Integrating Technology Into the Early Childhood Classroom: The Case of Literacy Learning

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Integration of computers across the classroom curriculum has been an object of debate for over 15 years. This paper compares the integration of computers with what has been learned about literacy education. The integration of literacy learning into the classroom is given as a model for computer integration. Examples are given of what constitutes quality computer integration and what does not. A basic set of "curriculum integration software" is described and recommended. A brief discussion of how computers can function as scaffolds and manipulatives is presented. A detailed example is given of how to design an integrated unit that incorporates technology. What children need to know to be independent computer users is also discussed. The authors emphasize that computers and other information technology should be thought of as just another learning tool. It is the software and the context within which it is used that makes the difference.

Over 18 years ago, Papert (1980) used the term “bricolage” to describe how children solve personal puzzles. Much like a tinker (“bricoleur”) fixes
a broken pot using whatever supplies and knowledge are on hand at that moment, so do children approach problem solving, drawing on whatever tools are available, including whatever knowledge and experience they have had up to that time. The important and spontaneous learning in the anecdote below from the University of Delaware Laboratory Preschool, serves as an example of *bricolage*:

We introduced a new computer program into the four-year-old classroom—"Just Grandma and Me" (Broderbund). This program reads and animates the Mercer Mayer book highlighting the text as it is read. Children can then select parts of the illustrations to animate or click on words to hear them pronounced. The children were intrigued by the new program. Sachi was exploring the program one day and discovered that the reading of the text, as well as the text on the screen, could be changed to Japanese. Sachi was thrilled. "That is my Dad’s Japanese, and see, there is writing like in his newspaper." Santiago was equally excited to discover that the text could also be read in Spanish. The two boys began to explain to the other children what was being said. They would translate the story back to English. Knowing a different language gained the two boys a new status in the classroom as friends began to ask the bilingual children for words in their native language to label objects in the room. (Jane Davidson, Newark, DE)

The children utilized the materials at hand—the computer and its software—and achieved on their own the teacher’s objective of appropriate and comfortable sharing of native languages.

In an educational sense, *bricolage* means providing children or adults in learning situations with the materials they need to learn and grow and providing an opportunity for them to use the knowledge they already posess. Imagine trying to learn to drive without a car, play the piano without a keyboard, or build a house without a hammer and nails. For proper learning to take place children and adults must have access to the tools necessary to do the job at hand. Of course, simply making these tools available does not guarantee that students will use them effectively. In order to become empowered in the art of *bricolage*, children must understand the application of the available materials; they must recognize the resources on hand as practical, useful tools that have real-life application. This perspective can only be accomplished by providing the children with the experience of using these tools to solve real problems. In the case of technology, this means that the computer must be integrated into the curriculum in such
a way that children come to view it as a practical, problem-solving tool that is used every day to accomplish real goals.

An integrated curriculum reflects the sentiment expressed by John Dewey (1943) that school is not a place to get ready for life; it is life. Instead of being a place where children learn lessons that have only a remote reference to some living meant to be done in the future, an integrated curriculum affords schools the chance to become a learning habitat, where children learn through directed living and exploration (p. 18). The integrated classroom, then, becomes a dynamic learning environment where children are active users of technology (and all other materials) and participants in computer activities that serve a personally meaningful purpose, instead of a waiting room where children are asked to get ready to do what they already capable of doing. (Goodman, 1990).

The call for an integrated approach is not a new battle cry in education. The term “integrated learning” has been a catch phrase for over a decade, yet the potential of this approach has only begun to be explored. The term “integration” connotes a variety of interpretations; for purposes of this discussion, let us look at the application of integration to literacy learning, and what it can teach us about the integration of technology.

WHAT LITERACY EDUCATION CAN TEACH US ABOUT INTEGRATING COMPUTERS

Though there can be no rational argument against the importance of learning to read and write, there has been considerable debate in the past 50 years concerning the best approach to teaching literacy. Finally, the great literacy debates are calming, as more is learned about literacy acquisition, and as the pedagogical pendulum invariably moves toward the middle.

What Research Says About Literacy Instruction

In a joint position statement, the International Reading Association (IRA) and the National Association for the Education of Young Children (NAEYC, 1998) summarized what the educational community has learned from research and practice concerning the most effective ways to help children become literate.

Some of the most salient points included the following:
Immersion in a print-rich environment from birth helps children form their concepts about print (Durkin, 1966; Holdaway, 1979; Teale, 1982).

Everyday, playful experiences with print expose children to the processes of reading and writing for real purposes (Vukelich, 1994; Neuman & Roskos 1997 in NAECY).

Many children acquire phonemic awareness (i.e., basic skills necessary for fluency) as a consequence of learning to read, rather than as a result of specific instruction and practice (Wagner & Torgesen, 1987).

Classrooms that give children regular opportunities to express themselves on paper with emphasis on communicating ideas rather than on spelling or letter formation, help children understand that writing has a real purpose (Graves, 1983).

**What This Means for Instruction**

Based on this and other evidence, most researchers and educators have come to the logical conclusion that in order to become literate, children must understand the power and functionality of language. They can achieve this by using reading and writing for real purposes, while at the same time being supported and instructed in the basic strategies and concepts of print.

For teachers of young children, this means that literacy activities become integrated throughout the entire curriculum. The classroom itself must be a print-rich environment, filled with books, posters, banners, charts, lists, signs, and labels. Teachers should read aloud to students from storybooks and other sources, and make books freely available to children for independent reading. Students should have tools to produce writing throughout the day for a variety of real purposes, including notes, invitations, journals, reports, and stories. Teachers must model the utility of reading and writing in every subject, such as math, social studies, and science. The dramatic play area should feature signs, labels, and other familiar print, while providing tools for children to create their own writing in this play environment.

In such a classroom where literacy is truly integrated in all that they do, children experience the joy and power associated with reading and writing while mastering basics strategies and concepts about print (NAEYC 1998). Most critically, the children themselves are revalued as active members of a literate community, respected for the individual abilities and knowledge they bring to the classroom, and empowered as language users as well as peer teachers (Goodman, 1992).
What This Means for Integrating Technology

Where language is being used for a real purpose, then true fluency is being developed (Edelsky, 1992). Similarly, technological fluency, like literacy, can be fostered only by having the technology integrated into the classroom environment in such a way that it is used appropriately as a natural tool for meaningful learning (Shade & Watson, 1990).

Following the tenets of an integrated literacy approach, then, means that integrating computers appropriately requires:

1. Using computers in meaningful, holistic activities as an appropriate tool for accomplishing a relevant purpose;
2. Providing specific instruction in necessary skills immediately relevant to a meaningful purpose;
3. Integrating computers into an environment that values children as active participants in their learning, and as sources of knowledge and skills they bring from personal experiences;
4. Encouraging social, interactive use of computers, with children contributing their personal knowledge and expertise to the education of all members of the learning community.

INTEGRATING COMPUTERS ACROSS THE EARLY CHILDHOOD CURRICULUM

Although computers have been available in the elementary school nearly two decades, they have yet to meet the full potential they offer to education, due largely to the ways in which this technology has been implemented in the schools. As discussed above, an integrated literacy approach offers a model for an environment naturally conducive to the most appropriate approach to computer implementation (Davis, 1995). Though integrated learning is gaining credence and popularity in education, many schools have been side-tracked along the way. Unfortunately, the term “integration” has been inaccurately applied to various forms of instruction that are not appropriate methods of using computer technology with young children. These types of misintegration, because they are not exploring the real potential of the computers for learning, tend to paint a distorted picture of computers as an add-on, an extra, or just one more thing a teacher must include in the schedule, resulting in teachers and children who are “turned off” to technology. In order to avoid falling into this trap, and to take another step toward true, meaningful computer integration, let us take a look at what computer integration is not.
WHAT INTEGRATION IS NOT

Computer Labs

In the nearly two decades since the microcomputer became available for classroom use, this technology has gained some acceptance as a unique and powerful learning tool. Unfortunately, many teachers and administrators reacted to the computer’s power with what Papert (1993) calls an “immune response.” Like a human body reacting to an intruding organism, these educators saw the computer as a new and foreign element in the school, something that did not really “fit” with traditional education. With all good intentions, educators felt the best way to manage the enormous power of computers (as well as their relatively large price tags) was to gather all the machines together in a single room. Here, in a computer lab, all students would have controlled, periodic access to the machines, during which time they would be taught the skills necessary to operate the computers under the guidance of a special subjects teacher.

Unfortunately, this “foreign intruder” view of computers has stunted this technology’s potential for education by making the computer an object of study, rather than a tool for learning. The fatal flaw in this computers-as-subject/lab approach to teaching computers is the fact that any bits of information learned about the computer today will be obsolete tomorrow. Instead, what children need to learn is the only truly important computer skill—the habit of using technology as a tool for accomplishing whatever task is at hand (Papert, 1993). Just as we cannot say that children are literate if they merely have skill at decoding groups of letters, we cannot view children as computer literate if they simply posses a series of unrelated computer skills. Computer literacy is not knowing only how to operate the machine, but how to approach a learning situation in a manner that results from fluency in using the computer as a tool (Papert, 1993). This type of fluency is not derived from the lab approach to computer education, but only when computers are made an integral part of classroom instruction, when they are applied to learning situations for which they are appropriate, and when they are embedded in a sound learning environment (Clements, Nastasi, & Swaminathan, 1993).

Though some researchers have defended the lab approach, claiming that computer integration into the classroom is not feasible for various reasons, such as lack of quality software and complexity of the technology (Maddux, 1991), several studies (Fisher, 1990/91; Hadlock & Morris, 1985; Honey & Moeller, 1990) have all concluded that children’s developmental
gains resulting from using appropriate software are significantly greater when the computers are in the classroom than when they are in a computer lab. There are several reasons for this:

- Children receive limited exposure to the computers in labs.
- Labs tend to use drill software while more tool-oriented software is used in the classroom.
- There is less collaboration and peer tutoring in a laboratory setting.

If students are going down the hall to a computer room once or twice a week, in spite of the fact that there are some excellent computer lab teachers doing their very best to be developmentally appropriate in a limited environment, they are not experiencing integrated technology use. As long as computers are thought of as curriculum add-ons, they will be treated as another academic subject, as a topic to be mastered before moving on to more sophisticated uses of computers (i.e., learning word processing before learning how to use a spreadsheet program). As Bredekamp and Rosegrant (date) have stated:

Pulling children out of the group into a computer laboratory demands rigid scheduling and takes away the other rich options from which children may choose. In kindergarten, preschool, or child care settings, if computers are used, they should be one of many classroom activity choices. In these settings, the teacher’s role mirrors the role played in many other learning situations...the teacher creates the environment in which children become aware and explore, and then acts to support their exploration and inquiry in many different ways. The children and the teacher learn something new together as they engage in the process of learning. The teacher does not have to be an expert but instead is a co-constructor of knowledge with children. (p. 60)

To be fair, computer labs have been shown to increase sustained interest, increase collaboration and problem solving, encourage children to solve their own writing problems, and increase reading enthusiasm (Butler & Cox, 1990); however, our contention is that developmental gains occur to a greater extent when computers are in the classroom, and integrated across the curriculum. Computer labs are not across the curriculum; they’re across the hall.
Integrated Learning Systems

“Integrated learning systems” or ILSs have gained popularity over the past decade, evidenced by the appearance of numerous prepackaged “math, reading or science curriculums.” In exchange for the high price tag of a computer-based ILS, you receive multiple floppy disks or several compact discs, one or more notebooks full of teacher lesson plans designed to go with the software, activity plans, perhaps a complete set of books to go with each software program, and workbook pages that can be copied for the children’s use. The money spent on one ILS could supply a classroom with one to three powerful computers and some appropriate software as well.

Are ILSs effective? According to NAEYC curriculum guidelines use of only drill-and-practice software—worksheets on a computer—is inappropriate (NAEYC, 1991). According to Clements (1994), “ILSs automatically load one of an extensive sequence of lessons into each child’s computer based on their previous performance.” (p. 33) In spite of the fact that they have been shown to be moderately successful in improving basic skills (Kelman, 1990; Becker 1992), Clements argues against ILSs because they diminish teacher and child control and represent a bureaucratic triumph over young children’s development.

One final word about Integrated Learning Systems—they are too convenient. Too easy to depend on and too often advertised as the “solution” to a teacher, classroom, school, or district’s needs in a particular curriculum area (or the entire curriculum). Kay (cited in Skolnik & Smith, 1993) warns that it is often too easy in the media world to choose convenience over quality. For example, “We replace high-resolution photographic representations of great art with lower resolution video disk images that distort both light and space” (p. 3). In other words, there is something lost in the translation. When convenience triumphs over quality, Kay continues, we have “junk learning.” Wright (1994) adds some significant conclusions that relate directly to ILSs. She states,

...when exquisitely illustrated picture books are replaced with cartoon-based CD-ROM talking books, when poorly written literature is mass produced to create 30 interactive storybooks for a computer reading series, or when low-quality music programs are designed that offer children opportunities to compose with poor timbre and pitch. Saying that a program addresses a particular intelligence is not the same as saying that the program offers an opportunity to enhance that intelligence. (p. 10)
Complete Thematic Units

Another product that has been marketed as promoting integrated learning are ready-to-use thematic units. From the shelves of teacher supply stores and the pages of educational catalogs, these products promise to furnish teachers with an instant integrated unit. Unfortunately, these well-marketed packages are no more than unrelated activities clustered around a single topic (e.g. dinosaurs, colors, etc.). Though these thematic units come with myriad plans and patterns, and conveniently plug into each subject area in the teacher’s plan book, they give little consideration to the development of larger concepts or goals (Routman, 1991).

True integration does not follow a prepackaged plan for teaching severed chunks of information centered around an exaggerated theme; rather, it is an approach to teaching and learning that respects the interrelationships of the disciplines—language, mathematics, science—as natural and necessary to achieving the goal of becoming educated about a particular topic (Davis, 1995).

In other words, simply setting up the computer and providing drill and practice software that features elements of various subject areas does not constitute an integrated use of technology; rather, true integration of the computer means using this tool in appropriate ways to help children achieve personal goals and get them excited about learning (Papert, 1993). In doing so, traditional subject area lines will be crossed by default, not by design (Dewey, 1943).

WHAT INTEGRATION IS

Computers belong in the classroom where children can use them in any number of ways in individual and small group projects. As Bredekamp and Rosegrant have noted (1992):

A series of unrelated or "Undisciplined" projects in not curriculum; If the conceptual dimensions of curriculum planning is considered on isolation from the others, the curriculum may be too idiosyncratic, lacking in direction or focus, or limited to "fun" activities that lack integrity. (p. 72)

The children may use invented spelling to make signs or labels for items in the room, or, they might use a drawing program to illustrate a book
they are making about dinosaurs. Some teachers use simple word processors to support integrated literacy by having the children dictate their “weekend news” while the teacher types it into the computer or a child records their story with a microphone. One is hard pressed to think of a curriculum area wherein the computer, with appropriate software, could not be used to enhance the learning taking place. Children have been observed using drawing software to plan what they are going to build in the block area. Some children enjoy making a picture with finger-paints and then going over to the computer to try to duplicate their picture with a drawing program. Printouts from storyboard software, wherein a child can make up a story by choosing a background and filling it with animated objects (somewhat reminiscent of flannel boards but far more interactive), have been used by young children as a script for dramatic play. All of this richness is lost in the computer lab where activities are more structured and software more drill oriented. Moreover, when a classroom is without computers, the machines are not available for use when spontaneous teaching moments occur.

Minimal Software Every Class Should Have

Moreover, it is our contention that true integration can be accomplished with a small core set of software programs rather than the large libraries most schools and computer labs try to maintain. A quality integrated classroom only requires approximately one dozen pieces of superior software. Here are the basic software needs followed by some recommended software which would vary given age. We are speaking here mainly of early childhood. Any prices quoted were obtained from the software company’s web sites. Furthermore, with a combined software evaluation experience of over 25 years, we do not make these recommendations lightly.

- File Manager Software
- Immediate Success Software
- Word Processing or Story Making Software
- Graphics Software
- Subject Area Software
- Multi-Media Software
- Microworld Software
- Content or Theme Software
**File Manager Software.** Manager software is software that functions as an interface between the young child and the computer’s hard drive. Several such programs have been developed by Edmark, Inc. (*Kid Desk Lite*, 1999; *Kid Desk Family Edition*, 1993; & *Kid Desk: Internet Safe*, 1998) all give varying levels of control to parents or teachers over what is available on the computer. *Kid Desk Lite* (which can be downloaded for free from www.edmark.com) allows adults to protect sensitive or important files from children. All versions of *Kid Desk* can be configured to start up automatically whenever the computer is turned on. Simple password control allows adults to disable *Kid Desk* at any time. *Kid Desk: Internet Safe* adds the ability to control what internet sites are available. Unlimited young children can launch programs from their very own graphical desk tops. A child can choose his or her desk top where on lie the icons of the programs to which he/she has been granted access. The cost of *Kid Desk* ranges from free for the Lite version (it’s safe to assume this is a demo with limited capability), $24.95 for *Kid Desk: Family Edition*, and $29.95 for *Kid Desk: Internet Safe*. We recommend *Kid Desk: Internet Safe*.

**Immediate success software.** When young children are first introduced to computers it is important that they have a successful experience in order to motivate them to master the machine. Any of the “Living Book” series by Broderbund would be appropriate here, (*Arthur’s Birthday*, 1997; *Arthur’s Teacher Trouble*, 1993; *Just Grandma and Me*, 1997; *Stellaluna*, 1996) or any of the other numerous programs in this series. All of these software programs are beautifully drawn, animated, and colored. Each of them can be experienced in two ways. One is to just let the software function as a story teller and the other allows children to interact with the program. In the interactive mode the software still reads the story but stops on each page so the child can hit all the hot spots. This is simple point and click work and therefore why children achieve instant success. Each page is covered with numerous hot spots for the child to click and set off an animation. There are no right or wrong answers. Just point, click, and have fun. Children can even click on separate words and hear them pronounced. One final nice feature of these programs is that you can change the language in which the stories are read and printed. As with real life, not all is perfect. Children lose interests in these programs after multiple play. When you’ve seen the starfish dance 100 times, it’s time to move on to something new. Still we think the initial boost to children’s self esteem from such programs is worth the $30.00-$40.00 they are going to cost you. Older versions have been reduced to less than $20.00. We recommend you purchase a minimum of two of these programs.
**Word processing or story making software.** Whether it be random key-boarding, invented spellings, or beginning sentences, young children need a way to express their ideas in the technology integrated classroom. Young children find it easier to type or click the letters they want with a mouse than to write with their poor, small motor control. We feel this is a form of scaffolding (Vygotsky, 1978) and that appropriate software can support children while in their zone of proximal development just as peers, parents, and teachers. *ClarisWorks for Kids* is tailor-made to help children in Grades K-5 (ages 5-11) do just that. Using a Writing Pad (word processing), Art Pad (painting), List Pad (database) and Graphing Pad (spreadsheets)—all designed for the younger child—teachers and students will find ClarisWorks for Kids has all the tools they need to work successfully. And it’s incredibly easy for new computer users to get started, thanks to templates that deliver everything from lined paper and notebooks to art “canvases” for painting. Dozens of other templates help children record weekly words, write a letter, make a graph, create an illustrated book report and much more. The cost for *ClarisWorks for Kids* (1997) is $49.00. Another of our favorites, due to its excellent graphics, is *Storybook Weaver Deluxe Classic* (1996) by MECC ($15.00 for a 1990 copyright), however *ClarisWorks for Kids* is the piece we recommend if you can only afford one word processing program.

**Graphics software.** The next piece in our list of core software is a good piece of graphics software. Children love to draw and drawing pictures on the computer can be as fun as finger paint. We recommend *Kid Pix* by Broderbund. There are currently two versions available. *Kid Pix Studio Deluxe* for $19.95 and the newer release *Kid Pix Classic* for $14.95. From the web descriptions it appears that the studio deluxe version has more features. *Kid Pix* will allow young children to go where crayons have never gone before. From simple doodles to 12 ways to erase to making your own animations. Preliterate children write by drawing and *Kid Pix* gives them all the tools they could ever want to express themselves. If asked to pick a program that represents the ultimate scaffold in a Vygotskian (1978) sense of the word, it would be any version of *Kid Pix*. We recommend *Kid Pix* above all other graphics programs.

**Subject Area Software**

The world is literally full of curriculum area software with a plethora of reading, mathematics, science, and art/creativity software (Buckleitner,
1998). We have already described a great deal of this software in our discussion of what is not integration. Yet, among this plethora of curriculum software products, there are some truly pleasing pieces. We highly recommend any of the “house” series. We recommend the following as staple classroom early childhood curriculum software: Bailey’s Book House (1995), Millie’s Math House (1992), Sammy’s Science House (1996), Stanley’s Sticker Stories (1996), and Trudy’s Time and Place House (1995). For additional pre-math concepts see the Thinkin’ Things Collections 1 (1993), 2 (1994), or 3 (1995). All of these products are listed for $19.95 on the Edmark web site. A nice mixture of these products, perhaps three to four, would make a contribution.

Multimedia Software

Although aimed at students in grade three and up, MPExpress (1998) from Bytes of Learning, is designed to allow children and teachers to make multimedia presentations a page at a time using a fill-in-the-blanks approach with ready-to-go templates pages. Intuitive graphic button palettes keep the process simple. Children can add any of the dozens of sample movies, pictures and sounds included on the CD-ROM or use their own. Why introduce children to multimedia software? Because it’s the wave of the future? Because it’s in vogue? No, because it offers children another sophisticated material in which to express themselves. Although a child’s multimedia presentation, the life of Sammy the Snail, may not look like much to you, it certainly means a great deal to the child because it represents projects done in collaboration with the teacher and other students in the classroom. And collaboration may be the best reason for multimedia. There are other multimedia programs available worth investigating but we recommend MPExpress as number one.

Microworld Software

What constitutes a microworld has been explained in detail elsewhere (Shade & Watson, 1990; Shade, 1997; ssss). Suffice it to say that a microworld is a special kind of software. Modeled after Logo (Papert, 1980), microworld software is a place where children can learn concepts placed there as easily as learning to speak French in France. Papert intended Logo to be a mathland. While playing with the Logo language and making designs with
geometric shapes they have programmed Logo to draw, children are learning Euclidean Geometry concepts.

Many of the Maxis products, \textit{(SimAnt Classic, 1996; SimCity 3000, 1998; SimFarm, 1993; SimTown, 1994)}, all have the same microworld quality. When you experiment with \textit{SimCity} you must begin to learn about budgeting, finance, city planning, and politics as you try to keep a high percentage of your voters happy. \textit{SimTown} is a scaled down version of the same activity for early childhood but instead of running the city, you live in the town. \textit{Roller Coaster Tycoon} (1998) by Hasbro Interactive is just such a piece for children eight and above. The child’s vision begins with an undeveloped tract of land, a modest bank account, and his/her wildest dreams. It’s up to him/her to construct, demolish, design, test and tinker (bricolage at it’s best). Along the way, they’ll encounter bad weather that keeps attendance down, roller coasters that prove to be menaces to society, and guests that get lost or complain because you haven’t put in enough restaurants or rest rooms!

Three other wonderful programs designed by Cyan, Inc. (the makers of \textit{Myst}, 1993), are \textit{Cosmic Osmo and the World Beyond the Mackerel} (1994), \textit{The Manhole Masterpiece Edition} (1994), and \textit{Spelunx and the Caves of Mr. Sudo} (1991). In \textit{Cosmo}, children five and up explore an vegetable moon, exploring switches, hidden animations, and other surprises. The \textit{Manhole} is a first person highly imaginative adventure game in which children aged seven and up follow a into a sunken ship, where they meet Mr. Rabbit and solve puzzles as they explore a vast, unknown world (Buckleitner, 1998). Finally, in \textit{Spelunx} children 5 to 12 must discover 20 activities hidden in a series of caves. On their journey they watch planets spinning, create custom trees, play with mystical machinery, compose music, and create stamp movies (Buckleitner, Orr, & Wolock, 1998).

\textbf{Content/Theme Software}

Every teacher has his/her favorite themes: the Rainforest, Native Americans, the ecology, insects, and so forth, that he/she enjoys doing in class year after year. There are a multitude of computer programs for all age levels that single in on specific topics. Edmark makes a number of wonderful programs in their “Imagination” series. \textit{Castle} (1994), \textit{Neighborhood} (1994), \textit{Rain Forest} (1995), \textit{Ocean} (1995), \textit{Pyramids} (1996), and \textit{Time Trip USA} (1996) (Colonial American). In \textit{Rain Forest} children can construct exciting interactive adventures filled with exotic plants, insects, waterfalls,
and Kuna Indians. Children, 6-12, can use creativity skills as they select select sceans and characters, plan plots, write, narrate, animate, and record dialogue to create fantastic adventures. Any of the imagination pieces cost $19.95. We recommend whichever of the Imagination series that fits your special interests.

Such open ended programs would cut across any number of topics. What we are describing here are classroom tools that would be useful in a large variety of projects. In such a classroom young children could write about the topic on one program, make illustrations on another, and graph natural resources on yet another. With as few as a dozen basic programs, any classroom could be truly integrated as pertaining to technology. Think of the hundreds and thousands of dollars wasted on drill-and-practice software.

Scaffolding

In addition to the complementary role described above, the computer is uniquely suited for adding depth to traditional early childhood curriculum. One such usage is as a “scaffold” not unlike the role played by older children and adults in Vygotsky’s (1978) “Zone of Proximal Development.” With the simplest of drawing programs a child can make a perfect square, triangle or circle. This is especially exciting to young children, given that many lack the fine motor control to do the same thing with crayons. Others (Strand, McCollum, & Genishi, 1985; Wright & Samaras, 1986) have written about the joys young children experience when they learn they can write on the computer with greater ease than using their insufficient small motor skills to print on paper. (It should be noted that no research evidence exists to indicate that such an activity on the computer results in later frustration as a child endeavors to produce print manually.) We are not suggesting that the computer replace traditional drawing and writing activities, but rather that it can incite and foster new ways of thinking about writing, drawing, and using math.

A good example of a recent program that scaffold’s young children is Orly’s Draw-A-Story (Broderbund). Orly, a young Jamaican girl begins to tell a story. Every now and then she will stop and say, “Hey, we need a really ugly monster for this story. Can you draw one?” Then the program jumps to drawing mode and whatever the child draws, whether it looks like a ugly monster or not, will be used as an illustration in the story as Orly completes the tale. There are many opportunities for the child to draw illustrations with each story Orly tells.
Software As Manipulatives

When thinking of integrating computers across the classroom curriculum, it is often helpful to think of software as a manipulative. After all, that is what the children think (Shade, Nida, Lipinski, & Watson, 1986). For any teacher who has spent a few moments with quality early childhood software, it is possible to see that the computer is not unlike other early childhood materials such as books, play dough, and blocks. Fourteen years ago, (Piestrup, 1985) noted that picture books were more static than computer software, and (Sheingold, 1986) emphasized that the symbolic nature of the microcomputer per se did not make the computer incompatible with or inappropriate for use by young children. She further listed the following as typical symbolic activities in which young children participate: communicating with gestures, speaking, pretend play, counting, tapping a rhythm, singing, making a picture, and making a clay object. Most recently, (Clements, Nastasi, & Swaminathan, 1993) noted that “what is ‘concrete’ to the child may have more to do with what is meaningful and manipulable than with its physical nature” (p. 259). With the right kind of software, computers are open-ended, discovery-oriented, and have 2- and 3-dimensional screen manipulatives that are controlled with various input devices. One simply points the mouse, clicks and drags the objects on the screen to your desired location. With such software, young children choose castle backgrounds and add princes, princesses, dragons, knights, and all manners of fairy tale makings. Sometimes the graphics are static, as in a picture book, and sometimes they are animated (birds fly, people walk, etc.). Therefore, we contend that computer graphics constitute manipulatives as do blocks, and so forth. (Davidson, 1989a; Davidson, 1989b; Shade & Watson, 1990).

Like any manipulative, computers can be used in many ways. They can be used wisely in a way that enhances development or in less appropriate ways. No one would argue against crayons as a necessary staple in the early childhood program. Yet, this does not mean we support having two-year-olds using crayons to color in ditto pages, trace letters of the alphabet on a workbook page, or use drill-and-practice software. Nor do we advocate the use of computer as a machine to drill children in rudimentary facts that are best learned by rote memorization (Shade & Watson, 1990).

If we continue to consider computer software as a material that young children manipulate and explore, then it is possible to further show how integration of computers into the classroom is similar to the use and integration of other typical early childhood materials and activities (Davis, 1995). Any time a new material is being introduced for the first time, whether it be
a special dramatic play set-up, a new puzzle, or a computer takes careful consideration and planning (Davidson, 1989a; 1989b).

**Learning WITH Computers**

Simply having a computer in your classroom is *not* curriculum integration, and as discussed above, simply learning *about* the computer or teaching computer literacy is not integration. In order to truly make the computer a working part of the classroom, the children must perceive the machine as a useful tool for accomplishing their own goals. In the adult world, the computer is used as a means, rather than as an end; for young children to develop the same perception, the teacher must thoughtfully and carefully consider how to use the technology in the curriculum, so that the children come to understand that the computer is one of many materials available and potentially useful for accomplishing personal goals.

**DESIGNING AN INTEGRATED UNIT THAT INCLUDES COMPUTER TECHNOLOGY**

**Step I: Choosing a Topic**

When striving for technology integration, it is easy for a teacher to feel pressured to include computers in every aspect of the curriculum. A common mistake in planning under this pressure is to think, “What topic can I teach that will allow me to use the computer?” Unfortunately, beginning with this question often leads to a classroom experience where the computer component seems forced or awkward, or where only superficial connections are made between the topic and the computers, through low-quality drill software. For example, using a drill program like *Reader Rabbit’s Kindergarten* (1997) and then having the children color numbered rabbits on a dit-to page. A teacher would never ask, “What topic can I teach that would allow the children to use pencils, or crayons?” Such a question would be ridiculous! Teachers know that which materials are used is not the primary concern; *the learning objectives must drive the choice of activities, and the activities drive the choice of materials*. Whatever materials or tools are best suited to the activity will be used; sometimes computers are the best tool for the job, and sometimes they are not; the secret is knowing the difference.

In planning an integrated unit, one does not start with the materials to be used or the subject areas of the traditional curriculum, but with the
choice of a topic for exploration that is both meaningful and relevant to the young children’s lives. A topic that holds a significant place within the life of the young children is one that grows out of their own experiences and thoughts, and grows further through exploration (Dewey, 1943). As Dewey suggested, if the topic of choice represents an authentic piece of real life, all areas of learning—language, calculating, social sciences—will be touched upon (p. 91).

The topic needs to be “deep” or “rich” to allow for days of exploration and discovery. Topics like families, whales, rain forests or dinosaurs would all be relevant and meaningful to young children: families because they all come from one; whales because of young children’s growing awareness of and relationships with all types of animals; rain forests because of the large variety of plant and animals to be found there (plus the ecological concerns); and dinosaurs because we’ve brought them back to life through books, video, and software.

**Step II: Defining Concepts**

Once an appropriate topic is selected, such as whales, it is the task of the teacher then to define the major concepts that will be explored throughout the unit. These concepts will be important for understanding the topic itself, and will represent what the children will have learned about the topic after participating in the unit. It will be these concepts, not the defined boundaries of the traditional disciplines (literacy, math, science, etc.) or the materials (i.e., computers), that will determine the learning activities to be pursued.

Concepts should be broadly defined, rather than naming specific facts about the topic. For example, in the unit on whales, the concepts might be: (a) whales are both like and unlike humans; (b) humans have been dependent on whales for many years; (c) whales’ survival may be threatened by humans if they are overfished, and (d) we no longer need to depend on whale oil for lamps.

**Step III: Breaking the Concepts Into Components**

Components are derived from the components, and, like puzzle pieces, should fit together to comprise the concepts. Here, the teacher may name specific facts or ideas the children will explore through activities. For concept one in our whale unit (Whales are both like and unlike humans.)
examples of components might be: (a) whales are mammals; (b) whales travel in families; (c) whales are very social; (d) whales nurture their young; (e) A whale’s anatomy includes parts that are similar to humans’; (f) whales live in the ocean; and (g) whales and humans can’t breathe underwater.

Through the exploration of these components, using the materials and activities best suited to the particular task, young children will exercise their literacy, logico-mathematical, science, social studies skills in real contexts, and in natural integration.

**Step IV: Deciding on the Best Activity and Material for Exploration of Each Component**

After deciding on the components that will be explored, the teacher must determine the activity most appropriate for investigating a particular idea. This is an essential step and the easiest place to blunder into cute activities that appear to fit the topic—that like coloring whales and cutting them out as a stand-alone activity—but are really only superficially related.

In our whale example, a teacher might decide that the best way to demonstrate the physical similarities between humans and whales is to examine the anatomies of both mammals and compare. This is a relevant activity that will require the children to exercise skill in language, visual perception, categorization, and general science, in a meaningful context.

Of course, once an activity is designed, the teacher must determine the materials to be used. This is a crucial part of planning because in any given instructional situation, a particular material, whether it be traditional or innovative, may or may not be the most appropriate for the task at hand (Clements, Nastasi, & Swaminathan, 1993). Here is where the computer makes its appearance as a useful and appropriate learning tool. For certain activities, the computer will prove to be the best tool for the job, just as coated paper is the best material to use with fingerpaints. Adding to the reasons why the computer needs to remain in the classroom.

For the activity mentioned above—comparing anatomies—the teacher is faced with the task of deciding on the best materials. In most classrooms, providing the children with real human and whale skeletons is probably out of the question. A book showing the different anatomies might offer a view. However, the computer is probably the best tool for this activity, because it affords the children opportunities that books cannot. In William K. Bradford’s *Explore-A-Science: Whales* program, for example, a child can remove the whale’s skin in portions to see the blubber, which can then be removed to see the muscles below, and so forth, right down to the bones. This allows
the child to literally get inside the whale, without putting the child or a
whale in danger. The same is true for a human anatomy program, such as
*Knowledge Adventure’s 3-D Body*, which lets the child explore the various
parts inside the human body (the fun part is trying to put them back toget-
er). Both of these programs utilize the tremendous graphic capabilities of the
computer to simulate mammal anatomy—in this case whales and humans.

In further exploring the concepts for this unit on whales, a teacher
might compose other activities that demand the strength and flexibility of-
fered best by a computer. For example, students could:

- use reference software (e.g., Microsoft’s *Explorapedia: The World of
  Nature*) (1996) and the Internet to gather information on the attributes
  and habits of whales;
- examine the whale’s habitats through the Internet or a piece of geogra-
  phy software (e.g., Compton’s *3-D World Atlas Delux*, (1998));
- visit the Web sites of environmental organizations to learn more about
  the status of the whale as an endangered or threatened species, then
  compose letters using a word processor program like Broderbund’s
  *Amazing Writing Machine* (1994) to make their opinions on the matter
  known; and
- report what they have learned through a multimedia presentation that
  includes pictures, animation, and sound (e.g., Edmark’s *Imagination
  Express: Oceans* (1995), Broderbund’s *Kid Pix Studio* (1998)).

In this and other units, the computer lends itself to several core activi-
ties that can be easily applied to any integrated unit. For example, a variety
of graphics and drawing programs allow young children to create their own
pictures, books, and even movies; simple word-processing programs can
capture an LEA story, a group story or report, or a child’s individual writ-
ing; interactive books and encyclopedias provide access to a huge amount
of information as well as spectacular photos, illustrations, and movie foot-
age (just to name a few). Here again we see that a core set of quality soft-
ware programs could more than meet the needs of the teacher desiring to
integrate computers into her/his program. One cannot help but wonder why
no one has come to this conclusion before this and saved school districts
millions of dollars.

Choosing the best materials for young children to explore activities that
will teach the concept components does not always mean a computer would
be chosen. Sometimes, a filmstrip, a book, markers and paper, a water table,
or playdough would be the best materials for a particular component. For
example, a videotape might be the best way to illustrate the family behavior of whales. However, because of its versatility and power, a computer often plays an important part in an integrated unit.

LEARNING ABOUT COMPUTERS

A significant portion of this chapter has promoted using technology as a tool for learning, rather than isolating the computer as an object of study in itself. However, when young children first encounter computers in the classroom, there will be an initial learning period that must be include teaching certain concepts that help children understand the technology, and certain skills children will need to be proficient computer users. This should not frighten teachers away from using computers, or be used to support the argument that computers are too complex for young children to master. Indeed, any new material—even the most intuitive—that is introduced to the classroom will require some explanation so that the children can make the best possible use of it. Even hamsters, robust and user-friendly though they might be, must be appropriately introduced to the children so that the best interaction possible can take place. No teacher would put a hamster in the room without ever mentioning it was there. With an appropriate introduction by the teacher, as well as some direct instruction and perhaps even practice, the hamster might become a valuable, respected, and well-cared-for member of the classroom community. The same holds true for the computer.

Basic knowledge of how and why computers work help young children understand that these are not magic boxes with little people inside. Also, the more children can learn about computers on a functional level, the more independent they will become as computer users (Davidson, 1989). This is not to say that young children should become computer technicians, or be required to understand all the ins and outs of the computer before being permitted to touch the machines. On the contrary, much of the understanding of how computers work results from successful interaction with the technology. With some support, both on and off the computer, children can master the skills and concepts necessary to become confident, independent users of technology.
What Young children Can Learn To Do With Computer Technology

Young children are capable of operating the computer and interacting with appropriate software without the constant companionship of an adult. This is especially relevant in areas where classes are large and teachers’ assistants or parent volunteers are few. In such an environment the solitary classroom teacher cannot be expected to spend all of her or his time in the computer area. Therefore, it is a critical goal to help young computer users become as independent of the teacher as possible. To this end, we have identified a number of skills that children need to become independent computer users. We are speaking here of empowering young children with enough knowledge to use the hardware and software of today. The list below has changed drastically since first drawn up in 1985 (Paris & Morris, 1985). We see this as an affirmation of Papert’s (1993) claim that spending too much time today on computer literacy is a waste because much of what young children learn today will not be needed tomorrow. For example, turning computers off and on was a difficult skill to master for a five-year-old in 1985 when computer components had to be turned on in a particular sequence. Today we just plug everything into a surge protector and let them flip the one red switch on the outlet strip. Many of these are modified from Davidson (1989a).

Children as young as four are able to master all of these skills.

Use correct terminology. Using the proper names for the parts of the computer and its peripherals, and employing the correct terminology for related actions and procedures (e.g., “loading software,” “booting up”) is part of being an independent user. Knowing correct terminology builds confidence in ones’ ability to do. In addition to modeling correct terminology in real computer situations, teachers can help young children master these terms through simple lessons that include labeling the computer and its various parts, or off-computer games that reinforce the vocabulary, such as a memory match in which children name the parts of the computer pictured on the cards.

Turn computer on and off. This includes the CPU, monitor, printer and any other external peripherals such as a hard disk drive or CD-ROM player. As mentioned earlier. It is no longer necessary to teach the children sequential steps to master using numbered stickers (Davidson, 1989a; 1989b) so that each part of the computer gets turned on in the right order. The old Apple II2 required everything to be turned on before the computer. Commodore had it’s own sequence. There were even warnings in user manuals about turning computer components on in an incorrect order. Today, we
simply plug everything into a surge protector, outlet strip and let the children flick that one button. We find they need no practice with this simple skill.

**Follow multi-stepped procedures.** The one remaining constant over the last twenty years is that computers operate in a step-by-step fashion. However, what we have chosen to focus on with young children has changed. Years ago, even with the most seamless interface, the procedures for turning on the machines, inserting discs, and selecting programs were often completed by following a similar series of steps. But hard disk drives have gotten larger and many programs can be stored on a single machine. Children no longer need handle every disk, although many programs do require the CD to be in the drive. Nevertheless, young children handle CD’s with the same finesse they did 5.25 and 3.5 inch floppy disks (Clements, 1987; Shade, Nida, Lipinski, & Watson, 1986).

Still, to be independent users, children must become familiar with following simple multi-step procedures in order, and responding to the concepts of “first,” “second,” “third.” Allowing young children to practice loading a cassette tape into a tape player (clearly marked with the large, colorful numbers “1,” “2,” “3”) gives them a familiar basis for understanding a series of steps:

1. Place the cassette in the player,
2. close the tape deck, and
3. push the “Play” button.

It takes three steps to exchange or place a CD ROM in the player. Push the button to open the drawer, place the CD in the tray, and push the button to close the drawer.

**Mouse manipulation.** Most regular education children’s software titles rely on the mouse as the primary input device. Children, then, need to know how to hold the mouse in the correct position for the cursor on the screen to behave as desired. They must master the technique of clicking or double-clicking the mouse button without moving the cursor, and be able to click and hold the button as they drag the mouse to a desired destination. Their fingers might have to stretch to span the width of a mouse, but, with practice, even three-year-olds quickly develop skill in using this device.

To gain comfort using the mouse, young children can practice driving real (but broken) computer mice through a wooden block maze they have built. If real computer mice are not available, a wooden block “dressed up”
with construction paper is a fine substitute. Note: The most challenging aspect of using a mouse is maintaining orientation. Therefore, having some kind of tail [pipe cleaners work well] on the practice mouse is crucial, so that the children understand that this tail must always face “up” or away from the child. Another perspective would be to say the mouse must always be looking at you. A recent study (Reville & Stroommen, 1990) of young children using the keyboard, joystick, mouse, and trackball showed that children make even less errors with a trackball than a mouse.

**Find needed keys on the keyboard.** Return, spacebar, escape, and arrow keys are the keys most used in early childhood software. Setting these keys off with colored stickers helps children to find them and remember where they are. Be consistent. Use the same color for the return key on all your computers, and so forth.

**Strike the selected keys accurately, with a single keystroke.** A single key press is all that is needed to send information to the computer. The “piano playing” method and pounding on the keyboard that very young children often employ will not produce effective results; at the same time, however, touch typing is not necessary for young children to use a keyboard successfully. Though there is some controversy surrounding the practice of allowing young children to “hunt-and-peck” their way through the keyboard, there is no indication that this practice will interfere with children’s ability to later learn touch typing (Shade, 1992). This becomes even less a problem as more software moves into the point and click arena.

One of the children’s favorite activities for developing the above two skills is the giant keyboard. A larger-than-life keyboard (10’ x 5’) can be constructed from sheets of construction paper, then laminated or drawn on a cheap, plastic picnic table cloth. Children practice locating keys by jumping from one key to the next, spelling words or finding letters that the teacher calls out. (A smaller version can be made on posterboard, and used with bean bags, or checkers.)

**Select activity from a picture menu.** Programs for young children often launch from a representative icon, usually a character or symbol from the program. Whether on the adult desktop or a child-friendly interface, the young computer user must be able to recognize and pick out the appropriate icon when a particular program is desired. Clicking on a picture of a printer allows the child to print a picture. Stop signs are a standard way of telling the child how to quit. Big, fat arrows on the screen usually mean “Click
here to turn the page.” Snack time is an excellent opportunity to develop skill in following picture directions. Any recipe can be converted to a series of rebus—or picture—steps, which the children must follow to cook their snack. (Making English Muffin Pizza by following a picture recipe is a traditional favorite).

Select the desired part of a program from a picture menu. It does little good to cram a program for young children with written directions when the majority of the audience cannot read. Picture directions have been the solution to this problem. Recently, as computing power and capability has increased, verbal directions are being added to software more frequently. And, as children become more familiar with the software environment, they are increasingly capable of maneuvering by selecting from these picture menus. A good example of a program when the main software character talks the child through the activity is Orly’s Draw-A-Story (Broderbund).

Dramatic play is a wonderful area for developing skills related to selecting from a picture menu. For example, any restaurant theme, such as an ice-cream parlor, requires the “customer” to choose from a menu (which is provided in picture choices). The “server” takes the order by locating the picture items circled on the order pad by the “customer,” and the “cook” prepares the food by gathering ingredients according to picture recipes.

Handle and load software correctly. Though more durable than their floppy predecessors, compact discs still require proper handling to ensure their usability, and must be inserted into the computer correctly for the drive to be able to read them.

Brief direct instruction and practice with a real CD is enough for most children to understand that they must hold the CD only by its edge (though small hands usually need to hold the disc with their thumb on the edge and their index finger in the center hole), and they must use their other hand to push the button to open and close the CD drive tray (since pushing the tray itself can cause damage). Some teachers feel more comfortable using a giveaway CD (i.e., the type that comes in junk mail or as a promotion, or even in a box of cereal) to practice. If additional reinforcement is needed, children can practice holding photographs by the edges, and can be shown how fingerprints mar the surface of the photos, making them harder to see.

One small point, with the size of hard drive today it is often possible to load all of the contents of a CD onto the hard drive. Do this only if you have adequate space and want to reduce the number of CD’s the children need to handle. Note: not all CD’s will allow themselves to be completely copies to the hard drive.
Apply memorized protocols. Using the keyboard shortcuts to quit (e.g., alt+Q or CTRL-Q) or print (e.g., alt+P) is much easier for young children than wading through multi-level drop-down menus. And recognizing the default (e.g., “OK” button) choice in a dialog box saves time and frustration, allowing a child to work without having to rely on an adult to walk through these familiar steps each time a program is used.

Teaching these simple protocols both on and off the computer help children memorize the steps necessary to complete the tasks. Children as young as three can understand and apply these keyboard shortcuts when they are given sufficient practice and reminders while using the computer. Labeling the keys with stickers and posting rebus cards near the computer help support these concepts until the children commit them to memory.

Make the transfer between horizontal and vertical planes (keyboard to screen). Children need to understand that anything they do on the keyboard has an effect on the screen. This is a challenge for three-year-olds, and occasionally four- and five-year-olds have not grasped this concept. The concept can be developed in children as early as two through a “lapware” experience; the child sits on the lap of an adult who acts as the child’s “third arm,” pointing out actions on the screen that are results of the child’s input. A simple drawing program is perfect for this type of activity.

Many folder games, with just a small revision, can build the skill of Horizontal—Vertical transfer. A pattern-matching game, for example, might give the prepared pattern on the left side of a manila folder, and children are asked to match the pattern with parquetry blocks on the right side. By simply repositioning the folder into an “L” shape, so that the prepared pattern side stands vertically (resting against a block or shoebox), and the child’s blank side lies horizontally, the game now parallels the monitor-keyboard arrangement of the computer.

What Children Can Learn About Computer Technologys

There is a difference between operational knowledge and functional knowledge (Davidson, 1989). Operational knowledge is the kind used every day by people turning on microwave ovens: they understand how to enter the desired power and duration, and how to press the “On” button, but they may not know (or care) how the machine works. This is the same type of knowledge required to successfully navigate through the computer environment on the most basic level, and is developed through the skills discussed above.
Functional knowledge goes slightly deeper; it is knowing how to add oil or windshield washer fluid to your car so that it will continue to run efficiently, or understanding that pumping your anti-lock brakes is the wrong thing to do when stopping suddenly (because that’s what anti-lock brakes do—pump). A small amount of functional knowledge helps a user become a little more independent, without feeling overwhelmed. In the computer environment, it is important to help children achieve a certain level of this operational knowledge, in order to demystify the technology and to bolster their confidence as users. Allowing the children to watch when adding memory to the motherboard, or encouraging the children to assist in troubleshooting a frozen cursor or watching you change the ink jet cartridge foster this level of understanding.

In addition, some concepts that are simple yet important for young children to grasp about the operation of technology in their quest to become independent users includes the following.

**Computers are made of many parts that work together.** By identifying the various components of the computer system by their proper names (e.g., monitor, keyboard, CPU, etc.), teachers help children understand that computers are simply machines that have various parts. Assembling and dismantling a computer station in front of the children, being sure to identify the cables that make the connections possible, is a good way to introduce children to this concept. Children can construct their own computers out of blocks or boxes and containers of different size and shapes. Young children have built computers in the block area which resulted in some designs that Steve Jobs or Bill Gates might find interesting. Children need this information to demystify the computer. In an earlier study (Shade, Nida, Lipinski, & Watson, 1986) children thought the animated characters on the screen lived in the disk drive. Revealing the insides of a broken computer can put this myth to rest.

**Input-CPU-Output.** Computers receive *input*, which is evaluated by the *central processing unit (CPU)*, which directs activity that results in *output*. At first, this is a vague concepts for children, who can plainly see that the CD-ROM they put *into* the computer looks nothing like their picture that came *out* of the computer. The idea of “processing” as changing form can be clearly illustrated by using a hot air popcorn popper (with all components clearly labeled). The raw popcorn is the *input*, the popcorn popper represents the *CPU*, and the popped corn is the *output*; the input was converted to a form that is now usable.
Through experience with many peripherals, children learn that various devices allow input (mouse, keyboard, trackball, touchscreen, microphone, scanner, etc.) and output (monitor, speakers, printer, etc.) The important point to stress is that the child is the controlling factor, the one who directs the input. There is no magic but what the child makes.

*Computers follow commands.* Children are very familiar with the idea of having someone telling them what they can and cannot do. When this concept is put in terms of the computer, the word “command” is used. Children can practice their understanding of the term with a Simon Says game, in which everything Simon tells the children to do is a command (e.g., “Simon commands, jump up and down”), and they are all computers processing the input. The output is their actions (e.g., jumping up and down.) The next concepts follows directly:

*A series of commands is a program.* Though it is challenging for children to understand this concept, especially since the series of commands is invisible to the child (i.e., the program commands run behind the user interface), teachers can help illustrate the concept through activities: When Simon gives two or three commands that the children must follow in a row, they are following a program. (e.g., “Simon programs, jump up and down, then clap your hands, then sit on the rug.”) From there it becomes easy to talk about the information on a disk or CD is a program.

*Computer technology is mechanical, not magical.* As powerful as computers seem, it is imperative that children be reminded that technology is, by definition, made and controlled by people, and that technology cannot function without people to give the commands. Even programs that seem to run on their own, with animated characters taking on their own personalities and action, have been created and defined by human programmers. Simple operations, like changing printer paper or ink, or cleaning the mouse, creating or deleting documents, demonstrate that humans are in control of the machines. One approached used by a teacher here at the University of Delaware is to allow the children to explore broken computers (monitors can’t be used because of voltage stored in the cathod ray tube).

*Computers can be connected to share information.* Even very young children now have exposure to computer networks and the Internet, but few understand the difference between a stand-alone computer with software and a computer that is in communication with many others. Comprehension of this concept can be developed through direct discussion about the Internet
as a group of computers in communication and about its various uses. An analogy to the more familiar telephone as a device to allow communication over distances also serves well in this discussion. A recent study (Shade & Roy, 1999) showed that until approximately 8 years of age, children do not grasp the concept of the internet and are mostly interested in printing off screens from the web sites they visited with the experimenter. By the age of eight children begin to fathom what the World Wide Web (WWW or Web) is, and by ten or eleven clearly understand that when using the Web they are communicating with other computers as opposed to using stand alone software.

**Computers have enormous potential as well as limitations.** Children, like adults, will quickly learn that the computer does not always do what you want it to do. Technical problems will occur in the classroom as they do anywhere else computers are used, and it is good for children to witness someone trying to fix these problems. Though frustrating, even these troubles serve as excellent opportunities to teach that technology does have its shortcomings. At the same time, however, students (and teachers) should be reminded that these problems do not outweigh the tremendous potential these machines have for children’s education. Therefore, a positive attitude should be maintained in the classroom. One rule of thumb to follow is this: if a computer breaks down in the middle of self-selected time, pull it and replace it with another activity. Even a non-computer activity. Even if you only have one computer in your class.

**Computers help people do many things.** As it has been discussed throughout this chapter, computer technology can be a powerful tool for integrated learning. If encouraged to use the technology whenever it is most appropriate, children will naturally come to view the computer as a tool that has a place in their everyday lives, and that can be used in many different ways. In addition, students will begin to notice and appreciate the application of technology in other areas of their society. Teachers can foster this concept by pointing out technology being used around the school, in the community, and—most importantly—in the children’s own lives in the classroom.
CONCLUSION

A great deal of landscape has been covered in this chapter. By defining integration and drawing on the model of integrated language learning, giving examples of integration and mis-integration, showing how to design an integrated unit, and giving examples of appropriate skills and concepts that children can learn about technology, the authors hope that teachers will be set firmly on the road to creating an integrated curriculum for the twenty-first century. Why does what we have recommended seem so different from the majority of classrooms? Perhaps it is because the software market is dominated by drill-and-practice tutorials and those who are in charge have the mistaken belief that you must have a program for every tiny bit of curriculum. Or, perhaps, it is just too easy to buy into the panacea syndrome—that all we need is enough software and our troubles are over. We conclude that the important decision of how computers are used in classrooms is being made by someone other than the teacher (Shade, 1990). We recommend that the power of compuring and how it will be used be placed in squarely in the hands of teachers. We further recommend that teachers and administrators begin to build up basic cores of software that can be used in or shared by classes. Thus saving thousands of dollars and at the same time giving classroom integration of computers a real thrust forward. We recommend that teachers take it easy, relax, and have fun with the software and children. Make having a computer in your classroom like the Samba school Papert describes in his 1980 book, Mindstorms where everyone is a teacher and everyone is a student.

References


Integrating Technology Into the Early Childhood Classroom