Ignite Student Learning: Insights from a Neurologist and Classroom Teacher

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Goals for This Presentation

- Using advances in memory research to **IGNITE** student learning
- Turning on the brain’s learning centers
- Maximizing and maintaining attention and focus

Books by Judy Willis, M.D., M.Ed

*Research-Based Strategies to Ignite Student Learning* ASCD 2006

*Brain Friendly Strategies for Inclusion Classrooms* ASCD 2007

*Teaching the Brain to Read: Strategies for Improving Fluency, Vocabulary, and Comprehension* ASCD 2008

*How Your Child Learns Best* Sourcebooks 2008

*Inspiring Middle School Minds: Gifted, Creative, and Challenging* Great Potentials Press 2008
Brain Words

Brain Puzzle by Judy Willis: Complete the puzzle using the clues shown below.

ACROSS
1. Reticular activating system
2. Capacity of brain to change
3. Eliminates unused neurons
4. Emotional memory
5. Space between neurons
6. Coordination and memory
7. Mediates conscious activity
8. Extension of neuron

DOWN
9. Chemical info carrier
10. Brain cell body
11. Memory consolidation
12. Pleasure neurotransmitter
13. Integrates sensory input

Select answers from these words:
Hippocampus, Amygdala, Neurotransmitter, Cerebellum, Thalamus, Axon, Neuron, Cerebrum, Dopamine, Pruning, Synapse, Plasticity, RAS
Write a few words that describe (for you) a challenging unit or lesson that you have not been happy with in the past (or want to improve) with regard to student engagement and memory. Nonteachers can consider lessons you taught in the past or a person-to-person interaction (advisor, reading specialist lesson, teaching faculty, parent-child) that fits this description. Try to select something that will come up again this school year.

MY CHALLENGE_________________________________

To be filled in as we go through R, A, D in the presentation

How I will incorporate RAD

R (Reticular activating system, RAS, - sensory input filter)

A (Amygdala-emotional filter)

D (Dopamine-Pleasure Response)
Brain imaging has succeeded in correlating successful cognitive psychology theories with visible evidence of how the brain processes information - learning. Functional imaging (PET scans, fMRI) has been able to document the brain’s metabolic and biochemical responses to strategies suggested by cognitive and educational researchers.

RAD LEARNING = Reticular Activating System + Amygdala’s Emotional Filter + Dopamine

**Reticular activating system:** how to use changes in the environment, surprise, teachable moments, multisensory lessons to turn on the brain’s attention via this filter that alerts the brain to changes and gets it primed to interact with new information and experiences.

**Amygdala:** how to keep filter from blocking information entering the brain due to stress. How to use some stimulation such as building curiosity, positive emotional associations and prior experience to actually expedite passage through the amygdala’s affective filter

**Dopamine:** this neurotransmitter’s release is associated with pleasurable experiences and in expectation of pleasurable experiences. Its release also increases focus and executive function in the frontal lobes. Strategies can make lessons that allign with the Dopamine-Reward Theory.

**Reticular Activating System**

Novelty alerts the brain to changes and gets it ready to pay attention. Examples of building novelty into learning new information: changes in voice, appearance, color, size, hat, changes in seating to standing, music, dance, picture, photo, radish!!!

**Attention and Focus**
- Students are criticized for not paying attention; they may just not paying attention to what their teachers think in important.
- **Emotional Charging of Memory Connections** - Conscious memory of personally meaningful and emotional experiences increases memory storage. Emotional Significance- Increased retention occurs when learning is linked to emotional experiences.

**Strategies**
- Help students remember important information by connecting the critical information to positive emotional experiences in the classroom.
- Start with global concept, prompt interest, invite engagement through prediction, KWL or KTWL
- Avoid Attention Divided: trying to listen and take notes can interfere with getting the big picture and making the connections that become memories. One brain activity at a time. If students need to take notes, stop and let them take notes. During the stop time you can answer questions.
- Focus: Students are most focused when they know they will have to do something with the information. (PET scan and reading study-the greatest brain activation when the students were told they would have to retell the story). Knowing a think-pair-share follows will increase active focus. Pairs write down and share one or two of their items with the whole class to validate.

**Strategies to Maintain Attention and Focus**
1. Color: marking key points in color results in increased recall. Write most important fact of the lesson in another color.
2. Graphic organizers as preview and overview of each lesson.
3. Physical activity every 15 minutes: Sing a song with associated movements, teach from a different part of the room so students turn their chairs.
4. Make the classroom come alive-vary bulletin boards, plants, and animals.
5. Novelty and surprise with music, costumes, speak in a different voice, hang a dollar bill, overhead
optical illusions or bizarre factoids.

*How could you build novelty and therefore focus attention on a study or review session about action verbs or the science concept of friction?*

________________________________________________________

**Affective Filter in Amygdala**

If students are stressed information won’t pass through the *affective filter* in the *amygdala.*

**Stress and the Amygdala’s Affective Filter.** Threat, fear, or high stress can activate excessive metabolic activity in the amygdala that interferes with information entering the brain’s processing, patterning, and memory circuits.

**Set the Emotional Climate:** be the solid force that keeps students feeling safe and the classroom community strong.

Keep stress down to prevent blocking the flow of information into the thinking parts of the brain. Common stressors in the classroom: fear of being wrong, embarrassed about reading aloud, test-taking anxiety, physical differences, language limitations, negative peer relationships, cliques, unpredictability, frustration with difficult material, boredom from lack of interest.

*What classroom community builders and/or confidence building activities can you use or have you used to reduce stress from one of these classroom stressors that interferes with learning?*

________________________________________________________

**Teachers Set the Emotional Climate:** The frontal lobes, where much of the ability to manage and control emotions is programmed, are the last part of the brain last to mature. This usually happens sometimes during adolescence, so teachers need to be the solid force that keeps students feeling safe and the classroom community strong.

• **Personalize** the information by relating it to their lives, current events, their interests, talents, or learning styles. “What does our town’s debates over the building of a skateboard park have in common with the causes of the American Revolution?” e.g. Regulation (taxation) without representation.

• **Open-ended discussion strategies:** Ask a question of interest related to the topic of study that has more than one answer. Give wait time before any responses are permitted so all students have a chance to think. Invite multiple students to voice opinions without indicating if their opinions are right or wrong. It is fine to ask them for reasons to support their opinions.

**Dopamine**

This neurotransmitter’s release is associated with pleasurable experiences. Dopamine release is also associated with increased Pleasure, Creativity, Inspiration, Motivation, Optimism, Curiosity, Persistence, and Perseverance.

Things known to increase brain levels of dopamine: movement, being read to, intrinsic satisfaction such as achievement of personally meaningful goals, humor, laughing, positive social interactions, optimism, acts of kindness, empathy, and choice.

**Strategies to make learning release dopamine:**

• Pantomime vocabulary words
• Put post it notes with the parts of a flowering plant on similar parts of the body e.g. head is flower, feet are roots, arms are leaves
• Ball-toss to review high points of a lesson (only if hands are turned up and eye contact is made)
• **Avoid Brain Burnout** with *Syn-naps* (brain breaks) needed to avoid depletion of neurotransmitters in the synapses. In this “burnout” state focus can’t be maintained and new memories can’t be created. Identify these overload times BEFORE they occur and have a break before that point.

**Dend-Writes for Memory Consolidation ...and More**

**Build relational memories with “Dend-Writes”**

**Personalization**

**Connection to prior knowledge**

**Mental manipulation through executive function**

In the last 5-10 minutes of a class or at completion of a lesson students write “Dend-Writes” in response to one or more of these prompts. (choice=dopamine, amygdala)

• Draw a picture, diagram, or graphic organizer of what you learned
• Create an analogy, write what it reminded you of, or how it fits with what you already know
• A reaction or a reflection of how something you learned relates to something in your life
• Something that made you wonder or surprised you; a new insight or discovery
• What do you predict will come next?
• How could you (or someone in a profession) use this knowledge?
• Something you are confused about or found difficult
• What you understood today that you haven’t understood before
• The part of lesson that you enjoyed the most and the part you’d like to understand better
• What strategy did you use to solve a problem today?
• The “So What” or the one thing you’ll remember about today’s lesson

**More Uses of Dend-Writes**

• Feedback - how accurately the lesson was understood
• Next class, correct any misperceptions you discover
• Check one or two responses on the best cards
• Students with checks share those insights with the class as review or to promote discussion *(Lower affective filter – increased participation because confident about what they will say to the class)*
• Students listen and can add to their own notes based on their classmates’ card reading
• Cards (notebook writing) become study aides
• Post on bulletin board cards that cover important information for students who were absent or for all to review.

**Did You Know?**

*Topics for discussion with your colleagues*

Through neuroimaging studies (of the amygdala, hippocampus, and the rest of the limbic system and through measurement of dopamine and other brain chemical transmitters) we now have visible evidence that there is a profound increase in long-term memory and higher order cognition when students have trust and positive feelings for teachers, and supportive classroom and school communities.
The more dopamine students have released by positive emotional experiences (in school and out) the less likely they are to seek dopamine/pleasure surges from high risk behavior of drugs, alcohol, promiscuity, risky fast driving, overeating. More sports, music, dramatics, and enjoyable learning = less high-risk behavior and suicide in teens. This brain research demonstrates that superior learning takes place when classroom experiences are enjoyable and relevant to students’ lives, interests, and experiences.

Learning connected with positive emotional significance that leads to the new information being stored in long-term memory. Learning associated with strong positive emotion is retained longer, and stress/anxiety interfere with learning, so those lessons do not sustain for end of the year testing, even if students pass unit tests.

Syn-naps: Any pleasurable activity (singing, walk about the room and chat with friends, listening to music, having a few pages of a class book read aloud to them, or sharing jokes) used even as a brief break can give the amygdala a chance to “cool down” and the neurotransmitters time to rebuild as the students are refreshed.

Dopamine release (and the pleasure associated with it) has been found highest in school children when they are moving, laughing, interacting, being read to, feel a sense of accomplishment, and when they have choice.

Discovery Learning: Interest and discovery drive achievement. Students are more likely to remember and really understand what they learn if they find it compelling or have some part in figuring it out or discovering some part of it for themselves.

The last part of the brain to mature (through plasticity and pruning is the prefrontal lobes. Children and many teenagers do not have fully developed delayed gratification skills during their school years. The prefrontal regions are major participants in the executive function networks of judgment, prioritizing, and delayed gratification processing. This is one reason students from kindergarten through high school continue to need support and encouragement from their teachers to keep their efforts directed on long-term goal achievement.

A longitudinal study of middle schoolers noted that teachers who emphasize competitive comparisons of student ability discourage students from asking for help.

For children with attention focusing difficulties, each time they focus their attention they are activating the brain’s alerting and focusing pathways. This repeated stimulation of these pathways makes the neural circuits stronger and increases their ability to actively direct their attention where it is needed.

Enthusiasm is generated when children are presented with novelty and find creative ways to explore or connect with the new material and are inspired by it. Whenever you can generate this awe and sense of wonder, your children will be pulled into the school lessons they bring home and they will be motivated to connect with the information in a meaningful way.

Students experience a greater level of understanding of concepts and ideas when they talked, explained, and argued about them with their group, instead of just passively listening to a lecture or reading a text.

Use more senses: The experiential education motto is that you learn 40% of what you hear, 60% of what you hear and see, and 80% of what you hear, see, and do.
Useful Definitions

Acetylcholine: A neurotransmitter that stimulates multiple brain centers including the hippocampus, brainstem, and forebrain where new learning takes place. Associated with attention and focus.

Affective filter: Steven Krashen, in his studies of linguistics developed a theory of language acquisition and development that included the hypothesis of an affective filter. He described higher success rate of second language acquisition in learners with low stress and slower language acquisition when stress was high. He postulated that anxiety and low self-image created a mental blockade that filtered or blocked out new learning. The term is now generalized to refer to an emotional state of stress in students during which they are not responsive to processing, learning, and storing new information. This affective filter is represented by objective physical evidence on neuroimaging of the amygdala, which becomes metabolically hyperactive during periods of high stress. In this hyperstimulated state, new information does not pass through the amygdala to reach the information processing centers of the brain.

Amygdala: Part of limbic system in the temporal lobe. It was first believed to function as a brain center for responding only to anxiety and fear. When the amygdala senses threat, it becomes overactivated (high metabolic activity as seen by greatly increased radioactive glucose and oxygen use in the amygdala region on PET and fMRI scans). In students, these neuroimaging findings are seen when they feel helpless and anxious. When the amygdala is in this state of stress, fear, or anxiety-induced overactivation, new information coming through the sensory intake areas of the brain cannot pass through the amygdala’s affective filter to gain access to the memory circuits.

Axon: The single fiber that extends from a neuron and transmits messages to the dendrites of other neurons (or to body tissues).

Brain Mapping: Using electrographic (EEG) response over time brain-mapping measures electrical activity representing brain activation along neural pathways. This technique allows scientists to track what parts of the brain are active when a person is processing information at various stages of information intake, patterning, storing, and retrieval. The levels of activation in particular brain regions are associated with the intensity of information processing.

Brain Stem: The brain region between the spinal cord and the rest of the brain. This is also where nerve centers essential for basic survival, such as heart rate, breathing, digestion, and sleep, are located.

Cerebellum: The lower posterior region of the brain that supervises coordinated movement, posture, and balance and adjusts actions in response to external cues, such as where your foot is in relation to the step. The greatest numbers of connecting neurons to and from the frontal lobe are in the cerebellum such that this region appears to influence higher cognitive processes such as reasoning.

Cerebral Cortex: This outer layer of the brain where most neurons are located is also called gray matter due to the coloration of the neurons. The cerebral cortex is associated with the highest cognitive processes, also referred to as executive functions, including planning, decision-making, reasoning, and analysis.

Computerized Tomography (CT Scan, CAT scan): This scan uses a narrow beam of x-rays to create brain images displayed as a series of brain slices. A computer program estimates how much x-ray is absorbed in small areas within cross sections of the brain to produce the image.

Dendrite: Branched protoplasmic extensions that sprout from the arms (axons) or the cell bodies of neurons. Dendrites conduct electrical impulses toward the neighboring neurons. A single nerve may possess many dendrites. Dendrites increase in size and number in response to learned skills, experience,
and information storage. New dendrites grow as branches from frequently activated neurons. Proteins called neurotrophins, such as nerve growth factor, stimulate this dendrite growth.

**Dopamine:** A neurotransmitter most associated with attention, decision-making, executive function, and reward-stimulated learning. Dopamine release on neuroimaging has been found to increase in response to rewards and positive experiences. Scans reveal greater dopamine release while subjects are playing, laughing, exercising, and receiving acknowledgement (e.g. praise) for achievement.

**EEG (Electroencephalogram):** EEG measures the electrical activity occurring from transmissions between neurons in the cerebral cortex.

**Executive Function:** Cognitive processing of information that takes place in areas in the prefrontal cortex that exercise conscious control over one’s emotions and thoughts. This control allows for patterned information to be used for organizing, analyzing, sorting, connecting, planning, prioritizing, sequencing, self-monitoring, self-correcting, assessment, abstractions, problem solving, attention focusing, and linking information to appropriate actions.

**Frontal Lobes:** With respect to learning, the frontal lobes contain the centers of executive function that organize and arrange information and coordinate the production of language and the focusing of attention.

**Functional Brain Imaging** (Neuroimaging): The use of techniques to directly or indirectly demonstrate the structure, function, or biochemical status of the brain. *Structural* imaging reveals the overall structure of the brain and *functional* neuroimaging provides visualization of the processing of sensory information coming to the brain and of commands going from the brain to the body. This processing is visualized directly as areas of the brain “lit up” by increased metabolism, blood flow, oxygen use, or glucose uptake. Functional brain imaging reveals neural activity in particular brain regions as the brain performs discrete cognitive tasks.

**Functional Magnetic Resonance Imaging** (fMRI): This type of functional brain imaging uses the paramagnetic properties of oxygen-carrying hemoglobin in the blood to demonstrate which brain structures are activated and to what degree during various performance and cognitive activities. Most fMRI scan learning research has subjects scanned while they are exposed to visual, auditory, or tactile stimuli and then reveals the brain structures that are activated by these experiences (exposures).

**Graphic organizers:** Diagrams that are designed to coincide with the brain’s style of patterning. For sensory information to be encoded (the initial processing of the information entering from the senses), consolidated, and stored the information must be patterned into a brain-compatible form. Graphic organizers can promote this more patterning if they guide students’ brains when they participate in this creating of relevant connections to their existing memory circuitry.

**Hippocampus:** A ridge in the floor of each lateral ventricle of the brain that consists mainly of gray matter that has a major role in memory processes. The hippocampus takes sensory inputs and integrates them with relational or associational patterns thereby binding the separate aspects of the experience into storable patterns of relational memories.

**Limbic System** A group of interconnected deep brain structures involved in olfaction (smell), emotion, motivation, behavior, and various autonomic functions. Included in the limbic system are the thalamus, amygdala, hippocampus, and portions of the frontal and temporal lobes. If the limbic system becomes overstimulated by stress-provoking emotion (seen as very high metabolic activity lighting up those brain areas) the information taught at that time will be poorly transmitted or stored in the long-term memory centers.
**Metacognition:** Knowledge about one’s own information processing and strategies that influence one’s learning that can optimize future learning. After a lesson or assessment, when students are prompted to recognize the successful learning strategies that they used, that reflection can reinforce the effective strategies.

**Neuronal Circuits:** Neurons communicate with each other by sending coded messages along electro-chemical connections. When there is repeated stimulation of specific patterns of a group of neurons, their connecting circuit becomes more developed and more accessible to efficient stimulation and response. This is where practice (repeated stimulation of grouped neuronal connections in neuronal circuits) results in more successful recall.

**Neuron:** Specialized cells in the brain and throughout the nervous system that conduct electrical impulses to, from, and within the brain. Neurons are composed of a main cell body, a single axon for outgoing electrical signals, and a varying number of dendrites for incoming signals in electrical form. There are more than 100 billion neurons in an average adult brain.

**Neurotransmitters:** Brain proteins that are released by the electrical impulses on one side of the synapse, to then float across the synaptic gap carrying the information with them to stimulate the next nerve ending in the pathway. Once the neurotransmitter is taken up by next nerve ending, the electric impulse is reactivated to travel along to the next nerve. Neurotransmitters in the brain include serotonin, tryptophan, acetylcholine, dopamine, and others that transport information across synapses. When neurotransmitters are depleted, by too much information traveling through a nerve circuit without a break, the speed of transmission along the nerve slows down to a less efficient level.

**Occipital Lobes** (visual memory areas): These posterior lobes of the brain processes optical input among other functions.

**Parietal Lobes:** Parietal lobes on each side of the brain process sensory data, among other functions.

**Plasticity:** Dendrite formation and dendrite and neuron destruction (pruning) allows the brain to reshape and reorganize the networks of dendrite-neuron connections in response to increased or decreased use of these pathways. Plasticity refers to the ability of synapses, neurons, or regions of the brain to change their properties in response to usage (stimulation).

**Positron Emission Tomography** (PET scans): Radioactive isotopes are injected into the blood attached to molecules of glucose. As a part of the brain is more active, its glucose and oxygen demands increase. The isotopes attached to the glucose give off measurable emissions used to produce maps of areas of brain activity. The higher the radioactivity count, the greater the activity taking place in that portion of the brain. PET scanning can show blood flow and oxygen and glucose metabolism in the tissues of the working brain that reflect the amount of brain activity in these regions while the brain is processing information or sensory input. The biggest drawback of PET scanning is that because the radioactivity decays rapidly, it is limited to monitoring short tasks. Newer fMRI technology does not have this same time limitation and has become the preferred functional imaging technique in learning research.

**Prefrontal Cortex** (front, outer parts of the frontal lobes): The prefrontal cortex (PFC) is a hub of neural networks with intake and output to almost all other regions of the brain. In the PFC relational, working-memories can be mentally manipulated to become long-term memory and emotions can be consciously evaluated. *Executive functions* directed by PFC networks respond to input through the highest levels of cognition. These functions include information evaluation, prediction, conscious decision making, emotional awareness and response, organizing, analyzing, sorting, connecting, planning, prioritizing,
sequencing, self-monitoring, self-correcting, assessment, abstraction, deduction, induction, problem solving, attention focusing, and linking information to planning and directing actions.

**Quantitative Encephalography** (qEEG; brain mapping): This brain wave monitoring provides brain-mapping data based on the very precise localization of brain wave patterns coming from the parts of the brain actively engaged in the processing of information. Quantitative EEG uses digital technology to record electrical patterns at the surface of the scalp that represents cortical electrical activity or brainwaves. "Functional" qEEG testing adds recording to evaluate the brain's responses to reading, listening, math, or other demands and provide visual summaries in topographic maps.

**Reinforcement Learning Theories:** Theories (such as *Dopamine Reward Learning*) based on the assumption that the brain finds some states of stimulation to be more desirable than others and makes associations between specific cues and these desirable states or goals.

**Relational Memory:** Learning consists of reinforcing the connections between neurons when students learn something that adds to what they have already mastered that expand on neuronal networks already present in the brain.

**Relaxed alertness:** A dynamic state of readiness that incorporates a sense of well-being with curiosity, engagement, confidence, and motivation. In a state of relaxed alertness a child is ready and desirous of taking on achievable challenge, making considered emotional and intellectual decisions, persevering through set-backs, and exploring new ideas, making connections, and processing information through the PFC executive functions.

**Reticular Activating System** (RAS): This lower part of the posterior brain filters all incoming stimuli and making the “decision” as to what people attend or ignore. The Reticular Activating System alerts the brain to sensory input that sense receptors in the body send up the spinal cord. The main categories that focus the attention of the RAS and therefore the student include physical need, choice, and novelty.

**Scaffolding:** This is instruction based on the concept that learning always proceeds from the known to the new. Children construct their new learning on the foundations of what they already know with the help of teachers, parents, or a more knowledgeable other who support them with instruction to help them build upon the abilities and knowledge they have to reach a higher level.

**Somatosensory Cortex Areas:** One in each parietal brain lobe where input from each individual sense (hearing, touch, taste, vision, smell) is ultimately processed.

**Survival Level of Attention:** Ideally students are beyond a basic survival mode and can direct attention to more than just avoiding danger. However, too much stress can push them into this survival mode. This can occur when students feel confused and overwhelmed by a classroom experience such that they cannot connect with, focus on, and create patterns and meaning from lesson’s sensory input data.

**Synapse:** These gaps between nerve endings are where neurotransmitters like dopamine carry information across the space separating the axon extensions of one neuron from the dendrite that leads to the next neuron in the pathway. Before and after crossing the synapse as a chemical message, information is carried in an electrical state when it travels down the nerve. It is through synaptic transmission that cells in the central nervous system communicate when an axon sends a neurotransmitter across the synaptic cleft to activate the receptor on the adjacent dendrite.

**Temporal Lobes:** These lobes on the sides of the brain process auditory and verbal input, language and phonetic discrimination, mood stability through projection fibers leading to limbic system, and learning.
**Venn Diagram**: A type of graphic organizer used to compare and contrast. The outer areas are for differences and the similarities are listed in the middle area.

**Working Memory** (Short-term memory): This memory can hold and manipulate information for use in the immediate future. Information is only held in working memory for about a minute. The memory working span of young adults is approximately seven for digits, six for letters, and five for words.
Additional Slides for your use with your faculty

- Suggestions you can use to guide the educators in your districts and schools using the material from the powerpoint, books, and study guides, for purposes of sharing the information about brain research-based teaching strategies.

PARTICIPANT ACTIVITY

Think of an dopamine strategy *(you can wait for the scaffolding)* that could be applied to the challenging staff interaction or interaction/activity or message you want your faculty/staff/parents to know.
WHY TEENAGERS ARE STRANGE CREATURES
TEENS’ BRAINS ARE DIFFERENT

High rate of dendrites and synapse formation (greater propensity for learning new things?).

Pruning, (loss of dendrites not being used) occurring more rapidly.

Myelination of more permanent, efficient neural circuits is last in the PFC.
Maturation seen as pruning occurs last in the prefrontal cortex. Executive functions are last to develop—well past teen years.

The above composite MRI brain images show the advancing pruning and thinning of unused networks and the increases in myelination (blue) in remaining networks. This myelination enhances transmission efficiency of the unpruned pathways. The process begins in the occipital (posterior) regions and doesn’t near completion in the prefrontal cortex until well into the 20’s. Thompson et al.

Risk-Taking and Adolescents

Teenagers are three to four times more likely to die than children past infancy.

Why?
They have lapses in judgment, inadequate decision-making skills, limited risk assessment, and particularly high response to the dopamine surge associated with high risk behavior.
Teens Emotionally-Driven

Teenagers do not have fully developed PFC executive functions such as judgment, prioritizing, critical analysis, emotional self-control, and delayed gratification.

Teens Need You as Their PFC Develops

With the PFC the last part of the brain to mature, decision-making process are governed by the lower brain.

Teens easily misidentify input resulting in misunderstandings, inappropriate language, unpredictable behavior, and bad decision making.

They need support and encouragement from adults to keep their efforts directed on long-term goal achievement and to learn to analyze before acting.

Some teachers don’t consider it their jobs to know how teens’ neurological development impacts their emotional states, classroom behavior, or what they can do to improve teen success.
Teachers Need

Guidance, modeling, & instruction about the cerebral functions that underlie teenage behavior to realize why misbehavior or inattention are not always conscious choices

With knowledge comes compassion, so they don’t take student behavior personally.

Encouragement to go beyond just teaching the curriculum.

Knowledge about the teen brain helps teachers understand what adaptations and effective strategies are necessary for their teenage students’ success.

Then they can provide explicit instruction in social-emotional skills and other strategies to help teenagers develop self-awareness.

Teacher Interventions

Use teachable moments as opportunities to help students reflect (PFC) on their reactive behavior. “What would you like to do differently next time?

Build relationships with students and show confidence in their abilities to succeed.

Acknowledge progress not just final product.

Teach conflict resolution
Next to the amygdala is the hippocampus.

In the hippocampus, new information is encoded with previously stored related knowledge. Consolidation.
Turning Working Memory into Relational Memory

1. Input begins from our senses or is activated by thinking or memory.

2. Information is routed to the thalamus for initial processing.

3. Simultaneously, the information is routed to the appropriate cortical structures for further processing.

4. Consolidation with prior knowledge in hippocampus coded as new relational memory.

PATTERNING IS ......
Patterning is matching prior knowledge to new information to encode new memory.

**Patterning Uses Prior Knowledge to Make Predictions - Solve New Problems**

**Patterning and Prediction**

Patterns allow our brains to make decisions based on prior experiences and learned knowledge.
Piaget’s “Schema” are mental maps or categories of knowledge that grow through pattern association.

The brain recognizes patterns or reacts to novelty when sensory input fits an existing pattern, memory builds as categories of information are expanded or revised.
Students learn by connecting new, related information to their stored patterns of knowledge.

When patterning is successful to a previously stored memory, the hippocampus encodes the new sensory input into relational memory.

Knowledge grows by adding new connections to existing neural networks.
That is **neuroplasticity**

**Neuroplasticity**

Mental Manipulation Strengthens Neural Pathways (more myelin, dendrites, and synapses)

Memories are more durable and stored information is more efficiently retrieved.

*Practice Makes Permanent*

Repeated exposure strengthens neural networks of patterns

Neuroplasticity: Patterns (neural templates) increase in size, number, accuracy

Greater accuracy of recognizing new input and **predicting** successful response
Restimulating the Networks

Long-term memory: If a group of neurons in a memory circuit is repeatedly activated, the connections between these neurons (dendrites, axon branches, synapses) will grow in number and durability in a process called plasticity.

Neurons that fire together, wire together.

Theory of Patterning–Prediction–Intelligence

Intelligence is the superior use of prior knowledge to predict the future

Better Pattern Recognition Skills and Quantity of Stored Categories (prior knowledge)

More Accurate Predicting (answers/solutions hypotheses) = Increased Intelligence

Working memory (short-term memory)

Unless something is done with new working memory, it is lost in less than a minute.
Working Memory holds data in mind temporarily while the brain manipulates it.

What is 13 x 24?

MENTAL MANIPULATION in the PREFRONTAL CORTEX to turn RELATIONAL MEMORIES INTO LONG-TERM MEMORIES

The person who does the work (thinks) LEARNS MENTAL MANIPULATION Turns Working into Long-Term Memory Literally changes the brain
Mental manipulation through personal response to new information with......

Dend-writes for memory consolidation

**DEND-WRITE PROMPTS**
- Draw a picture, diagram, or graphic organizer of what you learned
- Create an analogy. Did something in the lesson reminded you of something you already know?
- A reaction or a reflection of how something you learned relates to something in your life
- Something that made you wonder or surprised you; a new insight or discovery
- What do you predict will come next?
How could you (or someone in a profession) use this knowledge?

What you understood today that you haven’t understood before and something you are confused about or found difficult

The part of lesson that you enjoyed the most and the part that was most difficult for you

What strategy did you use to solve a problem today?

DEND-WRITES FOR MEMORY CONSOLIDATION & MORE

Build relational memories

Personalization

Connection to prior knowledge

Mental manipulation through EF

MORE USES OF DEND-WRITES

FEEDBACK TO YOU

CORRECT MISPERCEPTIONS

PUT CHECKS ON READ ALOUD CARDS TO SHARE
• Students listen and can add to their own notes based on their classmates’ card reading

• Cards (notebook writing) become study aides

• Post on bulletin board cards that cover important information for students who were absent or for all to review.

**PARTICIPANT ACTIVITY**

Select or create a DEND-WRITE prompt for your “challenge” lesson.

Individualized realistic challenge connects students to knowledge by communicating to them high expectations while insuring that they have the capacity to reach these goals.
**Realistic Challenge**

Differentiated instruction provides opportunities for student goals based on *individualized realistic challenge.*

Supported by clearly structured goals

Frequent feedback

Positive intrinsic reinforcement

Geared to students' developmental levels, intelligences and learning strengths.

Communicate high expectations while insuring that students have the appropriate tools to reach these goals.

The tools and scaffolding are differentiated, but the goals remain high.

**THE BARRIERS ARE LOWERED, NOT THE BAR!**
Collaborative Faculty Activity

Put the following educational needs in order of importance by collaboration. Using consensus, not majority voting, so everyone supports the final list. Like jury deliberation, if someone disagrees, you keep discussing.

How to Improve Education

1. Universal preschool access is a critical need
2. Access to technology is a critical need
3. Additional forms of assessment should be used to balance standardized tests (for differentiation)
4. Educators need tools & encouragement to reduce student stress.
5. Students need to know how to find accurate information and use critical analysis to assess the veracity/bias
6. In a global world of collaboration students need to develop tolerance (openness) to unfamiliar cultures and ideas. We are teaching students to live on a planet we’ve never seen. Because of this the curriculum for the next century (as well as for today), needs to focus on broad concepts and enduring knowledge rather than on isolated facts. Problem-based learning and projects are excellent ways to achieve this but they need to be carried out using real-life situations whenever possible.
7. Students learn best through their strengths and interests and this information should guide instruction. Traditional standardized tests, for the most part measure verbal/linguistic/mathematical abilities. This is too narrow a measure of the educated person. Attention needs to be given to developing the whole child, especially social/emotional skills.
8. Students need to use what they learn repeatedly and in different, personally meaningful ways for short-term memory to become permanent knowledge that can be retrieved and used in the future.
9. Teaching is not brain surgery. It’s Harder. When teachers receive the recognition, status, autonomy, and salary appropriate for professionals, the profession we will attract and keep the best and brightest.
10. Students need new collaboration and communication skills for the coming century -

Here is my upper school version of the Brain Owner’s Manual
Students need a brain owners’ guide and their teachers need the background with which to instruct their students to use their most powerful tool.

When children believe they have control over their success and intelligence, they have greater confidence in their ability to influence outcomes.

A Brain Owner’s Manual for Students

By Judy Willis, M.D., M.Ed

“I imaging neurons making connections in my brain when I study and I feel like I’m changing my brain when I learn something, understand it, and review it.”

“If I use my prefrontal cortex to mentally manipulate what I learn, my dendrites and synapses grow and I will own that learning for a long, long time. I won’t have to learn fractions all over again each year.”

I teach my middle school students about the changes in their brains that take place through neuroplasticity. 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 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 learn and review new material.
There are three main brain *systems* that are keys to having control of what your brain takes in and processes through your highest thinking and reasoning abilities that are in your prefrontal cortex (PFC), a thin layer of neurons in the front of your brain, behind your eyes.

The three systems are what I refer to as **RAD**, which is short for:

- **R**: Reticular Activating System (RAS)
- **A**: Affective Filter in the Amygdala
- **D**: Dopamine

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**Reticular Activating System (RAS)**

Information enters the brain starting as sensory data (from what you hear, see, smell, touch, or taste). For this sensory information to enter your brain it must first pass through the reticular activating system and later through the limbic system (especially the amygdala and hippocampus) to be acknowledged, recognized, coded into patterns, and ultimately stored in long-term memory.

The RAS is the attention switching system located at the lower back of your brain (brainstem). The RAS receives input from the sensory nerves of the body that converge into the spinal cord from sensory response nerve endings in the eyes, ears, mouth, face, arms, legs, trunk, head, neck, and internal organs. These sensory messages must pass through RAS to either (1) gain entry to the higher, thinking, and reflective prefrontal cortex (PFC) brain or (2) to be sent directly to the automatic, reactive response centers.

The goal in successful learning and emotional control is to keep the RAS filter open to the flow of information you want to enter your PFC.

The more stress you feel the harder it is for you to focus attention, create memories in your reflective brain, and use what you learn for test success and to be creative and solve problems. If you are overwhelmed and feel out of control your brain takes over and becomes automatic and what your experience, focus on, and remember is not in your control. If you build your power to focus your attention on the sensory input that is most valuable and important to attend to at the moment you are in control. It is the difference between reflecting and reacting to your world – being in control or letting things outside take control of you.

You can build your ability to choose the way your brain senses the things around you by practicing focusing and calming activities. Then you will be able to select where your awareness and focus goes and what information gets through your RAS to your thinking, creative, and learning PFC. You can make the decision to review and practice what you learn so you grow the dendrites and keep your axons strong and make your memory permanent.
Making Memories That Last

Next to the amygdala in the limbic system is the hippocampus. It is in this coding center new sensory input is linked to memories of your past experiences and things you already know that are pulled in from your memory storage. The newly coded relational memories, made of the new information linked to your existing memories, are now ready for processing in the PFC.

Each time you review, remember, and practice something you learned the connections between nerve cells that create a network that holds that memory becomes stronger. Just like your muscles become stronger when you exercise them. In your brain new sprouts called dendrites actually grow as branches from one nerve cell to the next when you practice a memory. The more connections that form, the stronger the memory becomes and the longer it will stay in your brain. With enough practice other branches in the memory network actually bulk up. Branches called axons get thicker coating called myelin. Myelin is like insulation in a wire that conducts electricity better than a wire without insulation. When there are lots of dendrites and the axons have nice, thick myelin the memory becomes permanent. Imagine how great it will be when your memory of the times tables is as permanent and automatic as your memory of how to ride a bike!
Prefrontal Cortex

There are highly developed nerve communication networks in your prefrontal cortex where creative, reflective, smarter thinking takes place. When the filters do not block the sensory information from what you hear, see, feel, and otherwise sense, the information can reach your higher brain function PFC regions. These higher thinking reflective networks process the new information through what are called executive functions including judgment, analysis, organizing, and creativity.

It is also in the executive function networks in your prefrontal cortex that short-term coded relational memories of the new information can become long-term memory. Repeat, review, and relate new information to new situations the networks become stronger, you mentally manipulate the new learning and build it into strong networks of long-term memory.

Conclusion

You hold the key that enables you to change sensory input into learned memory and to change your brain to do what you want it to do. You can reflect instead of react when you are in a challenging situation at school or with friends. You can construct strong networks of the information you study and build your brain to do and remember what you work at. You control your intelligence and with effort your brain becomes a more and more powerful tool so you can reach your greatest learning and creative potential. You can reach your dreams and take the information you learn from teachers, parents, friends, books, and the world around you to become the wise and caring person you want to be and help create the future you desire.

TOPICS FOR FACULTY DEVELOPMENT

1. How I used RAD (or just R, A, or D) in a lesson, interaction, activity, unit) and the results. Or, to also demonstrate differentiation, offer the choice (dopamine) to draw your class on a good day, or write it in words. What commonalities do these lessons share? How are they RAD?

2. How I used strategies to activate prior knowledge and/or provided opportunities for students to process learning using patterning to help facilitate the way the brain stores information in patterns (categories).

   Examples of activating prior knowledge: KWL, preunit assessment, video, class discussion starting with Here-ME-Now by using current events of high interest to the students to connect them to the unit or topic, relating the unit to prior knowledge with ball toss or discussing what they learned about the topic from the perspective of another class (if there is cross curricular planning).

   Examples of helping students “fit” new information into existing brain patterns (neural networks) such as graphic organizers, similarities/differences, prediction.

3. Since students’ greatest fear is making a mistake in front of the whole class, recall a time you (the teacher/group participant) made a mistake in front of peers, perhaps when you were a student. What did your teacher or another adult do to help decrease your stress so you would not stop being a participant – so you would keep trying instead of becoming less willing to participate for fear of making another mistake? OR if no one did help you during that stress, what do you think would have been an intervention, words, etc. that would have lowered the stress of the mistake moment. Now, think how you can apply these thoughts to things you can do with students (or faculty you supervise) when they are embarrassed or stressed after making a mistake in front of the class. Remember the goal is to keep all students participating and engaged because only the person who THINKS, Learns.

4. Use of dend-writes and creation of lists of class-appropriate dend-writes 3. Select a dend-write prompt you could use for a lesson (or to differentiate), modify it to suit your needs. Discuss why you think it would work.

   Such as, “I wanted them to summarize a complex topic in their own words, to remember it by personalizing it, see how well they understood the lesson and what I needed to reteach, what misconceptions did they have? The dend-write prompt I used was, “Today I learned new things about _____ such as ______. These reminded me of ______ (something I learned about, saw, read before in another class or outside of school or in a novel, movie, etc).”
Concluding Activity
(for your faculty training)

Each participant writes three immediate and three long-term goals about how you will incorporate things you learned today into your schools and classrooms.

(At faculty learning community meetings these would be shared at table groups or with all participants)

MY WEBSITE FOR ACCESS TO ARTICLES I’VE WRITTEN, BOOK CHAPTERS, AND TO MY EMAIL
www.RADTeach.com

WEBSITE FOR VISUAL ILLUSIONS
www.weirdomatic.com