape recorder can use this program to record and play MIDI sequences. It even notates automatically anything you play on a MIDI keyboard. *Studio* is great for teaching class piano; music teachers can record each one of their students on a different track, complete with orchestral accompaniment, which is highly motivating for students when they rehearse. The latest version of *Studio* lets you record and edit waveform audio, including vocals played in sync with the MIDI tracks. For more information and to download free demos of *Studio* and other music products, follow the *Multilit* Web site link to Midisoft.

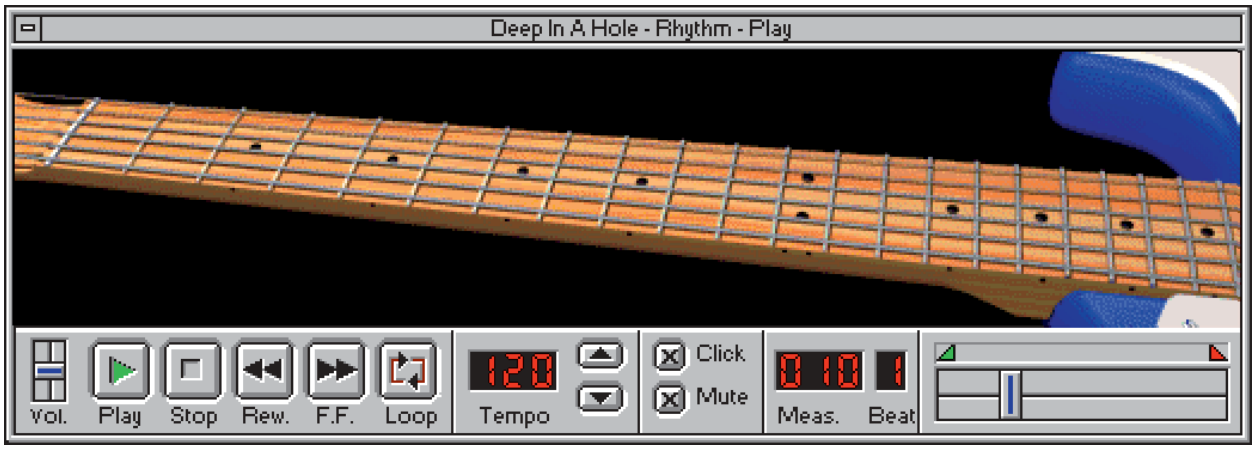

Figure 4-27 The guitar model in *Play Blues Guitar.*

In *Play Blues Guitar*, published by Play Music, Inc., the student enters a virtual music studio in which blues guitarist Keith Wyatt teaches how to play several blues styles. There are music videos of each piece performed on stage. Hypertext study guides provide historical backgrounds and stylistic explanations. Then Wyatt brings you into his studio and gives lessons on how to play the style. Figure 4-27 shows the guitar model on which the notes to play appear as dots on the fretboard, providing the student with a powerful tool for learning the comps and riffs. The student can speed up or slow the tempo and watch as indicators light up on the fretboard, showing what notes to play in time with the music. Play Music also publishes a basic guitar course called *Play Guitar* and intermediate guitar lessons called *Play Rock Guitar*. For more information about these breakthrough products, follow the *Multilit* Web site link to Play Music.

Discovering Music by Voyetra Turtle Beach is a highly produced suite of music software for learning music history, recording music, printing scores, and improvising with an automatic accompaniment program. Figure 4-28 shows the main menu. You can

Figure 4-28 *Discovering Music* CD-ROM.

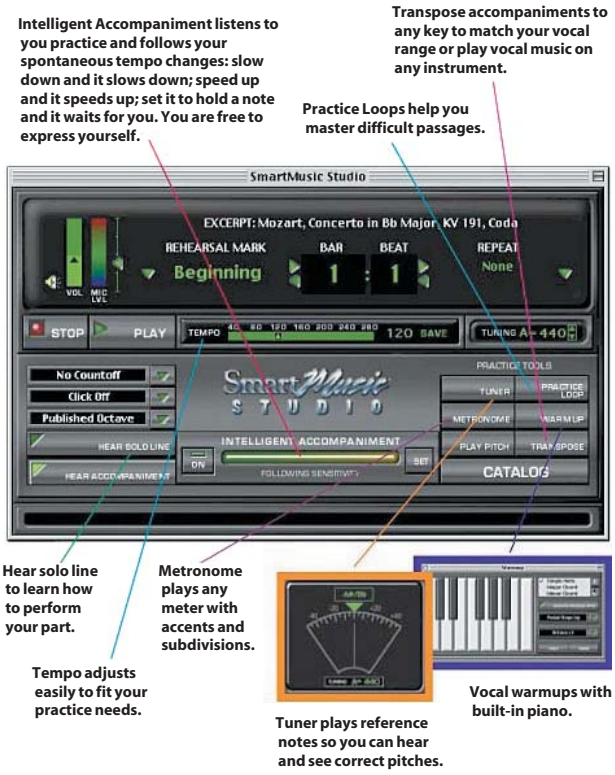

Figure 4-29 SmartMusic®Studio screen display and feature highlights.

SmartMusic®Studio is a registered trademark of Coda Music Technology.

download Jammin' Keys, Music Writer, and Recording Station at very reasonable prices, or pay a little more for CD-ROM versions. For details and downloads, follow the *Multilit* Web site links to Voyetra Turtle Beach.

Coda Music Technology achieved a breakthrough with its *SmartMusic®Studio* intelligent accompaniment software. *SmartMusic®Studio* listens to and follows a soloist's tempo changes, providing a way for students to practice playing with an ensemble when human performers are not available. Music schools around the world are using *SmartMusic®Studio* to provide a more realistic practice experience for soloists. An extensive library of more than 5000 instrumental and vocal music accompaniments is available. Figure 4-29 illustrates the *SmartMusic®Studio* features. For more information and to get a free demo, follow the *Multilit* Web site link to Coda Music Technology.

Music Resources on the World Wide Web

The music library at Indiana University has assumed the task of indexing all the music resources on the Web. By pointing your Web browser at this excellent index, you can navigate through a wealth of musical treasures. For example, BMG's Classics World lets you browse the latest releases of classical music on CD-ROM. At the Classical Music MIDI Archives, you can download and play MIDI files for thousands of classical music compositions. Indiana's artist-specific index lists hundreds of performing musicians who have established Web sites. To learn more about these exciting online music resources, follow the *Multilit* Web site links to Classic World, the Classic MIDI Archives, and Indiana University's music library.

Physics

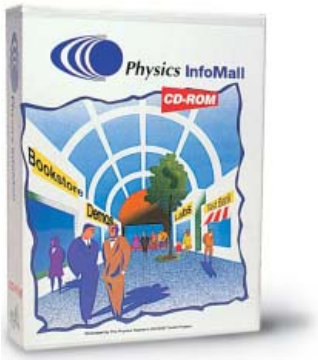

Figure 4-30 The *Physics InfoMall* CD-ROM.

Courtesy of www.learningteam.org.

Physics teachers are using multimedia to help achieve the goals of the National Science Education Standards, which call for providing students with opportunities to get involved in the active process of learning science. Escalada, Grabhorn, and Zollman (1996) used multimedia computers to develop visualization techniques that allow students to collect, analyze, and model motion data. Students use a video capture board to record experiments. Video Analyzer software makes it possible to collect two-dimensional spatial and temporal data, and a Visual Space-Time program combines parts of successive video images into a space-time diagram. These techniques enable students to make connections between concrete, everyday experiences and the abstract principles of physics.

Pictured in Figure 4-30, *Physics InfoMall* is a CD-ROM that contains the text and graphics from 19 physics textbooks and 3900 articles from *Physics Today*, *The Physics Teacher*, and *The American Journal of Physics*. The brainchild of University of Nebraska physicist Robert Fuller, *Physics InfoMall* provides a rich resource for physics teachers and students to research and explore. As Fuller explains, most students and physicists use books only to find examples of problems they are working on. The *Physics InfoMall* fulfills Fuller's dream of providing students with a compact, searchable CD-ROM resource from which physics examples can be cut and pasted and manipulated at will. Distributed by The Learning Team, *Physics InfoMall* includes a Problems Place containing

Figure 4-31 *The Video Encyclopedia of Physics Demonstrations.*

3000 problems and solutions, and a Demo and Lab Shop containing more than 1000 demos and laboratory exercises. For more information, follow the *Multilit* Web site link to the *Physics InfoMall.*

The Video Encyclopedia of Physics Demonstrations shown in Figure 4-31 is published by The Education Group. It consists of 25 videodiscs that present 600 demonstrations of basic physical principles. Most segments have narration (written scripts are included), and many segments feature slow-motion photography or computer animations. Topics include mechanics, waves, sound, fluid dynamics, heat, thermodynamics, electricity, magnetism, optics, and modern physics. An extensive 1500-page companion explains how to use the videos. In his very positive review of this package, Beichner (1993) describes how the series can be used to assign homework in which students use data from the videos: "For example, a series of balls of varying diameters and masses are dropped from nearly 4 meters. By stepping through the video a frame at a time, position measurements can be made as the balls fall. Time is included on each frame." The series is also available in middle school and primary school versions.

By the time you read this, a DVD version will be available. There is a video clip on the *Multilit* CD that shows examples from *The Video Encyclopedia of Physics Demonstrations.* To view it, use the Windows Explorer or the Macintosh Finder to locate the movie called *physics* in the *movies* folder, then double-click the movie to play it.

Science

Science teachers are using the Internet to provide students with collaborative learning experiences, access to scientific databases, and virtual visits to science laboratories. Reporting on the New Jersey Networking Infrastructure in Education project, Friedman, Baron, and Addison (1996) cite several compelling examples of science study via the Internet. Students gather samples from local pond water, measure chemical characteristics, examine organisms, and share observations with peers over the Internet. An ocean weather database that tracks ships at sea enables students to calculate the speed and direction of oceangoing vessels and predict arrival times.

Students visit the Plasma Physics Laboratory at Princeton University to access data from fusion experiments as quickly as Princeton scientists. Follow the *Multilit* Web site links to visit these projects online.

Multimedia CDs complement these online materials. *Science 2000+* is a comprehensive science curriculum for grades 5 to 8 published by Decision Development Corporation. Consistent with the most advanced science frameworks and employing the latest in educational technology, *Science 2000+* takes an activity-based, thematic approach to teaching science. Within its flexible and open-ended structure, students actively investigate and explore science. They gain a better understanding of a world increasingly shaped by science and technology, plus an insight into the importance of science in solving some of today's critical environmental and health issues. Organized into nine-week units, the curriculum in *Science 2000+* is connected by central themes and is oriented toward solving problems. Multiple disciplines, such as life, health, social, earth, physical and environmental sciences, math, anthropology, and language arts, are brought into play as students research real-life situations. To see how the activities in *Science 2000+* relate to the national science standards, follow the *Multilit* Web site link to Decision Development Corporation, click *Science 2000+*, and then click Curriculum.

Videodiscovery publishes a series of innovative videodiscs and multimedia CDs for teaching science. The *Science Forums* challenge students in sixth through ninth grades to grapple with real-world problems. Using a town meeting format, the forums present role-playing scenarios that focus on science, technology, and societal problems. For example, Figure 4-32 is from a forum on fossil fuel and the greenhouse effect. Students consider whether fossil fuel users should be taxed according to the amount of carbon dioxide that the fuels release into the atmosphere, with the tax revenue used to pay for the greenhouse effects of global warming.

Also from Videodiscovery is a series of *Science Sleuths* videodiscs and CDs, in which students solve wacky dilemmas using the research methods and tools of actual scientists. There are 24 open-ended mysteries, ranging from exploding grain silos to crashing computers. Through careful observation and research, students must develop a rational explanation and report their findings. For example, Figure 4-33 is from *The Case of*

Figure 4-32 Carbon dioxide turns the earth into a giant greenhouse by absorbing heat and trapping it inside the atmosphere. From *Science Forums,* volume I, "Fossil Fuel and the Greenhouse Effect."

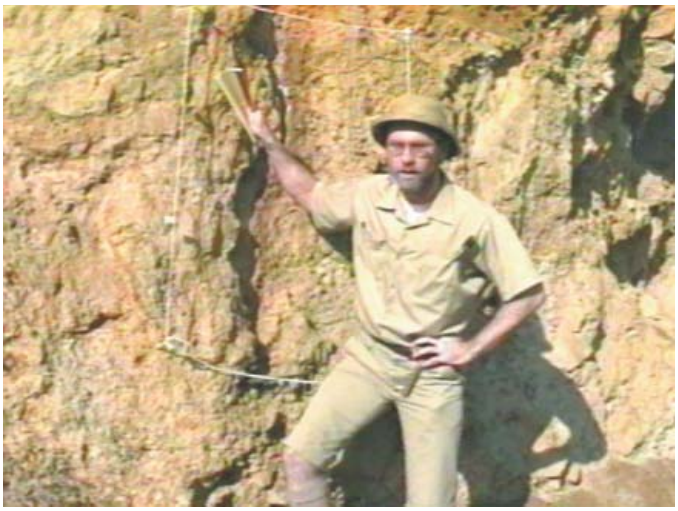

Figure 4-33 A palentologist shows the fault line in which a dinosaur bone was found. From *The Case of the Misplaced Fossil* in *Science Sleuths.*

the Misplaced Fossil. An amateur paleontologist found a dinosaur bone from the Cretaceous Age (65 to 140 million years ago) in a Tertiary Stratum dating back to only 10 million years ago, and the student must explain the mystery of how it got there. Beautifully produced student manuals and instructor guides accompany the Videodiscovery discs and CDs. For a complete list of products, follow the *Multilit* Web site link to Videodiscovery.

Falcon Software's *Environmental Science: Field Laboratory CD-ROM* contains seven modules: stream pollution, minerals for society, energy from coal, radiation, legal control of the environment, streams and floods, and geology of homesite selection. Students learn how to define a problem, sample data, model phenomena, and draw conclusions. For more information, follow the *Multilit* Web site link to Falcon Software.

Elementary Education

Children's Software Revue (CSR) is a magazine and a Web site devoted to empowering children to foster their growth and development through quality software. As depicted in Figure 4-34, *CSR* reviews the software and informs teachers and parents about its relative merits. The Children's Software Finder lets you search for more than 4200 products by platform, subject, grade level, rating, or title.

Figure 4-34 The Children's Software Revue (CSR) Web site.

One such title is the CD-ROM version of the best-selling *Macmillan Dictionary for Children* pictured in Figure 4-35. With 12,000 word entries, 1000 illustrations, and 400 sound effects, it has a spelling bee and hangman games, and a tour guide named Zak who helps kids learn how to pronounce words. Zak, who is a real ham, is likely to give you his personal reaction as you look up a word. Figure 4-36 shows a sample screen in which the student has looked up the word *apple.* The four icons along the right of the screen let the student look up other words, compile a word list, play games, and get help. The *Dictionary* also has word etymologies and language notes.

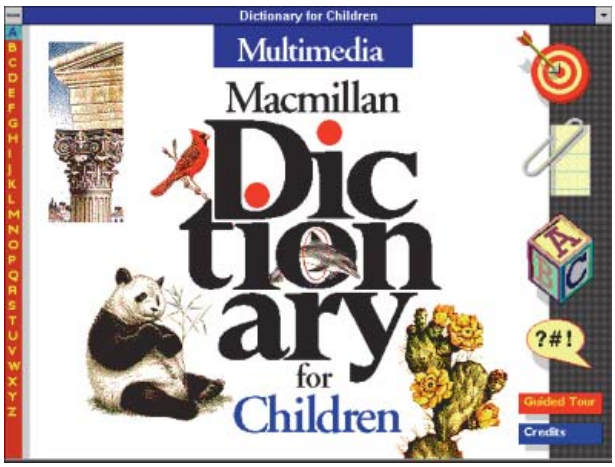

Figure 4-35 The title screen from the best-selling *Macmillan Dictionary for Children.*

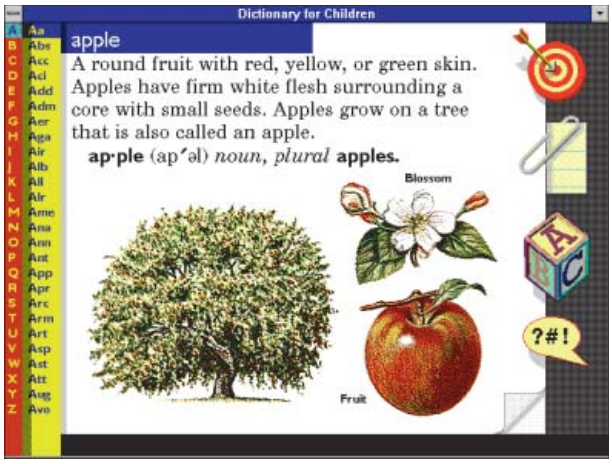

Figure 4-36 The result of looking up the word *apple* in the *Macmillan Dictionary for Children.*

The National Geographic Kids Online network (Kids Net) combines online computer activity with real-life interactions and experimentation. Electronic mail engages children in cooperative learning across the Internet. For example, consider the Acid Rain Project for which students designed acid rain collectors and inspected tombstones for acid rain damage. After compiling and analyzing the data, students shared results through e-mail. The result provided a comparison of acid rain damage throughout the United States and Canada. To find out about other Kids Net activities, follow the *Multilit* Web site link to Kids Net. While there, see the Kids Archive, which is full of stories about Kids Net accomplishments.

Another online collaborative network is organized by the KIDLINK Society. Since 1990, KIDLINK has united 175,000 children from 132 countries. Their primary means of communication is e-mail, although the children also use Internet chat rooms and videoconferencing. Kids can connect at any time to join conversations on a wide range of subjects. To join in, click KIDLINK at the *Multilit* Web site.

Reading and Writing

Multimedia computers enhance the teaching and learning of reading and writing by providing an environment that motivates students to read and makes it easy for students to begin writing at an early age. The software discussed here demonstrates how the computer addresses a variety of learning styles, puts students in control, encourages exploration and peer tutoring, and fosters the development of modern communication skills.

CD-ROMs that present stories for children in a hypermedia format are becoming very popular. The CDs display full-color illustrations and let the child click items on the screen to have words spoken, defined, or used in sentences, to trigger sound effects and animations, and to link to related materials. The only technical drawback is that although the CDs are highly interactive, the child cannot slow down the pace of the audio. In a controlled study of the impact of CD-ROM storybooks on children's reading comprehension, Matthew (1998) found that children who use CD-ROMs read equally as well but become significantly better storytellers than students who learn to read only from books.

Just Grandma and Me was the first title to appear in the *Living Books* series by Brøderbund. Based on the best-selling book by Mercer Mayer, the CD contains 12 pages of lively animations, music, sound effects, narration, and talking characters who teach early reading and storytelling skills. Its purpose is to enable children ages three to eight to explore the printed words, as well as the pictures, and to learn words, phrases, and complete sentences. Full Spanish and Japanese translations are included.

Arthur's Teacher Trouble, the second in Brøderbund's *Living Books* series, is based on the best-selling book by Marc Brown. This interactive, animated storybook features lively animations, original music, realistic sounds, and hundreds of words written, spoken, and even spelled out loud. By putting the child in control of exploring the printed words and the pictures, the CD engages kids in this "whole language" approach to learning. A full Spanish translation is included. Figure 4-37 illustrates the first page of the book. Active items include objects on the bulletin board, the window shades, the door, each student, and different parts of the professor's body.

One criticism of the *Living Books* has been that the animations take students on tangents that do not contribute to the story. More recent *Living Books* titles such as *The Tortoise and the Hare* and *New Kid on the Block* are linking the animations closer to the story, so the animations lead to better comprehension. *Dr. Seuss's ABC* was so popular that *Living Books* followed it with another Dr. Seuss classic, *Green Eggs and Ham*. The *Living Books* have won dozens of awards, including Best Overall Educational Program from the Software Publishers Association, Parent's Choice from the Parent's Choice Foundation,

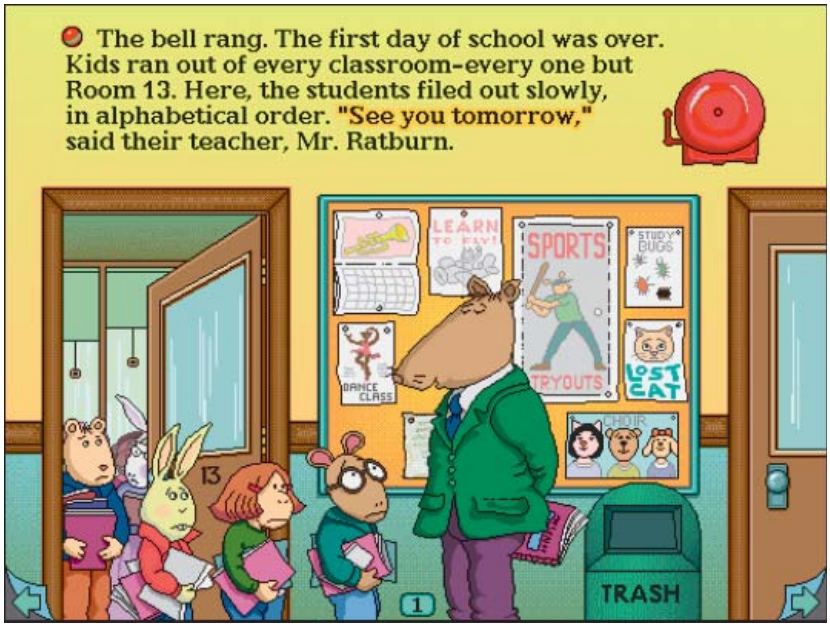

Figure 4-37 The first page of *Arthur's Teacher Trouble.*

Figure 4-38 Reader Rabbit's *Complete Learn to Read System.*

and Best Early Childhood Software from the High/Scope Educational Research Foundation. For more information about the *Living Books,* follow the *Multilit* Web site link to The Learning Company.

Also from The Learning Company is a highly rated series of Reader Rabbit products. The series targets learners ranging in age from baby through toddler, preschool, kindergarten, and grade school. Figure 4-38 shows how Reader Rabbit's *Complete Learn to Read System* integrates multimedia CDs with flashcards, workbooks, and storybooks. First the students learn letters and sounds, then they read words and sentences. *Children's Software Revue (CSR)* has reviewed dozens of Reader Rabbit products. To read these reviews, follow the *Multilit* Web site link to *CSR* and use the Children's Software Finder to locate titles that begin with the words Reader Rabbit.

An Internet resource for young writers is the Alphabet Superhighway, which was created under the Department of Education's READ*WRITE*NOW! initiative. On the Alphabet Superhighway, students learn to create, locate, and communicate information through mentoring, guided discovery, competitions, and other online activities. The goal is to raise reading and writing achievement levels in the United States. Information is organized around Knowledge Neighborhoods, where general topics such as space, earth, peoples and cultures, and technology can be browsed. At the heart of the Alphabet Superhighway are places for students to display their work (such as the Cyberzine and Exhibit Center), and facilities for finding information (the Library and the Smart Searcher) and for learning and reinforcing skills and topics (the Traveling Tutor and the Challenge Chaser). The Traveling Tutor teaches a variety of topics including how to write better reports and how to draw graphs and diagrams. The Challenge Chaser presents challenges for students to write essays, search for information, spell words, and solve word puzzles. Smart Searcher helps find information, either within the Alphabet Superhighway or out on the Web. Assisting teachers and parents are a Teachers' Lounge and a Parents' Place. To visit, follow the *Multilit* Web site link to the Alphabet Superhighway.

exercises

1. What percentage of your teachers used multimedia in the classroom when you were in elementary school? What percentage of teachers do you believe will be using multimedia computers as a classroom teaching aid by the year 2010?

2. How do you believe multimedia technology will affect the future of schooling? If the Information Superhighway could serve all the nation's educational software to children at home, for example, would there be no further need for schools as we know them? Are there any aspects of schooling that technology cannot replace?

3. The *Macmillan Dictionary for Children* was shown in Figures 4-35 and 4-36. Follow the *Multilit* Web site link to the *Children's Software Review (CSR),* and find out whether *CSR* recommends the CD-ROM version of this dictionary. What rating does *CSR* give the *Macmillan Dictionary for Children?* Does *CSR* recommend any other multimedia dictionaries?

4. If you would like to learn more about cognitive psychology and the constructivist movement in education, see Bruning's textbook *Cognitive Psychology and Instruction* (Englewood Cliffs, N.J.: Merrill/Prentice-Hall, 1998, ISBN 0-13-716606-0). The introduction provides an excellent overview, history, and comparison of the behavioral and constructivist movements in education. Another excellent text is Mark and Cindy Grabe's *Integrating Technology for Meaningful Learning* (Boston: Houghton Mifflin, 1998, ISBN 0-395-87136-4). Chapter 2 is devoted to cognitive learning and technology tools.