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While brain research does not provide all the answers to our educational problems, when the research is well grounded and correlated with strategies and interventions that are consistent with knowledgeable interpretations of the research, foundational understanding of neuroscience can provides educators with the background to make informed decisions about products/curriculum that claim to be brain-based. Perhaps most important is that educators with this background can understand why their best strategies work and how to apply them to different units of instruction and to suit the strengths of individual learners. Then they can empower and motivate their students by sharing this knowledge of how their own most important tool can work optimally through their own efforts.

After practicing as an adult and child neurologist for 15 years, in the early 1990s I became distressed by the epidemic of referrals I was getting to evaluate children for ADHD, OCD, petit mal staring spell epilepsy, oppositional-defiant syndrome, and other behavior and attention disorders. The percentage of these children who actually had the conditions for which they were referred didn’t change.

Since teachers prompted the referrals, I began observing classrooms, talking with educators, and reading about the standardized testing impact on the type of instruction taking place in classrooms. I found that the pressure to teach to the test was so intense it was embedded into rigid curriculum with a predominance of drill and minimal engaging student-centered activities.

My neuroscience background became the lens through which I could evaluate the quality and potential applications of the new science of learning. For the past ten years as a teacher I’ve evaluated the neuroscience and cognitive science research as it applied to my own classrooms, and later to problems common to many teachers. During that time I began to write books, articles, and give presentations/professional development workshops
nationally and internationally about using brain research as a bridge to neuro-logical teaching strategies.

**Mind, Brain, and Education**
The union of mind, brain, and learning with laboratory and cognitive research is limited to suggesting strategies based on what I call neuro-logical predictions. By neuro-logical, I refer to strategies suggested or supported by research that are consistent with my neuroscience background and my own, and others', classroom experiences. I consider a strategy neuro-logical when it correlates with the accumulating data about how the brain appears to process sensory input into learning.

Although what we see in brain scans or other laboratory research cannot predict what a strategy or intervention will mean for individual students, the information can guide the planning of instruction. It will increasingly fall to professional educators possessing background knowledge about the brain to use the deductions of scientific research to guide the strategies, curriculum, and interventions they select for specific goals and individual students.

**Attentive Students**
As many of the children referred to my practice were sent for evaluation of attention problems, I initially investigated the research regarding attention. All learning comes through the senses and what sensory information comes in is the unconscious response of filters in our primitive lower brains that are essentially the same as other mammals. Animals need that filter system to give priority attention to signs of danger and potential pleasure (the sight of potential prey or the smell of a potential mate). Humans have this same primitive brain information intake system. At the unconscious, reflexive level our brains are programmed to give intake priority (pay attention) to change and novelty, especially cues that are linked with danger or pleasure.

The first intake filter that determines brain entry of sensory input is the reticular activating system (RAS) in humans and other mammals. The RAS admits less than one percent of the sensory information available to it each second. As survival priority is given to change or novelty in the environment that is associated with threat or evokes curiosity.

Essentially, the students who were believed to not be paying attention, were
paying attention to something, just not what the teacher offered as sensory input. This led me to try and then recommend that teachers first create and maintain safe and supportive classroom environments. Then they can use lessons that promote curiosity, which are more likely to promote the sensory input of the lesson to their students' brains. Examples of novelty that promotes curiosity and attention include wearing an unusual item of clothing, having something different on the wall, playing a song when students enter the room, changing the arrangement of furniture in the classroom, or even taking a suspenseful pause during a lecture – because silence is often a novelty in a classroom.

After a few years I realized that my students were particularly curious about their own brains. At first I shared information about how their emotional states can determine the pathway input takes in the brain. We discussed that when the brain is very stressed or very confused and frustrated it goes into survival mode and the information will be sent into the lower brain, where the resulting behaviors are related to survival such as fight/flight/freeze. I explained that the amygdala, part of the brain's emotional limbic system, can change that when stress is reduced. The goal was to be in the relaxed, alert state so input travels through the amygdala to higher cognitive prefrontal cortex where it can be recognized and processed by thinking instead of reacting.

**Calm and Focused for Increased Memory**

The brain produces brain waves at varying electrical frequencies measured in hertz (cycles per second). During the brain wave electrical frequencies called Theta the frequency of 4 to 7 Hz correlates with a state of calm and periods of heightened awareness. Theta frequency can be seen during daydreaming with bursts of creative insight and advanced meditation. Recent research results from EEG studies done with implanted electrodes (on patients being evaluated for surgical removal of epileptic trigger areas) found that in the relaxed, alert stage, when theta waves are prominent on EEG, memories are stronger (Rutishauser,, Ross, Mamelak, & Schuman, 2010).

One of the lessons students were particularly excited about was the lesson when they discover that their mood and focused attention determines what information gets into their “thinking” reflective brains. We reviewed the amygdala and they recalled that if they are are calm and focused their
amygdalas will make the “decision” to send the information to their thinking brain in the prefrontal cortex. I explained about the EEG research and that in the mindful state of focused alertness they will learn more of what they hear and read and be able to have more thoughtful control of their emotions and creativity.

We then did mindfulness activities and they experience their increased awareness when they purposely focused their attention on a sound or the visualization of something they learn in history. After that, we did often did relaxation breathing before we began tests or challenging lessons and students described their calmer moods and heightened awareness and felt they understood and remembered more.

A 7th grade girl with ADHD who also suffered from test anxiety said, “I want my RAS to let in the information I want and my amygdala to keep what I hear in class flowing into my thinking brain. It worked in class so I tried it on my own at home. It worked. I did my homework faster and even got the hard problems right because I didn’t get frustrated the minute I didn’t understand something. I just pictured my own brain opening up the flow to my prefrontal cortex and went back to the hard problem with a better attitude. It worked at home and now it works on tests.”

**Teaching Students a Brain Owner’s Manual**

I found that when students know about how their brains learn they are motivated to take action. Especially when students feel they are “not smart” and nothing they do can change that, the realization that they can literally change their brains through study and review strategies is empowering. Children, as well as many adults, think that intelligence is determined at or before birth and no amount of effort will change their academic success.

When I taught my upper elementary and later my middle school students about the changes in their brains that take place through neuroplasticity they even “got” the purpose of review and homework. I explain, show them brain scans, and we draw diagrams about the construction of connections between neurons that grow when new information is learned, and how more dendrites grow when information is reviewed. Their responses are wonderful. One ten-year-old boy said, “I didn’t know that I could grow my brain. Now I know about growing dendrites when I study and get a good night sleep. Now
when I think about watching TV or reviewing my notes I tell myself that I have the power to grow brain cells if I review. I’d still rather watch TV, but I do the review because I want my brain to grow smarter. It is already working and feels really good.”

I use sports analogies about building greater skill the more students practice a basketball shot and dance analogies for students who have seen their performance improve the more they rehearse. Then we make connections to explain that their brains respond the same way when they practice their multiplication facts or reread confusing parts of a book.

My students told their parents about “making my brain work the way I want it to” and soon other teachers were asking me for my brain lessons. I wrote a middle school version of the Brain Owner’s Manuel lessons for educators to modify as they choose and use for their students, especially students with attention difficulties or learning challenges.

When I went to medical school and became a neurologist I didn’t know that I’d eventually become a teacher and write about brain research-based teaching strategies, but once I started making connections between my two professions the links became clear. Once I saw how my students responded and the interest they developed in brain science I was so glad I could pass along a Brain Owner’s Manual for other educators to share with their students.

References

Addidional Brain Owner’s Manual Links

How to Teach Students About the Brain:
http://www.radteach.com/page1/page8/page44/page44.html

What You Should Know About Your Brain:
Books by Dr. Willis (available at the New Horizons for Learning Store)


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