MEMORY STRATEGIES TO USE WITH STUDENTS FOLLOWING TRAUMATIC BRAIN INJURY

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ABSTRACT

Following a traumatic brain injury, including a mild concussion, most students will have some degree of memory impairment. It can take 1–3 years for a child's memory to improve to its maximum capability following injury. Children cannot wait that long before returning to school. Teachers need to know how to diversify their instruction in order to assist children with traumatic brain injuries in transitioning back to school. Students cannot simply be provided with a list of memory strategies and be expected to use them successfully; a variety of memory strategies is only the beginning. Teachers should know how to select one or two strategies that will work best given a student's individual strengths. These strategies must then be taught through repetition, practice and assisted use until the employment of those strategies becomes automatic. This article will (1) explain a variety of memory strategies and how to select strategies based on students' strengths, (2) compare several scan-and-read software programs presently available to schools and explain how to use them as memory aides, and (3) provide memory tools to use in studying for tests.

The greatest drawback to students' learning after a traumatic brain injury (TBI) is their poor memory. Part of the reason for this, according to the Department of Psychology at Bar-Ilan University (Vakil, 2005) in Israel, is that TBI affects a large range of memory aspects and does not selectively impair memory. Even students who have suffered only mild concussions will

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experience difficulties with memory that they never had before. The National Institute of Neurological Disorders and Stroke (2004) states that "the most common cognitive impairment among severely head-injured patients is memory loss, characterized by some loss of specific memories and the partial inability to form or store new ones" (p. 10).

The IDEA 1997 initiated Traumatic Brain Injury as a classification for special education services in schools. In 1998 the National Institutes of Health Consensus Panel on Comprehensive Rehabilitation Strategy for Brain Injury emphasized the importance of schools in serving children with TBI. School services for children with disabilities must include strategies to assist those who have TBI. This is difficult due to the wide range of impairments that TBI can cause.

Memory loss is not immediately visible as a result of the brain injury (Vakil, 2005). Students often do not realize how poor their memory is until they try to perform an assignment or take a test after their return to school. However, it should be the first concern of their teachers when they provide classroom accommodations for students who have experienced a traumatic brain injury. Finding memory strategies is relatively easy these days with the internet search engines. Knowing which strategies will work for a specific student is challenging, however, especially for teachers with large student caseloads and no training in special education. This article will address a variety of memory strategies, and will offer suggestions of how to use these strategies as well as how to match memory strategies to the specific needs of each student with memory impairment.

TYPES OF MEMORY

Everyone utilizes three types of memory: Short Term Memory, Active Working Memory and Long Term Memory. Levine of the All Kinds of Minds Institute (Levine, 2002b) calls these the "mind's storage depots" (p. 92). (See Figure 1 for concise definitions of memory.)

Short Term Memory works with data for just a brief time; i.e.: remembering what a teacher has said long enough to write it down in a notebook; recalling a person's name just during an introduction; or remembering the question long enough to write or state an answer. According to this diagram, data enter the brain at the short term memory "depot" in the parietal lobe. From this point the person uses the information and forgets it, sends it to Long Term Memory for later use, or uses the information and then sends it to Long Term Memory. While the data are in Short Term Memory, Active Working Memory maintains it until the activity is completed. For example,
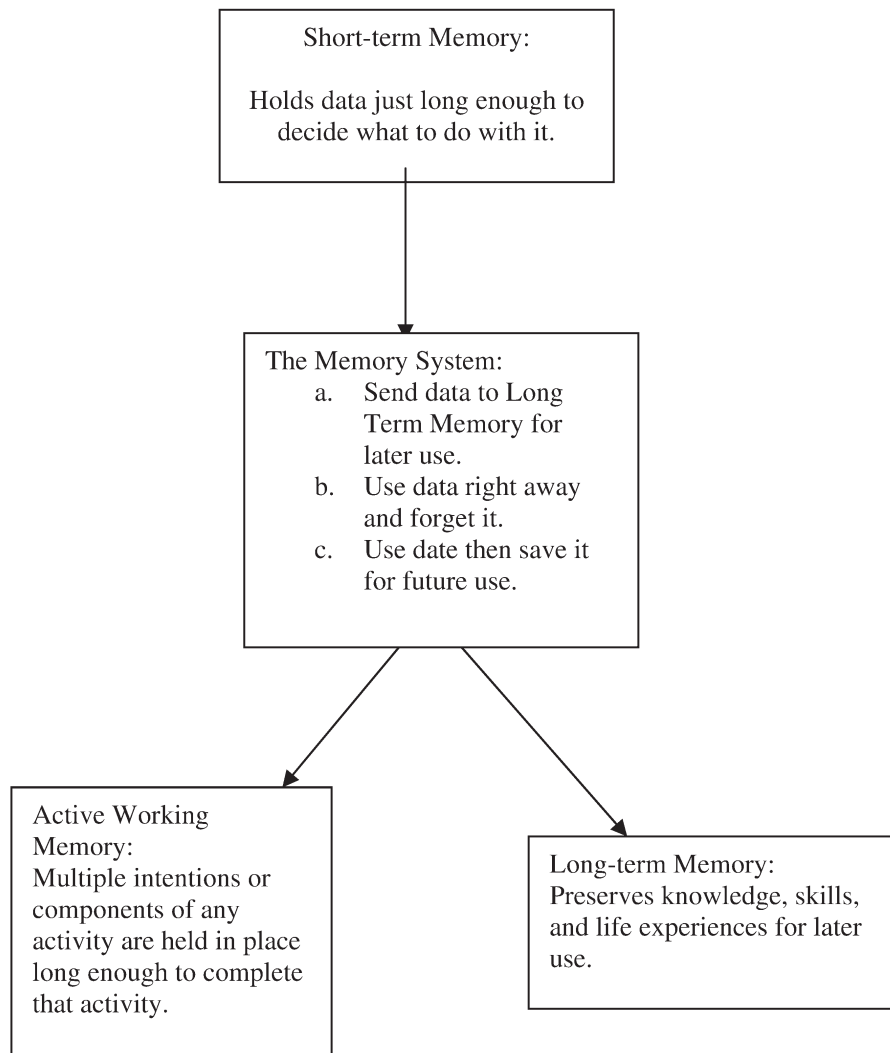
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┌─────────────────────────────────┐
│     Short-term Memory:          │
│                                 │
│   Holds data just long enough to│
│     decide what to do with it.  │
└─────────────────────────────────┘
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┌─────────────────────────────────┐
│  The Memory System:             │
│     a.  Send data to Long       │
│         Term Memory for         │
│         later use.              │
│     b.  Use data right away     │
│         and forget it.          │
│     c.  Use date then save it   │
│         for future use.         │
└─────────────────────────────────┘
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┌───────────────────────┐          ┌───────────────────────┐
│ Active Working        │          │ Long-term Memory:     │
│ Memory:               │          │ Preserves knowledge,  │
│ Multiple intentions or│          │ skills, and life      │
│ components of any     │          │ experiences for later │
│ activity are held in  │          │ use.                  │
│ place long enough to  │          └───────────────────────┘
│ complete that activity.│
└───────────────────────┘
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Figure 1,

(Levine, 2002b)

Active Working Memory keeps the data read in the first sentence available until the end of the reading section in order for the brain to determine whether to save the data in Long Term Memory or erase it. In this computer-savvy world, everyone learns early that if data are not saved periodically, they will be lost. Sending data to the Long Term Memory depot is similar to clicking the "save" icon in word processing. In a healthy brain, data can be

retrieved from Long Term Memory much like opening a file in word processing. However, a student with a TBI may not be able to recall the data long enough to get it to Long Term Memory. Or, if it gets there, may not be able to retrieve it, depending on where the damage is in the brain. It is not important for teachers to know which is not working. The problem that needs to be addressed is that students with TBI cannot always recall information. Strategies that compensate for the memory process must be taught to these students, and then prompts can be used to assist with making the new process for memory an automatic program in their brain.

While all three types of memory are necessary for good learning, deficits in Active Working Memory undermine a student's ability to accurately complete class work and homework. A student with poor Active Working Memory may have to reread short passages several times before that data can be assimilated and then placed in the appropriate depot. Multi-step math problems are extremely frustrating for students with poor Active Working Memory, especially a good math student who was accustomed to solving problems in his or her head. Recalling where one is in the order of operations becomes a challenge when data are erased before the activity is completed. This, in turn creates frustration for students, teachers and parents. Students may become so upset they will act out aggressively. In some students, especially those who were high achievers before their injury, the loss of Active Working Memory is so defeating that it could cause clinical depression (National Institute of Neurological Disorders and Stroke, 2004). Seeing a student who worked at a high level of accuracy before the TBI suddenly struggle with a simple activity can cause dedicated teachers to question their own abilities. Parents many times agonize over how to get help for a child who seems to be spiraling down to failure. Knowing how memory works and how a TBI can interrupt the memory process is the first step in assisting students with TBI to get back on track with their learning.

STUDENT RISK FACTORS FOR MEMORY DEFICITS

Levine (2002b) writes: "Memory is a complicated multidepartmental operation that does its work at many diverse brain sites, a lot of which have not even been located by neuroscientists" (p. 91). Therefore, memory impairment can result from a multiple of conditions; i.e.: a prolonged illness requiring bed rest or hospitalization, respiratory arrest or distress resulting in loss of oxygen to the brain, high temperatures for prolonged periods of time, suicide attempts, and/or near drowning. The list is endless. The memory process is multidimensional, making it entirely possible for all children to have deficits

in some part of that process. Teachers can provide a variety of memory strategies that will help all children to learn and retain the information for future use. Sousa (2006) suggests that "Learning and retention are different. We can learn something for just a few minutes and then lose it forever" (p. 85) unless teachers encourage students to get it into permanent memory via memory strategies.

All individuals need memory strategies, and most develop their own. However, what may have worked in the past might no longer be a strength for the student who has survived a traumatic brain injury (National Institute of Neurological Disorders and Stroke, 2004). For example, a student with good auditory processing before a traumatic brain injury would be able to hear information once and recall it immediately and long term. After an injury to the temporal lobes that student would attempt to use the same memory strategies as before, but be unsuccessful. Memory can be so impaired that details are not recalled from one day to the next. Some students do not recall information from one class to the next, or long enough to help with homework that evening.

How do teachers identify which students might have memory deficits? Unusually poor grades on a test or different classroom behavior, such as not turning in homework or not participating in a group conversation, should alert teachers that something might have happened to change a student's learning process. Students who had hospital stays due to an accident or trauma, and then returned to school, should be observed for memory deficits. However, students who have mild concussions, and are seen in the emergency room and released right away, are often not identifiable (Lash & Associates Publishing/Training, Inc., 1999). The real message here, though, is that any child who is struggling with learning new material could benefit from learning and using memory strategies.

TYPES OF MEMORY STRATEGIES

Since memory is the overall problem that students with a TBI must rehabilitate, they will need to use strategies to compensate for memory in order to learn. Three general memory strategies will be described: Lock In Memory Strategies, Recall Memory Strategies and Ease of Burden Memory Strategies (bindependent, 2004). Lock-In Memory strategies are those that support data retention. Recall Memory strategies help with data retrieval, and Ease of Burden Memory strategies function as memory prosthetics.

LOCK-IN MEMORY STRATEGIES

Several strategies to lock-in memory are especially useful for students following a Traumatic Brain Injury. These include Rehearsal Strategy, Grouping Strategies, Association Strategies.

Rehearsal Strategy (Levine, 1990) is commonly used to help retain information for the short term. Any time one repeats information several times aloud, whether it is a person's name, a definition, or an address, it is being locked into memory auditorily. By utilizing more than one repetition, the possibility of long term retention is increased. Students should be encouraged to practice rehearsal strategies by repeating information out loud or sotto voce several times.

Grouping Strategies (Levine, 1990) is chunking information into groups, pairs, or categories, thus contracting large pieces of data into memorable size. This is particularly helpful when trying to remember lists. Grouping words that rhyme relies heavily on auditory memory, and works well for students with strong auditory processing. Also helpful with this strategy is to assign the number of items to the group. Recalling the group and the number of items in the group will stimulate the recall of each of the items.

In *Association Strategy* words are matched with objects or pictures. (Levine, 2002a) When language is first learned as a young child, it is learned through association. However, all ages have specific memory associated with smell, taste, view, sound and touch. People use anagrams and colloquial sayings to associate the first letter of each word with the first letter of words in lists. For example; the phrase, My Very Educated Mother Just Served Us Nine Pancakes is used to help recall the order of the planets from the sun. Another association memory tool is the phrase, Please Excuse My Dear Aunt Sally, for the order of operations in Algebra. "Memory strategies date back to early Greek and Roman orators who memorized lengthy speeches. One memory strategy they used was associating each thought to a part of their house; i.e.: first idea—front door, second idea—foyer, third idea—living room. This is where the phrase, 'in the first place' came from" (Lorayne & Lucas, 1996, p. 17). This strategy works well for visual and visual-auditory learners. Students need to be able to visualize the concept or anagram in order to stimulate memory.

RECALL MEMORY STRATEGIES

Once a student has developed a workable strategy for retaining information, then he or she needs to have a process to recall the data. Knowing that the information is locked in memory does not guarantee that the student will automatically recall it when needed. A student who has suffered a traumatic

brain injury needs a back-up system for when recall breaks down. The website www.bindependent.com offers six steps to use to recall a memory. First, "Make a Start". When you cannot recall needed information, write down what you are thinking about and see if that solves the problem. If not, "Jog your Memory" by returning to the last spot when your memory ends. Be in the same physical position as at the time of that memory.

Next, "Relax". Take deep breaths, close eyes and wait a few moments for the memory to materialize. Then, "Form a Habit" for activities that occur daily. Have a hook by the door where keys are hung. When finished with homework, always put it in the book bag and set the bag by the door normally exited when going to school. When papers are returned from the teacher, immediately put them in the correct 3-ring binder notebook.

Recall data in the form of verbal information should be written down for safe retrieval. When asked to "Keep a Journal," students decide if they are most comfortable using an agenda, a Day Planner or a Palm Pilot/Blackberry, and then use that consistently to write down information. Teachers encourage the students to choose something familiar. If the student has always written assignments and or appointments in an agenda, then he or she should also use the agenda to jot down brief conversations or telephone numbers. If before the injury the student was highly proficient with a Palm Pilot or Blackberry, then using that device for recall may come automatically. Teachers of students with brain injuries should adopt this important adage: Teach Memory Strategies, not how to use new and unfamiliar devices.

The final suggestion for Recall Memory is to "Keep and Display Physical Tokens and Mementos". Something physical or concrete works as a great reminder of events and dates. For example: attaching the actual doctor's appointment card to the page of that appointment in the Day Planner. Also, pictures are great mementos. Students who are technically savvy can have a whole journal of pictures taken with camera cell phones and transferred to a printed page.

These strategies will assist students with retrieving data that has been successfully planted in the memory bank. Examples of recall memory strategies are SQR3 Strategy, Visualization and Study Strategies.

SQR3 Strategy (Lee, 2000) uses an anagram to remember what is read. SQR3 stands for Survey, Question, Read, Recite and Review. First, the student Surveys by scanning through the chapter of a text or the index of a reading source, taking in headings, words in bold print, pictures and charts. Next, the student looks for answers to the following broad Questions: What topics are covered? What are the general ideas or objectives? What ideas are recurring themes? What are the new concepts? This is preparation before reading

and should be set up in outline form so when the student actually Reads the assignment, he or she can take notes on each of these areas. Sections that seem confusing should be read several times. Students keep a list of unfamiliar words with their definitions. After this arduous reading, students try to answer the questions they have already posed without looking at their notes. It is best to Recite the answers, or state them out loud, in order to involve more than one sense. Finally, students with memory deficits MUST check and recheck, or Review everything that they do for accuracy.

A good study tool to use with SQR3 strategy is the Study Checklist found in Appendix A. Although somewhat laborious, this tool will not only teach students new study skills, but will provide them with succinct information for notebooks which can then be used for taking tests. It is a great resource for Social Studies or Science classes which have textbooks, new vocabulary and study questions.

To use the Study Checklist in Appendix A the student enters the name of the text on the line under "Study Source". Each time a student sits down to read a chapter, the date is entered in the "Date" column with the chapters read. While reading, the student outlines the chapter or highlight if possible. Any words that the student does not know, not just the words in bold print, are written on a separate sheet of paper labeled, "Word List" for the student to research for definitions and/or pronunciation. When this list is completed with definitions, the student writes the date in the column next to "Word List" and the paper is placed in the subject notebook for use in class and with class tests and quizzes. After reading the chapter, students write out the questions and the answers whether or not it was assigned and these worksheets should also be placed in the subject notebook. If there are no questions at the end of the chapter, the student makes up questions and/or writes questions they have. Once all of these notes have been completed (outline, word lists and questions & answers) the information is chunked and organized in a notebook with tabs for each category used. This will make information easier to find if using notebook as memory when taking classroom tests.

Numbers 7–12 of this checklist are the actual study parts, while numbers 1–6 are preliminary and necessary to have accurate and useful information. Everything that is generated by this checklist is chunked and placed accordingly in the subject notebook. Many teachers at the middle and high school levels require notebook checks. The student who follows this study checklist has a better chance of having an organized notebook.

Many students and teachers do not realize how much extra time is needed to use Memory Strategies appropriately. Students with traumatic brain injury who use this study checklist share their work with their teachers to

ensure that they will be provided extra time to use this technique for more thorough learning. This checklist actually uses the following memory strategies: Rehearsal, Grouping, SQR3, and Study.

Visualization is a memory strategy used by students with poor auditory processing as well as students who develop visual impairments from injury or illness. Students should be encouraged to picture in their minds what is being said to help retain the thought in their memory. They should add color and movement to their minds' picture to stimulate memory. (University of Western Ontario, 2004) The student describes what is seen in order to ascertain that the image has the accuracy to aid memory. Students who do not have visual deficits should draw the picture first, then say the word or phrase paired with the image several times before closing their eyes and "seeing" the image in their minds only.

Using *study strategies* is necessary for most students, but absolutely essential for students who have a traumatic brain injury. Studying for tests with poor active working memory is very defeating. Students who have traumatic brain injuries need to be taught how to study so as not to waste time. The majority will try to study as they have in the past, unaware of what is not retained until they get their very poor grades. These students must be given a variety of study strategies, be taught how and when to use them, and be guided in the practice of using them over several days or weeks until they have internalized the need for and use of the strategies.

Appendix A and Appendix B are two different checklists for use in studying. Middle and high school students are encouraged to use several at one time for thorough studying. Many of the notes generated by these checklists can be used by students when taking a test if they have 'permission to use notes' as an accommodation.

Appendix A was described earlier as an SQR3 Strategy. Appendix B gives students a well-ordered list of activities utilizing all learning styles as well as the following memory strategies: Rehearsal, Grouping, Association, SQR3, Study and Visual Imagery. Point number 9 of this strategy: Review Before Bedtime, is based on research which indicates that students' Long Term Memory works more efficiently during sleep, so it is appropriate to do homework just before bed (University of Western Ontario, 2004).

EASE OF BURDEN MEMORY STRATEGIES

Some students have such poor recall memory that nothing, not even something concrete, will jog their memories. Most students who have a traumatic brain injury find it particularly difficult to recall information they have read from a text. For this, there are "By Pass Strategies" (Levine, 1990). In

this case students use computer software to capture data and keep it organized in notebooks. Below is a graph comparing five different types of software available to help students read text as well as capture data for recall.

The majority of these programs will read scanned material to the student highlighting each word as it is read to assist with attention. The student can

FEATURES	Kurzweil 3000	Wynn Wizard	Text Help 7 Gold	Premier AT E-text Reader	DonJohnston Read:Outloud Solo
Scan Text	X	X	X	X	X
Turn Text to Correct Position	X	X			X
Read Text by Word	X	X	X	X	X
Read Text by Sentence	X	X	X	X	X
Read Text by Paragraph	X	X	X	X	X
Reread Selected Text	X	X	X		X
Dictionary	X	X	X		X
Type in notes on page	X	X		X	X
Color Highlight	X	X		X	X
Mask other words		X			
Inserts Bookmarks				X	X*
Magnifies Print	X	X		X	X
PC Windows	X	X	X	X	X
MAC	X				X
Email	X	X			X
Web	X	X			X
Cost	$1,495	$970	$645	$29.95	$299
Website .com	kurzweiledu	wynnwizard	texthelp	premier-programming	donjohnston

*All information interfaces with and transfers to: Write:Outloud Solo, Draft:Builder Solo Co:Writer Solo

Figure 2.

Software Comparison

stop and have the computer reread at any time. In addition, most of the programs have a dictionary so that any word can be defined. The word and the definition can be extracted to a separate list and printed out at the end of the reading. It is easy to color-coordinate notes using this type of program by highlighting information in different colors. This way the student can "chunk" vital information by color; for example: character in yellow, setting in green, problems in purple, solutions in blue. The highlighted information is extracted and organized before printing and placing in a notebook.

Many school systems have one or more of these programs available; some are more affordable than others for parents to obtain for home use. Many are also available at colleges and universities. For recall, students 1) print out highlighted notes from text, 2) combine these with notes from class, and 3) get permission to use notes for classroom tests. To "study" for tests students should organize the notes in order to find information quickly. Students may need a quiet, separate place to take the test with extra time. As with any memory strategy, a teacher instructs students on the use of this software, to take notes on reading, and provides time to practice using it appropriately for taking tests. Also, only students who are familiar with computers and enjoy using computers are good candidates for this type of memory strategy.

Following even a mild traumatic brain injury, the brain needs time to find detours around the injured neurons in order to complete thoughts and functions (Tyler & Mira, 1999). This takes energy. When the brain fatigues, it takes a break. This is not a long break; just a minute or two. At first students do not realize that this is happening. When the brain rests, no thought is happening. Therefore, anything they read, hear, or write may have voids or confusion from that break. Students must check their work again and again to find these blank spots.

How to Select the Right Memory Strategy

Knowing different kinds of Memory Strategies is a good start to serving a child with a Traumatic Brain Injury. Being able to select the right memory strategy for each child's needs is paramount. Start by detecting the child's preferred learning style. If a student has been identified as an Exceptional Child and has an IEP, teachers can read the Psychological Report to locate the student's learning strengths. Determining a student's favored learning style can be done subjectively through observation and looking for the following clues. An auditory learner will repeat information, read aloud, talk through a problem, close eyes when listening to block out visual distractions, or move lips when reading silently. A visual learner will actually look at the verbal source, even if it is a recorder or CD player. Many visual learners take

copious notes so they can see what is said, or draw a picture before attempting to solve a problem. Kinesthetic learners are the students in the class who wiggle in their seats, tap pencils or jiggle knees. Some part of their body has to be moving in order for learning to take place. Once the preferred learning style has been identified, teachers can use the chart in Figure 3 to select appropriate memory strategies.

SUMMARY

How can students possibly learn new information if they have little or no memory? This is an important question for teachers to ponder if they are notified that they are to receive a student who has a traumatic brain injury. It is vital that students return to their normal routines after they get home from the hospital in order to continue the brain retraining. School is a major part of that recovery process, yet can be very frustrating and defeating if the student returns with no support services or accommodations in place. This

CHOOSING MEMORY STRATEGIES FOR LEARNING STYLES

Preferred Learning Style	Recommended Memory Strategies
Auditory	Rehearsal, Grouping, Association, Relaxation, SQR3, Study, ByPass
Visual	Grouping, Association, Relaxation, SQR3, Visualization, Study, ByPass
Kinesthetic	Relaxation, SQR3, Study, ByPass

Figure 3.

Choosing Memory Strategies for Learning Styles

article offers memory strategies that can be taught to students. These ideas and strategies are offered to teachers in the hope that they will be used not only with students with traumatic brain injuries, but also with other special education and general education students to reinforce their own memory strategies. The goal today for all teachers is to leave no child behind. Teaching memory strategies to all students can help in that endeavor.

A lesson plan that uses children's literature to teach memory strategies is available by contacting the author at andi.pershelli@carolinashealthcare.org.

APPENDIX A.
Study Checklist

Study Source:	Date	Date	Date	Date	Date
1. Read Text					
2. Outline Text					
3. Word List					
4. Questions?					
5. Combine and Read Notes					
6. Organize Notes, Chunk, Color-Coordinate					
7. Read Outline					
8. Read Words & Definitions					
9. Read Questions					
10. Read Answers					
11. Make up Test Questions					
12. Read Study Questions and Answers Several Times					

(Pershelli, 2006)

APPENDIX B.
Sound Memory Strategies

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1. Monitor your comprehension
   a. You can only remember and fully use ideas that you understand
   b. Think: What does this mean to me
   c. Generate your own examples
2. Pay attention
   a. Attach emotion. If you feel strongly about something, you will have better attention.
   b. Look, listen and act
3. Make Connections
   a. Associate new material with information and experiences you already know.
   b. Link to sight, sound or action.
   c. Link the unknown with the known
4. Get Organized
   a. Break information into smaller components to recall (Chunking)
   b. Think small.
   c. Organize in notebooks with tabs, with sticky notes, using baskets or boxes
5. Think in Pictures, Colors and Shapes
   a. Color code instructions with examples
   b. Use different highlighter pens or pencils for different purposes
   c. Draw cartoons of actions in sequence
   d. Triangles for three things, Pentads for 5 things, etc.
6. Use mnemonic devices
   a. Anagrams—My Very Excellent Mother Just Served Us Nine Pizzas (Order of Planets), Please Excuse My Dear Aunt Sally (Order of Operations)
   b. Rhythm and rhyme—make a song of information (Conjunction Junction)
7. Use graphic organizers
   a. Visualize it (Mandala for Character analysis)
   b. Venn Diagrams, Webs, Flow Charts
8. Use Repetition and Rehearsal
   a. Practice, practice, practice
   b. Recite often
   c. Set up a daily routine

- Teachers always write homework assignment in upper right corner of board.
- For turning in homework: At home place completed homework in notebook, notebook in backpack, unpack backpack at beginning of each class to get out homework.

9. Review Before Bedtime

   Your brain actually processes and stores information in Long Term Memory more efficiently while you sleep because it has less interference from the outside world.

(University of Western Ontario, 2004)

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