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Enhancing Student Learning with Brain-Based Research

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ENHANCING STUDENT LEARNING WITH BRAIN-BASED RESEARCH

by

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ABSTRACT

Enhancing Student Learning with Brain-Based Research

This paper discusses brain-based learning and its relation to classroom instruction. A growing quantity of research currently exists regarding how the brain perceives, processes, and ultimately learns new information. In order to maximize their teaching efficacy, educators should have a basic understanding of key memory functions in the brain, and how these functions relate to student learning. In this paper, the author surveys current literature to identify foundational instructional strategies that are supported by brain-based research. A Microsoft PowerPoint® presentation is included that is intended for use at an in-service training with the goal of providing participants with (1) an overview of research findings with respect to the information processing and memory functions of the brain, and (2) overarching areas of instructional strategies that are supported by current research. The presentation is designed for use by educators and others involved in direct instruction in both primary and secondary education.

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INTRODUCTION

In order to maximize the efficacy of instructional delivery, it must be tailored to reflect what research has established as effective practice for brain-compatible learning. The rapidly expanding field of brain-based research has clearly established that the process of learning changes both the structure and functional organization of the brain (Bransford, Brown, & Cocking, 1999). Modern educators should approach teaching within the confines of a biologically driven instructional framework to support this structure and function regarding how students learn best (Spears & Wilson, n.d.). Understanding both the foundational practices and the reasons behind each practice will enable teachers to provide the highest quality education possible to help students actualize their potential for achievement.

Statement of the Problem

Regardless of quality, instruction is limited by the student's ability to retain and recall the information being taught. For instruction to be effective, it must be adjusted to reflect research-based best practices regarding how students receive and process new information. This helps educators transition their emphasis from the teaching side to the learning side of the teaching/learning cycle to better focus on a measurable end product (Banikowski & Mehring, 1999). Teachers need to become critical consumers of strategies in order to understand, design, and implement brain-based instruction. They should be encouraged to develop a foundational knowledge of strategies that are supported by actual research, so that research-based practices can become the basis for classroom instruction (Peace, Mayo, & Watkins, 2000). As scientists and researchers are continually unfolding the mysteries of the human brain and discovering how we learn best, teachers must hone their abilities to sift through this mountain of research and advice to select key elements that they can use to improve their teaching. While brain research may never be able to dictate exactly what teachers must do in the classroom, "[I]f educators do not develop a functional understanding of the brain and its processes, we will be vulnerable to pseudoscientific fads, inappropriate generalizations, and dubious programs" (Wolfe & Brandt, 1998, p. 8).

Purpose of the Project

Teachers are perpetually inundated with myriad strategies for performing their job better; anecdotal claims to research and empirical teaching maxims abound (Peace, Mayo, & Watkins, 2000). The purpose of this project was to provide teachers with pertinent research findings concerning how the brain learns best, and to illustrate what instructional strategies are appropriate and why they are appropriate in the classroom. The information was designed to be presented to teachers at an in-service training in the form of a Microsoft PowerPoint® presentation that focused on practical modifications to instruction backed by summary research findings. It is this author's opinion that teachers are more receptive to this type of information if it is presented in a non-technical format, with an emphasis on practical and feasible strategy implementation in the classroom.

Chapter Summary

The best means by which teachers can enhance their efficacy to educate the brain of a student is to deepen their understanding of how the brain works. In essence, the role of teachers is not to teach, per se, it is to ensure that students learn. Information can be presented to a student with great repetition and in astounding quantity, but only when that information passes into permanent memory does learning occur. It is this author’s belief that teachers must become versed in critical aspects of brain-based research in order to capitalize on foundational strategies that will enhance their effectiveness. In Chapter 2, the author presents a review of current research studies relating to the functions of the brain and key instructional strategies that support brain-based research.

Chapter 2

REVIEW OF LITERATURE

The purpose of this project was to develop an in-service training presentation to provide teachers with key elements of the functional characteristics, rather than the biological or structural features, of brain-based learning. Knowledge of how the brain processes, retains, and recalls information can help inform educators about best practices for instruction in the classroom. While this project should also be useful to administrators, parents, and community stakeholders, it is primarily targeted at teachers as an aid to designing, implementing, and differentiating instruction. A vast amount of research exists regarding memory and how the brain retains and recalls information most effectively. This author attempted to survey key points relating to the fundamental functions of sensory, working, and long-term memory, and how this knowledge can be used to improve teacher efficacy in the classroom.

Definition of Brain-Based Learning

According to Madrazo and Motz (2005), brain-based learning is the use of "research in neuroscience on how the brain works to gain an understanding of how students learn and develop in a classroom" (p. 56). Brain-compatible instruction is education that is specifically tailored to reflect current knowledge of how the brain processes and utilizes knowledge. The underlying rationale behind the value of brain-based learning is that neural connections in the brain, those connections that represent the formation of knowledge, are dynamically created and modified throughout a person's lifetime (Berger, 2005). This potential for continual growth in response to new information is critical to the efforts of modern educators to advance the concept and value of lifelong learning. Madrazo and Motz (2005) described this trait of *plasticity* in the working functions of the brain as the fundamental advantage in enhancing the retention and recall of knowledge, the common goal of both the educator and the learner. Banikowski and Mehring (1999) stated succinctly that "[F]or educators, memory is the only evidence that something or anything has been learned" (p. 1). Tapping into the power of memory must become a priority for educators.

Sensory Memory

Before information can be processed by the brain, it must first be received. The first step in the predominant *information-processing model* of memory is sensory input, in which the brain receives raw information through the five sensory receptors, or sense organs, of the body. This information is stored for only a fraction of a second before the subconscious decision is made concerning how to process the information; in other words, sensations are only stored momentarily for perception (Berger, 2005). Wolfe (2001) described the process of sensory perception as being very complex, in that incoming stimuli are essentially bombarding the brain at any given moment in time. This incoming information would quickly result in sensory overload without the buffering mechanism that is referred to as sensory memory. As information is received by sensory receptors, the sensory memory begins to filter, or truly perceive, the information. Wolfe likened this function of the brain to a sieve, rather than the popular metaphor of the brain as a sponge, in that the sensory memory discards the vast majority of incoming information almost immediately. This initial organization stage in the brain plays a critical role in sifting through information before more substantial memory processes are activated to process key bits of information further into cogent perceptions.

Attention dictates whether select information moves from sensation to perception, which Wolfe (2001) described as largely an automatic, subconscious process. The automaticity of selective attention is generally a product of the varying novelty, intensity, or movement of stimuli as received by the senses. However, this automaticity of stimuli processing can be countered by the conscious attentive effort of the learner, coupled with the introduction of the factors of meaning and emotion. These factors can be greatly influenced by educators when they present information in a manner designed to address and engage the various multiple intelligences and learning modalities of the students.

Multiple Intelligences

Closely related to the construct of the sensory register component of memory is the idea of the interrelated and relatively autonomous brain systems proposed by psychologist Howard Gardner (Gardner, 1983; as cited in Armstrong, 2000). Gardner posited a theory that humans possess eight distinct categories of abilities which he called multiple intelligences: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalist. Gardner suggested a ninth intelligence, existential, which is essentially the capacity of an individual to be acutely aware of himself and the universe around him, although Armstrong found that this intelligence has not been widely accepted within the framework of existing Multiple Intelligence (MI) Theory (Gardner, 1999; as cited in Armstrong). The theory of multiple intelligences was developed by Gardner partly as a result of his work with individuals who had suffered brain damage. In his tests of cognitive ability with these individuals, Gardner observed that one type of ability or intelligence might be affected, but others might not be affected or impaired at all (Gardner, 1983; as cited in Armstrong). Although Gardner felt that most individuals would manifest greater capacities in some intelligences than in others, he believed that people possess some capacity in each intelligence area, regardless of preference or conscious effort. Gardner's framework of varied capacity in individuals suggests a complex, interrelated system in the brain of perception and information-processing.

Learning Modalities

Like the theory of multiple intelligences, the idea of learning modalities suggests that people perceive and process information in separate but interrelated ways of thinking (Samples, 1992). The perspectives and research from a variety of theorists and researchers support the existence of distinct learning modalities, including symbolic-abstract, visual-spatial, kinesthetic, auditory, and synergic (Bruner, 1967; Bateson, 1979; Bateson & Bateson, 1987; McCarthy, 1984; all as cited in Samples). The major classes of learning modalities are separate from standard references to visual or kinesthetic learners because these assessments are essentially linked to sensory systems. Samples explained that "learning modalities are derived from biologically designed sensory and processing systems and stand on their own as worthy domains of thought and reason in human experience" (p. 64). Students of varied abilities are able to demonstrate their knowledge and understanding of a topic when they are allowed to move beyond the typical symbolic confines of standard school curricula. Educators should be aware of the diverse systems present in the brain, which suggest that the presentation of interrelated subject content in the classroom is mirrored in the complex processing centers of the brain and the different learning modalities of the individual.

Working Memory

Working memory, also known as short-term memory, is the component of memory responsible for the majority of the meaningful processing of new information (Banikowski and Mehring, 1999). Its primary purpose is tri-fold: (1) to purge or release the new information from memory; (2) to maintain the information in working memory via simple rehearsal; or (3) to move (encode) the information from working memory into long-term memory for later recall (Eggen & Kauchak, 1997; as cited in Banikowski & Mehring).

Engel, Santos, and Gathercole (2008) surveyed existing research studies and models relating to theories about working memory and its components. One of the most scientifically popular models they cited was that of Baddeley (1986, 2000, as cited in Engel et al.), who describes the working memory as consisting of two temporary memory stores and two domain components. The components, the *central executive* and the *episodic buffer*, work in concert to process input; the former allocates resources within the limited capacity of working memory, while the latter acts as a buffer that aids knowledge integration from working memory into long-term memory. The specialized temporary stores are the *phonological loop*, which stores visual information in a quickly decaying form, and the *visuospatial sketchpad*, which stores information relating to spatial and visual input. The phonological loop is thought to play a primary role for temporary storage of vocabulary until permanent coding into long-term memory occurs (Baddeley, Gathercole, & Papagno, 1998; Gathercole, 2006; all as cited in Engel et al.).

Additionally, studies have shown that the phonological loop is closely linked with new word learning and overall short-term memory verbal learning skills (Avons, Wragg, Cupples, & Lovegrove, 1998; Baddeley et al., 1998; Gathercole, Hitch, Service, & Martin, 1997; Majerus, Poncelet, Greffe, & Van der Linden, 2006; Service & Kohonen, 1995; all as cited in Engel et al.).

Processing and Encoding

Banikowski and Mehring (1999) described the information processing and encoding capability of working memory to be extremely short in duration, and an individual must use conscious strategies to focus on new information to retain it for longer periods of time for additional processing. One such strategy is the use of *rehearsal*, which can take two primary forms. *Maintenance rehearsal* is the simple repetition of new information by an individual by either oral, written, or internalized/mental means. *Elaborative rehearsal* occurs when the individual attempts to connect the new information with existing information already encoded into long-term memory. Processing and encoding of new information into working memory can be enhanced in either form of rehearsal using the strategy of *chunking* information. Chunking involves combining separate pieces of information into more substantial chunks, which thus requires less working memory space in the brain as each chunk is processed as a single unit. The transitory holding capability of information in working memory can be partially overcome with *automaticity,* which results from sufficient practice and rehearsal of information to engender automatic, albeit temporary, recall. Researchers have estimated that average student learners need about 40 exposures to information before automaticity is reached; 200 exposures for students with even mild cognitive disabilities (Sowell, 1981; as cited in Banikowski & Mehring).

Capacity

Without the use of any active strategies, researchers have estimated that information stored in working memory is limited in capacity to approximately five to nine items, retained for durations of between 10 and 20 seconds in adults (Gagne, Yekovich, & Yekovich, 1993; as cited in Banikowski & Mehring, 1999). For educators, appropriate pacing of presented information and the use of frequent pauses and questioning in the classroom are excellent strategies to aid effective student processing and encoding of information into working memory.

Cowan, Saults, and Morey (2006) surveyed existing research concerning ideas regarding systems that support working memory capacity. How the information is stored in the brain is still not understood, especially how abstract information is stored in the construct of temporary or working memory. Little is also known concerning how abstract information stored in working memory is affected by associations between both conscious and subconscious information coding strategies. Concepts, propositions, and issues relating to advanced comprehension all represent abstract information that the working memory must process, retain, and ultimately code for recall (Phillips, Gilhooly, Logie, Della Sala, & Wynn, 2003; Haarman, Davelaar, & Usher, 2003; all as cited in Cowan et al.). Prior research supports an advantage in working memory recall gained by adding additional descriptive features to an object (Luck & Vogel, 1997; Radvansky & Zacks, 1991; all as cited in Cowan et al.).

According to Cowan et al. (2006), the capacity of working memory may be indicated by the strength in form of verbal and spatial code associations made in the brain. Abstract associative representations in working memory may be separately coded, such as lexically, verbally, spatially, or phonologically, for later recall by the brain. However, they may also be coded separately, such as verbally and spatially, then used in parallel for recall. Some types of information in working memory are benefitted by this parallel use in verbal and spatial codes, which thus becomes a strong measure of capacity. Cowan et al. determined that the development of verbal-spatial associations in working memory shifts from selective uneven assignment in children, to a preferred 1-to-1 assignment in adults. They also found that the retention and recall of approximately half the abstract items on a six-item list was consistent with existing research regarding expectations of working memory capacity, overall attention focus, and temporal memory buffering (Broadbent, 1975; Cowan, 2001; Baddeley, 2000, 2001; all as cited in Cowan et al.). The findings of Cowan et al. are important for educators in that they support the idea that verbal-spatial association coding is a less complex method of coding knowledge than individual coding methods; it is accomplished by the brain as a single task, yet contains dual functions; negates the demands for fast presentation; and is well adapted to a multitude of standard memory tasks. Encouraging methods that present information that support the parallel use of verbal and spatial associations can augment the naturally developing skills surrounding retention and recall in the working memory of students, thereby maximizing capacity.

Socioeconomic Factors

Performance on working memory assessments is closely linked with language learning and the prediction of student academic achievement, but the extent to which this performance is affected by a child's *socioeconomic status* (*SES*) is uncertain (Engel, Santos, & Gathercole, 2008). Engel et al. examined research that explored the association between the working memory phonological loop and differences in socioeconomic background. While the performance of children from different SES backgrounds tends to vary on standardized tests, this cultural variance does not occur in tests of nonword repetition (Campbell, Dollaghan, Needleman, & Janosky, 1997; Ellis Weismer et al., 2000; all as cited in Engel et al.). However, there is strong evidence that cultural environment factors affect vocabulary development (Hart & Risley, 1995; Hoff & Tian, 2005; Walker, Greenwood, Hart, & Carta, 1994; all as cited in Engel et al.). Although the causes behind this cultural effect are still being studied, researchers have found that the procedures utilized in tests of vocabulary differ from working memory in that memory cannot be explicitly taught, while vocabulary skills and knowledge can be acquired with instruction (Cattell, 1963; Horn & Cattell, 1967; all as cited in Engel et al.). This might explain why tests of working memory only do not indicate a cultural advantage or disadvantage.

Engel et al. (2008) found significant effect sizes and group differences in performance between high and low SES groups on tests of expressive vocabulary and receptive vocabulary; participants in the high SES group scored significantly higher on both measures. Measures of working memory taken revealed no significant effect or differences between high and low SES groups, which supports previous research

(Campbell et al., 1997; Dollaghan & Campbell, 1998; Jensen, 1970; Santos & Bueno, 2003; all as cited in Engel et al.). This independence of working memory from SES was observed in measures of both the phonological loop and the central executive. The finding of Engel et al. that standard language assessments of vocabulary knowledge are more sensitive to SES influences than measures of working memory reinforces existing research reports that describe the impact environmental factors have on norm-referenced tests of student performance (Campbell et al., 1997; Jensen, 1970; Tomblin et al., 1997; all as cited in Engel et al.).

Long-Term Memory

If information passes into the sensory register and held through working memory, it can be permanently encoded into long-term memory. The key characteristics of long-term memory are a long duration of knowledge retention, a virtually unlimited capacity for storage of information and recall, and the existence of a complex network of interconnections among the vast amount of stored knowledge (Banikowski and Mehring, 1999). While scientists and researchers cannot confirm the theory that duration and capacity in long-term memory are unlimited, most agree with the assumption that duration and capacity have no known practical limitations in the average individual (Ormrod, 1998; Eysenck & Kean, 1990; Anderson, 1995; Lofthus & Lofthus, 1980; all as cited in Banikowski & Mehring). Information that moves into long-term memory is encoded for recall in two major forms, *procedural* and *declarative* (Banikowski & Mehring, 1999; Wolfe, 2001).

Procedural Form

Procedural, or nondeclarative, memory is the unconscious encoding of simple information for recall (Wolfe, 2001). The two types of procedural memory are *skills* and *priming*. Skills encoding is the retention of information related to basic skills or automatic processes, like driving a car or brushing your teeth, for memory recall. These simple procedures are implicit in nature and do not require conscious thought, as they are generally the result of continual repetition, practice, and habit. Priming is the process of recalling encoded information aided by the unconscious influence of past experience or knowledge. The enhancement of priming on memory recall results from the existence of past experiences that were not consciously recalled from long-term memory, such as repeating a past skill or activity that an individual does not recollect (Amaral, 2000; as cited in Wolfe). Both skills and priming memory suggest that unconscious mental activity has a powerful influence on long-term retention and recall (Wolfe).

Declarative Form

Declarative memory represents the conscious, explicit effort to store and recall information (Banikowski and Mehring, 1999). The two types of declarative memory are *semantic* and *episodic*. Semantic memory represents the facts, concepts, and problem-solving strategies that are organized as interconnected relationships in long-term memory (Voss & Wiley, 1995; as cited in Banikowski & Mehring). It is the general information that a person relies on and accesses continually during their conscious processing and thinking. Episodic memory includes information which is encoded and processed under the construct of personal experience. Unlike the more abstract knowledge represented in semantic encoding, this type of memory is not linear. Episodic memory connects information with the place, activities, time, and sensory input that is present when the information is processed. While semantic memory is generally thought to be fairly accurate, episodic memory can be less accurate due to the included sensory and emotional factors associated with encoding and recall (Wolfe, 2001).

Consolidation

Regardless of the type or form of long-term memory encoding, Wolfe (2001) described that scientists view this permanence of encoding as the fundamental "changes in the neurons and connections between neurons that form the physiological basis of storing and retrieving information" (p. 117). Working memory, and subsequently long-term memory, is strengthened by conscious effort strategies such as rehearsal and practice, and the avoidance of additional distractors for a period of time, for example, the use of *wait time*. However, long-term memory does not represent an instantaneous event or step just beyond working memory processing. When the brain is given time to process new information without additional interaction, interference, or distractors, it is able to unconsciously continue to process the new information and connect it with existing knowledge in long-term memory storage in a process known as *consolidation*.

Rasch and Born (2008) found a large body of research that supports the strong effect of sleep on the consolidation of information into long-term memory. During sleep, newly encoded memories are unconsciously reactivated for integration into the complex network of existing permanent memory (Born, Rasch, & Gais, 2006; Walker & Stickgold, 2006; Marshal & Born, 2007; all cited in Rasch & Born). It remains uncertain if sleep strengthens long-term memory retention by minimizing interference from competing stimuli, or by simply erasing weaker connections present in the processing centers of the brain. However, Rasch and Born concluded that the memory functions of the brain are very active during sleep creating and integrating information that ultimately affects our conscious behavior and frames our thinking. How much time is needed for consolidation, either during waking or sleeping hours, is unclear. What is clear is that some duration of time is needed either without the further interference of new or additional information, or in the form of extended rehearsal or practice.

Overlearning

The study of the relationship between long-term memory and study session duration is an area of practical concern for teachers and students alike (Rohrer, Taylor, Pashler, Wixted, & Cepeda, 2005). The practice of continuing to commit knowledge to memory beyond a criterion of one perfect trial is termed *overlearning*. Overlearning is a strategy in which a student continues studying target information during a single study session, beyond the point where that student is able to demonstrate mastery during that session. Rohrer et al. found that the effectiveness of overlearning was not supported as a strategy for long-term retention, as recall performance of participants in their study declined so rapidly over several weeks when using overlearning as a retention and recall strategy. Overlearning can serve as a viable learning strategy in certain situations, such as test preparation for students or foreign language learning for brief business trips, where this strategy might be of benefit. Rohrer et al. also noted that "overlearning would be appropriate when there are dire consequences of forgetting" (p. 366), such as the case of an employee needing to commit important safety procedures rapidly to memory.

The results of the Rohrer et al. (2005) study are important for educators in that they shed light on the efficacy of a teaching practice that is used quite frequently. Until further research is performed regarding the effects of overlearning with different encoding strategies and varied study material, Rohrer et al. recommended that overlearning-style teaching methods, such as drill and practice, be tempered with the strategy of distributed practice, that is, post-criterion practice, across multiple sessions. Rather than trying to amass heaps of information in a single setting, educators can complement their use of overlearning with more volume-oriented tasks (e.g., large vocabulary lists) with the positive benefits noted with the spacing effect of distributed practice, such as when more complex or abstract information needs to be learned. Rohrer et al. concluded that spaced learning could compensate for the severe limitations of overlearning, while still retaining the positive situational aspects of overlearning as a teaching strategy.

Making the Leap from Perception to Long-Term Memory

Moving information from sensory input to permanent long-term memory storage is the goal of every educator. Modern neuroscience has established that dendrites, the communication arms between neurons in the brain, increase in both size and quantity in response to learning (Willis, 2007). The more areas of the brain that are stimulated by incoming information, the more dendrite-neural connections are increased and strengthened, and the more interconnections across information in permanent memory are formed. Willis concluded that "[T]his cross-referencing of data means we have learned, rather than just memorized" (p. 311). In addition to the concept of plasticity already noted, the brain also continually clears unused knowledge from long-term memory storage in a process known as *pruning*. Without this streamlining of needed information and pruning of unneeded knowledge, the essentially unlimited capacity of long-term memory would quickly amass too much information and prevent memory from operating efficiently (Giedd et al., 2004; as cited in Willis). The use-them-or-lose-them implication regarding dendrite connections is prevalent in brain research (Kaufeldt, 2002; as cited in Konecki & Schiller, 2003; Wolfe & Brandt, 1998; Willis, 2007; Banikowski & Mehring, 1999; Wolfe, 2001). The primal strategy for influencing the success of knowledge transfer into long-term memory is teaching to address multiple learning pathways in the brain of the learner, thereby maximizing synaptic growth.

Nine Essential Strategies

Marzano, Pickering, and Pollock (2001) identified nine categories of research-based instructional strategies in their meta-analyses of prior research studies. While Marzano et al. cited general research support bases for the positive effects of identified strategies on student achievement, they also noted specific brain-based research support for the strategies. Identifying similarities and differences is a core strategy for initial processing of information (Gentner & Markman, 1994; Markman & Gentner, 1993a, 1993b; Medin, Goldstone, & Markman, 1995; as cited in Marzano et al.). The strategy of summarizing and note-taking supports the natural plasticity and pruning functions of the brain as it selects information to both cross-code into memory (Kintsch, 1979; van Dijk, 1980; as cited in Marzano et al.), and personalize into meaningful chunks of content for deeper understanding (Anderson & Armbruster, 1986; Denner, 1986; Einstein, Morris, & Smith, 1985; all as cited in Marzano et al.). Homework and practice are clear examples that support the memory enhancing strategy of rehearsal, while the strategy of cooperative learning naturally increases episodic intensity in learning new information. The use of nonlinguistic representations is a strategy that addresses key visual elements in different learning styles and modalities, and supports dual-coding of various stimuli to increase neural activity (Paivio, 1969, 1971, 1990; Gerlic & Jausovec, 1999; all as cited in Marzano et al.). Setting objectives and providing feedback helps students to develop their own metacognitive abilities and a general awareness of both what they are learning—and how they are learning it. The strategy of generating and testing hypotheses supports research in both inductive and deductive thinking as actions that inherently trigger connections with prior knowledge (Holland, Holyoak, Nisbett, & Thagard, 1986; as cited in Marzano et al.). Finally, using cues, questions, and advance organizers helps students develop greater interest by encouraging deeper connections to presented information, and supports the tendency of the brain to organize knowledge for long-term storage and recall (Alexander & Judy, 1988; Alexander, Kulikowich, & Schulze, 1994; Risner, Nicholson, & Webb, 1994; all as cited in Marzano et al.). The strategies identified by Marzano et al. can form a working framework for instructional delivery that is strongly supported by current brain-based research.

Emotion

Wolfe and Brandt (1998) found that emotion can have a great influence on retention and recall of information. Emotion often provides a stronger backing for a given learning experience, and acts as an intensifier in episodic memory. The addition of an emotional component to information helps to add meaning and excitement. This not only aids retention by promoting multiple pathway encoding, but recall of knowledge is simultaneously enhanced when information is emotionally-tinted. However, the learner can perceive presented information as threatening if the emotional component is too strong, thus decreasing retention and recall (LeDoux, 1996; as cited in Wolfe and

Brandt). The importance of avoiding this stress-induced interference with learning was also noted by Kaufeldt (2002; as cited in Konecki & Schiller, 2003). Willis (2007) concluded that adding emotional components to new information, such as the heightened sensory input that might be engendered by a surprise activity or novel demonstration, can promote student enthusiasm and help illuminate seldom used pathways to long-term memory storage. The increased interest linked with an emotional response also helps to keep active attention on new information in working memory, thereby lengthening the window of opportunity for new knowledge to be permanently encoded. According to McGaugh et al. (1995; as cited in Banikowski and Mehring, 1999), the use of emotion at the conclusion of a learning activity increases both knowledge retention and recall accuracy. With skilled management, the propensity of some students to engage in strong emotional responses could transition from behavioral liability to memory asset.

Authentic Learning Activities

Authentic, real-world learning activities activate multiple pathways in the brain, and promote dendrite growth and maintenance (Kaufeldt, 2002; as cited in Konecki & Schiller, 2003). Authentic learning helps the students to create meaning through experience, and stimulates brain activity through complex interactions, contexts, and inquiry (Konecki & Schiller, 2003). A natural interconnectedness of content, concept, and context results from experiential learning, which tends to incorporate diverse learning styles and intelligences in a variety of settings. According to Caine and Caine (2001), "[C]ontext provides indispensable input and stimulation for the grasp of any complex idea or skill…[T]he context always teaches" (p. 4-10). The advantage of experiential context in memory is that the learner experiences it on both conscious and unconscious levels of perception. Caine and Caine astutely observed that there is a difference between knowing content or information, which is important, and being able to apply it, which is essential.

According to Wolfe (2001), real-life problem solving, projects, and simulations are excellent types of authentic learning activities to help develop knowledge application skills. Each is useful in promoting active learning and long-term retention. Problem-solving activities that feature actual or realistic problems from the students' school or community provide a meaningful framework for students to encode the application and importance of content. Projects act to enrich the learning environment and aid motivation and interest in content beyond abstract presentation. Simulations, or role-playing, help to activate physical and emotional learning pathways and enhance episodic memory input. Martin (1993; as cited in Banikowski & Mehring, 1999) also found that these types of activities help to create a rich, stimulating environment that encourages active processing and aids synaptic growth in memory for better retention and recall.

Scope of Teacher Influence on Brain-Based Learning

Banikowski and Mehring (1999) recommended that educators ask themselves key questions when planning instruction to create a framework that supports brain-based learning and enhances memory. These reflective questions should be focused on identifying strategies that could be used in instruction to increase student attention, activate prior knowledge, promote active learning, help construct meaning, and provide students with the opportunity to demonstrate learning. Woolfolk (1998; as quoted in Banikowski & Mehring) offered six practical recommendations for enhancing long-term retention and recall in the classroom:

1. Make sure you have students' attention.
2. Help students separate essential from nonessential details and focus on the most important.
3. Help students connect new information with what they know already.
4. Provide for repetition and review of information.
5. Present material in a clear, organized way.
6. Focus on meaning, not memorization. (p. 17)

Although these guidelines may seem empirical to many educators, it is important to note that they are well supported by brain-based research in memory.

Chapter Summary

Clearly, educators must become aware of how the brain processes and retains information to maximize their teaching efficiency. They must choose to use brain-based strategies in instruction—it is not an automatic process. Wolfe (2001) stated that the brain is "an essential element in the foundation on which we should base our educational decisions" (p. 191). Teachers must augment the presentation of content with modified instructional delivery that addresses the widest breadth of learning styles and processing pathways of memory. While no lesson can incorporate every possible method of presentation or activity, each lesson can capitalize on a variety of brain-based instructional techniques to ever nurture the development of a rich learning environment. Banikowski and Mehring (1999) concluded that "[T]he ultimate goal of teaching techniques for enhancing memory is to allow students to control their learning" (p. 17). Modern educators have embraced the concept that while teaching may still be an art, it must be based on science. Through the overall merging of instructional techniques with brain-based research data, we have the best means to maximize student achievement and ensure their ultimate success.

Chapter 3

METHOD

The purpose of this project was to develop a teacher in-service presentation that explains key characteristics of brain-based learning from current research, and connects this research to instructional strategies that enhance student learning within the classroom. The presentation provided summary research findings and direct recommendations for strategy use that is supported by this research. A large body of research exists regarding brain-based teaching and learning, and while researchers do not agree as to precisely how this research informs the field of pedagogy, the potential for positive impact is clear in both the regular and special needs classroom (Winters, 2001). Even in the absence of specific direction, general direction is nonetheless indicated, with current brain research as a primary vehicle for the advancement of teacher efficacy. Insight into how the brain functions and how memory can be maximized should help teachers design instruction that promotes student success (Peace, Mayo, & Watkins, 2000). Rather than present a series of cursory hints or maxims, with little explanation or supporting research citations, this author attempted to present and explain the key functional components of the brain as they relate to memory and learning, and focused on describing select strategies that are well-grounded in current research.

Target Audience

The project is designed as an in-service presentation for elementary school teachers, regardless of experience or education level. The information should easily be adaptable for use in secondary education, as the information relating to memory attributes and brain-based instructional strategies is not limited in scope by the age of the learner. Additionally, this basic knowledge of brain functions and foundational teaching strategies may be of interest to administrators, parents, support staff, school board members, and community stakeholders; all in their interrelated roles of advancing student learning. The strategies described should be applicable for use in the classroom irrespective of teaching style (e.g., behaviorism or constructivism).

Organization of the Project

A Microsoft PowerPoint® presentation was developed to: (a) provide teachers with an overview of core characteristics of how the brain receives, processes, and stores information into memory; and (b) identify key strategies that support brain-based research regarding the movement of information into long-term memory for recall. Information was presented in a descriptive format and annotated with research citations to provide teachers with avenues for further study.

Peer Assessment Plan

The author designed a short survey for in-service participants to complete to establish what they knew about the topic prior to viewing the presentation, and a follow up survey to see how their knowledge has changed after viewing the presentation. Additionally, the author sought written feedback from all participants concerning the quality, quantity, and overall usefulness of the information presented. This feedback was used to identify possible changes and improvements to the presentation for future use with non-participant colleagues, and also for use by the author for staff professional development in his prospective role as a school administrator.

Chapter Summary

The goal of this project was to enhance the effectiveness of teachers by providing them with a fundamental, working knowledge of brain-based research and how this research can inform instructional best practices in the classroom. The body of research regarding the brain and memory continues to grow at a rapid pace, and this project was intended to give educators a meaningful snapshot of the current research base and its implications for instruction, to provide yet another tool to help them in their daily work of teaching each and every student. This author used information garnered from a review of relevant literature to develop a presentation that provides participants the opportunity to expand their knowledge of brain-based research in memory and learning, and gives them insight into the practical design, modification, and implementation of instructional strategies supported by this research. Chapter 4 contains the annotated Microsoft PowerPoint® presentation.

Chapter 4

RESULTS

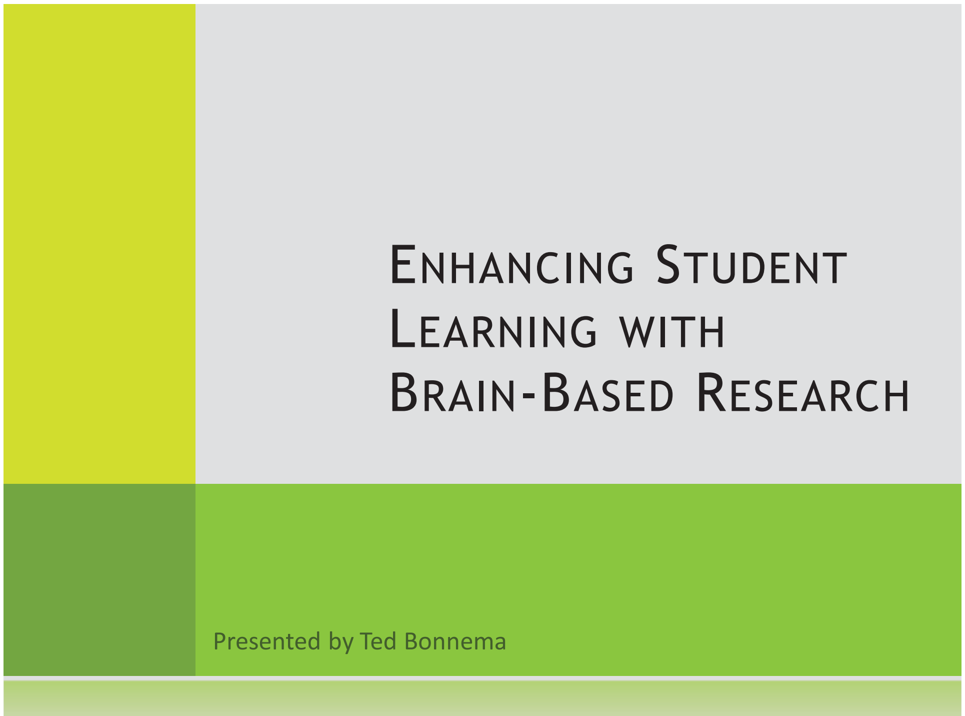
For the goal of establishing a brain-based educational environment to be realized, it is paramount that teachers are informed about the basic working processes of perception and memory. Using this background knowledge, they should be better able to design instruction that supports brain research concerning how students learn best. The goal of this in-service presentation was to provide teachers with summary information about basic memory processes and identify core teaching strategies that support these processes. According to Willis (2007):

> Strategies abound that keep students interested in what they are learning, thus helping to move information from temporary working memory into memory storage. … Successful brain-based teaching builds more connections and stronger circuits. Students will have more roadways to carry new information into their memory storage region and to carry out the stored knowledge when it is needed. (p. 313)

Using brain-based instructional techniques thus becomes a foundational methodology for maximizing teacher efficacy in enhancing student learning.

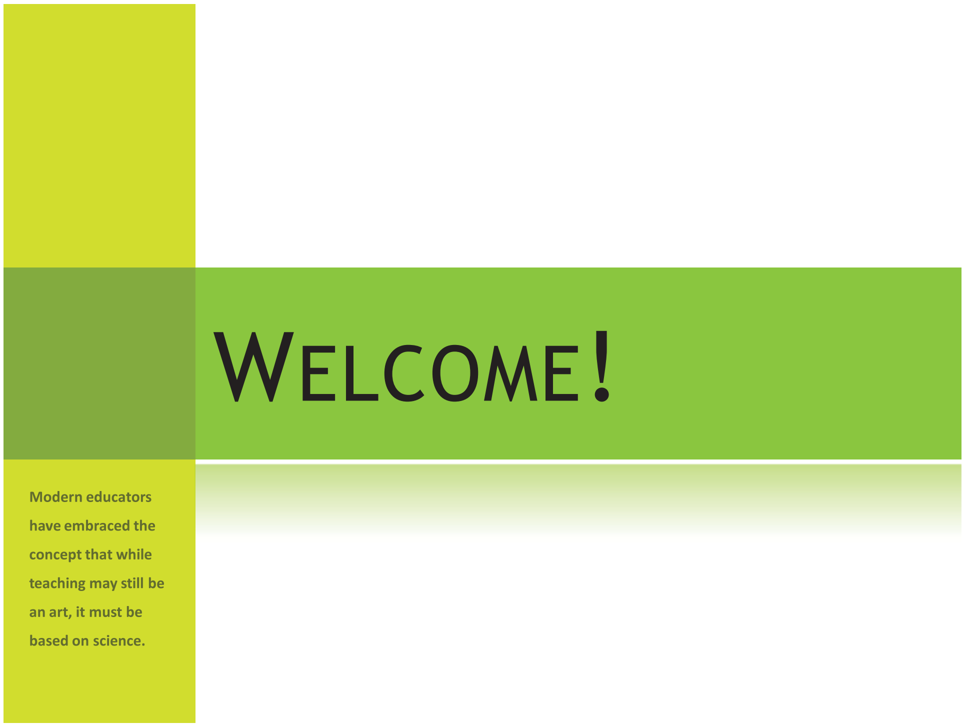
Prior to viewing this presentation, the author asked participants to complete a short survey regarding their current school roles and experience with teaching, as well as their current knowledge of brain-based learning. Following the presentation, the participants were asked to complete a short exit survey to see how their knowledge of brain-based learning had changed, and to solicit general descriptive feedback on the effectiveness of the presentation. Copies of both surveys can be found in the Appendices.

Presentation



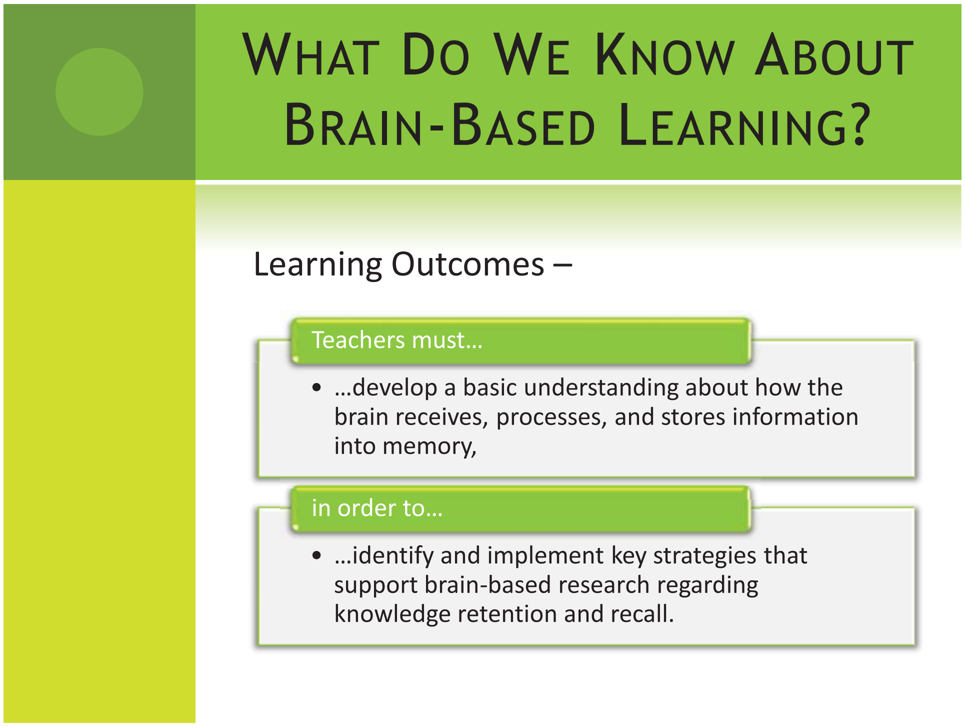
[*Title Slide – Presenter should move around to greet participants and request that they complete the short Pre-Presentation Survey located on their tables. Direct participants to refreshments and let them know that the presentation will be starting shortly.*]

Author's note: The following narrative cannot replace the dynamics of an active, thoughtful presenter; it only represents a suggested framework for thought within which the information featured on the slides might be presented. The presenter should use his or her own expertise and professional judgment to guide the presentation and supplement or clarify information according to the needs of the participants. Bracketed, italicized text represents non-spoken directions or suggestions to the presenter. Italicized text within a sentence suggests emphasis.

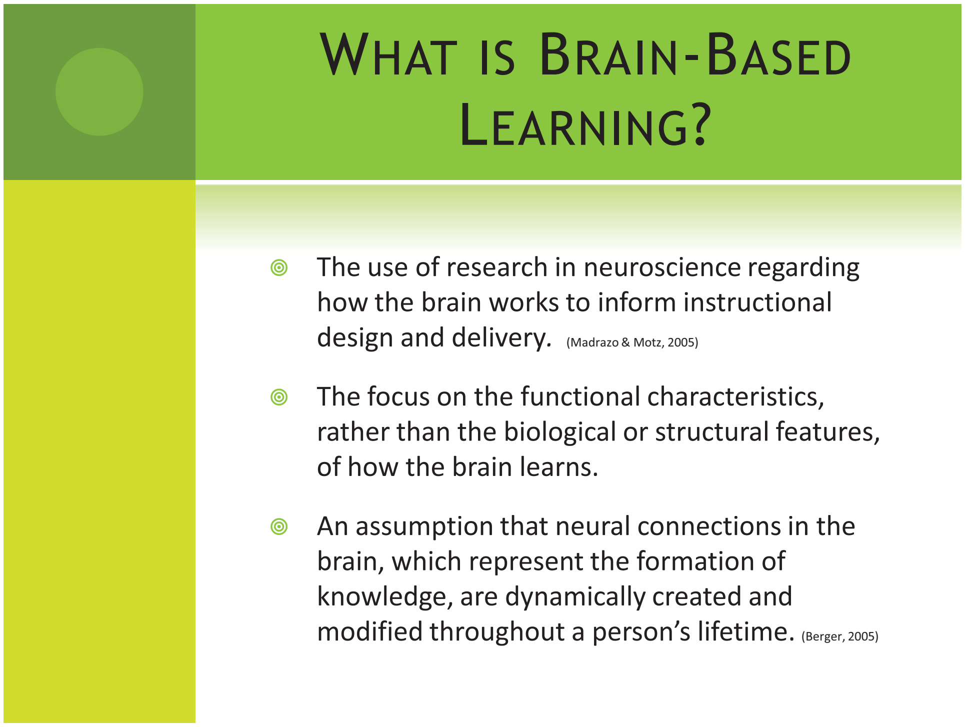


Welcome to Enhancing Student Learning with Brain-Based Research! Thank you all for coming today. I am constantly impressed with the time and commitment to student achievement displayed by my fellow teachers. Your attendance at presentations like this one is testament to that commitment. I wanted to wait until everyone had a chance to complete their survey before we got started. The presentation should last about 45 minutes, so if there are not any questions, let's begin.

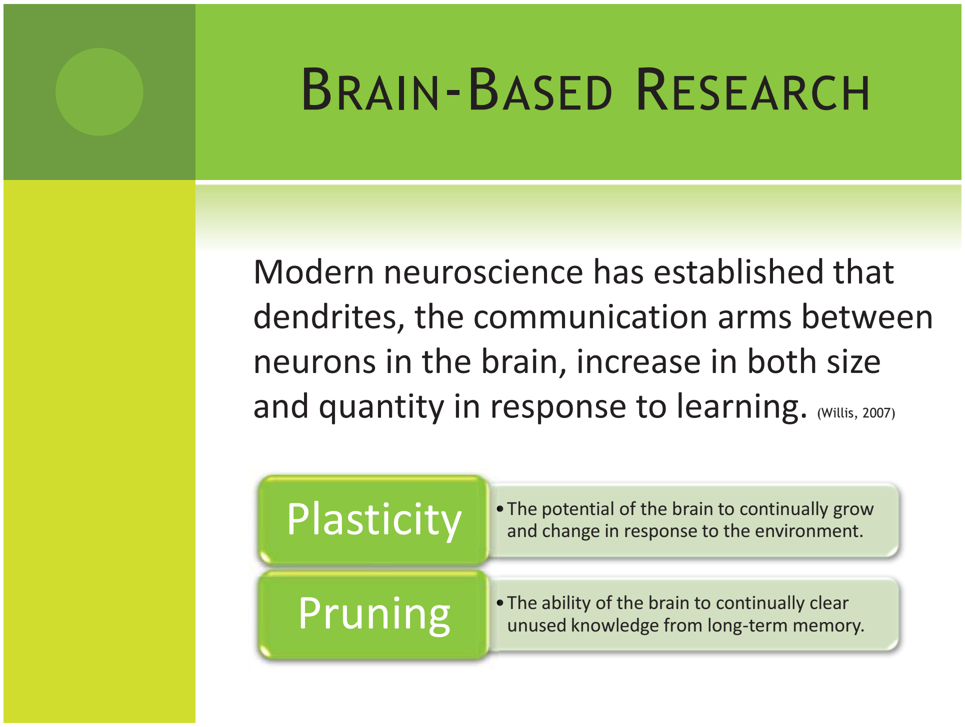
Today's information is designed primarily for teachers, although anyone involved in teaching children should find it useful, including paraprofessionals, classroom volunteers, and parents. [*Read slide quote.*] The science of brain-based learning is the focus for this presentation. Hopefully, this science will be evident as we progress.



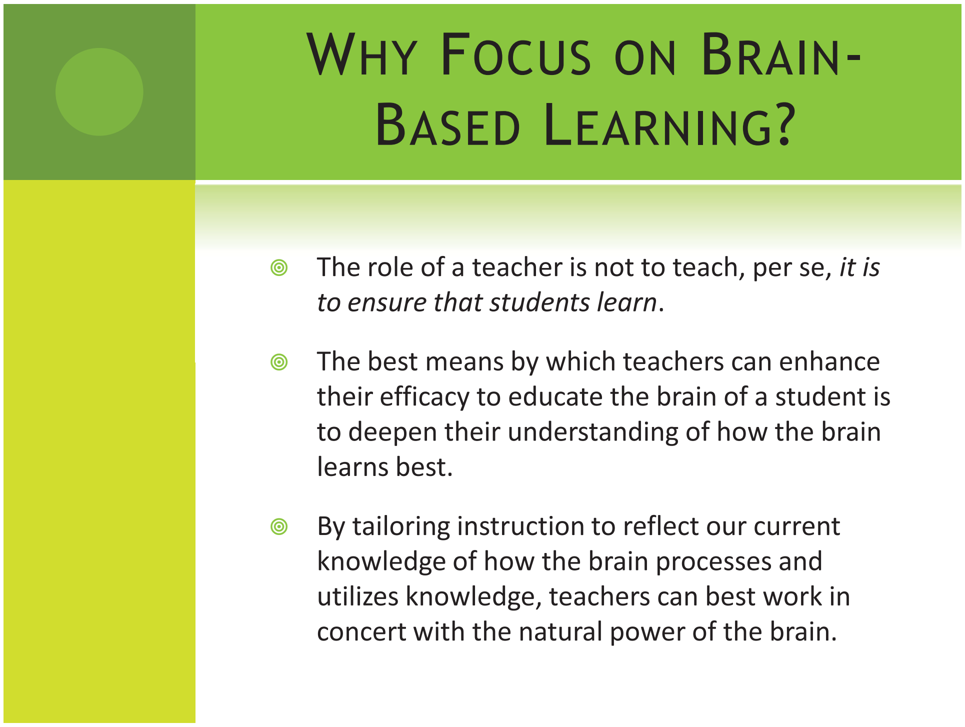
Our goal today is simple, in that I hope to instill several core concepts about how the general memory functions of the brain work, and connect that knowledge with practical instructional strategies for use in the classroom. Rather than read every part of each slide verbatim to an adult audience of experienced readers, as this is one of the primary complaints I hear about slide presentations, I will rather convey key points and augment the displayed information as needed. Feel free to raise your hand and ask for clarification of any presented information, but please know that I have set aside time at the *end* of the presentation for "Q and A." I hope to convey the information in a friendly, non-technical format to maximize our discussion points. Also, keep in mind that while I will not be citing many references orally, all references are annotated in the presentation. The first thing on our agenda today is to establish what the term "brain-based learning" encompasses.



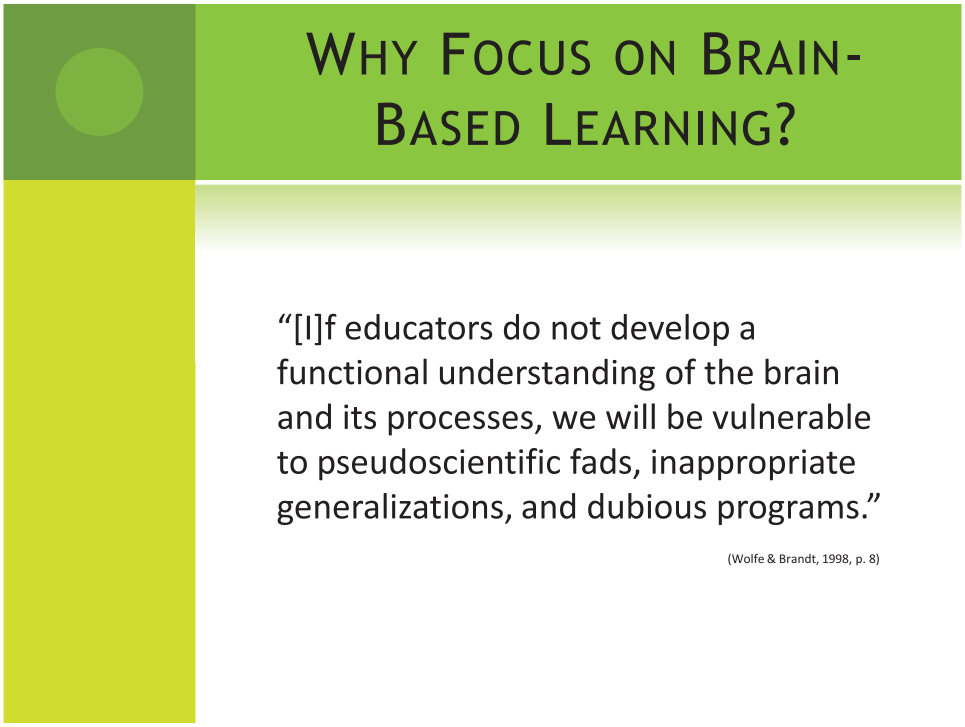
Brain-based learning is practical and classroom-relevant because it is classroom- and student-focused. Understanding the "why" gives us needed insight in designing the "how." While knowing where the Hippocampus is (or how to spell it) or which brain lobes handle the sensory experience of what a piece of chicken tastes like is all well and good, but that information doesn't tell us how a student *functionally* learns—it only describes the biological and physiological features behind it all. As teachers, we may find all this information very interesting, but what we really want to know is *how to teach our kids so they remember*. This is what brain-based learning is all about. [*Paraphrase final bullet*.] Science has established that the brain continually changes in response to its environment, and that's where we come in.



Many of you have probably heard of the "use-it-or-lose-it" effect of information stored in the brain. Well, numerous studies have shown this effect to be a reality—a reality that is especially problematic for teachers, who are assigned the daunting task of educating students under ever-increasing pressures for performance and achievement. Although brain research may never be able to dictate exactly what we should do in a classroom, it *can* enhance our effectiveness at reaching the minds of our students. Even if brain research never reaches the point of prescribing instruction, as educators we can still capitalize on the inherent power of the brain to incorporate new knowledge and sweep away the old. These traits of plasticity and pruning help us to view the brain not as static and fixed in time, but as a dynamic and responsive tool for learning to be harnessed and developed.



[*Read first bullet*.] Focusing on brain-based strategies is focusing on research that informs and drives best practices in instruction. We have the power to commit to the creation of instruction that is truly based on research; to found our teaching on practice beyond theory. We can work *with* the findings of professional research, not despite it. We can work *with* the built-in systems of information processing and memory in the brain to better reach—and thus better teach—our students each and every day.

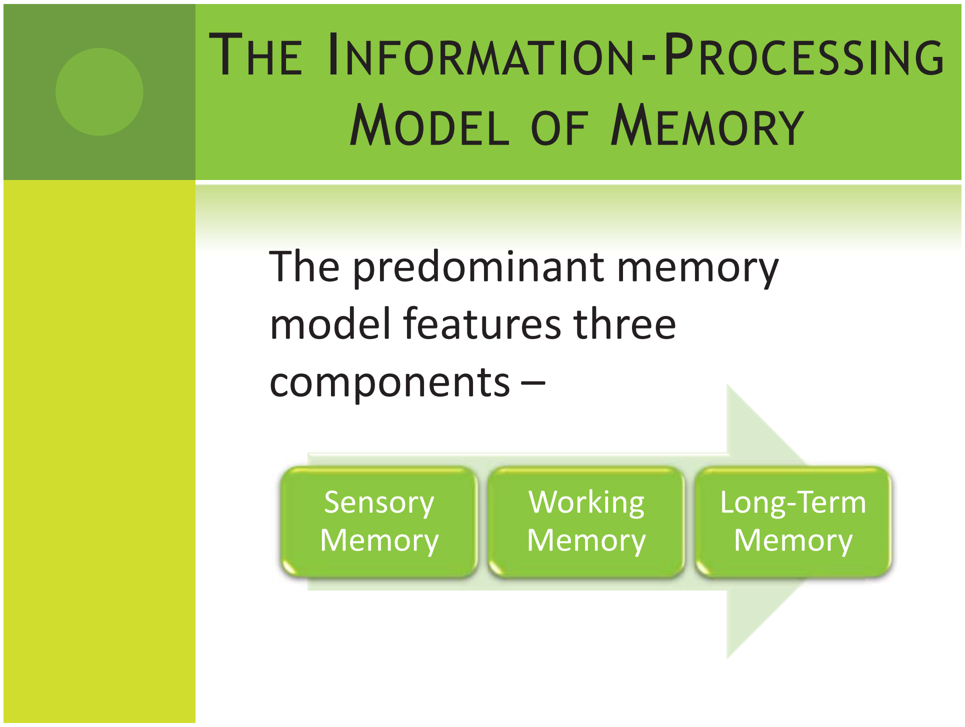


This astute quote by educational consultants Wolfe and Brandt provides us with a baseline rationale for hopping on the "brain-train" before we lose sight of the caboose. We have learned more about the brain in the past few years—and this likely can be said regardless of when in the future this slide show is again presented—than in the past century. Teaching is changing, so teachers are changing. The learner remains the same and we have acknowledged that they are the one component in the system that cannot be changed, as that change is out of our control. So we change ourselves; our perspective; our style; our methodology; our materials; our environment; our priorities.

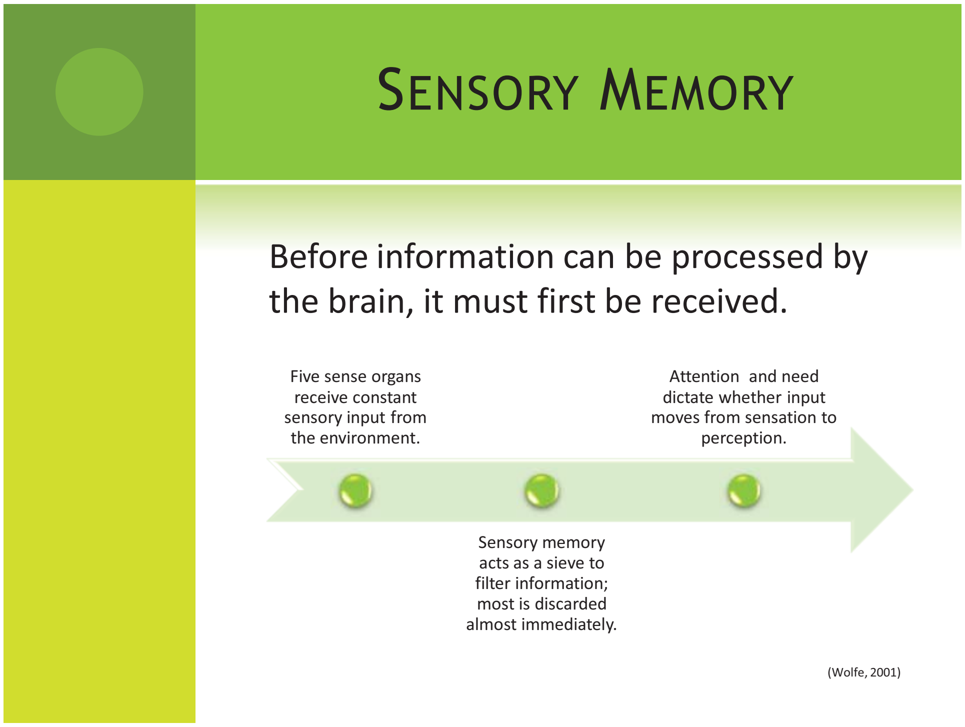
Tapping into the power of memory must become a priority for educators.

"For educators, memory is the only evidence that something or anything has been learned." (Banikowski & Mehring, 1999, p. 1)

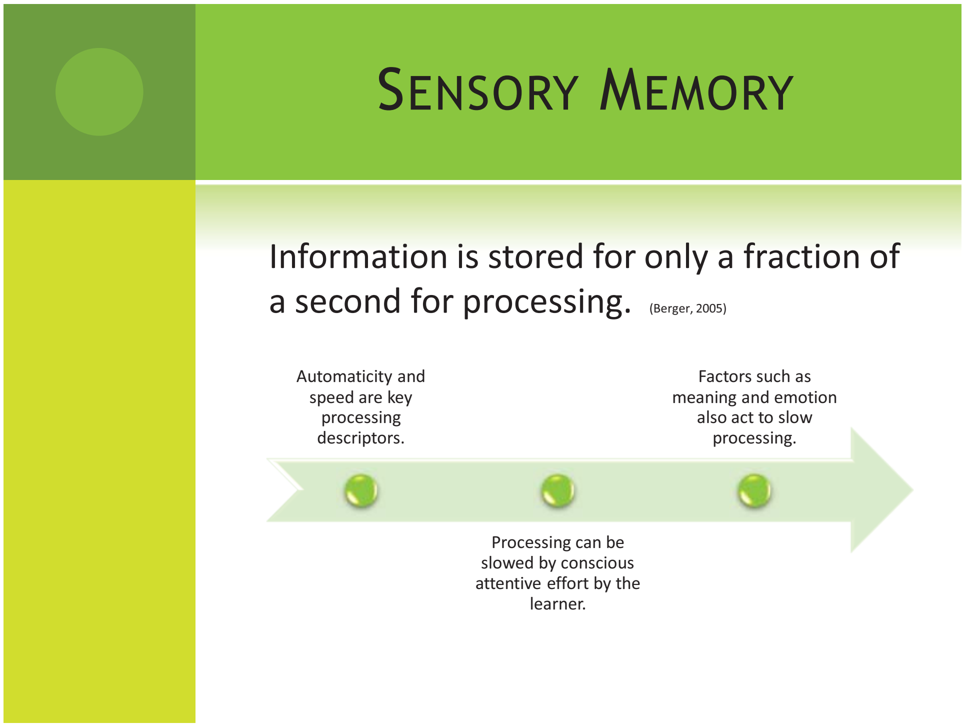
[*Read quote in yellow*.] So a new priority comes to the surface. Let's move forward and take a brief tour through the key components of memory and how they interrelate to help our young charges reach their goals.



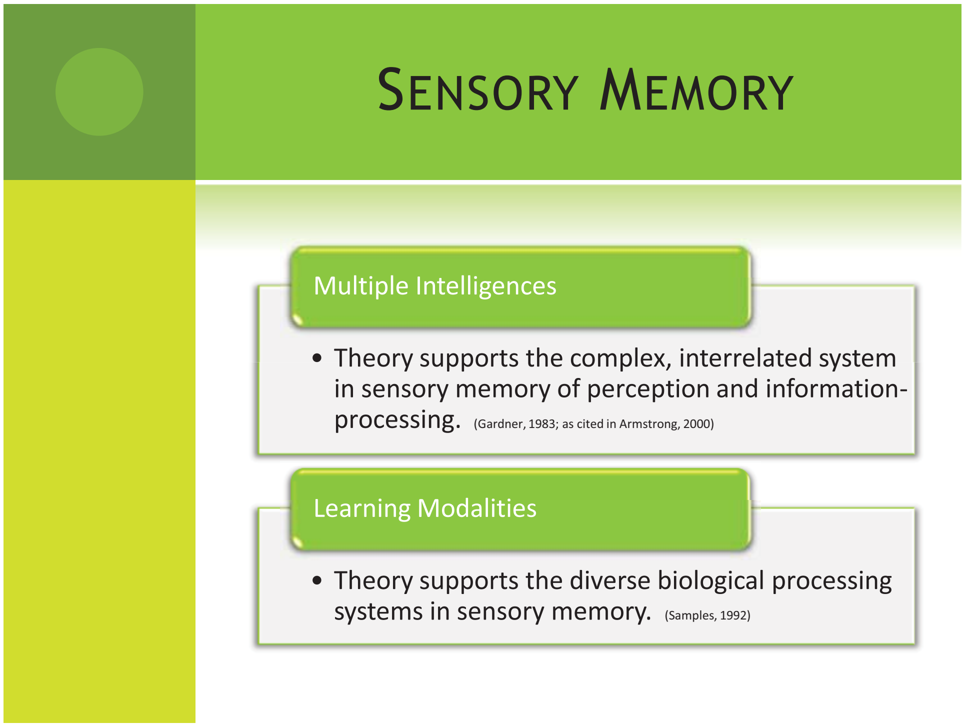
The information-processing model of memory is by far the most ubiquitous model in the scientific community. In fact, its difficult to find other theories of memory described in the past several decades. This model is built on the general premise that information is moved, or processed, through the brain from initial perception to various decisions regarding the ultimate destination of the information. This might be likened to the processing by a computer of initial input through to various actions.



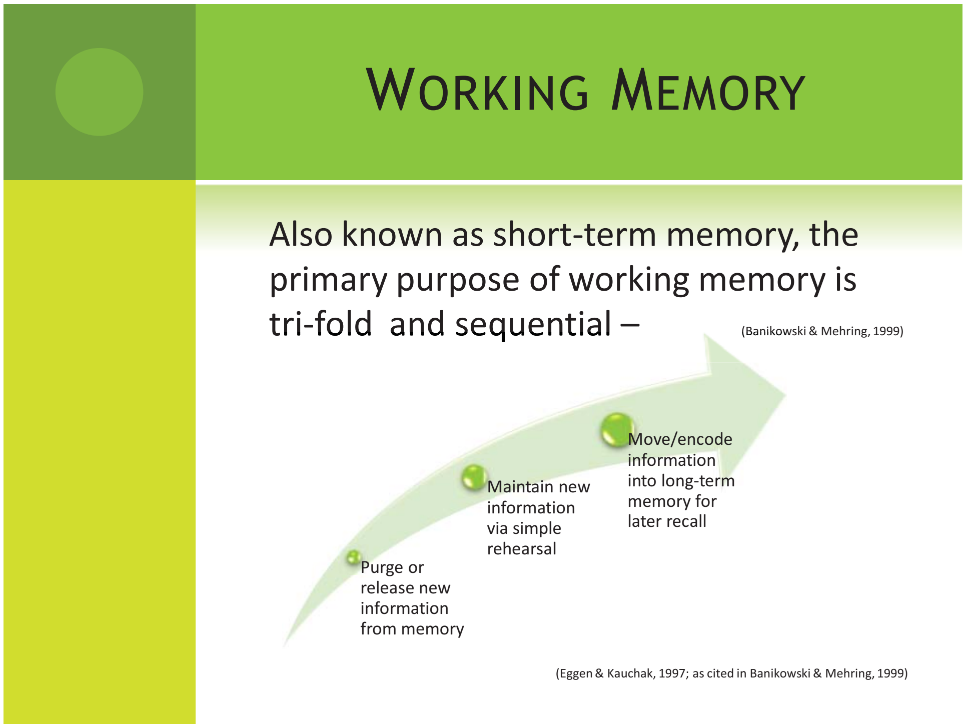
The first step toward memory is the actual sensing of an incoming stimulus. The sensory memory, also known as the sensory register, simply refers to the sense organs responsible for experiencing the environment—our five senses. Try to imagine the sheer quantity of sensory input that is bombarding us at any given point in time. Even now, you are listening to me, attending to the visual slide presentation, noting the movement and general activity within the room, hearing sounds from outside, people walking by…its quite staggering when you think about it. Without the sensory memory acting like the proverbial doorman, letting only very select pieces of information through and disregarding the vast majority of the rest, we would quickly reach sensory overload and be unable to function at a conscious level. This sensory overload effect is easily remarked in very young children and students, who often become visibly overwhelmed with what is going on around them to the exclusion of any direction or communication whatsoever.



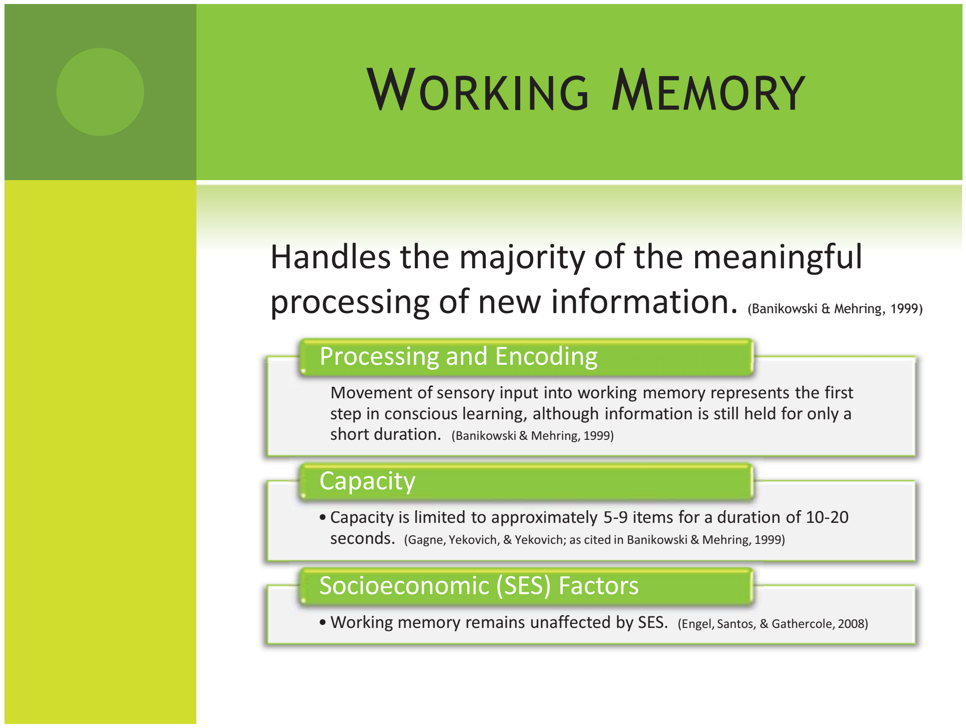
So our sensory doorman quickly checks the list to see if incoming data has any business coming through. Due to the sheer mass of information begging for an audience, speed and efficiency are the watchwords. Of course, sometimes he has to check the list extra carefully, as not every piece of data is what it claims to be. This is where factors such as attention, meaning, and emotion come into play to slow this all-but-automatic process down to conscious thought. With simple effort, sensory memory can be shifted into a lower gear to scrutinize the incoming data with a more critical eye. We can't stop it—and we really wouldn't want to—but we can slow it down enough to make a good decision. That's where the next phase of processing begins to shine.



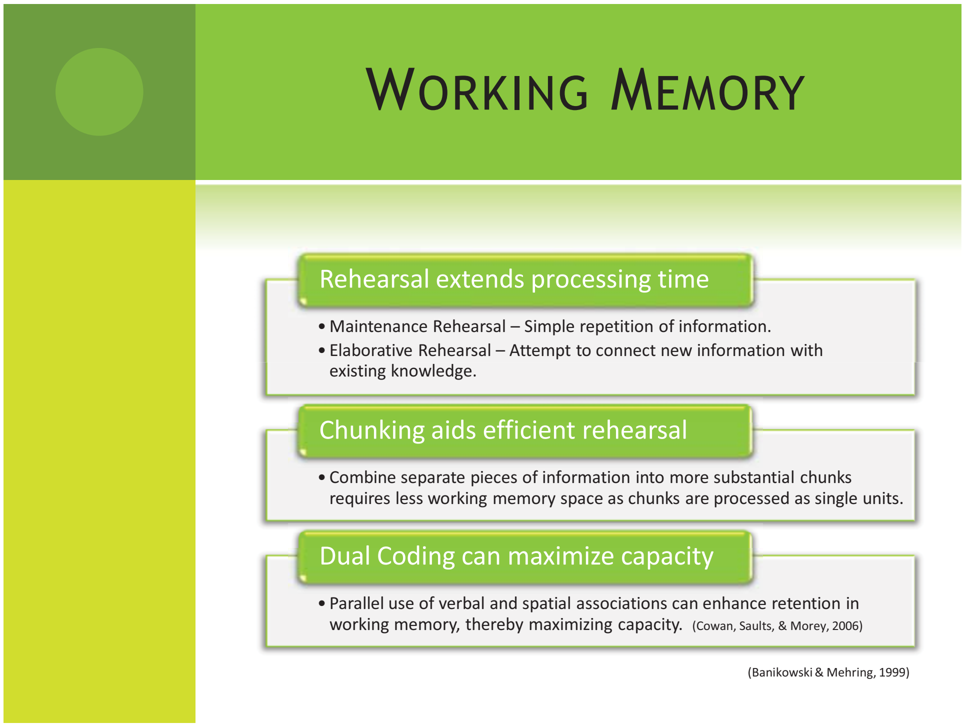
Before we leave sensory memory, it is important to note that the theories of multiple intelligences and learning modalities echo the complex processing systems and decision-making of sensory memory. Stimulating multiple learning pathways and senses results in significantly greater opportunities to process information. Consider how much more effectively you can process information when it is presented to more than one sense; more than one way of thinking; more than one way of doing or being. The attempt to present information in as many forms as possible is always rewarded, even if the rewards don't manifest themselves to the naked eye.



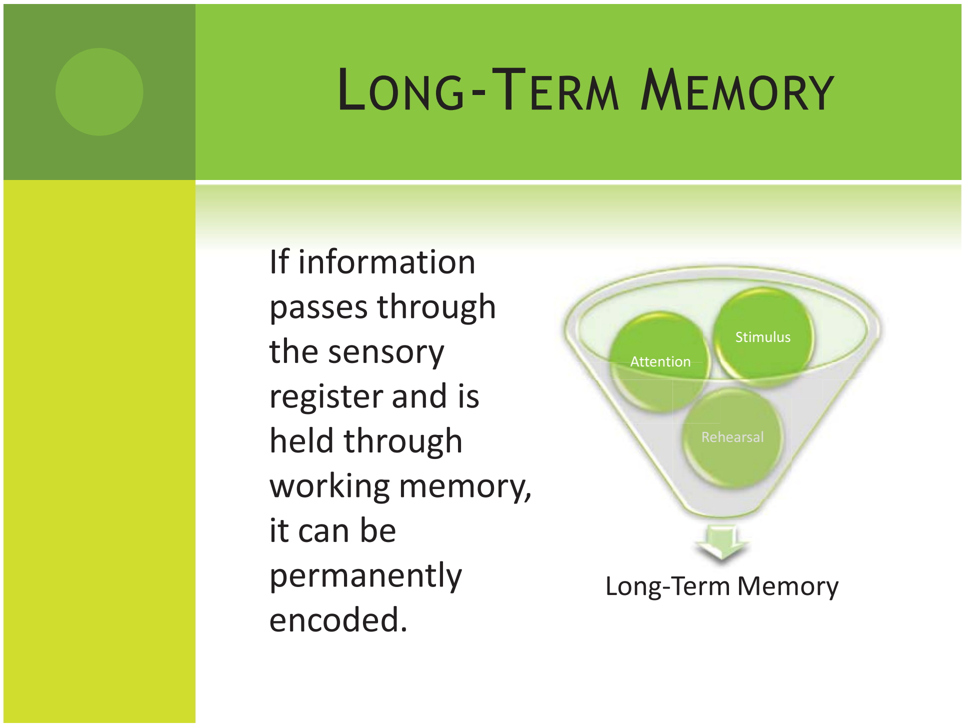
Now we come to the workhorse of memory. I remember working memory from my undergrad psyche classes being referred to as short-term memory, operant memory, processing memory, etcetera. While it may be known by many names, its really where the input hits the fan. Working memory is where sensory input either makes the transition to meaningful processing, or is washed away.



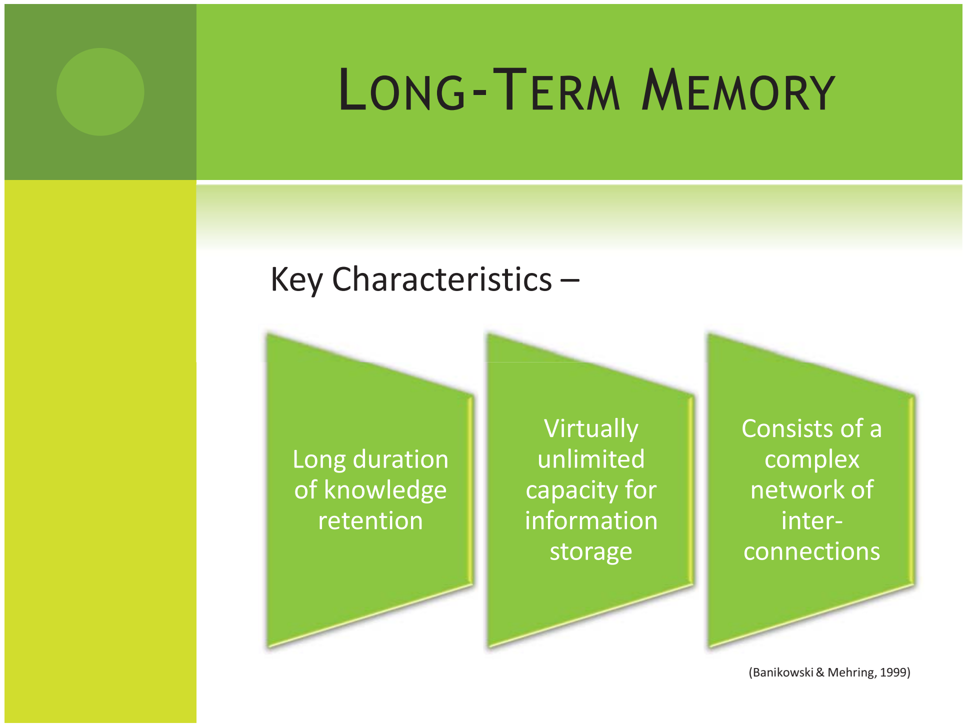
Working memory is really the operative gateway to gaining knowledge, as it represents the first step to actual—that is, permanent—learning. A plethora of research studies exist regarding exactly how much information working memory can process at any given time. You may recall the time-honored maxim of between two and six items. Some research in this area suggests pushing this envelope of conscious processing to closer to nine items. However, research by Nelson Cowan of the University of Missouri, one of the preeminent names in educational research regarding the brain, limits the practical number of pieces of information that can be meaningfully processed to four [*Cowan, 2000*]. In other words, only four pieces of information, or chunks of information, can be held in working memory storage at any one time to become the meat of actual thinking. This is probably the conservative target we should aim for as educators. [*Note last bullet-box to audience.*]



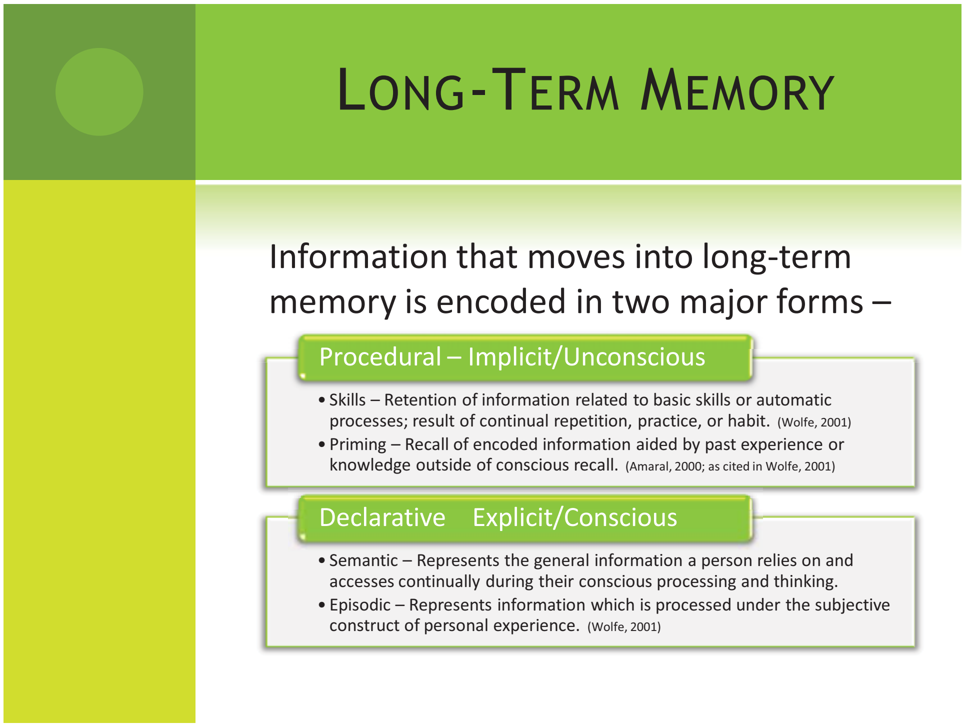
So, how do we help extend that critical processing time in working memory? While many strategies exist, the three that most concern us are rehearsal, chunking, and multiple coding, and these really supplement one another and give us the most bang for our proverbial buck. We all know the anti-constructivist platform that condemns simple or rote rehearsal, but this traditional method of practice is not without merit. While elaborative, meaningful rehearsal is touted as the most effective means of keeping information in the forefront of our focus and attention, and rightly so, rote rehearsal must have its place. In fact, there is a decent body of research that suggests students prefer at least a component of traditional drill-and-practice activities over an exclusively thematic or inquiry-based curriculum [*Peladeau, Forget, & Gagne, 2003*]. Students like fluency practice; *they get it,* and they like to *get it*—it's a good feeling to *get it*. Supporting rehearsal and working memory as a whole is the idea of chunking, or linking key pieces of information together to be processed as a single unit. Textbook examples of this reside in our phone and social security numbers, and the various acronyms and mnemonics we use to remember the order of mathematical operations or the planets in our solar system. This really brings us to the final box of the slide. One of the key strategies to maximize working memory lies in the dual or multiple coding of information. Like multiple sensory input, coding—or processing, or storing—information in more than one way helps not only to record the information from more than one perspective, but it thus also helps recall the information from more than one perspective. This, then, leads us into the permanent knowledge stores of long-term memory.



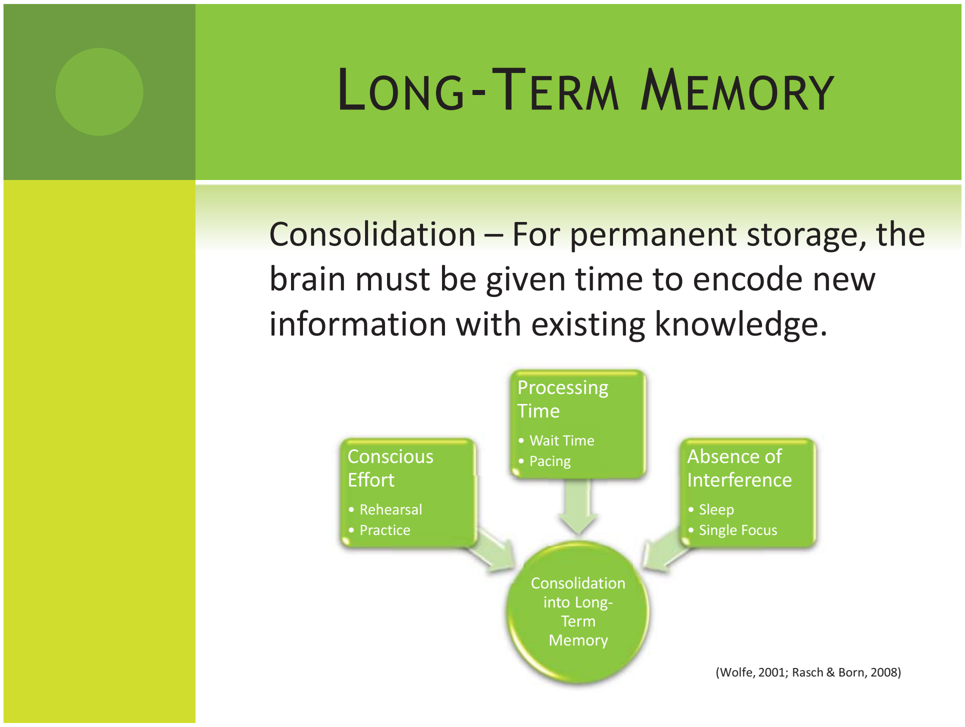
Welcome to the goal of every teacher and parent alike. The kids pay attention, we present them with stimulating information and continuous opportunities to rehearse it in myriad ways and—Shazaam!—its encoded into permanent memory…we hope. Sensory, working, and long-term memory are not individualized components that work in isolation. They are really descriptors that help us to understand the fundamental process by which information enters and is stored into the mind; for us, the minds of our students.



Long-term memory is the "white whale" that we seem to be destined to chase. It is a teacher's lot in life. On the bright side, when we do get an occasional harpoon past the waves, it sets knowledge into a framework with no known limit of time or capacity. We don't understand how knowledge is interconnected into long-term memory, we only appreciate that it is. So we look at this complexity of knowledge as a cue for our own methods of instruction.



Of the two primary forms in which long-term memories are encoded, as educators, we are really only concerned with one, namely, declarative. The skills base of procedural memory and its hallmarks of practice and repetition are initially attractive when we think of facts fluency or classroom management routines, but quickly pale in the light of their true nature—that of combing one's hair a thousand times…of getting dressed…of using a spoon. These actions are largely unconscious; school and our learning goals are truly conscious, and contain only subtle hints of implicit thought. The semantics of knowledge to be learned and the episodic factors of how we learn it form the crux of formal education. Yet, this is a good thing. Remember that we decided to change the variables within our power; to change the social construct within which our students learn. Their learning begins consciously because *we form it that way*. It is a decision that both teacher and learner silently acknowledge when they enter the classroom each day.

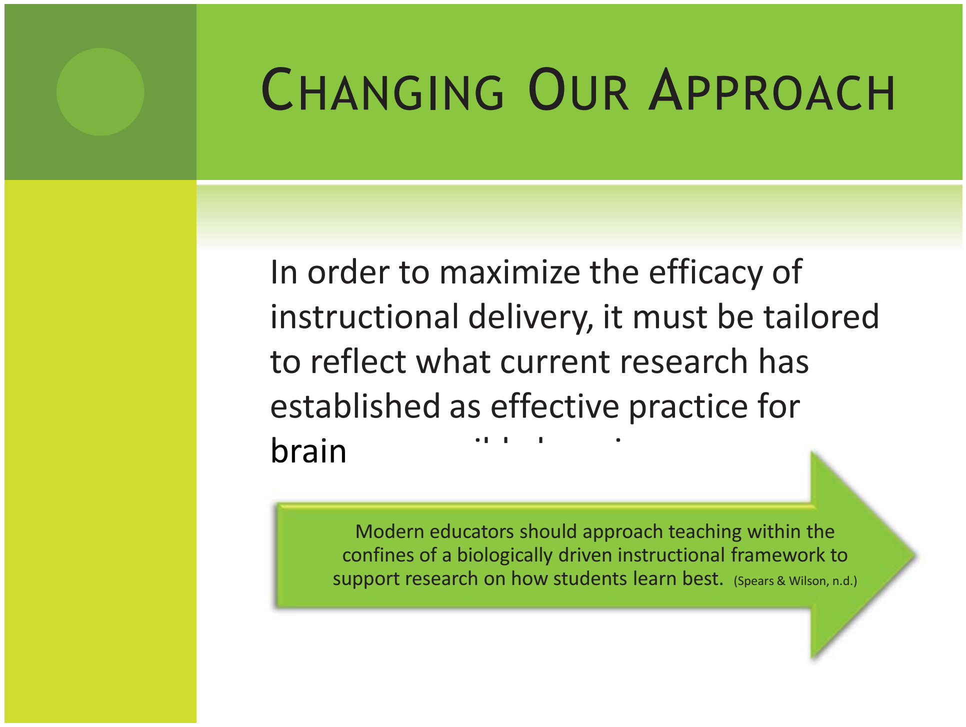


So, the dog-and-pony show has concluded, the students have applauded, and your observing principal has offered kudos to your distinguished instruction; the media has likely been notified. Now what? We have to give them time to process the information. Seconds? Yes. Minutes? Yes. More? If we can. The easiest method to use in the classroom is probably that of wait-time. While there are many types of wait-time, at least eight at last count, they all center around the concept that whatever is said, by teacher or student, in question, or response, or comment, needs to have a few seconds of silent time tacked on to give the brain a chance to let it sink in [*Stahl, 1994*]. The purpose of wait-time is simple: to extend processing time in working memory to maximize successful transfer into long-term memory. This wait-time or think-time is complemented by careful pacing by the teacher, who must constantly adjust for both perceived and implied need of the students as they try to take in new content. Pausing the flow of information gives the brain a chance to *consolidate* the information, or link the new information with what is already encoded in permanent memory. Ironically, the most consolidation occurs automatically as we sleep—yet another reason to remind the students to get their rest. Stop…shhhh…think. Confidentially, it works for us too. Research shows that both *in* our learning and *during* out teaching our questioning and conscious use of strategies increases in complexity. So, we slow it down and model the pacing and interactions. Pretty soon the students are using wait-time with one another. Depth of processing yields depth of thinking and depth of connective interactions across all communications.

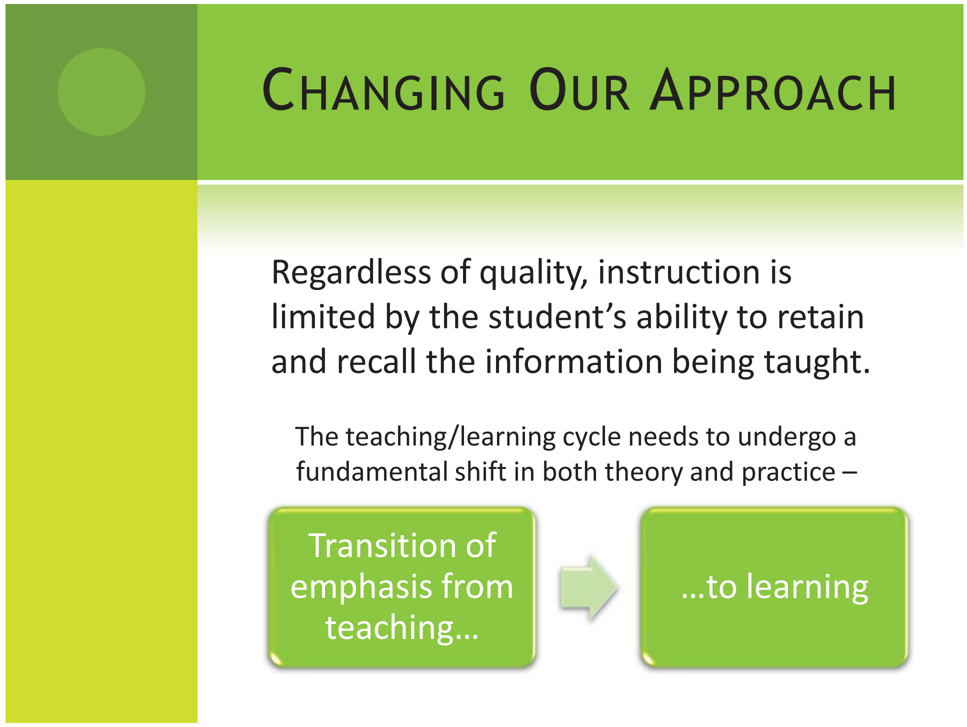
Moving information from sensory input to permanent long-term memory storage is our goal.

"The interrelating of long-term memory data "means we have learned, rather than just memorized." (Willis, 2007, p. 311)

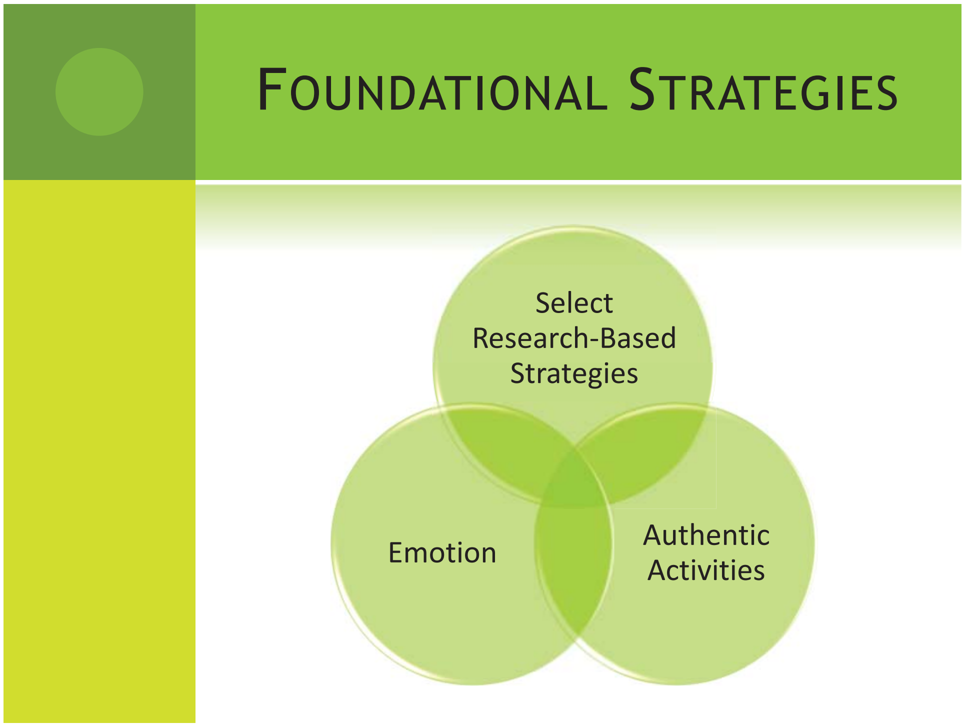
If we make it into the knowledge retention fields of long-term memory, we have earned some game points. Yes, I know, long-term recall presents its own problems and is another issue, but its also another slide show. Today, we are focusing on getting the information in and out within the time constraints of our ongoing months with our students. I can't fix summer break quite yet.



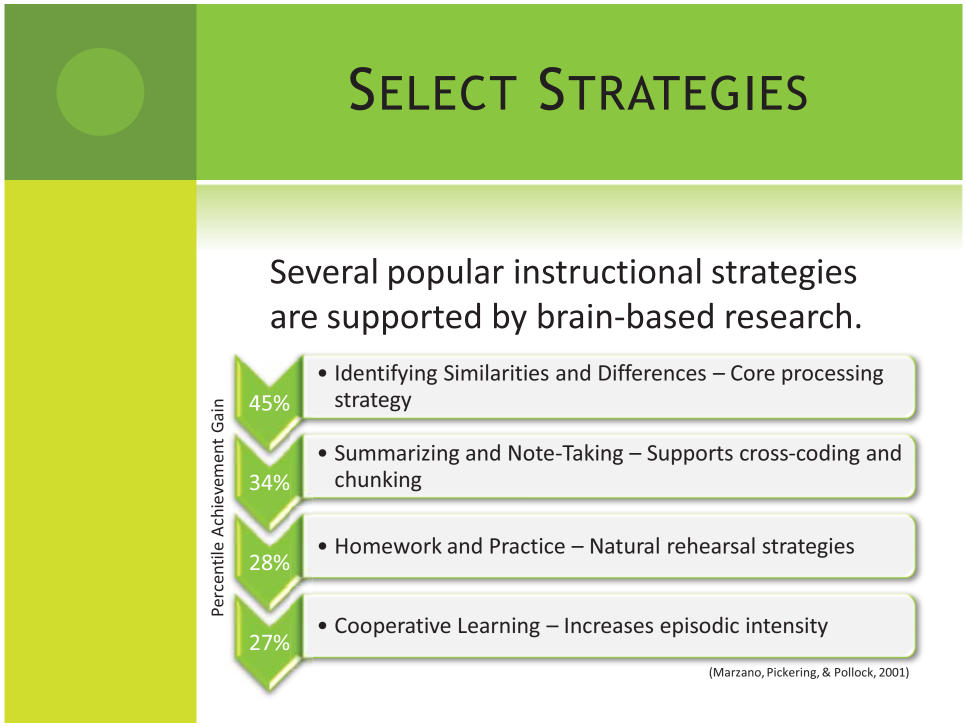
To provide the most effective instruction, we have to *apply* the information that research has provided to us; it serves little purpose lying in wait in one of the umpteen online information clearinghouses. Taking the initiative and working to modify our instruction to adopt brain-based best practices helps establish a sound starting point, and allows for further strategy use that complements brain-compatible instruction, but continually reaps the benefits of a solid footing.



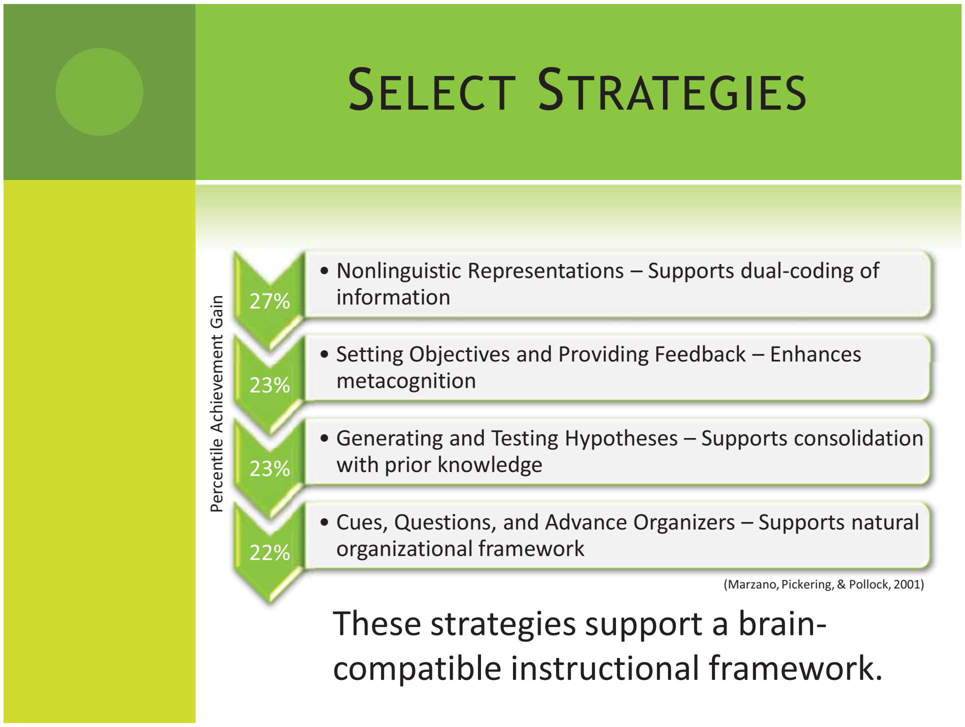
Now, obviously, brain-based learning doesn't have a corner on this empirical statement [*indicate top sentence*]. However, brain-based learning can become the focal point of our instructional delivery and methodology. Notice that I haven't once said *brain-based teaching*; that's not what we are focused upon. We are modern educators and we are focused on that measurable end product. The teaching and learning cycle is well entrenched in present educational theory and, hopefully, in practice. We plan, pre-assess, teach, assess, evaluate, plan, pre-assess, ad infinitum. Sometimes I feel like we collect data on our data at this point. We have ideas, theories, and hierarchies running through our heads. Cambourne, Maslow, and Bloom; Piaget, Skinner, Vygotsky, and Freud; our colleagues drop more names in the lounge than a mob boss gives up turning state's evidence. But beyond the theories and beyond the citations we remember the goal—to make sure students learn what they need to learn. The content is specified, again the "what;" and we look to the "how."



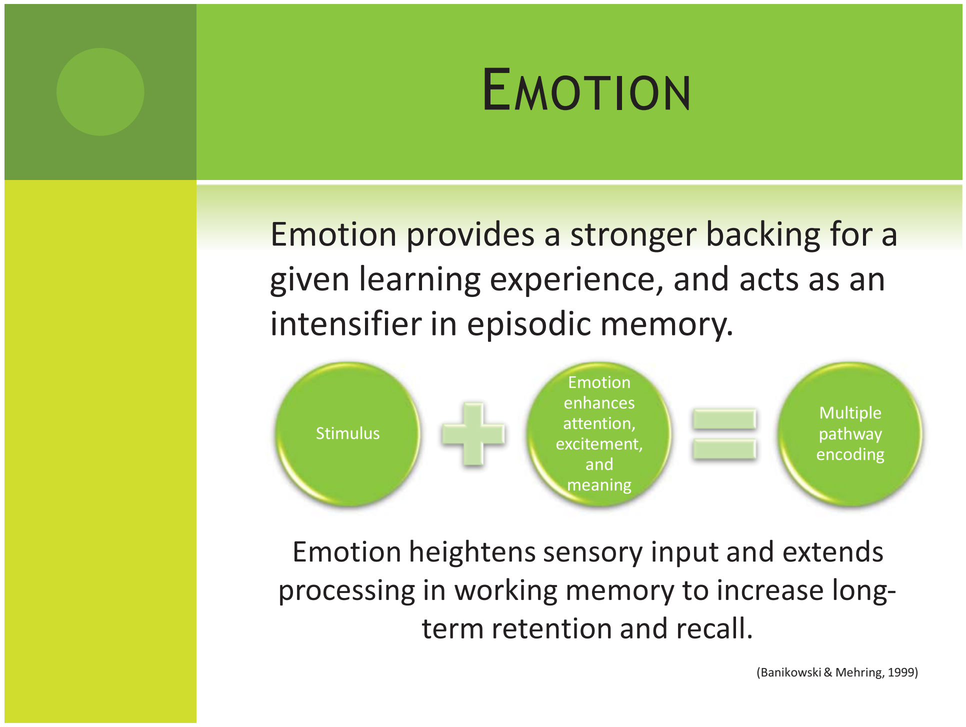
Rather than jump to the full list of every strategy that finds support in brain-based research, I have selected three key categories. [*Read slide*.]



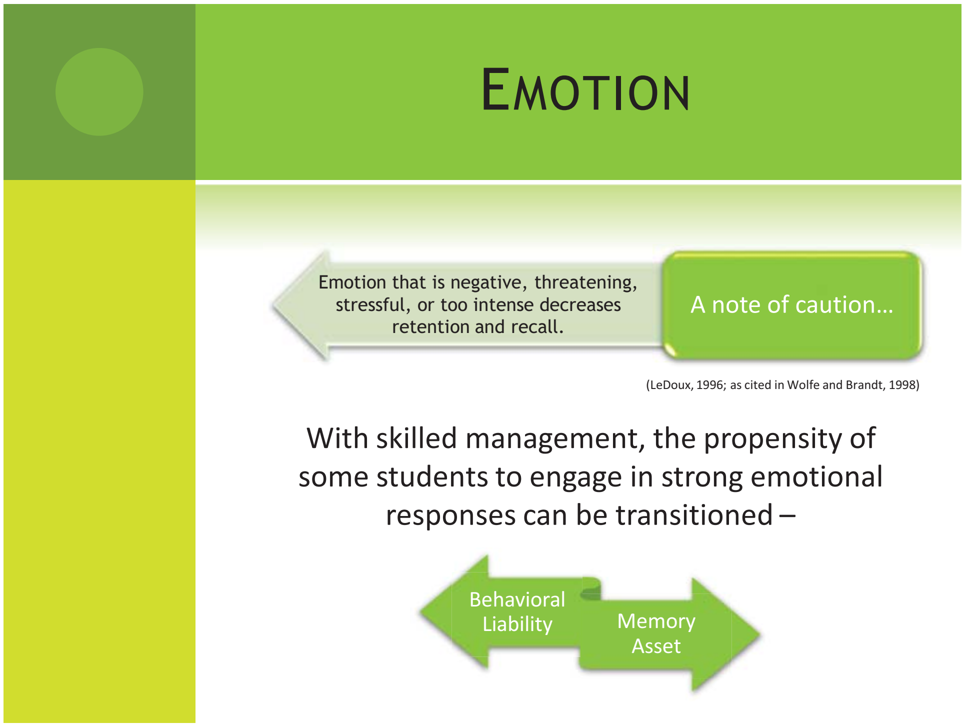
Any questions regarding the popularity in this region of Marzano and company's nine essential strategies have become somewhat of a foregone conclusion. It is certainly not my intent to review their extensive meta-analysis, or to sell any one of the strategies over the others. I would simply note that in addition to other achievement data noted by those esteemed researchers, each instructional strategy may be linked with brain-based research to at least some extent—although some anecdotal evidence and empirical reasoning is necessary—to make these popular strategies compatible with our focus on brain-compatible learning.



[*Allow time to read this slide. Consider moving back and forth from this slide to the previous slide to briefly call attention to average percentile gains (as opposed to effect sizes).*] So these essential strategies give us a quiver of arrows for effective classroom instruction, but they still need a little help to consistently reach all the targets.



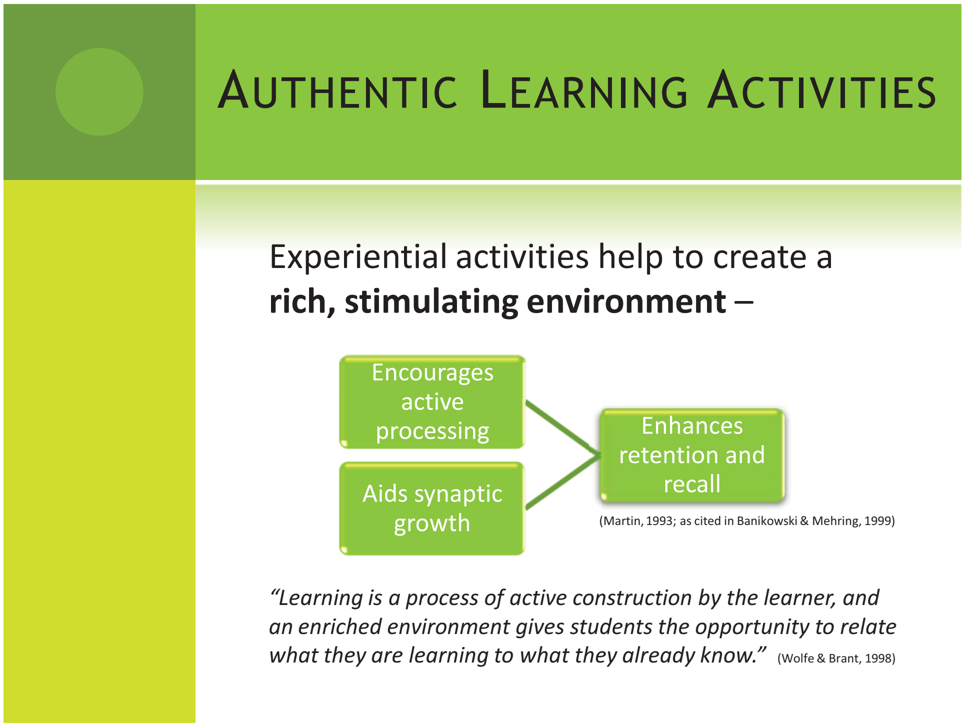
When it comes to brain-based learning, one of the two major pillars is emotion. We are social creatures at heart, and youth arguably presents an enhanced range and variety of emotional stimuli and responses. Yet, the typical response by teachers when emotion is mentioned in the same breath as instruction is, "*Every lesson can't be fun*." The beneficial, intensifying effect of emotion is not limited to strong positives; a vast degree of emotions exist before we reach negative territory. For example, intrigue, wonder, anticipation, excitement, challenge, success, struggle—even controlled confusion—all can have their part to heighten sensory input and increase attention and meaningfulness to the learner, which then extends information processing time in working memory. With the addition of emotion, the social context of the learning situation imprints with the knowledge itself, significantly increasing the quantity and intensity of encoded pathways in the brain. More coding means better coding, which in turn means enhanced retention and longer duration of recall.



Of course, as you might assume, emotion that is too overpowering or negative can hinder retention or recall, or worse, can imprint a negative experience all too sharply in long-term memory. Think back to your own public education. I can certainly think of exceptionally strong negative memories that I remember as if they happened yesterday; meaningless except in the light of the negative aspects of their social context. So we try to trigger the multifaceted possibilities of emotion short of negativity or overload, and hopefully turn what typically is a classroom management liability into a working asset. Remember that this need not be during the lesson. Research studies have shown that triggering emotion prior to or following lesson content has beneficial effects on retention and recall—don't forget that consolidation takes time! Those kids are still learning what you taught them long after they leave you, interference and distractions notwithstanding. Focus on *changing* the feeling. Keep them safe but off-balance. Switch up the learning; the method; the action; the surprise. *We* control the environment.

The second major instructional pillar in brain-based research is authentic learning activities. The true power of authentic instruction, from a brain-based perspective, brings together the advantages of heightened sensory input, multiple pathways of encoding, personalized meaning, and episodic intensity. It is not "say, see, then do," it is "say and do, see and do, say and do, see and do, and so on." Authentic, experiential learning engages the student in the powerful cycles of *active learning*; of "hands-on, minds-on." Active learning subsequently features inherently memorable, emotional triggers as well—so we keep our first instructional pillar strongly in hand. Another benefit not often realized [*indicate last bullet*] is that these types of activities are perceived and processed both consciously and unconsciously. In authentic learning, we automatically enjoy the benefits of many-for-the-price-of-one.

The complex nature of authentic activities like these enrich the learning environment multifold. An enriched environment creates more diverse stimuli to be processed at varied levels of consciousness, and thus activates enhanced processing throughout the brain's memory continuum. Experiential activities both in and out of the classroom setting help students develop personal ownership and meaning in applying abstract concepts to their concrete world. Considering that knowledge is of little value if it cannot be applied, authentic learning well serves our purpose as educators.



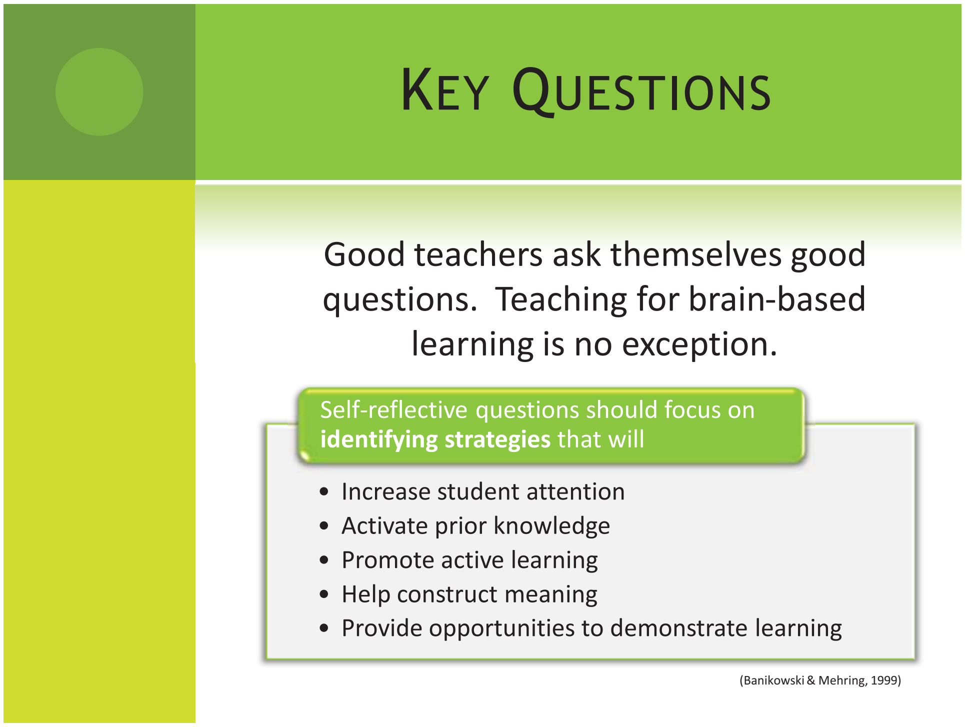
[*Read top of slide*.] An enriched environment simultaneously addresses a multitude of our needs. It helps us engage multiple learning modalities and intelligences. It helps us engender creativity and diversity in learning, and the demonstration and application of that learning. It mirrors the complexities that are inherent in the reality our students live in. Research tells us that we learn best through interaction and relation; through activity and engagement; through construction over simple reception. As teachers, we explicitly change our methods and our environment; the students implicitly change their activity and attention; the natural result benefits each of us.

WE FOCUS ON MEANING OVER MEMORIZATION—PRACTICE AND APPLICATION OVER THEORY.

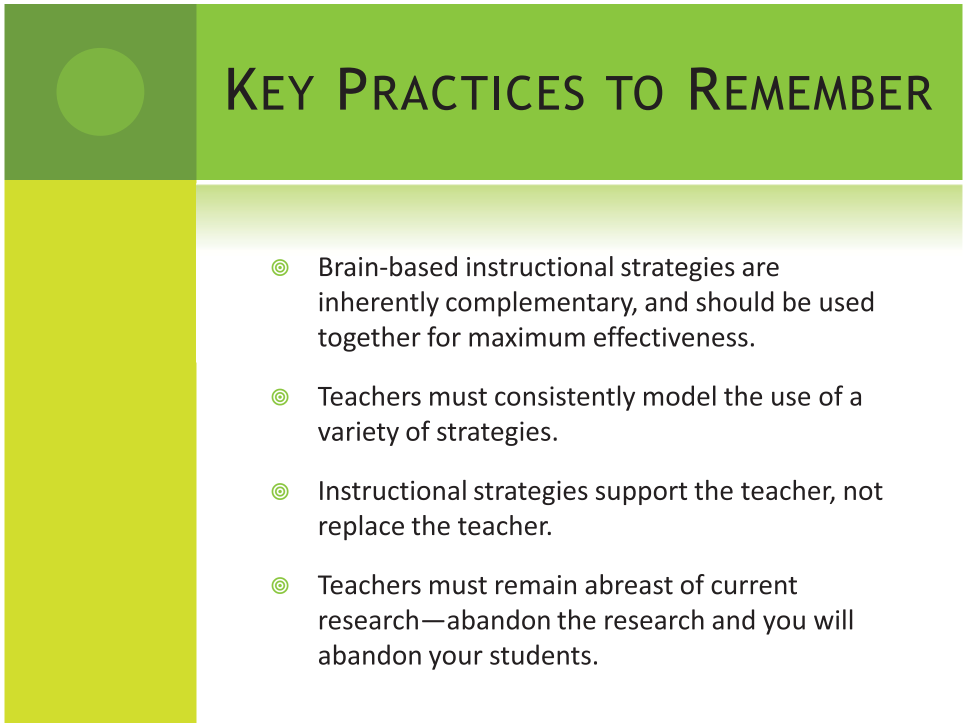
"A man has no ears for that which experience has given him no access."
Friedrich Nietzsche, *Ecce Homo* (1888)

I love this quote by Nietzsche; even very angry men can occasionally get it right.

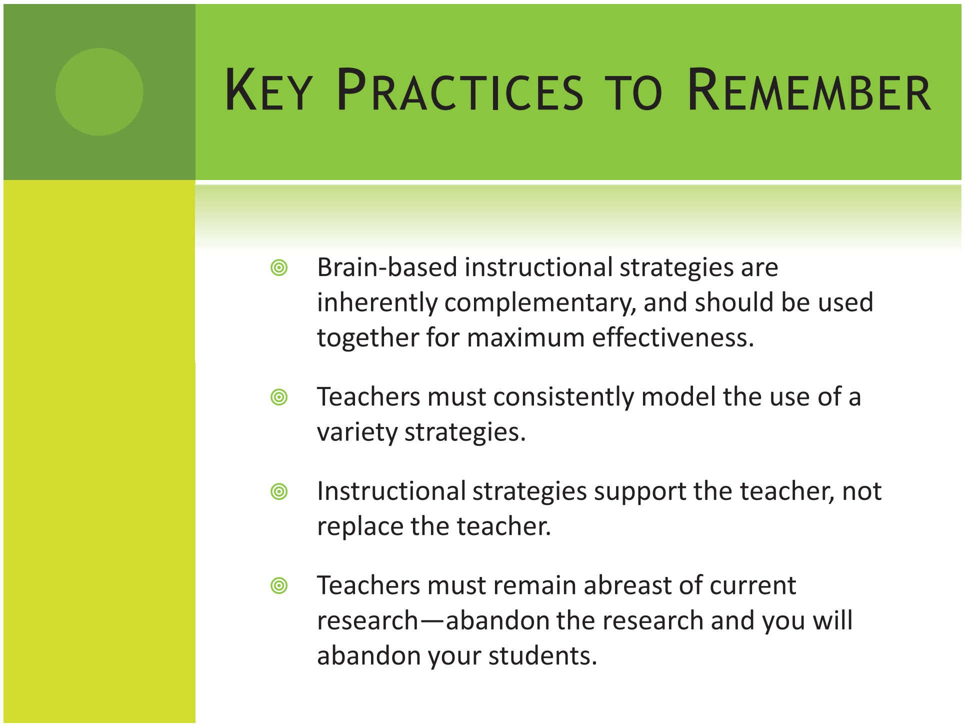
[*Read quote, then section closer.*]



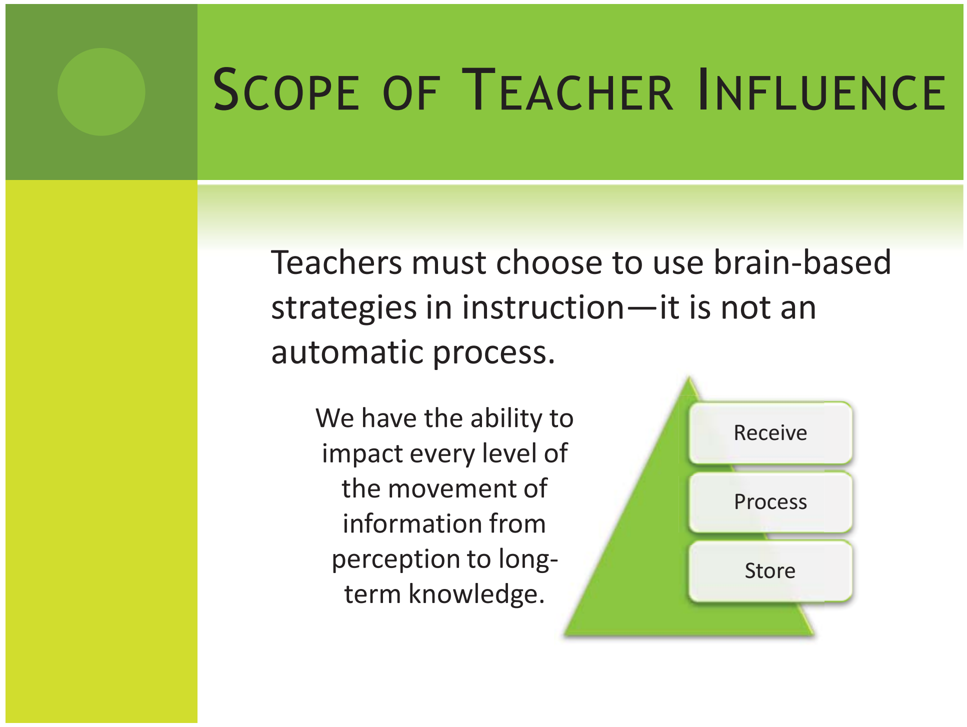
[*Read first sentence.*] Reflective learning, reflective teaching; every time we turn around we are prompted to self-reflect. What did you do? How did it go? What would you do different next time? Considering brain-based learning, we simply ensure that our self-reflection focuses on *changing what we do* in light of our specialized goals, which really should overlap and support what we are already doing as professionals—it can be a change, or perhaps only a reminder, of our focus on active strategy use.



As I begin to sum up this snapshot of brain-based learning, its important to note a few reminders regarding our subject. [*Note each bullet; move through slide quickly.*]



[*Read each bullet; emphasize final bullet*.] We tend to have somewhat of an aphoristic glibness toward our self-described educational system—like “data-driven instruction,” “standards-based curriculum,” “balanced something-or-other,” “guided this and guided that,”—I know, if it has a hyphen its got to mean more work for us. But if we’re going to change these maxims into a stolid and permanent reality, immune to the whims of historical caprice, we must embrace the consistent and systematic use of research as a powerful tool for change. Brain-based learning is one hyphenated term that should ease our burden by helping us to become more effective.

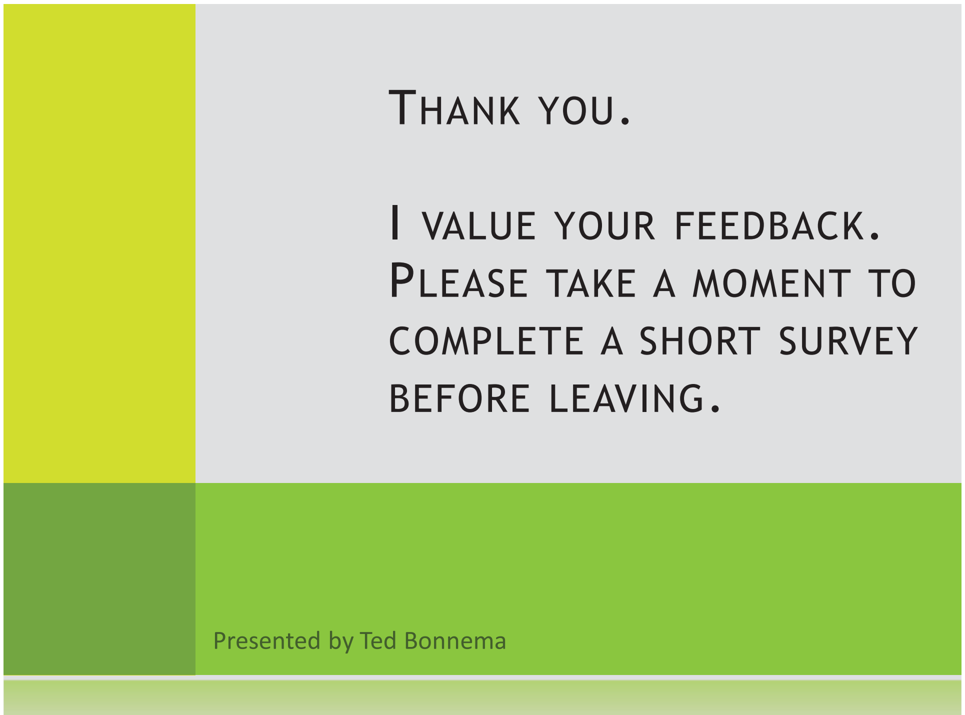


Like anything else, using brain-based strategies in the classroom is a result of conscious choice. And like any good choice—and it is a good choice—we strive to internalize our best practices so what initially seems new and uncomfortable becomes second nature. Using what we know about how the brain learns best to positively impact processing and retention will help our students succeed, and that's why we're here. Obviously, a topical slide show barely scratches the surface of such a broad topic such as brain research in education. But hopefully this information helped convey the importance of brain-based learning to our students' goals, and perhaps whet your appetite for further study.

Q AND A

"Our brains are fascinating, intricate structures, with unique complexities that continue to marvel researchers and teachers alike." Madrazo & Motz, 2005, p. 57

[*Open the floor to questions, concerns, and the sharing of ideas as time allows*.]



Thank you again for coming today. I hope that the presentation was informative and will be of use to you. As you're gathering up your personal effects and paperwork, please take a moment to complete this very brief exit survey before you leave, which you can place [*indicate*] here when you are finished. [*Personally thank participants for attending as you quickly hand survey out.*]

Chapter Summary

All teachers face the challenge of appropriately selecting the best instructional strategies in order to effectively deliver prescribed content to their students. However, the number of strategies available to teachers can often leave them with more choices than time or expertise to choose. The author designed this presentation to give participants a descriptive overview of how key components of memory function, and what foundational instructional strategies support how students learn best in light of these functions, and according to current brain-based research. Although this presentation can only serve as one facet in the greater goal to found modern teaching practices on stolid research, it is the intent of this author that it spurs participants to self-reflect on their own teaching practices in the classroom, and whets their appetite for further study. Chapter 5, Discussion, reviews peer feedback and discusses the overall effectiveness of the project.

Chapter 5

DISCUSSION

The purpose of this project was to develop an in-service presentation that linked current research on how students learn to best practices in the classroom. The presentation described key aspects of memory and foundational instructional strategies that support the natural information processing structures of the brain. Integrated teaching elements were put forth that suggested methods to immerse the student in the learning experience. The strategies presented were chosen specifically as representative of overarching theories of practice that provide the broadest impact on student learning and long-term memory storage, which unite to comprise the ultimate goal of educators.

Contribution of the Project

The author reviewed a variety of current literature and condensed this research to identify fundamental instructional strategies that would positively affect student learning and knowledge retention. An in-service presentation provided educators with summary findings accompanied by pertinent research citations to both support these findings and encourage further study. The primary components of the predominant model of memory were reviewed, followed by the identification of strategies that capitalize on research supported theories of processing, retention, and recall. Significant factors affecting memory and learning were identified, including those that increase attention, motivation, and active engagement. The information was presented in a nontechnical format to extend audience accessibility for the widest range of individuals involved in education.

While the information may be of most use to newer teachers, it should be of value to those more experienced in education as well, as research is ever adding to our knowledge base at a surprisingly rapid pace, and continually changing our understanding of how students learn best.

Limitations of the Project

Research on the brain with regard to learning and memory is extensive, and interpretive commentary on this swiftly growing body of research is even larger. It is difficult to identify summary findings from such a wide research field, so more in-depth examination of identified strategies is implied. Expanding the in-service presentation to incorporate additional inquiry into practical design and application of identified instructional strategies would be most apropos, and would echo the very learning activities that were lauded in the presentation. Participants involved in a professional development sequence such as this would have the opportunity to devise lessons, model instruction and strategy use, and involve themselves in a more purposeful discussion with immediate constructive feedback from their peers.

Peer Assessment Results

The PowerPoint® presentation was reviewed by five elementary school colleagues; one principal, two regular classroom teachers, one special education teacher, and one literacy/math interventionist. Electronic versions of both the Pre- and Post-Presentation Surveys contained in the Appendices were utilized for ease and flexibility of communication. Results from the Pre-Presentation Survey (see Appendix A) indicated that each colleague had over seven years teaching experience and had taught at various levels in elementary education. Responses relating to existing knowledge of brain-based learning were varied, but commonalities included the features of addressing multiple learning styles, varying instructional delivery methods, and emphasizing student-to-student interaction.

Feedback on the presentation itself was collected via the Post-Presentation Survey (see Appendix B) and was quite positive. The average rating from the participants regarding the quality and quantity of information, the aesthetics of the presentation, and the usefulness/applicability of the information to their current role, was excellent. The average rating of the value of the accompanying presenter's notes/narrative and the overall length of the presentation was good. All participants also provided descriptive feedback on this survey. Several noted that the presentation would obviously be more engaging and interactive when actually presented, thus the accompanying presenter's notes made review somewhat laborious and would have been more appreciated if delivered by a live presenter. While participants acknowledged the topical nature of an introductory presentation, two noted that additional follow up collaboration would make the information that much more meaningful. All participants indicated that the presentation added to their knowledge of brain-based learning; the majority referencing the sections on the interrelatedness of memory processes, and the power of emotion as a research-based learning strategy. Comments relating to possible changes in the participants' teaching methodology were very general in nature, and centered around utilizing the strategies mentioned and increasing student information processing time. Differences in feedback relating to each participant's current school role were unremarkable.

Recommendations for Further Development

It is this author's opinion that strategies that support brain-based learning utilized by educators should support all learning across the curriculum, and that the recognition and implementation of such overarching strategies will be more naturally and continuously sustained in teaching. The development of a professional development in-service sequence to allow for more in-depth study and discourse regarding cited strategies should increase not only the applicability and relevance of the information to educators, but also the likelihood that it will be integrated into daily use. It is the recommendation of this author that select strategies be singled out for more intense study, and supported by an ongoing cycle of practical application with peer coaching, collaboration, and feedback.

Project Summary

Modern educators must be more than mere dispensers of information, they must be active enhancers of memory (Willis, 2007). It is apparent that teachers need to become aware of current research in effective instruction if they are to successfully implement those strategies as a means to enhance their own effectiveness in enhancing student learning. The goal of this project was for presentation participants to come away with an enhanced understanding of some foundational best practices for delivering instruction that is supported by current brain-based research, and the assurance that they need not recreate the wheel in order to implement these practices, but only modify aspects of existing instructional design.

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APPENDIX A

Pre-Presentation Survey

PRE-PRESENTATION SURVEY

Before we begin, please take a few moments to complete this short survey.

Date of Presentation: ________________

Which best describes your primary current school role? (Select one)

- ☐ Regular classroom teacher
- ☐ Special education teacher
- ☐ Interventionist (literacy, etc.)
- ☐ Specials teacher
- ☐ Paraprofessional
- ☐ Administrator
- ☐ Student teacher or candidate
- ☐ Parent or school volunteer
- ☐ Other (describe): ____

What school(s) do you currently work at or are you affiliated with in this role?

____

How many years of experience do you have teaching?

☐ None ☐ 1-3 years ☐ 4-6 years ☐ 7+ years

What grade levels have you taught? _________________________

What does the term “brain-based learning” mean to you?

____
____
____
____

What instructional strategies support brain-based learning?

____
____
____
____

What does brain-based learning look like in the classroom?

____
____
____
____

APPENDIX B

Post-Presentation Survey

POST-PRESENTATION SURVEY

Thank you for attending.
Your thoughtful feedback will help improve this presentation for future participants.

Date of Presentation: ________________

Please rate each category on a scale of 1-5, with 1 being poor and 5 being excellent:

Quality of information presented:	1	2	3	4	5
Quantity of information presented:	1	2	3	4	5
Presentation aesthetics (style, readability, interest, etc.):	1	2	3	4	5
Value of presenter's notes or accompanying narrative:	1	2	3	4	5
Length of presentation:	1	2	3	4	5
Usefulness/applicability of presentation to your current role:	1	2	3	4	5

Is there any information that you would like to see added, deleted, or otherwise changed in the presentation?

____

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Has this presentation added to your knowledge of brain-based learning? If so, how?

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Do you plan to change any aspects of your teaching methodology (or other changes as applicable to your role) as a result of the information presented? If so, please describe.

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____

If you need more space, or would like leave additional feedback, please use the back of this form. Thank you!