REPORT OF THE
DEPARTMENT OF EDUCATION

# MEMORY: AGE-APPROPRIATE TECHNIQUES TO IMPROVE THE MEMORY OF STUDENTS

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

## HOUSE DOCUMENT NO. 23

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# COMMONWEALTH *of* VIRGINIA

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November 9, 1999

The Honorable James S. Gilmore, III
Governor of Virginia
State Capitol Building
Richmond, Virginia 23219

Dear Governor Gilmore and Members of the General Assembly:

The report transmitted herewith is pursuant to House Joint Resolution 678 of the 1999 General Assembly of Virginia. This resolution requested the Department of Education to study age-appropriate techniques to improve the memory of students and to disseminate its findings to all school divisions.

Respectfully submitted,

Paul D. Stapleton

PDS/hdc/sac

Enclosure

# Preface

This study was authorized by House Joint Resolution 678 patroned by Delegate Marshall. A copy of the resolution is included in Appendix A. This report addresses age-appropriate techniques to improve the memory of students.

The study was directed by Don Fleming, Virginia Department of Education, and the document was written by Kate Franson, Virginia Department of Education. Contributors included Joyce Finnerty, Institute for Neurolearning, University of Virginia, Richmond Center; Barbara Scott, Chesterfield County; Steve Harkins, Medical College of Virginia; and Kevin Ricker, Henrico County Public Schools. The document was reviewed by a committee including Pat Parrott, Chesterfield County Public Schools; Frank Howe, Longwood College; Michael Werner, Hanover County Public Schools; and Deborah Cooper, Buckingham County Public Schools. Appreciation is extended to the contributors and reviewers of this document for their input and guidance.

# Contents

# Executive Summary

Educators can use the information learned from research findings on the brain, memory, and learning to enhance student recall of information and improve performance in the classroom. The techniques and strategies presented in this document offer supervisors and instructional specialists a sound research base on which they can build a curriculum that is compatible with the findings of neuroscientists, psychologists, and cognitive researchers. Definitions of memory and a summary of how the brain stores and retrieves information are followed by recommendations for increasing memory by using certain strategies.

Strategies found to be most effective include mnemonics, the Recall Enhancement Routine developed by researchers at the University of Kansas, collaborative learning, integration of content, the use of novelty, and graphic organizers. Some memory strategies are particularly effective in specific content areas such as mathematics, English and language arts, science, social studies, and technology. This document highlights the most relevant research on memory and learning, but it is by no means a comprehensive training manual. Implementation of the recommendations presented would require further development of these strategies and training of teachers and administrators.

# MEMORY
# Age-appropriate Techniques to Improve the Memory and Learning of Students

## Introduction

As one of the most important concepts in learning, memory has been approached from several different directions by researchers who are eager to understand the intricate workings of the brain. Educators can use the findings of these researchers to help them understand the process of learning and to train students to use specific strategies to remember information. Memory enhancement techniques, although well-represented in educational research, are not used often enough in the classroom. The purpose of this study, which was conducted in response to House Joint Resolution 678 (Appendix A), is to present scientific evidence, theories, and guidelines on memory enhancement training techniques. Suggestions are included for incorporating memory enhancement techniques into school curricula. The techniques would become age-appropriate by differentiating areas such as content, pacing, and language for learners.

## History

Interest in identifying memory enhancement techniques dates back to at least 2,500 years ago. Mnemonic devices were an essential part of rhetoric during classical times. The Greeks were interested in visual imagery, and Cicero described the central role that imagery played in *De Oratore*:

> Persons desiring to train this facility (of memory) must select places and form mental images of the things they wish to remember and store these images in the places, so that the order of the places will preserve the order of the things, and the images of the things will denote themselves. (Yates, 1966, p.2)

The first experimental efforts to study memory enhancement were accomplished in the latter part of the nineteenth century with some positive results. Kirkpatrick (1894) found that people who were shown objects recalled seven times as much as people who were given the names of objects. Calkins (1898) obtained similar results using pictures of objects rather than the objects themselves. These studies suggest that visual imagery is helpful in memory. The use of visual imagery is still emphasized in memory training books (e.g., Lorayne & Lucas, 1974).

Twentieth century investigations of memory enhancement did not begin until the 1960s for several reasons. First, cognitive science was not a respectable field of study before that time. Second, American pyschology had a behavioralist slant during the first half of the 20th century and psychologists were trying to be scientific in their observations. Third, memory enhancement strategies at that time were viewed as "gimmicks" that were not worthy of scientific study. As psychologists began to study the importance of memory in learning, cognitive science gained popularity and respect.

Today, the study of memory involves medicine, psychology, and education. Researchers are investigating the workings of the brain not only in physiological terms, but also in terms of how brain science affects education. Presently, educational psychologists are finding many practical answers to the questions that follow by examining the research of neuroscientists.

## Types of memory

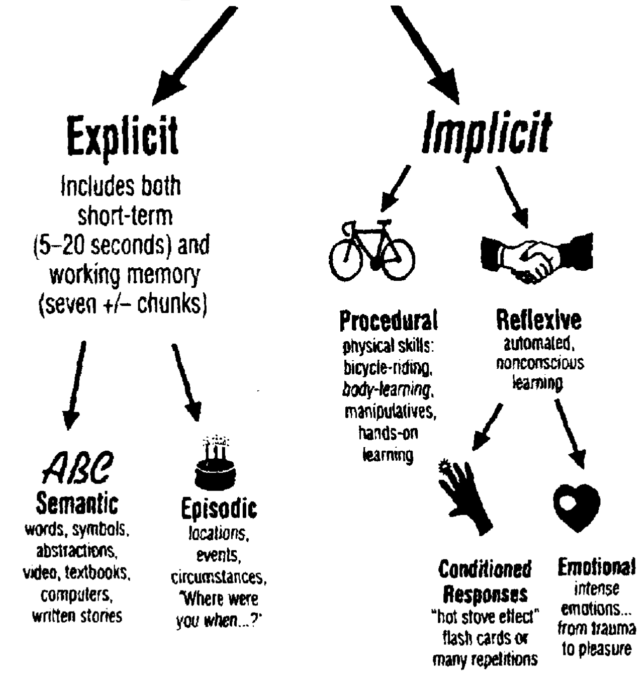
How do we define memory? What types of memory are used in learning? Memory and learning are inextricably combined. One cannot be described without the other, and memory is the initial process used to repeat or apply what is learned. However, there is no firm distinction between how well a person *thinks* and how well he or she *remembers* (Turkington, 1996). Bloom's taxonomy of thinking (Appendix B) describes recall of general knowledge as the most basic level for learning. In education, it is of course desirable to include the full range of thinking and application for the acquired general knowledge.

Sensory data are categorized as information, then codified and stored in meaningful networks. Schacter (1992), as well as Calvin and Ojemann (1994), describe memory as a *process rather than a location*. Multiple locations and systems are responsible for our best memory and learning. Memories are *recreations* of the original event which only take a split second to reactivate. Edelman (1992) describes it as a "memory of a memory." These memories become more inaccurate over time unless they are used frequently.

For memory strategies to be fully utilized, teachers need a basic understanding of the process of memory. Memory is a process; it is not a fixed thing or singular skill (Jensen, 1998). Memory can be described in several different terms: iconic and echoic memory, short-term versus long-term memory, episodic and semantic memory, and explicit versus implicit memory. Iconic memory deals with the storage of visual data, while echoic memory deals with auditory data. Short-term memory is used for storage of temporary items, while long-term memory stores permanent data. Episodic memory involves recall of events, while semantic memory involves recall of words; both are types of explicit memory. Implicit memory consists of procedural (remembering how to do things) and reflexive memory (conditioned and emotional responses).

Figure 1 is a visual representation of the relationship between explicit and implicit memory pathways.

Figure 1. Memory Pathways




(Jensen, 1998, p.103)

Different kinds of learning require different ways to store and recall information. The brain sorts and stores information based on whether it is heavily embedded in *context* or in *content* (O'Keefe and Nadel , 1978). The difference between the two can be described this way: Information embedded in *context* ("episodic" memory) means it is stored based primarily on a location or circumstance. Information embedded in *content* ("semantic" memory) is usually found in a book, computer, list, or other information source.

Contextual/Episodic memory has some special qualities:

- unlimited capacity;
- forms quickly;
- is easily updated;
- requires no practice;
- is effortless; and
- is used naturally by everyone.

Content/Semantic memory has very different qualities:

- requires rehearsal;
- is difficult to update, change, and revise;
- has strict limits; and
- often requires extrinsic motivation.

In one study, Fabiani, et. al. (1990), learners were asked to use either rote or elaborate strategies to memorize words. Those using the rote method had higher forgetfulness ratios and a lower recall performance. The rote method involved simple repetition, also called "semantic" memory. Bahrick (1975, 1983, 1984) and Bahrick and Hall (1991) demonstrated remarkable recall across many content areas when careful attention was paid to *contextual/episodic memory*. Ninety percent of what is retained is contextually embedded information (vs. rote).

## Storage and retrieval of information

How does the brain store and retrieve information? The brain is, of course, the primary site of processing of sensory input and controls the generation of responses. Traditionally, the brain is described as lateral, containing a right hemisphere that is intuitive and creative, and a left hemisphere that is verbal and analytical. However, research does not conclusively support this view of brain laterality. Driscoll (1994) highlights three important structures in the brain that are associated with memory: the frontal lobe, parietal lobe, and hippocampus. The frontal lobe controls attention and speech, while the parietal lobe directs the organization of information and language. The hippocampus, part of the mid-brain, is responsible for semantic and episodic memory.

The brain is made up of billions of cells which fall into two categories: neurons and glia (or interneurons). Glia compose most of the brain's cells and perform various functions, including transporting nutrients and regulating the immune system. Only ten percent of the brain's cells are neurons and they are arranged in a network pattern. Communication between different areas of the brain occurs via these "neuron pathways." The pathways are electrical, but information must be transmitted between these neurons in a chemical form. Chemicals called neurotransmitters carry the electrical signals from one nerve to the next, and a shortage of certain neurotransmitters can cause a disruption in the signal. Neurons are coated with a myelin sheath that allows for greater electrical impulse connectivity. Physically strengthening the myelin sheath through different experiences allows for incredible complexity of recall. Thus, the neurophysiology of the brain can determine how effectively information will be processed.

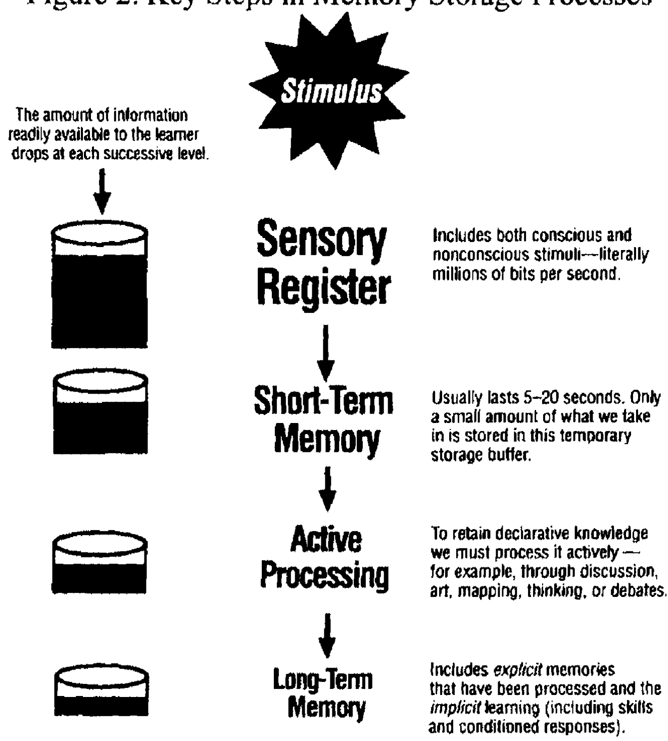
Recent neuroscientific findings have given educators new ways to understand teaching and learning. Wolfe and Brandt (1998) offer three recent findings:

1. The brain changes physiologically as a result of experience.
2. IQ is not fixed at birth.
3. Some abilities are acquired more easily during a certain "window of opportunity."

Other neurological experts disagree on the value these findings have for education. John Bruer (1999) believes that new findings on the critical periods in the development of the brain will have little relevant impact on education. Fischer and Rose (1998) have replaced the idea that development occurs as a sequence of stages with the biological concept of a recurring cycle of growth.

How does the process of memory actually work? Storage and retrieval systems in the brain have been described in several different models. Generally, memory is triggered by a stimulus that is obtained via our five senses. Stevich (1996) has identified seven sensory modalities that help us obtain information: visual, auditory, cutaneous, kinesthetic, gustatory, olfactory, and organic. These modalities go well beyond the five senses (sight, hearing, smell, taste, and feel) that are usually considered in a traditional view of sensory input. Once information has been obtained, it must be processed in the brain. The information processing theory has been widely accepted as a valid model. According to this model, information gained from various is stored in short-term memory for a period of time. If the information does not need to be stored in long-term memory, then a response is made and the information is discarded. Through rehearsal and encoding techniques, the information can be stored in long-term memory if necessary (Atkinson and Shiffrin, 1968). The dual coding model is similar to this theory, but stimuli are processed both verbally and visually. A third model, ISM (Image-Somatic response-Meaning), involves forming an image of the information, creating a somatic response, and then attaching a meaning to that information to allow it to be stored in long-term memory. The general process of memory storage is summarized in Figure 2.

Figure 2. Key Steps in Memory Storage Processes




(Jensen, 1998, p. 105)

Janet Metcalfe Eich (1982) developed a Composite Holographic Associative Recall Model (CHARM) that describes association formation, storage, and retrieval of information. According to this model, items are associated by the operation of convolution and the associations are stored by being superimposed in a composite memory trace. A response is selected by matching retrieved items with all of the items in semantic memory. Thus, retrieval occurs by means of the operation of correlation. This model is unique because it stores both item and associative information in a single trace. This model also gives some insight as to how people can alter and mentally transform old ideas into new ones.

Once information is stored in long-term memory, it must be retrieved in order to be used. If a pathway has been established for the retrieval of that information, the information can be readily used. Each time new information is presented, the network of neurons in the brain must increase in complexity if that information is going to be remembered. Experiences that increase the complexity of the neuronal network help students to comprehend and remember more information. Specific recall techniques can enhance this networking and consequently enhance memory in students. Mnemonic devices, for example, enhance recall by creating cognitive cuing structures according to the following principles: meaningfulness, organization, association, visualization, attention, interest, and feedback (Highbee, 1977).

The Canadian psychologist Donald Hebb hypothesized more than 50 years ago that memory and learning had occurred when a cell requires *less* input from another cell the next time it is activated. At MIT, the research team of Nobel Laureates Tonegawa and Kandel identified a single specific gene that activates the above memory process (Saltus, 1997). There is a genetic base for one person to have a better memory than another. Neurobiologist Eric Kandel from Columbia University has identified a critical protein molecule, known as CREB. It serves as a logic switch, signaling nerve cells to store the memory as short-term or permanently engrave it in long-term memory (Wickelgren, 1996).

There is no single location in the brain for all memories. The process for retrieval is much more consistent within individuals than is the location from which the memory was elicited. The retrieval process activates dormant neurons to trigger our memories. Calvin (1996) and Gazzaniga (1997) state that memory and retrieval cannot be separated. Memory is determined by what kind of retrieval process is activated. Each type of learning requires its own type of triggering. When a sufficient quantity of the right type of neurons that are firing in the right way are stimulated, retrieval is successful. In larger patterns, whole neuronal networks can be activated (Calvin, 1996). The more experiences you have, the more possibilities there are for complexity of neuronal networks.

For most of our word-based recalling, we use mental "indexes" to help us find the word we want (Damasio, 1994). A word like *classroom* is very likely stored and connected to several related indexes like school, teacher, peer groups, or specific content. The neuronal network can be related to hundreds of words which are instantly up on a screen to access for thought and sentences formation. The more experiences we have had, the greater the resources and complexity of connectedness in the network. We retrieve five synonyms that have subtle differences. We may use a word that does not quite reflect what we mean and then correct ourselves. Or, it is also possible to retrieve a word that sounds like the word we want to say but does not have the same meaning.

The limbic, or inner mid-brain, contains the hippocampus which is active for the formation of spatial and other explicit memories, such as memory for speaking, reading, and recall about an emotional event. Connected to the hippocampus, the amygdala is quite active for implicit, usually negative, emotional events. This close proximity of the amygdala can interefere with memory. Consequently, anxiety and stress directly interfere with memory. Neural bundles of fibers from the amygdala activate the release of chemicals which immediately diminish the normal pathway processing used for recall (LeDoux, 1996).

All content knowledge is housed in an emotional casing. If someone tells you that you will have a test on this document, retrieval will occur for the neuronal network associated with "test" and in milliseconds, the emotional array from past test experiences will be experienced before any other processing occurs. If the past has been positive, receptivity continues to be high. If the past has been negative, receptivity will be lowered and strategies will be needed to curb anxiety or anger (LeDoux, 1996).

## Memory strategies

### Mnemonics

Perhaps one of the oldest and most popular memory enhancement techniques, mnemonics can be used to learn different sets of material by constructing systems to aid retrieval. Mnemonic strategies have been in use for more than 2,000 years, but most of the experimental research on mnemonics has been conducted in the last 15 years. These strategies are primarily used for recall of information and they do little to foster understanding of material. Mnemonic strategies are occasionally called upon to promote recall in students, but they cannot be used intuitively. Students must be taught these strategies and advised how to use them.

Mnemonics can be divided into three categories: peg-type, chain-type, and encoding. Peg-type mnemonics include the method of loci, in which a mental image of a location acts as a prompt, and peg-word mnemonics, in which an image of a concrete object acts as a prompt. Chain-type mnemonics, such as the story mnemonic and link mnemonic, involve an overlapping series of images that associate a sequence of items and act like links in a chain. Encoding mnemonics are sometimes referred to as single-use mnemonics because they require the creation of a new organizational mnemonic for each set of information that must be remembered.

Despite the fact that mnemonic devices do little or nothing to help students understand the content of the material being learned, they greatly enhance learning and recall. Carlson, et. al., (1976) reported that students who spontaneously used a mnemonic device in learning a list of words had a mean GPA of 2.80, while those who did not use a mnemonic device had a mean GPA of 2.37. Mnemonics can also be used to learn prose, spelling, historical facts and figures, and vocabulary.

The question now becomes: How can teachers arrange and organize a curriculum that includes both content and memory enhancement strategies? According to Bloom's taxonomy, knowledge is the recall of material such as facts, dates, and principles. Memory enhancement strategies such as mnemonics are readily used at this level of learning. However, these strategies are much more difficult to apply to the upper levels of Bloom's taxonomy such as comprehension and application. Comprehension involves more than just recall; information must be encoded to be comprehended. Since students are often expected to learn from texts, strategies that assist them in reading and understanding texts would be most helpful. Teachers should be very sensitive to their students' reading abilities and the degree of difficulty of texts. Kintsch (1994) found that for readers with adequate background knowledge, texts with coherent gaps that stimulate constructive activities are better for learning than texts that are as coherent and explicit as possible. For low-knowledge readers, however, highly coherent, explicit texts improved their performance on reading comprehension tests. Advance organizers are often used by teachers to help students with difficult texts, but research on their effectiveness is inconsistent. Thus, the match between reading ability and coherence of text seems to be of utmost importance to increasing skills in reading comprehension.

Application, according to Bloom, requires that students apply rules or principles to a new situation. Thus, students need to remember not only rules or principles, but also when and how to use them. When teaching rules or principles that students will be expected to be able to apply to other situations, teachers should provide an indication of when the rules apply. Constructing a mnemonic device can be very helpful in these situations. Learning-disabled students especially benefit from using acronym mnemonics in mathematics to learn basic facts and solve word problems (Miller & Mercer, 1993).

**Instructional Approaches**

As today's teachers face the challenges of meeting their students' needs, support becomes increasingly important. Teachers are expected to cover more material in less time while expectations for students are rising. These challenges have created a need for instructional approaches such as Content Enhancement (Schumaker, et. al., 1998) that are effective and acceptable to both teachers and students. Content Enhancement involves making decisions about what content to teach, manipulating and translating that content into easy-to-understand formats, and presenting it in memorable ways. Part of this Content Enhancement Series is called the Recall Enhancement Routine, which was originally developed to help students study for tests. As part of the routine, a *Recall Device* is presented to students. During the presentation of the Recall Device, teachers follow a set of *Linking Steps* that are imbedded within the instructional sequence called the *Cue-Do-Review Sequence*. The Cue-Do-Review sequence serves three purposes:

1. It gets students ready to learn the information and the Recall Device.
2. It co-constructs the Recall Device with students.
3. It checks the students' recall of the Recall Device and the information.

Research on the Recall Enhancement Routine has shown that teachers easily learn to use it and students benefit from its use (Bulgren, Deshler, & Schumaker, 1997). However, implementing such a program into an existing curriculum could only be possible under certain circumstances. First, teachers must be trained to use this routine, and training may present personnel and funding issues. Second, the training must continue throughout the academic year with workshops that may infringe on teachers' planning time. Third, the program and teachers that use the program must receive administrative support.

**Supportive/ Social-Emotional Content**

Collaborative learning is highly memory-inducing. When learners share ideas and collaborate about content, there is an increase in intellectual functioning, recall and complexity of neuronal networks. What is important to remember in this collaborative work is that the dialogue and exchange needs to be kept just above the level where children can perform independently.

Vygotsky calls this the *Zone of Proximal Development.* He noted that children interacting toward a common goal tend to regulate each other's actions. Other researchers (e.g. Forman & Cazden, 1986) have observed that when students work together on complex tasks, they assist each other in much the same way adults assist children. In such tasks, dialogue consists of mutual regulation. Together, they can solve difficult problems that they cannot solve working independently.

As learning increases, the collaboration is not as necessary and greater responsibility for the task is given to the individual. Jerome Bruner and his colleagues call this *scaffolding*. A scaffold, as it is known in building construction, provides support and allows the worker to accomplish a task not otherwise possible. Scaffolding allows learners to construct knowledge using the instructor or an advanced peer as a supportive tool. It takes place within a child's zone of proximal development or the level in which a child can perform a task with help.

## Integrated, Contextual, Natural Learning Environments

Integration of content increases recall of a subject (Boller and Rovee-Collier, 1992). When patterns and relationships across content areas are clearer, greater memory occurs. This allows for easier neuronal network connections (scaffolding) to previously learned material.

In real life, we don't "study" science as a separate subject between 10:00 a.m. and 10:40 a.m. We learn much of our "curriculum" through natural, contextual settings. For example, as the seasons of the year change, so does nature. We learn the effects of light, temperature, etc. through our daily experiences. Out of problems and needs that are results of experiences, we attend and remember what is essential. To increase memory, teachers should create as many natural, contextual settings as possible for embedding key ideas, present familiar examples, and dramatically enact behaviors associated with content or processes. They should also use analogies and metaphors frequently and demonstrate and model more often.

Story is one of the main resources for making such settings. Any content told in story form is more memorable. This is true, of course, in history: A Story of Us. But it is also true for ALL content areas. That is because story is about relationship. Relationship exists both within content and among content areas. Mathematics is about relationship of numbers. English is about relationship of words. Both are major communication systems to increase relationships with others. Stories that explain many complex relationships across content areas will provide a *cognitive map* to help with memory. This cognitive map/neuronal network/scaffolding is the neurological structure needed to assist with recall.

Sylwester (1995) states that although storytelling is a natural process that we generally do not consciously carry out, the formation of a story is a memory process involving five stages. The stages are as follows:

1. *Define the gist.* Key elements of the total experience constitute the gist, or essence, of the experience.
2. *Sequence the activities.* The events of the experience can be arranged chronologically, in terms of importance, or in a customized sequence to enhance memory.
3. *Index the story.* Key concepts and terms can be indexed to facilitate recall.
4. *Tell the story.* Pieces of the story can actually be made up during the telling using natural conversational language.
5. *Amplify the story.* Details that were not necessarily stored in long-term memory can be inserted.

Many things cannot be communicated easily outside the context of a story. For example, telling a family member what we did during the day requires using the framework of a story. Storytelling can also be used to define a word and it often works better than a dictionary because it creates many connections for remembering the meaning of the word (Sylwester, 1995).

**Novelty**

Making something *new* and *different* increases abilities to remember. Our brains are designed to make meaning out of every new event. The ones that get the most attention are the ones that do not follow known patterns already in the brain. The body's natural stress levels are increased to pay more attention.

Adrenaline is produced to determine any possible relationship to known patterns. If there is enough similarity in this new experience to an old one, then scaffolding occurs. The neuronal networking connections expand to include this *novel* experience and the adrenaline becomes the memory fixative. Cortisol is released if it is too difficult and there is not enough similarity in this new experience to fit into a pattern and scaffold. Stress, frustration and negativity occur and become associated with the content (McGaugh et al. 1990).

Novelty is increased when using an approach called *problem-based learning.* The brain is much more attentive and remembers better if students are given real world problems to solve in context. Begin with the required curriculum content (Standards of Learning).

- What problems *naturally* occur out of this content?
- Is the problem *appropriate* for my students?
- Is the question broad enough that it addresses real-life, contextual issues?
- Can they actually answer (get closure) from this problem?

EXAMPLE:
Content: *World War II*
Theme/Integration: <u>The Diary of Anne Frank</u> LanguageArts/History SOLS
Problem: How do people accept differences in others?
How do people not show acceptance of differences in others?

Studying World War II suddenly becomes very engaging when such a current issue is made the problem for study. The above problem helps to provide the level of novelty needed. It also lends itself well for positions and debates that intrigue students and increase memory.

**The Arts**

Visual arts, music, drama, and movement used to present content assist with recall for that content. All of them activate distinct parts of the brain, but are also highly interrelated with what Howard Gardner (1993) describes as multiple intelligences.
The arts expand on the meaning of knowledge and provide a variety of qualities to the content. They are accessed in conjunction with recall of core content as described in the Standards of Learning. According to the College Board in 1995-96, students who studied in the arts outscored their non-art peers by 59 points in SAT verbal sections and by 44 points in the math segments. The arts enable children to use complex symbols to communicate. Serious study of the arts requires analysis, synthesis, and evaluation of intricate information. These critical thinking skills lead to improved performance in all subjects and endeavors in the workplace.

Because humans are mobile throughout life, we need an intelligent cognitive system that can transform sensory input and imagination into appropriate motor output. In their uniquely integrative way, the arts provide opportunities to:

1. heighten motor skills that we call *performance* and
2. appreciate sensory-motor capabilities that we call *aesthetics*.

Our sensory system and finely controlled movements are central to the visual, aural, and movement arts. For example, we have distinct neural systems that process musical and language elements. Tone, melody, harmony, and rhythm are accessed in conjunction with verbal messages to give subtlety to responses. The appropriate contextual verbal response can be produced based on the evaluation of the setting.

Research about the relationship between music and spatial-temporal reasoning has been completed by Rauscher et. al. (1997). Training was provided for piano keyboarding, computers, and singing in preschool children. The piano keyboarding group dramatically improved in spatial-temporal reasoning. Their abilities to understand proportion and temporal sequences of spatial patterns increased as a result of music training. These abilities are used heavily in mathematics and science.

Teachers should use Howard Gardner's multiple intelligence (Appendix C) approach to the curriculum to open as many cognitive doors as possible. They should present information to students via one intelligence and then challenge them to paraphrase it using another. They should develop open-ended projects that encouraged students to explore multiple approaches to learning the material. They should encourage students with different interests and abilities to work together. Gardner's focus on the complexity of intelligence has provided welcome scientific support for those who have long believed that verbal/linguistic and mathematical/logical intelligences are not the only intelligences we use in learning.

### Graphic Organizers

Graphic organizers match the *mapping* in the brain that occurs in learning. The neuronal networks or scaffolding are built on *patterns* and *relationships*. The graphic organizer forms a powerful visual picture of information and allows the mind to "see" patterns and relationships for large amounts of content. The brain then "distills" these ideas into *conceptual pegs* on which a great deal of information can be placed.

The calendar is an example of a descriptive matrix. It helps us to gather, sift, sort, and share information. Many other visual forms of organizing are possible and the forms are becoming more highly personalized to reflect individual thinking through software programs.

### Time for Exploration

We know that repeating experiences increases memory for them. We also know that daily drilling must be kept to a minimum before the brain decreases attention and is no longer receptive to memorizing content. The nature of teaching memory strategies has been described above but the issue of repetition has not been addressed. "Coverage" is *not* sufficient. "Finishing the book" does not describe the quality and complexity of the stored knowledge. It is essential for learners to revisit material as they study new content. As they are exploring new material, it is very helpful to reference links in this new setting with former bodies of knowledge.

## Content-specific strategies

Gillam (1998) developed six strategies to enhance language learning in all subjects through memory enhancement strategies. They are as follows:

1. Promote attention by pre-activating relevant information in long-term memory or helping children selectively attend to the most critical information.
2. Speak clearly and slowly so that learners have more time to process information.
3. Promote phonological coding by using rhymes or phonological awareness training.
4. Plan activities around familiar topics or concepts.
5. Help children organize new knowledge by chunking or other methods.
6. Provide students with retention cues by using questions, summaries, drawings, and pictures.

While these strategies are useful in all subject areas, content areas such as mathematics, science, social studies, English, and language arts each have specific memory enhancement strategies that are particularly effective.

## Mathematics

In the subject area of mathematics, many teachers use mnemonics. In algebra, for example, students who have trouble remembering the order in which binomials are multiplied can use "FOIL," which stands for first terms, outer terms, inner terms, and last terms. Sometimes, however, students need more than a simple memory device. Mathematics involves mental arithmetic which requires the temporary storage of information while new information is being processed and other cognitive tasks are being performed. A number of studies have reported short-term memory deficits in children with arithmetical difficulties, but Bull and Johnston (1997) concluded that these children also have problems in automating basic arithmetic facts which may stem from a general speed-of-processing deficit. Therefore, frequent practice of basic skills can be a simple way to raise achievement for students with mathematical difficulties.

## Science

Science can be challenging for many students because the terminology is often unfamiliar and problem-solving requires very methodical thinking. A good way to help students learn difficult terminology and develop problem-solving skills is to design instruction in the format of a bridge (Stevick, 1996). This format for organizing lessons is based on an idea developed by Henry Widdowson in 1978. The first phase in designing a bridge is the DO phase, in which teachers create instruction that is relevant, rewarding, and rich. In the second phase, OBSERVATION, students listen and read to discover how others have handled a task that they are about to undertake. This is the second phase in designing a bridge, but the first phase in using one. The final phase in designing a bridge, SPAN, is actually the middle phase in using the bridge. Here, learners engage in activities that explore meaning and add content to their holding memories. Such activities might include flashcards, comprehension questions, charts, or drill exercises.

## English/Language Arts

Educators agree that strong reading comprehension skills are essential for success in the classroom. To sharpen these skills, students must first differentiate between content area reading and leisure reading. Students should not use the same techniques for reading a science textbook that they do for reading a comic book. Reading specialists can help students comprehend more challenging texts by introducing and modeling memory strategies, but they are often the first to lose their jobs when middle and high schools are faced with budget cuts (Vacca, 1998). Thus, regular classroom teachers are left on their own in dealing with the literacy development of their students.

Salembier (1999) devised a novel system of cues called "SCAN and RUN" to increase reading comprehension in students. This mnemonic consists of seven cues for strategies that assist students with planning and monitoring their comprehension before, during, and after reading text. Before reading the text, students SCAN the material to activate prior knowledge and preview the selection. SCAN stands for: Survey headings and turn them into questions, Capture the captions and visuals, Attack boldface words, and Note and read the chapter questions. While reading, students use the RUN cues to monitor comprehension and expand their understanding of the text. RUN stands for: Read and adjust speed, Use sounding it out skills, and Notice and check parts I don't understand and reread or read on. After reading, students answer questions and participate in a class discussion. SCAN and RUN can be helpful to students, but it is also easy, inexpensive, and requires little training for teachers.

One of the ways that memory is increased for content is to develop abilities to image the material or "picture it in the mind". Research shows that students with the best reading comprehension skills are excellent at being able to recall the images they make while reading material. Bales (1984), Carrier, et al. (1983), and Gambrell & Bales (1986), found that oral imagery instructions led to better recall performance as opposed to imagery imposed instructions. Finnerty (1993) also found that imagery inducing (oral storytelling) led to increased reading comprehension. Imagery imposed (video) instruction methods decreased levels of reading comprehension.

Although visuals such as graphic organizers can assist with memory at a later point, the opportunity needs to occur for the brain to form its personal image initially. It would be desirable to increase imagery inducing instructional methods in the classroom to enhance memory and comprehension. This would be especially true for lesson advanced organizers and for initial stages of content presentation. This part of instruction would be oriented toward story, the arts, and contextual experiences to maximize learning.

Greater numbers of children are having difficulty with attention and memory. They are also receiving more hours of what is called *imagery imposed instruction* (Healy, 1998). The kinds of instruction that are imagery imposed would be television, video and computer games. These processes are registered by the brain as providing the stimulus and the response. They replace valuable time designed by the brain to be having imagery inducing instruction as described above. This is especially true of the preschool years. After age seven, if the experiences have been there to fire up the neuronal pathways needed later for symbolic work required in school, there is not as much damage. The earliest years are the most critical by far (Begley, 1996).

Another effective technique for language learning is chunking. The term "chunking" implies that large amounts of information are broken into smaller pieces. The smaller pieces, or "chunks", are usually meaningful, familiar terms. For example, the Turkish saying "*bilmeyenbilmez*" is written as a sequence of 14 letters. An advanced learner would break this saying into chunks: *bil-* (="know"); *-me-* (="negative"); *-en* (="one who"), and so on, and memorize these (Stevick, 1996). Chunking allows students to remember remarkable amounts of information if teachers build the chunks up skillfully and encourage students to have faith that they can handle the task.

**Social Studies**

Students with reading comprehension deficits often struggle in social studies because this content area assumes that students are proficient readers and are able to remember what they have read. Strategies that enhance reading comprehension, such as SCAN and RUN, can be very helpful. Study skills such as outlining and summarizing are used heavily in this content area and students should be given every opportunity to develop those skills. Teachers should take advantage of the chance to allow students to use several different types of memory in their social studies classes. Social studies teachers can use episodic strategies to enhance recall. The movie *Dead Poets Society* showed examples of why students recalled so much of their learning. There were changes in location, circumstances, use of emotions, movement, and novel classroom positions. Students remember more when learning is connected to a field trip, music, a guest speaker, or a novel learning location (Jensen, 1998). Procedural strategies can also help students learn new information. Teachers can create role plays or reenactments that give students a way to remember in what order things happened. Students can also write a song or a story that is meaningful to them.

**Technology**

Our brain has developed various forms of technology to solve biologically impossible memory tasks. For instance, our phone books eliminate the need to memorize hundreds of phone numbers. The dictionary allows us to access words when needed. Calculators give us the power to multiply and divide large numbers without having to recall multiplication or division rules. Technology provides us with resources we have not had before. However, students need to learn to use technology effectively by practicing strategies used to access information. For example, many students use the internet to do research, but to do so, they need to remember how to get on the internet and how to perform a search for specific information. Teachers can help students develop these skills by giving them the opportunity to practice often, allowing them to develop a base knowledge so that information on technology can be generated from memory.

# Conclusion

In conclusion, teaching with the brain and its workings in mind is not just a good idea; it is an essential part of education as we move into the 21st century. Education is not just about teaching anymore. Today, it is about teaching and *learning*. Learning requires memory, so it is well worth an educator's time to understand how memory enhancement techniques can affect learning.

Memory and learning strategies have briefly been described in this document. It does not provide all of the new research but highlights and defines significant directions educators would take to increase memory and learning. This study describes primarily the *processes* (not programs) that would match what we know from research. Some information on programs in memory enhancement is available in Appendix D. Some of the processes may already be in place at some level but in many classrooms, they are not operational enough to impact learning. This document does not translate the degree or quality of the implementation; educators need training to develop and implement the recommendations. It creates shifts in the school learning environment, curriculum presentation formats, and instruction. An annotated bibliography (Appendix E) is provided to facilitate the translation of the information presented in this document. Schools in Virginia have a most challenging set of criteria to meet at this time. Both acquisition and application of knowledge would increase with implementation of these strategies.

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# Appendix A

**HOUSE JOINT RESOLUTION NO. 678**

Offered January 21, 1999

*Requesting the Department of Education to study age-appropriate techniques to improve the memory of students.*

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Patrons – Marshall, Councill, Darner, Day, Diamondstein, Dillard and Hamilton

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Referred to Committee on Education

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WHEREAS, human memory is the mental ability to retain and recall facts and past experiences; and

WHEREAS, neuroscientists and cognitive researchers have explored and unraveled many mysteries concerning the brain and its marvelous ability to store and retrieve information; and

WHEREAS, students must learn and recall many facts and figures during their school careers, yet few educators use the data and information learned from highly sophisticated and technical research findings on the brain and memory to enhance learning in the classroom; and

WHEREAS, much of what we require students to learn requires strong reading comprehension skills, short-term and long-term memory, and the ability to make associations between events and facts and to understand the significance of such facts; and

WHEREAS, research indicates that individuals can be trained to use more of their mental abilities, and such techniques are now used by scientists, mathematicians, business tycoons, athletes, and other professionals who are required to recall complicated data and information and to apply facts that they remember; and

WHEREAS, given a more rigorous curriculum and stringent requirements that affect all students, enhanced learning and improved tests scores may result if teachers are encouraged to make effective use of sound medical research findings on the brain and its capacity for recall and application of facts; now, therefore, be it

RESOLVED by the House of Delegates, the Senate concurring, That the Department of Education be requested to study age-appropriate techniques to improve the memory of students. In conducting the study, the Department shall examine the need for strong reading, speed, and comprehension skill vis-à-vis course work and curriculum content requirements; consider the medical and scientific foundation regarding the human capacity for memory; review information concerning the effectiveness of memory training enhancement and memory recall techniques; identify ways to help students stretch their minds to comprehend, recall, and apply facts, understand the significance of the facts, and use memory techniques for success in the classroom and on tests; and disseminate the Department's findings to all school divisions. The Department shall conduct a literature search regarding the use of memory training enhancement and recall techniques, confer with neuroscientists, cognition research experts, the medical profession, reading specialists, and educators who have used memory course work and techniques to assist students in learning.

All agencies of the Commonwealth shall provide assistance to the Department, upon request.

# Appendix B

## Bloom's taxonomy of cognitive outcomes

| | |
|---|---|
| Knowledge | Remembering previously learned material, including facts, vocabulary, concepts, and principles |
| Comprehension | Grasping the meaning of material |
| Application | Using abstractions, rules, principles, ideas, and other information in concrete situations |
| Analysis | Breaking down material into its constituent elements or parts |
| Synthesis | Combining elements, pieces, or parts to form a whole or constitute a new pattern or structure |
| Evaluation | Making judgments about the extent to which methods or materials satisfy extant criteria |

(Driscoll, 1994, p. 335)

# Appendix C

## Gardner's theory of multiple intelligences

The theory of multiple intelligences, proposed by Howard Gardner in 1983, suggests the existence of several human intelligences. Intelligence is defined as the capacity to solve problems or to fashion products that are valued in one or more cultural settings. The seven intelligences are listed below.

***Logical-mathematical***

***Linguistic***

***Musical***

***Spatial***

***Bodily-kinesthetic***

***Interpersonal***

***Intrapersonal***

# Appendix D

## Resources

***Lindamood-Bell Learning Processes*** offers conferences, programs, workshops, and publications to assist teachers and students in reading, spelling, and comprehension. A major emphasis of the training programs offered is on improving memory to enhance learning. For more information, contact Barabara Scott at (804) 794-2103 or

Lindamood-Bell Learning Processes
416 Higuera Street
San Luis Obispo, CA 93401
(800) 233-1819 (805) 541-3836
http:/www.lblp.com

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***The University of Kansas Center for Research on Learning*** has been an excellent source for research findings on learning and strategies that promote student academic and behavioral progress. A recent thrust of the work at the center has been memory enhancement. For more information, particularly about the Content Enhancement Series, contact:

University of Kansas Center for Research on Learning
3061 Dole
Lawrence, KS 66045
Order desk: (785) 864-0617
Main office: (785) 864-4780
http://www.ku-crl.org/

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***The Institute for Neurolearning at the University of Virginia Richmond Center*** offers training seminars that help teachers translate research on memory enhancement into effective classroom practices. For further information or questions contact:

Dr. Joyce Finnerty, Executive Director
Institute for Neurolearning, University of Virginia, Richmond Center
7740 Shrader Road
Richmond, VA 23228
(804) 662-7464 FAX (804) 662-9827
jfinnert@pen.k12.va.us

# Appendix E

## Annotated bibliography

Kelly, E.B. (1994). *Memory enhancement for educators. Fastback 365.* Bloomington, IN: Phi Delta Kappa Educational Foundation.
This Fastback addresses questions that many educators have about memory strategies and techniques. It provides a summary of facts about memory and memory enhancement strategies as well as covering teaching techniques to help students learn these strategies.

Sealander, K.A. (1999). Collaboration for success: simple instructional strategies for the classroom. *The School Psychologist, 53 (3)*, 65, 68-70.
This article presents several easy-to-implement strategies that school personnel and parents can use. The strategies are in the form of mnemonics and are identified for several different content areas.

Schumaker, J.B., Bulgren, J.A., Deshler, D.D., & Lenz, B.K. (1998). *The content enhancement series.* USA: The University of Kansas.
Developed by researchers at the University of Kansas Center for Research on Learning, this publication contains a series of guidebooks, each of which focus on an important aspect of teaching. One of these guidebooks, the Recall Enhancement Routine, was designed to enable teachers to show students how to create and use mnemonic devices.

Sprenger, M. (1999). *Learning and memory. The brain in action.* Alexandria, Virginia: Association for Supervision and Curriculum Development.
In addition to summarizing recent brain research, this book offers valid, useful ideas that teachers can incorporate into the classroom to bridge the gap between theory and practice.