RESEARCH AREA & SOURCE	DESCRIPTION & MAIN FINDINGS/ARGUMENTS
Brain Research *Paper presented at the Michigan Academy of Science, Arts & Letters*	**Stickel, S. (2005) Advances in Brain Research: Implications for Educators** This paper argues that it is essential for educators and educational policy makers to keep abreast of developments in Brain Research in three areas: Brain Anatomy, Brain Development and Biocultural Diversity related to the brain. The paper summarizes some of the major recent findings in Brain Research and some of their implications for education. **Main Arguments:** ● Learning is a complex process of rapidly changing connections and pathways involving which, how many, how loudly, and in what temporal and spatial configurations neurons are "talking" to each other. ● Development of each area of the brain must be considered in deciding what and how to teach - eg both the emotional areas (amygdala etc) and those responsible for higher order thinking. ● Periods of growth may suggest that brain maturation is key to the timing of when individuals are ready for different stages of learning and children may process information differently and different stages of brain development ● There are gender differences in brain development ● The traditional measure of what counts as intelligence is only able to predict about 15% - to 25% of an individual's academic success. ● Strong emotions influence learning ● The theory of 'pruning' suggests that appropriate stimulation may be necessary at different stages of development ● The frontal lobes, which control much of reason, logic and emotional control are the last to reach maturity, perhaps as late as the early 20's. ● Education is a critical influence on strengthening neocortical control and self-awareness, maintaining attention and managing affect. ● Students can better demonstrate knowledge and skills with several ways to both retrieve information and demonstrate their knowledge.
Brain Research *The Australian Educational Researcher, 31, 87 – 104)*	**MacNaughton, G. (2004). The Politics of Logic in Early Childhood Research: A Case of the Brain, Hard Facts, Trees and Rhizomes.** This article takes claims that have been made as a result of brain research about the importance of Early Childhood Education as a foundation for later learning and argues that though it is politically tempting as an EC educator to swallow these whole, one should be very wary of any claim that Brian Research can be generalized due to the complexity of human beings and human society and culture.
Brain Research *Scientific American Mind Vol. 18, No. 4, p.9*	**Binns, C. (2007) The hidden power of culture: The society in which we live influences the way our brain perceives the world.** 200 complex scenes, such as an elephant in a jungle or a plane flying over a city were shown to individuals of different cultural backgrounds (young and elderly people from, Singapore and the U.S.) while their brains were scanned. **Main Findings:** • For Westerners of all ages, the images triggered activity in the lateral occipital region of the brain (associated with object recognition), whereas the same areas were not activated in the older Singaporean's brains. Essentially this would mean that while the Americans were seeing an elephant and perhaps noticing the jungle around it, the older Asians were seeing a jungle that happened to have an elephant in it. • The older and younger Asian groups differed in their responses, which the researchers interpreted as meaning that the culture people grow up in influences perception.

Brain Research *Scientific American Mind Vol. 18. No. 4 p. 12*	**Flores, Graciela (2007) Sleep on it: Give your brain a break, and it will find hidden connections.** Subjects were given a learning task involving images then different groups were tested at different intervals after the learning experience. **Main Findings:** ● Subjects tested 20 minutes after the learning period performed no better than chance. ● Subjects tested after 12 hours were much more successful. ● Subjects tested after having slept outperformed the other groups in the most difficult inferences. The conclusion – " As we sleep or focus on other tasks, our brain forges connections in the background, fitting newly learned information into a bigger picture."
Brain Research *Science Daily, September 28, 2007*	**Music and Language Are Processed By The Same Brain Systems** Researchers used familiar and unfamiliar melodies containing notes which violated the listener's memory of the melody, but not the rules of harmony and other melodies with notes that violated the rules of harmony. Brain waves of listener's were monitored and the results were compared to similar tests that had been done using violations of language rules. **Main Findings:** • The two aspects of music, rules and memorized melodies depend on two different brain systems. • The same brain systems underlie rules (eg grammar) and memorization (eg vocabulary) in language.
Brain Research *Sydney Morning Herald July 14, 2007*	**Sample, Ian (2007) Tests show how we remember to forget.** This study had volunteers try to memorize 40 pairs of pictures of human faces linked to disturbing images. The participants were then place in a brain scanner and show only the human faces. Half were asked to try and forget the disturbing images and the other half to remember them. In a subsequent memory test 71% of those asked to remember the images still could but only 53% of those to try and forget them still could. The brain scans showed that suppression took part in two stages and was linked to specific parts of the brain. **Main Findings:** ● It is possible to suppress emotionally disturbing memories quite efficiently so that they are erased from memory and unable to be retrieved ● The suppression is linked to two specific areas of the brain.
Brain Research *The Economist Dec23, 2006 – Jan 5, 2007*	**Who do you think you are? (p. 3/4) / Captain Kirk's Revenge (p. 4, 5 &7) / Brainbox (p.5) / Dreamweavers (p. 7 – 9), As Others See Us (p. 9,10) I Think, Therefore I am, I Think (p.11,12).** A series of articles summarizing brain research up to now. Some salient points that may relate to education: ● A study by Terrie Moffitt in NZ demonstrated that nature and nurture can interact in predictable ways. An enzyme which regulates neurotransmitters including serotonin and dopamine comes in two versions. One version in combination with abuse during childhood resulted in severely violent adults while either abuse alone or that particular version of the enzyme on its own produced only violent tendencies. ● 'Higher emotions' (guilt, shame, sympathy), which have in common that they depend not just on what a person thinks about others, but on what the person feeling thinks others are thinking about them, are located not in the limbic system (where more primitive emotions such as fear emanate), but for the most part in the cerebral cortex. This suggests that these emotions work closely together with our rational mind. ● Declarative memory involves the hippocampus, whereas procedural memory involves the cerebellum and the basal ganglia. ● There appear to be two types of explicit memory. Episodic memory records our experiences and is stored in the hippocampus. Semantic memory tries to generalize from our experience and is consolidated in the cerebral cortex. ● Memory evolved to serve a purpose, which is to help us learn to react appropriately to stimuli in the environment by drawing on previous experience. The most efficient way to do this is to generalize and disregard individual details. ● The hippocampus replays experiences during REM while we sleep and seems to also do this to a certain extent when we are resting. ● Long-term memory is encoded(at least in part) by changes in the strength of synapses and the recapitulation of experience in the form of

	neuronal firing patterns appears to be responsible for changing the pattern of synapses. ● Certain sections of our cerebral cortex seem to be able to extract the essential properties of different objects. One are for example responds strongly to faces. Another area seems to handle written words. ● It is impossible that the area of the brain which handles written text is a result of evolutionary processes as writing is too recent an invention. It must be the result of developmental processes. ● Many believe that the evolutionary pressure which drove the enlargement of the human brain was more a need to negotiate the social world than to survive in the physical world. A recent study has suggested that autism may be the result of a failure of what are known as 'mirror neurons', which mirror that actions and thoughts of others.
Assessment *Learning and Instruction 16, 416 – 432.*	**Hovardis, T., & Korfiatis, K. (2006) Word associations as a tool for assessing conceptual change in science education.** By analyzing pre-tests and post-tests of a word association task researchers described the conceptual change in science class. The change described was a social representation (the change in the shared conceptual structure of the students in the class) rather than an individual description. **Main Findings:** ● For all stimulus terms, new associations relating to the field of ecology were introduced after the course (in population ecology) ● Associations to field other than ecology were reduced after the course. (10 words associations were recorded for each stimulus term) ● Before the course, the 'core' of students' conceptual structures included mainly non-scientific terms. Increased frequencies (number of students mentioning) and higher ranks (mentioned earlier) for ecological associations were demonstrated. ● The newly introduced associations comprised coherent groups describing causality mechanisms in population dynamics, indicating the coherence of the conceptual structures. ● The increased frequency and rank of ecological associations could comprise and index of the improved availability of the corresponding ecological conceptual structure. ● The core gives the meaning to the conceptual structure and is unaffected by situational variation. ● Results indicated that the enhanced homogeneity of the social representation was accompanied by increased heterogeneity in individual representations. (Low and High use student groups)
Instructional Strategies / Brain Research *Learning and Instruction Vol. 18, pp. 513 - 527*	**Strømsø, H., Bråten, I. & Samuelstuen, M. (2008) Dimensions of topic-specific epistemological beliefs as predictors of multiple text understanding.** In this study with 157 first year undergraduates at Norwegian universities the researchers investigated whether students' beliefs about knowledge and how it is constructed affected their ability to read and understand multiple, complex texts (sometimes containing conflicting viewpoints) on the same topic. Students' beliefs about knowledge were plotted along four continua: "(a) *certainty of knowledge* – ranging from the belief that knowledge is absolute and unchanging to the belief that knowledge is tentative and evolving; (b) *simplicity of knowledge* – ranging from the belief that knowledge consists of more or less isolated facts to the belief that knowledge consists of highly interrelated concepts; (c) *source of knowledge* – ranging from the belief that knowledge is transmitted from external authority to the belief that knowledge is actively constructed by individuals in interaction with the environment; and (d) *justification for knowing* – ranging from justification through observation, authority, or what feels right to the use of rules of inquiry and the valuation and integration of multiple sources". It should be noted that the instruments used to ascertain students' beliefs in this study related specifically to the topic of climate change. The extent to which an individual's epistemological beliefs are domain-specific or domain-general is contended. Understanding of text was measured on three levels using different instruments: (1) students' surface level understanding of individual texts (factual recall); (2) students' deeper understanding of individual texts (intratextual understanding); and (3) students' ability to draw inferences

	from the combined information of multiple texts (intertextual understanding). **Main Findings:** • Students who believed knowledge to be complex and theoretical scored higher on the test of factual recall. • Students who believed knowledge to be complex and theoretical scored higher on tests of inference related both to single texts and across texts, indicating that this belief enabled them to compare and integrate key information. • Students who believed knowledge to be constructed by individuals interacting with their environment scored lower on measures of deep understanding of texts. The authors interpret this as suggesting that when reading a complex set of expository texts, readers should pay close attention to the author's intended meaning and not rely too heavily on their personal interpretations. There needs to be a balance of personal judgment and reliance on external authority. • Students who believed knowledge to be tentative and evolving scored higher on the measure of intertextual understanding. • Beliefs about justification of knowing did not relate with measures of understanding. The authors advance two possible reasons for this: (1) possible difficulties in validly measuring justification; or (2) students may accept that knowledge claims in multiple texts should be verified through reasoning and the use of other sources, but may not have the skills to perform such an evaluation. • Prior knowledge predicted scores on all three reading measures, confirming that topic knowledge does affect understanding.
Brain Research / Curriculum Development Handbook of Research on Curriculum	**Bereiter, C. & Scardamalia, M. (1992) Cognition and curriculum.** This is an article summarizing research into cognition as it relates to curriculum. **Main Arguments / Findings:** Conceptual change ● A growing body of research supports the proposition that all concepts are grounded in implicit theories. If this is true, then dealing effectively with students' misconceptions is to require digging beyond the manifest errors to the underlying system of beliefs that gives rise to them. Such belief systems are almost always tacit. The centrality of knowledge ● Background knowledge, in the form of hierarchically structured schemata, affects how new information is encoded or registered, by determining what elements are attended to as significant. It affects remembering by providing plans used to search memory. It provides a basis for inferential elaboration and gap-filling. ● Research on expertise suggests that experts are distinguished from novices more by what they know than by their ability to reason more effectively. Chess experts do not think more deeply or cleverly than novices. Rather they can take in chessboard configurations at a glance because they have stored a huge number of patterns in memory. Humans are poor at extended chains of reasoning but good at pattern recognition. Becoming an expert involves shifting the cognitive burden from what we are poor at to what we are good at. ● Researchers in artificial intelligence have found that they get the best results by having a relatively simple inferential system and putting the expertise into the knowledge base. Metacognition ● Research shows that students are often unaware of the nature and purpose of what they are learning ● Learners are often unaware of the cognitive demands being placed on them and tend to assume that these are of a lower order than they actually are. ● Teachers often do not recognize metacognition as an important part of competence and therefore do most of the metacognitive work (such as setting objectives, activating relevant knowledge, judging what is important, evaluating understanding and identifying difficulties) themselves, so that learners never become responsible for it. ● The importance of metacognition during teacher-directed learning is shown by studies which have found that successful learners monitor every interchange when the teacher is calling on students, covertly responding themselves and trying to learn from the feedback teachers

	give other students. Less successful students think only about their own turns to perform. Learning as problem solving ● Ng and Bereiter found that in a computer programming course about half the learners concentrated exclusively on accomplishing the programming tasks with hardly any attention to what they were supposed to be learning from the tasks (ie learning through problem solving). The other half, to varying extents, focused on the learning itself as problematic. These students showed superior learning. ● Chi found that high achieving students, rather than merely transferring procedures from a worked example of a problem, spent time studying the example and trying to understanding why the modeled procedures worked and hot they related to underlying laws. Learning through problem solving ● Studies by Sweller indicate that textbook problems of the usual kind are a poor vehicle for learning generalizable concepts and principles. They induce students to use means-end methods in which they focus on answer-generating formulas and devote little attention to the concepts to which the formulas refer. Automaticity and processing load ● There are three related ways that we can overcome the limitations of working memory (considered to be able to deal with approximately 4 pieces of information at once) **1.** Using long-term memory for look-up (eg – number facts in mathematical word problems) **2.** Chunking (combining several ideas so that they are treated as a single unit in working memory) **3.** Automaticity (eg – alphabetic decoding becomes automatic and frees working memory to concentrate on meaning)
Brain Research *Engaging Minds. (Chapter 1 p. 1-47 Mahwah, NJ: Lawrence Erlbaum Associates*	**Davis, B, Sumara, D. & Luce-Kapler, R. (2000) Knowing Looks** This chapter has to do with consciousness, our ability to perceive and the implications of what we know about perception for the classroom. **Interesting definitions used by the authors:** 1. learning - has to do with prompting learners to notice certain aspects of their worlds and to interpret those elements in particular ways. 2. information - consists of variations, irregularities, and so on that are significant enough to impinge on the senses. **Main Arguments / Facts:** ● Our sense organs combined can register in the range of 11 million bits of information each second, but only a small portion of these sensory possibilities ever reaches consciousness. A typical person can be consciously aware of only 10 to 40 bits of information per second. ● Those sensations that do not impinge on consciousness still affect our learning. ● Much of what we have learned unconsciously can fall apart when conscious attention is drawn to it. ● For sensation to makes sense in the context of a human culture, the sensing person must interpret, and that interpretation will affect what is allowed to impinge on consciousness in future experiences (examples are give of research with people who lost their sight as children and regained it as adults - they literally cannot ‘see’ - meaning they cannot pull coherent images out of the visual ‘noise’.) ● Well before we become aware of a perception or a thought, complex non-conscious processes have sorted through and discarded information so that what enters consciousness has already been rendered meaningful. ● Initial research into Artificial Intelligence suggested that computers would one day be able to outperform humans on school-related tasks. This has not happened, because AI researchers made the mistake of regarding conscious knowledge (rules) as more important that the complex web of experiences and interpretations that support conscious thought. AI researchers have now moved away from teaching computers rules toward the provision of examples and experiences. **Implications:** ● Teaching and learning should embrace the breadth of human sensation. Teachers should provide rich, open sorts of activities and work to direct their students’ attention toward particular aspects of those activities. ● Strategies for focusing attention include: repetition, well-timed questions, highlights, practice, not-taking, discussion, resymbolization or

	rephrasing of ideas. ● Activities to be avoided include: elaborate explanations, extended instructions, decontextualised formulations. ● Teaching is about maintaining a balance of richness of detail and narrowness of focus. ● Mindful practice relies on well developed abilities to let other worries slide into the background - so skills necessary for performance need to become automatic or else they will take up too much of working memory when performing a complex task. ● Learners can often make no sense of abstractions without the bodily sensations that are the root of our experience in the world. ● Teaching is less about teaching student what they don't know and more about helping them notice what they haven't noticed. ● Teachers must understand what kind of discernments in perception are important to a given concept and what sorts of artifacts and events might be useful in highlighting those distinctions.
Teaching strategies / Brain research *Scientific American Mind 18.4. p. 11*	**Sachan, D. (2007) Behave Yourself! Kids who can control their impulses do better in school.** A study by Pennsylvania State University researchers of 3 – 5 year olds. **Main Findings:** • The ability to self-regulate (defined as the ability to pay attention to a task and inhibit impulsive behavior) was the best predictor of performance in math and reading in kindergarten, despite that fact that most people believe that intelligence plays the key role. • The researchers recommend that curricula should provide children with regular activities to decrease impulsiveness and instant gratification and promote attention and awareness of one's own and others' thoughts and feelings. Recommendations include activities that involve taking turns, paying attention for sustained periods and giving incentives for thoughtful responses.