Computer Learning Environments Designed to Enhance Learning for Children with Language Processing Disabilities

Abstract

Computer based learning environments can enhance learning and improve education. There is limited understanding of how computer assisted instruction curriculum programs can best be designed and implemented. The first step is to decide what types of learning are warranted and which environments promote this type of learning. Studies confirm the idea that computers facilitate the acquisition and transfer of language processing skills in students with reading disabilities. Researchers from around the world are conducting studies to develop learning systems to support such learning.
Computer Learning Environments Designed to Enhance Learning for Children with Language Processing Disabilities

Studies indicate that close to one third of students in Texas Public Schools are learning disabled and that the primary area of dysfunction is reading ability. Computers promote student success, motivation and enthusiasm for learning. Can they actually stimulate brain function and increase learning for the 30% of students in our public schools who have learning differences? Computer-based learning environments must address two basic premises central to curriculum development. The computer programs must be designed to provide a tool for what is taught by facilitating the acquisition and transfer of concepts and skills. The computer system must be designed to provide a tool for how skills are presented by enhancing delivery of these concepts and skills. Designers must decide what types of learning are warranted and which environment supports this type of learning. Studies are being conducted internationally to develop this type of innovative computer environment that will prevent childhood failures and create a successful learning environment for all students.

Computer Technology Enhances What is Taught

Computer-based learning environments represent complex phenomenon with high potential for improving education and enhancing learning. When a child is born, their brain is a one-pound walnut-shaped collection of nerve cells. The brain begins a process before birth that develops the wiring of nerves and connections that will allow the child to make sense of the world. Much of the brain’s wiring is laid out during pregnancy but
literally trillions of connections remain to be made. The child’s brain must continue the process of wiring itself during the first year of life as the child develops the ability to distinguish sounds, to see, and to master motor skills. The child’s brain is deeply affected by experience. At birth, an infant is ready to learn any language in the world, but by six months is beginning to specialize based on experience. Sensory stimulation shapes the child’s brain. Electrical connections are formed in response to this sensory stimulation. (Lyon, 1997)

Scientist are comparing people with and without learning disabilities to observe certain differences in the structure and functioning of the brain. In recent years, scientists thought that all learning differences were caused by a single neurological problem – abnormal brain structures. However, new studies show that most learning disabilities do not stem from an abnormality in a single area of the brain, but from difficulties in correlating information from various brain regions. They have found that children without early language experiences may fail to build these connections. Children with atypical brain functioning may also fail to build connections. Current brain research that diagrams brain functions and categorizes learning to specific neuron fields suggests that students with severe processing problems may have confused brain pathways. (Woods, 1996) These students could benefit from electronic curriculum that provides multi-sensory stimulation to enhance brain function in areas that are otherwise not stimulated. The computer can provide the sensory stimulation to stimulate neural fields and explicit activities to build brain pathways.
If technology is to facilitate the acquisition and transfer of cognitive skills, the learning need of the targeted students must be assessed. Two areas specific areas of brain activity activated by reading tasks have been identified as necessary to develop reading skills: auditory and visual processing. The region activated depends upon the reading task being undertaken. Neuroimaging reveals that the region of the brain activated depends on the strategy that the child is using to recognize each word. Studies show that 80% of all words are phonetically correct. In the early grades when reading text is contrived to fit developmental levels, students rely on auditory processes to analyze and decode these words as they develop phonetic reading strategies. The estimated 20% of “sight words” which do not follow phonetic rules must be identified in another manner. Students rely on visual memory to analyze and decode these words. By the time a child is in the fourth grade, students no longer rely on phonetic principles to read most words. It is estimated that 98% of words read at this level are memorized. Unknown words are decoded using auditory skills learned in earlier grade levels. It is at this stage, that a child becomes a fluent reader. The relationship between the auditory and visual senses in the act of reading has been examined by Lawrence Weiskrantz of Oxford University. This neurologist administered a test battery using computer synthesized sounds and digitally enhanced symbols. The results suggest that children’s sensitivity to both dynamic auditory and visual stimuli are related to their literacy skills. Auditory sensitivity covaried with phonological skills and visual motion sensitivity covaried with orthographic (sight word) skills. His studies show that the auditory and visual regions of the brain work separately to perform the complex task of reading. (Weiskrantz, 1999)
Auditory Processing

When auditory regions of the brain do not process human sounds, language acquisition is hindered. The sense of hearing is the gateway to language. In a child with normal hearing, the ears tune themselves to human sounds at birth, connecting the neural fields that enable language, emotions and intelligence. Even the smallest change in the way a child comprehends or encodes sound can hinder development. Over seven million students in America have problems processing sounds although they do not have hearing problems. The problem seems to be that the sounds do not resonate long enough for the learners to process them. They hear the sound, but it is not transmitted to the brain properly. This inability to hear the sounds of human speech properly hinders reading development. The phonetic sounds of the language cannot be analyzed into phonemic units and synthesized into the phonetic patterns that enable the student to decode words. New research from Yale University, the University of Colorado, Bowman Gray School of Medicine, University of Miami and Johns Hopkins School of Medicine have identified the need to add phonological awareness processing skills to programs focusing on advancing language processing. These studies conclude that remedial instruction must develop auditory processing skills which many poor readers lack. (Stanovich, 1997) Most structured reading programs begin at the level of association of sounds with written symbols. There is growing evidence that the reading process really begins at the more basic level of auditorally discriminating sounds. (Torgesen, 1997) Torgeson contends that the ability to isolate and manipulate the constituent sounds of words, known as phonemic awareness, is directly related to reading ability. The National Institute of Child Health and Human Development emphasizes that:
“Auditory word discrimination skills are necessary to help children with language and reading problems recognize distinctions among similar word sounds and understand why their representations in letters are different.” (Lyon, 1998)

Dr. Stephen Porges of the Department of Human Development at the University of Maryland is currently testing a new biologically-based intervention that uses computer originated acoustic stimulation to activate the nervous system and improve listening skills for autistic children. This approach is based on the premise that auditory information is not being perceived in the auditory region of the brain. The scientist believes that some children hear frightening noises instead of normal sounds. Tiny muscles in their ears that filter sounds malfunction and allow them only to hear low pitches. This makes the child anxious and unable to control many emotional responses. The Listening Project model uses a relatively narrow frequency band that focuses on the frequencies of human voice. The acoustic stimuli are computer-altered by applying digital filters to extract specific frequencies. Porges believes that exercising the neural system may help autistic students identify tones and sounds. When these human sounds are altered by computer to filter out low sounds and force the ear muscles to identify the pitches of human speech and the process of producing and understanding language begins. (Porges, 1999)

If a child cannot identify individual phonemes, he/she will not be able to blend or segment these sounds into language units. Activating the neural fields that enable the student to discriminate between sounds is a difficult classroom task. The computer is a multi-sensory tool that can produce and manipulate sounds to stimulate auditory processing. One software product designed upon the principle that the brain must process
sequential units of sound to develop language skills has been developed, *Earobics*. The program focuses on developing basic auditory discrimination processes that are the basis of decoding. This computer program synthesizes sound at varying rates and frequencies. The student listens to a sequence of sounds and responds to show discrimination of varying sounds. Once the student can identify the isolated sounds, the process of blending and segmenting phoneme units begins. This program is not an independent tutoring system, but is a curriculum tool for use within an intensive intervention program. A study tracking the achievement of students undergoing intensive daily training for phonological awareness has recently been conducted by a group of scientists in Germany. Half of the students received exercises consisting of normal, unmodified speech, the other students received exactly the same exercises modified with systematic enhancement of duration and amplitude of the short transitional speech elements. Improvement in the phonological abilities was significantly greater in the group receiving modified speech, this effect persisting one month after then end of the training period. (Giraud, 1999)

**Visual Processing**

When visual regions of the brain do not process language symbols, language acquisition is hindered. The sense of vision is the body's top intelligence gatherer and constitutes one-fourth of the brain's cerebral cortex. This sensory organ has offered scientists their most powerful insights into the brain's structure and operation because it is easy to study. In the 1950's, two neurobiologists from Johns Hopkins conducted a series of experiments in which they implanted electrodes in the brain of a cat. When the firing of single neurons were recorded, it was found that the neurons produce a visual map that respond
to color, form and motion. There are at least five maps in the visual system alone and each responds to different stimuli. It has been determined that these visual senses work with other senses to determine memory, language, and cognition. The visual aspect of reading deals with imagery of language symbols and memory. The role that vision plays in the process of language acquisition is important, since visual recognition of words in a quick and accurate manner is the fundamental element of reading fluency. In the act of reading, visual word identification abilities work in correspondence with auditory processing skills.

Dr. David Marks, Head of the Health Research Center in Middlesex, England is currently exploring the role of visual imagery in cognition and consciousness. He has developed a Visual Imagery Questionnaire which has revealed consistencies in cognitive and perceptual motor performance in groups of high and low visual imaging. His studies indicate that there is a relationship between the discrimination and memory of visual images and the processes of speaking and reading. (Marks, 1999) Dr. Allan Paivio, Professor at the University of Western Ontario, Canada, is further examining the link between visual memory and language learning. He is exploring the dual coding system and has found parallels between imaging object or events, knowledge in the form of concepts and visual linguistic units. (Paivio, 1999) These findings are supported by a series of studies revealing that students with dyslexia, a reading disability, have abnormal left hemisphere activation during language task performance. Lynn Flowers, professor at Wake Forest School of Medicine in North Carolina, believes that the disturbance begins before birth. In people with dyslexia, the structure of the brain called the planum
temporale which is located in both sides of the brain is affected. In people who are not dyslexic, the left planum temporale is noticeably larger, but in dyslexics, it is the same size as the planum temporale on the right side. This points to the conclusion that the area of the brain that enables auditory language processing is not being stimulated. Flowers contends that axons activated by visual stimuli are normally targeted for a specific temporal regions of the brain, but they find targets in another region. These confused pathways prevent the child from matching graphemes (visual input – letter symbols) to phonemes (auditory input) and language processing is inhibited.

Computer programs that develop the fundamental visual processes of language acquisition have not been fully developed. Dr. Flowers is currently utilizing brain imaging technologies to determine the underlying processes that enable the identification of language symbols. She leads a team of researchers developing a computer program to enhance the stimulation of the visual imagery and rapid naming processes that are the basis of fluent reading. (Flowers, 1999) A software program that addresses retrieval skills associated with these processes is Kurzweil. The software program is designed to compliment explicit teacher instruction. Kurzweil is designed to present scanned text to the learner. The text is read by a synthesized voice to the student as the text is highlighted. The speed of reading can be increased as the child increases rapid naming of sight words. Also, the amount of text that is highlighted can be adjusted to include larger sections of text as visual memory processes develop. This program is versatile for the classroom since any text can be scanned and saved into the program’s software format.
The computer will also read the definition of selected words and is capable of highlighting important passages.

**Computer Technology Enhances How Curriculum is Taught**

Although studies have filed to conclusively confirm the idea that computer-based learning environments facilitate the acquisition and transfer of higher-order thinking and learning skills, many see the computer as a means to enhance students’ cognitive skills and general problem-solving ability. G. Salomon, a renowned cognitive psychologist believes that computers make possible student involvement in higher-order thinking skills by providing memory support, juggling interrelated variables and performing low level tasks for the user. He feels the partnership creates

“a zone of proximal development whereby learners are capable of carrying out tasks they could not possibly carry out without the support provided by the computer.” (Salomon, 1996)

He feels that computer activities must be fully integrated into other activities. This creates a computer-based learning environment rather than learning environments to which computers are added. You do not go into a room with a lot of word and learn spelling, you do not go into a room with computers and have computer based learning. In the article, “Bits, Bytes, and a New Millenium,” Judy Salpeter explains that our first mission in education must be to design instruction based on what we want our students to know and achieve integration by relating media to curriculum objectives. The first phase of developing an effective instructional setting involves providing an environment that develops the mastery of basic curriculum skills and concepts.
Computer assisted instruction created to increase language acquisition develops auditory and visual processing skills, provides application of language tasks, and encourages extension of the information and sharing of ideas. The computer is utilized as a multi-sensory tool to create an environment that promotes student success, motivation and enthusiasm for learning.

Auditory Processing

For auditory processing lessons, the instructional tasks must encompass five stages of auditory processing: sensory input, perception, conceptualization, storage, and retrieval. Students with learning differences may have difficulty in any or all of these areas. When a student encounters difficulty in any one of the last four processes, it is usually an indication of incompleteness in the first process, sensory input. (Lindamood, 1998) The computer could be used as a tool to stimulate phonemic awareness, the identification and discrimination of speech and language sounds. This is the sensory input stage of auditory language development.

Once sounds are perceived, lessons must focus on applying the knowledge to phonics tasks so that the child can conceptualize and store the information. Application of skills means linking together the processes in the total act of auditory processing as it relates to speech, spelling, and reading. These activities would be designed to use the developed sensory input in sequential lessons to develop specific decoding strategies. Activities are explicitly planned and executed with feedback to define the use of skills within a specific
The final process of retrieval is the use of the speech, reading, spelling and writing strategies in a product. In this stage of the process, skills and strategies are no longer overtly observable. They are being used to create a product such as the creation of a sentence, list of words, or essay. Conscience feedback is no longer necessary as the students’ use of language skills is automatic feedback self-generating and self-correcting.

*Fast Forward* is a sequenced program designed to develop all five auditory processes. The program is internet-based and students log in daily to receive instruction. Student responses are analyzed daily, and activities are assigned based on progress. A trained clinician supervises progress in 12-14 hours/week. Students are expected to devote the same amount of time independently. Two training studies examined this computerized intervention designed to improve “temporal processing” skills. The students observed were between five and ten years old. The children had severe language impairments. In the studies, the children engaged in various kinds of special activities for 22 to 32 hours per week, for four weeks. Components of the intervention involved audiovisual games, listening to recordings of stories and participating in language games, and exercises that were designed to train the children in speech discrimination and to sensitize them to grammar utilizing speech that was acoustically altered. A control group was established for each study. The control group in study 1 received more time in the laboratory playing learning games and no time practicing at home. The control group in Study 2 received the same language listening exercises but with unaltered speech. Various tests were given to all students before and after the intervention. In Study 1, two tests were used to
assess the child’s ability to identify sounds and determine number of sounds. Students in both groups showed significantly higher scores with the achievement of the control group being slightly lower. In Study 2, two tests that assess receptive language skills were administered. The control group, which engaged in the same language exercises but with acoustically normal sound, improved less than the experimental subjects trained with modified speech. The researchers concluded that the practice with slowed-down auditory and speech stimuli allowed the children to improve their auditory perception skills which benefited language comprehension. (Merzenich, 1999 and Tallal, 1999)

**Visual Processing**

To develop visual processing skills, the same sequence of computer assisted instruction must be designed: develop processing skills, provide application of language tasks, and encourage extension of the information and sharing of ideas. The computer could be used as a tool to stimulate the identification and discrimination of language symbols and symbol imagery.

Once the symbols are perceived, lessons must focus on applying the knowledge to language tasks so that the child can conceptualize and store the information. Application of skills means linking together the processes in the total act of visual processing as it relates to auditory processing, spelling, and reading. These activities would be designed to use the developed sensory input in sequential lessons to develop specific strategies such as remembering sequences of letters, developing sight word recognition and
improving fluency. Activities are explicitly planned and executed with feedback to define the use of skills within a specific task.

The final process, retrieval, is the use of the reading, spelling and writing strategies in a product. The product would be the same as the auditory processing retrieval since both processes work together to enable the student to read, spell and write. This phase of the instructional setting engages students in electronic learning as they begin using computer applications as tools to publish their writing products and create learning centers. In an article published in Electronic Learning, Joan Novelli points out that the focus of classroom curriculum must now shift from using technology as an instructor to using media as a tool to meeting instructional goals. Co-Writer is a software program developed to enable the reader to retrieve sight words in written text format. The writer may not be able to retrieve specific sight words while completing a writing activity. The program identifies the partial image or incomplete phonemic spelling and supplies eight word that begin with the initial letters typed by the student. The words chosen by the computer fit in context of the sentence and are read by the computer if the student selects the word with the mouse. Once a sentence is complete, the program reads the entire sentence and places it in the user’s text program of choice. Choices include any text program compatible with the computer’s operating system including email.

Co-Writer allows students with learning differences to produce written text and participate in writing activities. A project encouraging participation between schools around the world is the Reading Rainbow Young Writer’s contest. The project is based
on the Reading Rainbow Television series that is telecast internationally. The contest supports the idea that computers can significantly alter the learning environment. Project activities pattern schools after research communities. This provides sustained, collaborative inquiry. Work is based on the idea that students learn through apprenticeship with published authors. Student products are entered into a hypermedia student-generated presentation portal. The young artists and writers become educators as their projects become textbooks accessible to all students via the internet.

Can computer-based learning environments enhance brain function? Although studies have failed to conclusively confirm the idea that computer-based learning environments facilitate the acquisition and transfer of higher-order thinking and learning skills, many see the computer as a means to enhance students’ cognitive skills and general problem solving ability. The new systems of computer-based learning environments are being designed to facilitate complex learning processes and may be the tool that helps millions of students find success in reading.
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