
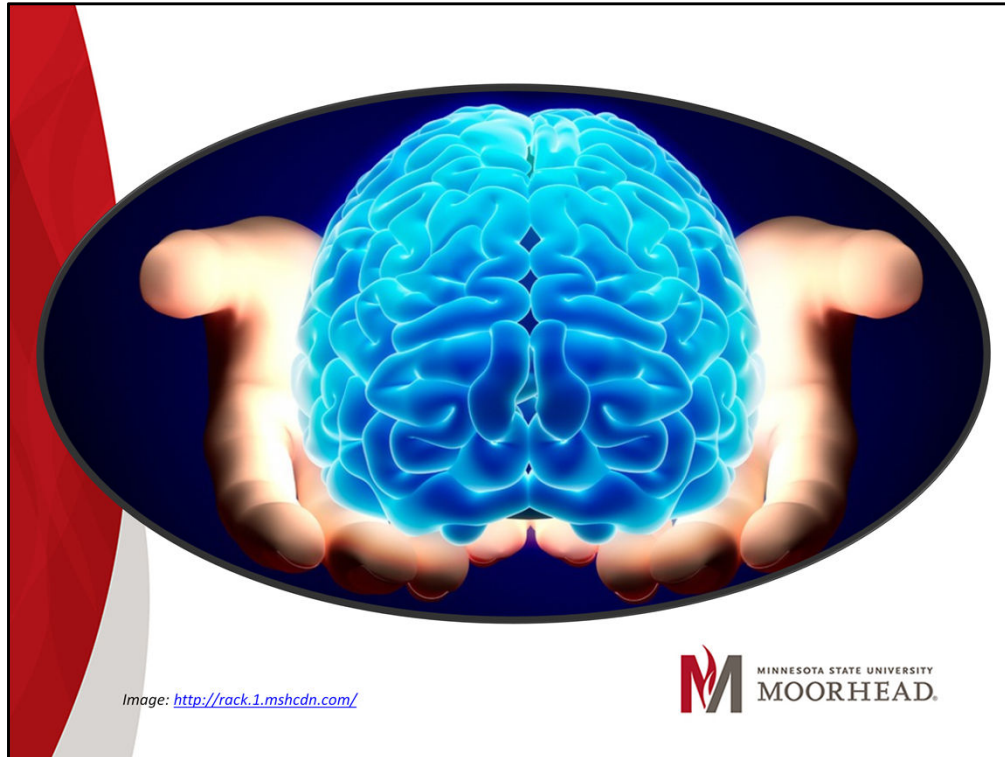


*Connecting Neuroscience and
Education*

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 MINNESOTA STATE UNIVERSITY
MOORHEAD.

Brain research and its interpretation. Is the research valid?



Educational neuroscience

<http://www.dana.org/News/NeuroEducation/>

Brain Imaging

- Advances in technology enable us to view the working of the brain as it learns.
- Educators can now find evidence-based neuroimaging and brain-mapping studies to determine effective ways to teach.



Helpful in overcoming brain injuries or understanding diseases that affect the brain.

fMRI

Functional Magnetic Resonance Imaging

The colored sections below show active regions of the brain performing a complicated task for the first time, and then after an hour of practice.

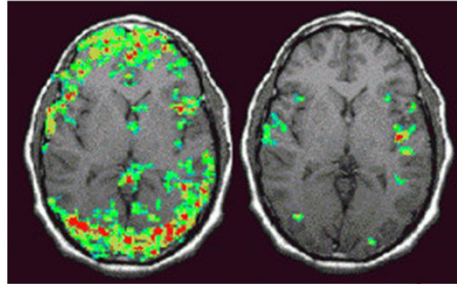


Image: <http://diffusionoflight.wordpress.com>



When a part of the brain becomes active, the need for oxygen and nutrients increases. Oxygen is carried to the brain cells by hemoglobin. Hemoglobin contains iron, which is magnetic. The fMRI uses a large magnet and compares the amount of oxygenated hemoglobin entering brain cells with the amount of deoxygenated hemoglobin leaving cells. The computer colors in the brain regions receiving more oxygenated blood and can locate the activated brain region to within one centimeter. (Sousa, How the Brain Learns, 2011)

The scientific study of the nervous system is entering a new golden age. Researchers and clinicians continue to advance the treatment of conditions such as Alzheimer's syndrome, Parkinson's disease, epilepsy, and traumatic brain injury.

Today we will...

- Look at how the brain learns.
- Discuss how different factors affect the ability of the brain to learn and remember.
- Review a learning/study cycle keeping the brain in mind.
- Provide incentive to reflect on our methodology and further investigate the connection between neuroscience and education.



As scientific understanding of learning includes understanding about learning processes, learning environments, teaching, sociocultural processes, and the many other factors that contribute to learning. Research on all of these topics, both in the field and in laboratories, provides the fundamental knowledge base for understanding and implementing changes in education.

(National Research Council, 2000)

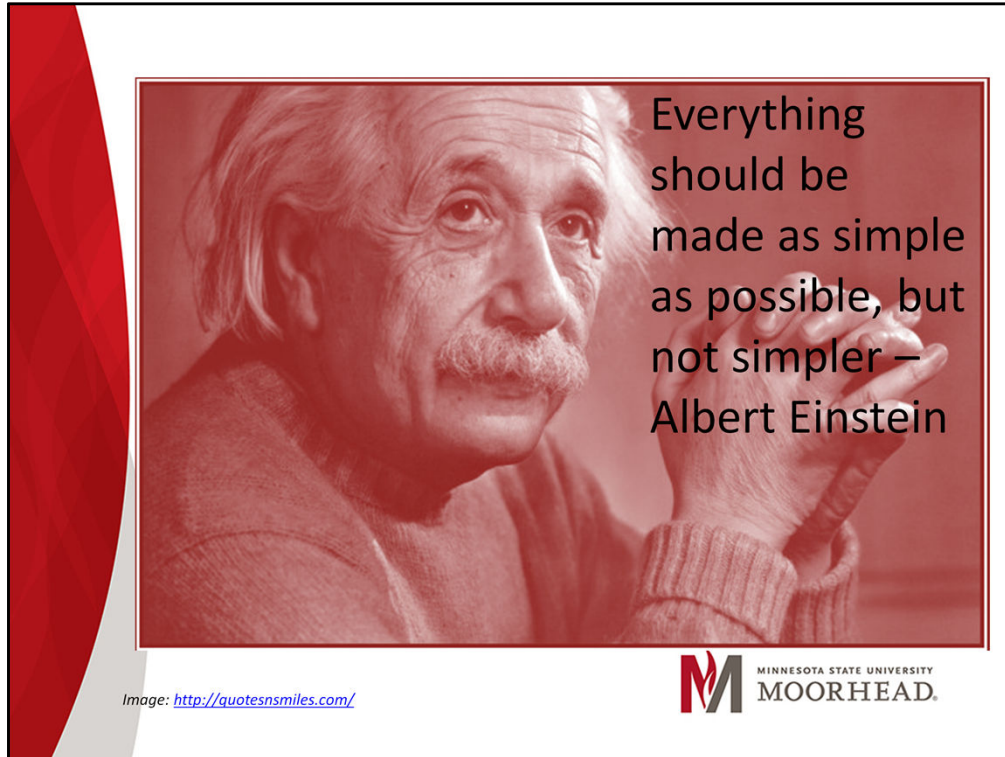
This presentation will summarize these areas concentrating on the learning processes.

Brain Changers

- Teachers are brain changers!
- The more we know about how the brain learns, the better equipped we will be to help students learn how to learn.
- The more we know, the more equipped we are to *tell fact from hype* when it comes to brain research.



Knowing how the human brain seems to process information and learn can help teachers plan lessons that students are more likely to understand and remember. The more we know about how we learn, the more we can be in control of our learning...metacognition. Education seems to be a fertile area for the development of “[neuromyths](#)”, and despite this kind of criticism, new variants have flourished in the last few years. ...They promise easy fixes and quick gains, based on “proven” research. Scientists need to be bolder in refuting some of these claims. At the same time, educators and business leaders need to be more critical in approaching them. (Wall, 2014)



We take the 'complicated' and make it understandable without jeopardizing the integrity of the facts or true intentions of the research.

We don't 'read' too much into the results and overextend the application hap-hazardly.

Neurons

- A cell that receives information from other neurons and then decides whether to send it on to other neurons.
- There is lifelong growth of the support and connecting cells that enhance the communication between neurons.

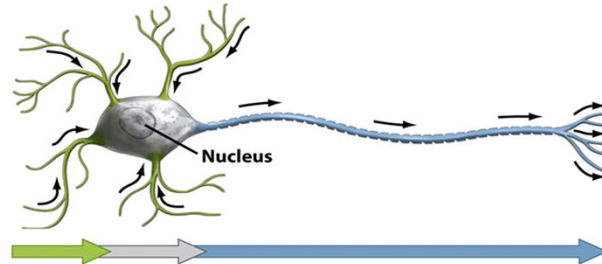


Glial cells hold neurons together and act as filters to keep harmful substances out of neurons. A neuron is about 1/100th the size of a period on a page. Neurons represent 10% of the brain cells – roughly 100 billion.

Dendrites and Axons

- Dendrites are treelike extensions that receive information.
- Information is transferred to other neurons along axons.

Information flow through neurons

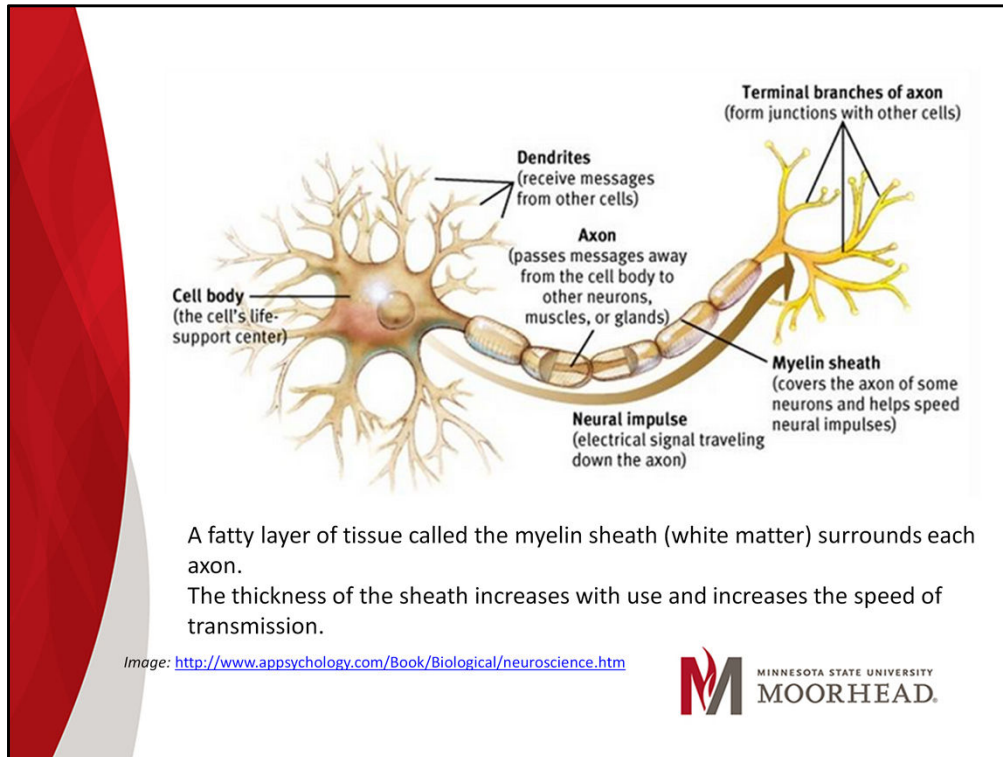


Dendrites	Cell body	Axon
Collect electrical signals	Integrates incoming signals and generates outgoing signal to axon	Passes electrical signals to dendrites of another cell

Figure 45.3b Biological Science, 2/e
© 2005 Pearson Prentice Hall, Inc.



Glial cells hold neurons together and act as filters to keep harmful substances out of neurons. A neuron is about 1/100th the size of a period on a page. Neurons represent 10% of the brain cells – roughly 100 billion.



A neuron can transmit between 250 and 2500 impulses per second. Its possible to have up to one quadrillion (1×10^{15}) synaptic connections in one brain. So as we practice, ... we trigger a pattern of electrical signals through our neurons. Over time, that triggers the glial cell duo to myelinate those axons, increasing the speed and strength of the signal. **Like going from dial-up to broadband.** <http://blog.bufferapp.com/why-practice-actually-makes-perfect-how-to-rewire-your-brain-for-better-performance>

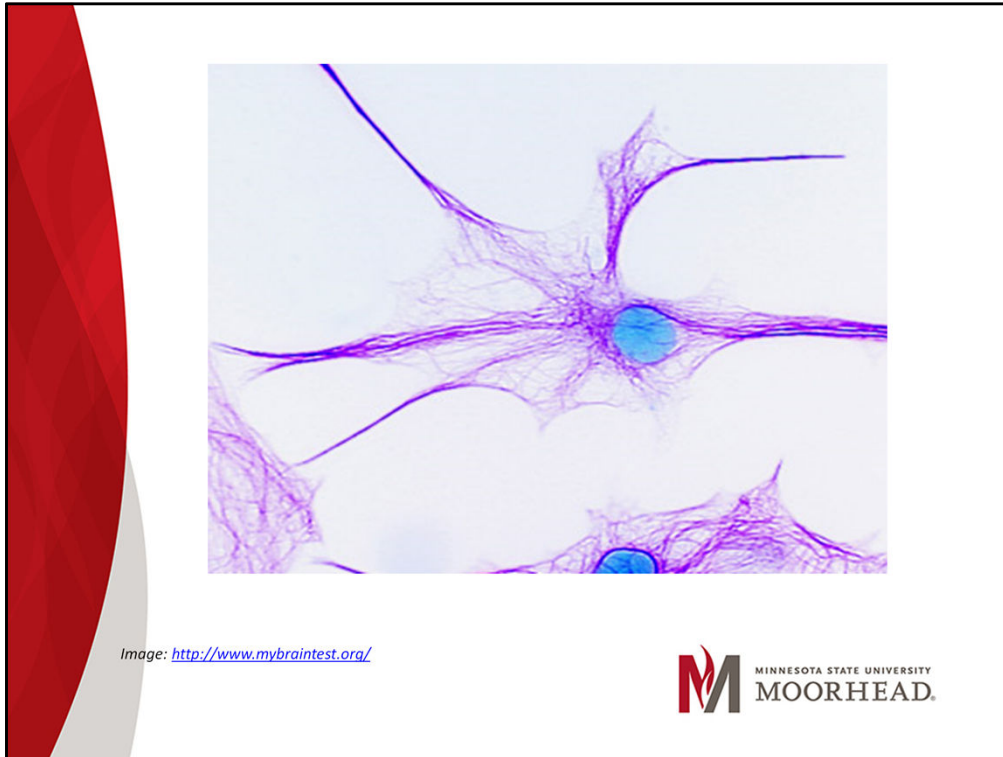
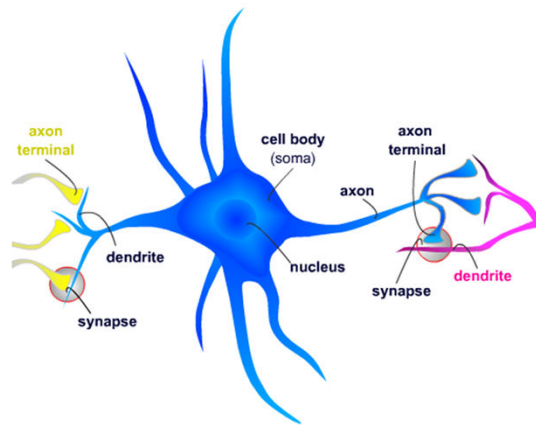


Image: <http://www.mybraintest.org/>



Each neuron can have up to 10,000 branches, dendrites.



Impulses are sent to other cells along the axon by shooting neurotransmitters across the synapse to their dendrites, which is a little space between neurons. Neurons do not touch each other.

Image: <http://www.mybraintest.org/>



Neurotransmitters

- Brain chemicals that bathe the brain cells and either permit signals to pass between them or inhibit them.
- The transmission slows down when the neurotransmitters are depleted by too much information traveling a circuit. Information processing takes longer, which can lead to student frustration and less successful memory storage.



INHIBITORY : does not stimulate the brain

Serotonin: necessary for a stable mood and to balance excessive excitatory neurotransmitters.

Gaba: sent to attempt to balance excitatory overfiring.

Dopamine: can be both. Helps with depressions and focus.

EXCITATORY

Dopamine: is our main focus neurotransmitter.

Dopamine is also responsible for our drive or desire to get things done – or motivation. Stimulants such as medications for ADD/ADHD and caffeine cause dopamine to be pushed into the synapse so that focus is improved. Unfortunately, stimulating dopamine

consistently can cause a depletion of dopamine over time.

Norepinephrine: is an excitatory neurotransmitter that is responsible for stimulatory processes in the body.

Norepinephrine helps to make epinephrine as well. This neurotransmitter can cause ANXIETY at elevated excretion levels as well as some “MOOD DAMPENING” effects. Low levels of norepinephrine are associated with LOW ENERGY, DECREASED FOCUS ability and sleep cycle problems.

Epinephrine: is reflective of stress. Long term STRESS or INSOMNIA can cause epinephrine levels to be depleted (low).

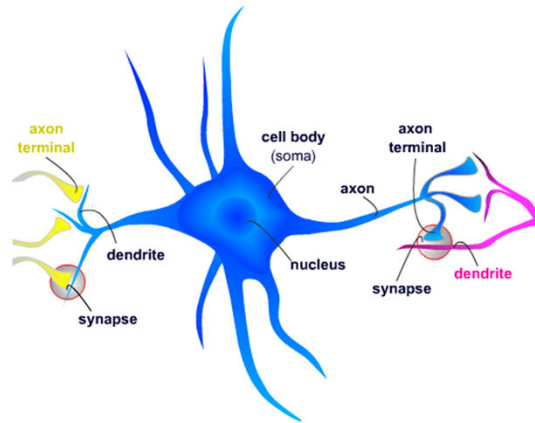


"Mr. Osborne, may I be excused? My brain is full."

<https://s-media...>



1. Draw a neuron and label the components we discussed.



Chunking. It is possible to increase the number of items within the functional capacity of working memory through a process called chunking. Keep the number of items in a lesson objective within the capacity limits of students, and they are likely to remember more of what they learned. Less is more!

Syn-naps

This take on the word synapse is a reminder that there needs to be a brain rest so the neurotransmitters can be restored to relay the next message.

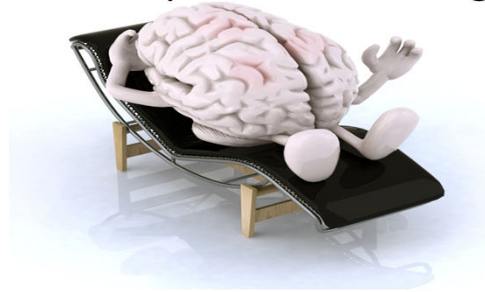


Image: <http://bitterempire.com>



Daily lesson: Introduce some new material, practice, repeat. Example: practice worksheet.

Syn-naps are brain breaks that restore neurotransmitters depleted when the same neural circuit is used for extended periods. They help the amygdala from getting overstressed. The newly learned material has the opportunity to go beyond working memory to be consolidated into relational memory in the hippocampus while students replenish their supply of neurotransmitters (dopamine and serotonin) in one circuit and use another neural pathway for a new activity. (Willis, 2010)

Working Memory

- After 10 – 20 minutes, mental fatigue or boredom with an item occurs and focus drifts.
- For focus to continue, there must be some change in the way the individual is dealing with the item.
- Help students make connections and see patterns.



On average an adolescent or adult time for processing an item.

Suggests to pack lessons in 15 – 20 minute segments.
Items may stay in working memory for hours or days
(Sousa)

Whenever new material is presented in such a way that students see relationships, they generate greater brain cell activity (forming new neural connections) and achieve more successful long-term memory storage and retrieval. (Willis, 2006)

Graphic organizers.

Rote learning is inefficient.

Implications:

Teach new material first. Don't let prime time get contaminated with wrong information. (not spent taking attendance, distributing or collecting homework..)

Follow the new material by practice or review during the down-time.

Closure should take place in prime-time-2. This is where the learner determines sense and meaning.


More attention occurs when lessons are shorter and meaningful. (Sousa, How the Brain Learns, 2011)

2. Look at the list of 10 'words' for 12 seconds.

KEF
LAK
MIL
NIR
VEK
LUN
NEM
BEB
SAR
FIF




2.



Write each word on the line that represents its position on the list.

1. KEF
2. LAK
3. MIL
4. NIR
5. VEK
6. LUN
7. NEM
8. BEB
9. SAR
10. FIF



Check your list. To be correct the word must be spelled correctly and in the right position. Chances are your remembered the first three to five words and the last two words, but had difficulty with the middle one. (Sousa, How the Brain Learns, 2011)

We remember best that which comes first, second best that which comes last, and least that which comes just past the middle. The first items are within the working memories capacity. As the learning episode concludes, items in the working memory are sorted or chunked to allow for additional processing of the arriving final items. Chunking is used to combine more than one item into a given chunk of items so there's more 'room' in the short term memory.

Primacy-Recency Effect

We remember best that which comes first, second best that which comes last, and least that which comes just past the middle. The first items are within the working memories capacity. As the learning episode concludes, items in the working memory are sorted or chunked to allow for additional processing of the arriving final items.



Primacy-Recency Effect

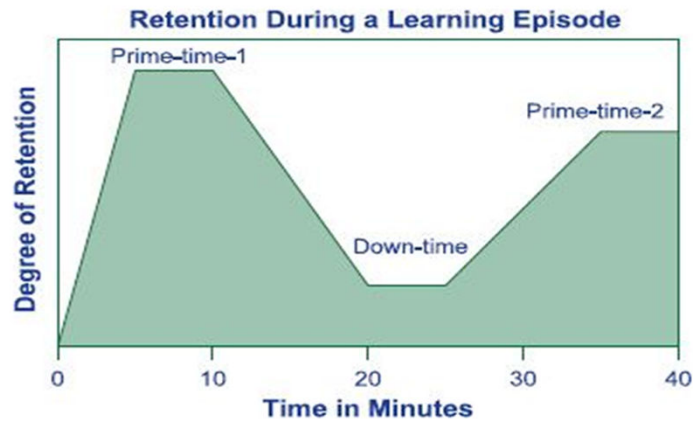
Implications:

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Primacy-Recency Effect



(Sousa, 2011)



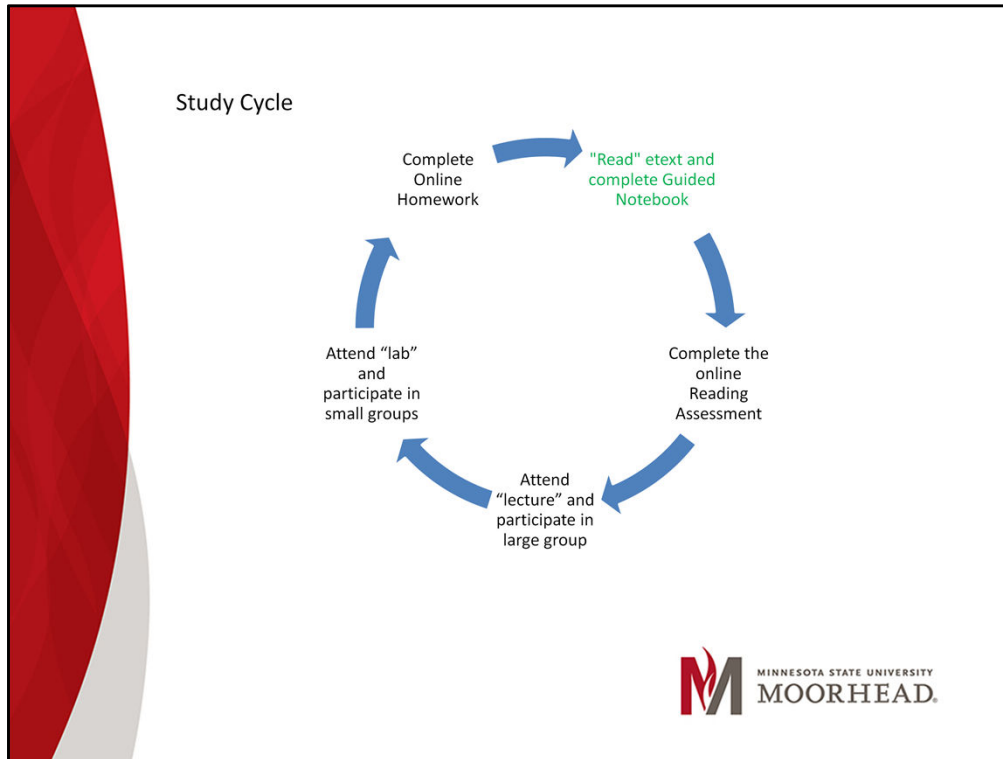
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Episode Time	Prime-Times		Down-Time	
	Total Number of Minutes	Percentage of Total Time	Number of Minutes	Percentage of Total Time
20 minutes	18	90	2	10
40 minutes	30	75	10	25
80 minutes	50	62	30	38


(Sousa, 2011)






The study cycle may be familiar to many, but why does it work? How does each step of the study cycle figure in to the learning process and what is happening in the brain?

3. Lecture: Draw or outline how the time is spent in one class period.



- Numerous studies have shown that teacher lecture often results in the lowest student retention compared to other instructional methods. Rehearsal is minimal or nonexistent.
- It's not what the teacher presents, it's what is learned.
- Interactive lecture includes the teacher providing information and direction, but the students have periodic opportunities during the lesson to give feedback on what they have learned.



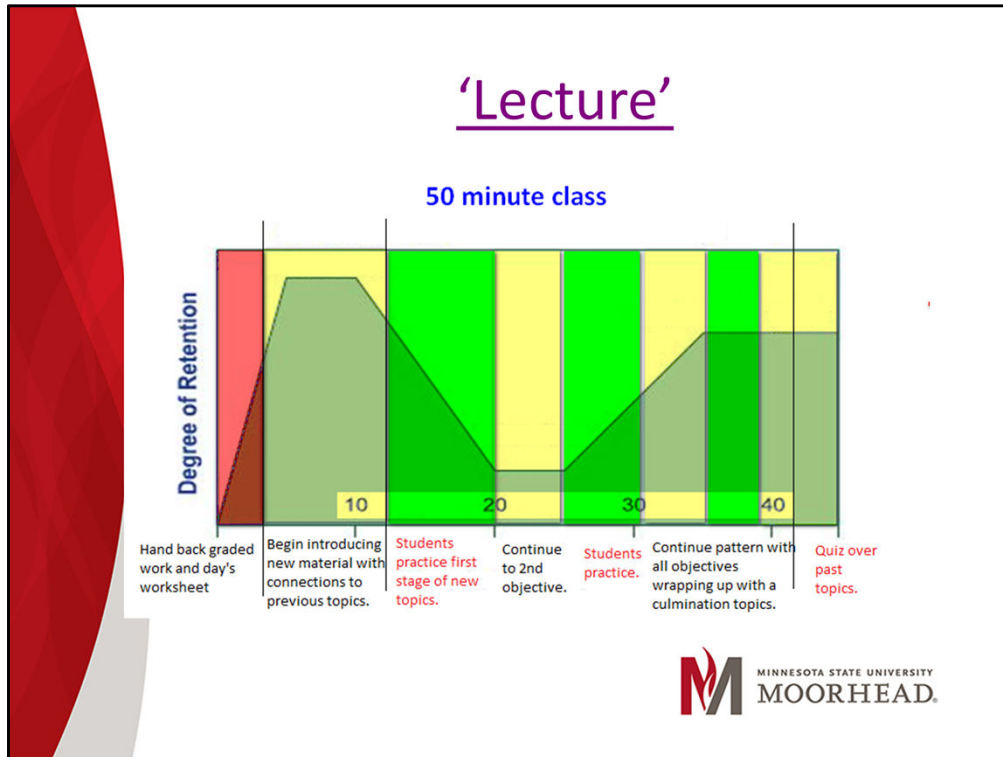
In 2006, 81,499 students in grades 9 – 12 from 26 states participated in a survey of student engagement and reasons for dropping out. Only 27 percent said they would consider dropping out because the work was too difficult. The majority said the reason they would consider it was because it was boring, with 31% attributing their boredom to having “ no interaction with teachers” (Yazzie-Mintz, 2007)



3. Break down class time.




Chunking. It is possible to increase the number of items within the functional capacity of working memory through a process called chunking. Keep the number of items in a lesson objective within the capacity limits of students, and they are likely to remember more of what they learned. Less is more!



Approach the daily lessons with the primacy-recency effect in mind. The students spend as much, or more, time practicing and explaining what they did as the instructor spends talking. Worksheets provide more than enough problems to account for the various rates of completion for the students. During student practice time, incorporate a Socratic questioning technique.

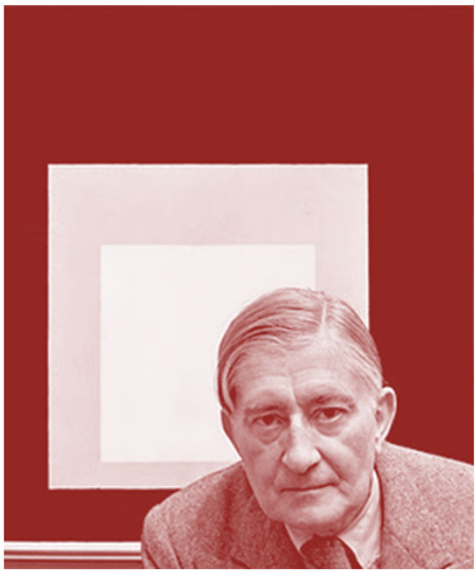
Making connections to facilitate chunking.


<ul style="list-style-type: none"> Find cube roots. Find and approximate nth roots. 	<ul style="list-style-type: none"> Find cube roots. Find and approximate nth roots.
<ul style="list-style-type: none"> 18.2 Radical Functions Evaluate radical functions. Find the domain of a radical function. Graph functions that contain square roots or cube roots. 	<ul style="list-style-type: none"> 18.2 Radical Functions Evaluate radical functions. Find the domain of a radical function. Graph functions that contain square roots or cube roots.
<ul style="list-style-type: none"> 18.3 Rational Exponents and Simplifying Radical Expressions Use the definition for rational exponents in the form $a^{1/n}$. Use the definition for rational exponents in the form $a^{m/n}$. Simplify exponential expressions involving rational exponents. Use rational exponents to simplify radical expressions. Simplify radical expressions using the product rule. Simplify radical expressions using the quotient rule. 	<ul style="list-style-type: none"> 18.3 Rational Exponents and Simplifying Radical Expressions Use the definition for rational exponents in the form $a^{1/n}$. Use the definition for rational exponents in the form $a^{m/n}$. Simplify exponential expressions involving rational exponents. Use rational exponents to simplify radical expressions. Simplify radical expressions using the product rule. Simplify radical expressions using the quotient rule.
<ul style="list-style-type: none"> 18.4 Operations with Radicals Add and subtract radical expressions. Multiply radical expressions. Rationalize denominators of radical expressions. 	<ul style="list-style-type: none"> 18.4 Operations with Radicals Add and subtract radical expressions. Multiply radical expressions. Rationalize denominators of radical expressions.
<ul style="list-style-type: none"> 18.5 Radical Equations and Models Solve equations involving one radical expression. Solve equations involving two radical expressions. Use radical equations and models to solve application problems. 	<ul style="list-style-type: none"> 18.5 Radical Equations and Models Solve equations involving one radical expression. Solve equations involving two radical expressions. Use radical equations and models to solve application problems.
<ul style="list-style-type: none"> M 19: Quadratic Equations and Functions; Circles 19.1 Solving Quadratic Equations Solve quadratic equations using the square root property. Solve quadratic equations by completing the square. Solve quadratic equations using the quadratic formula. 	<ul style="list-style-type: none"> M 19: Quadratic Equations and Functions; Circles 19.1 Solving Quadratic Equations Solve quadratic equations using the square root property. Solve quadratic equations by completing the square. Solve quadratic equations using the quadratic formula.



A small of a change as breaking up a topic into two sections may help students get a better grasp of a concept before making connections with the next level.

“Good teaching is more a giving of right questions than a giving of right answers.” ~ Josef Albers

A portrait of Josef Albers, an older man with light hair, wearing a suit and tie, looking slightly to the right. The portrait is set against a dark red background with a white square frame around it.

The logo for Minnesota State University Moorhead, featuring a stylized red 'M' and the text 'MINNESOTA STATE UNIVERSITY MOORHEAD.'

Socratic vs. Didactic

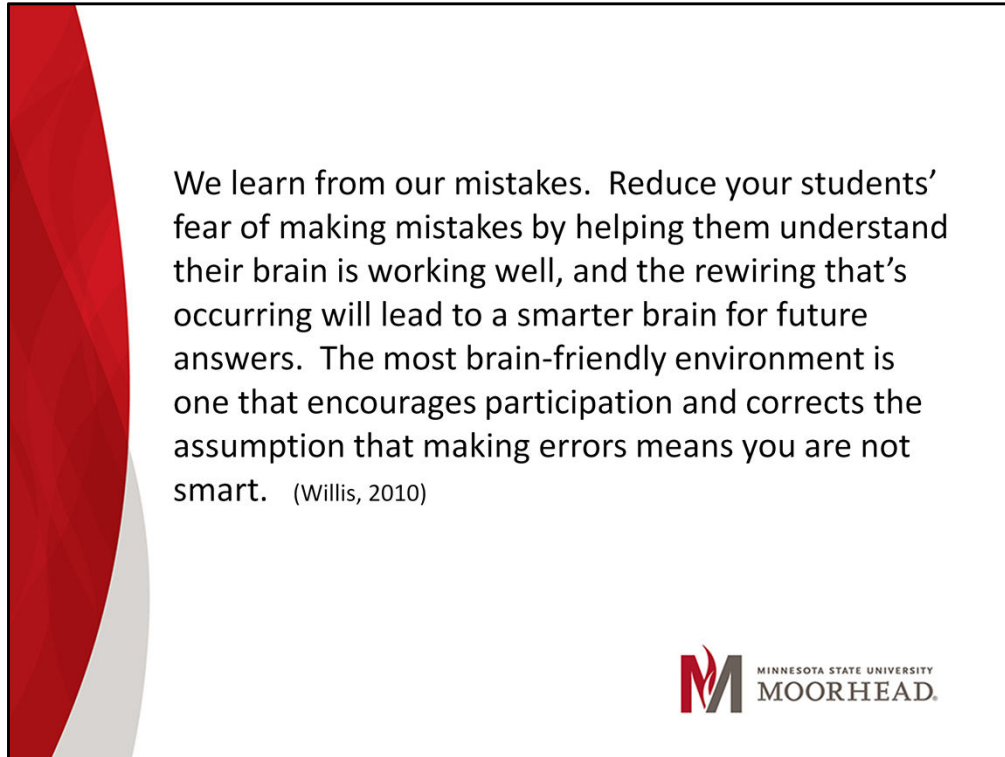
Large and Small group – instructor, MLC director, tutor(s)

Utilize Socratic tutoring style versus didactic tutoring style (both can be effective)

When a student explains their thinking out loud it enhances their learning. (Socratic versus Didactic Tutoring, 2001)

Both can use open ended questions. In socratic, the tutee does more of the talking.

6pq tutoring



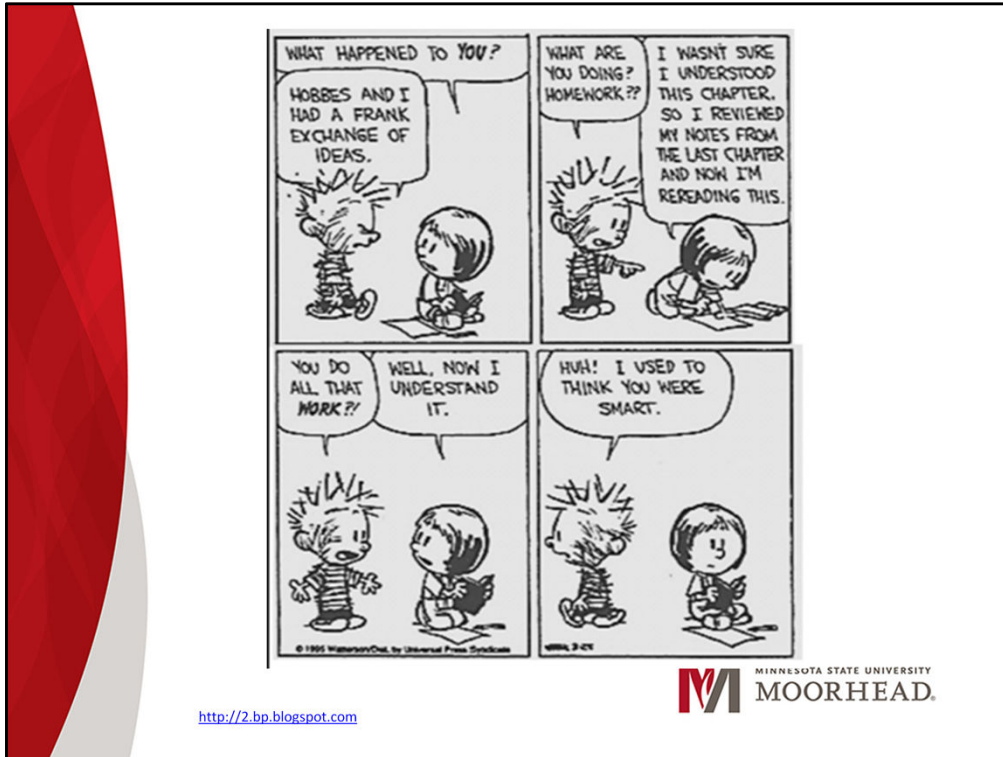
Subsequent research revealed that after presentation of pleasurable, comforting, positively reinforcing, intrinsically motivating stimuli, the amygdala could be moderately stimulated or warmed up to the alert state that actually facilitates active processing and neuronal transport of information. (Willis, 2006)

Amygdala hijacking – negative feelings cause the hormone cortisol to enter the bloodstream. Cortisol puts the brain into survival mode; this shifts the brain's attention away from learning so it can deal with the source of stress.

When students feel positive about a learning situation, chemicals called endorphins (provide feeling of euphoria) and dopamine (stimulates the prefrontal cortex) become

active.

A stress state happens when a lesson is tedious, not relevant to their lives, confusing, or anxiety-provoking.



<http://2.bp.blogspot.com>

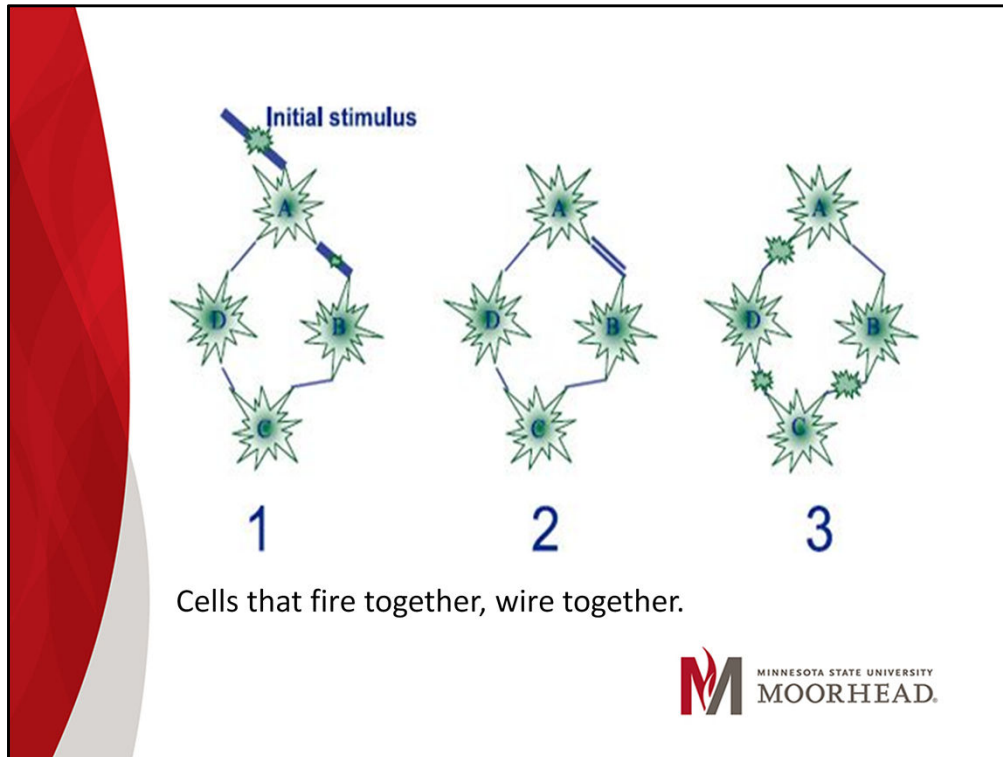
What is our definition of smart?

Memory

- Sensory/immediate memory
 - Holds data for up to 30 seconds.
 - The individual determines the importance and whether or not to retain it.
- Working (or short term) memory
 - Embedded by repetition into long-term memory.
- Long-term memory
 - Needs periodic repetition to avoid fading from disuse.



Memories are not stored intact. Instead, they are stored in pieces and distributed in sites throughout the cerebrum. Which storage sites to select could be determined by the number of associations that the brain makes between new and past learning. The more connections made, the more understanding and meaning the learner can attach to the new learning, and the more likely it is that it will be stored in different networks. (Sousa, How the Brain Learns, 2011)



(1) Neuron A receives a stimulus, which causes it to set off neuron B. (2) If neuron A fires again soon, a link is established. Later, neuron A can just fire weakly to set off neuron B. (3) The firing of neurons A and B may set off neighboring neurons C and D. If this happens repeatedly, the four cells become a network and will fire together in the future – forming a memory. (Sousa, How the Brain Learns, 2011)

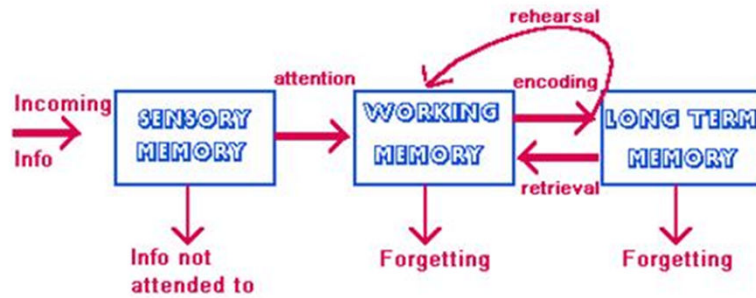


Image: http://healthpsych.psy.vanderbilt.edu/alcoholMemory_files/image007.jpg



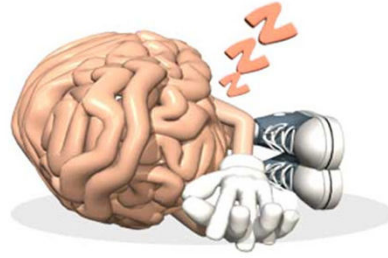
Forgetting

- When the brain is exposed to new information, the greatest amount of forgetting occurs shortly after the learning task is completed, and continues rapidly throughout the first day. Items that do not make sense to the learner are usually forgotten first.



We can't possibly remember everything. We filter out the trivial to leave room for the more important.

Sleep



- 70 – 90% of new learning is forgotten within 18 to 24 hours after the lesson.
- Processing and transfer needs adequate time to process.
- It is during sleep that the brain reaccumulates the greatest amount of the neurochemicals needed to stimulate dendritic growth.
- The period of deep sleep is the critical time when brain transforms recent memories into long-term memories by building and extending the dendritic branches.

Image: <http://cdn.zmescience.com>



Studies suggest that if students review their notes thoroughly and stop and go to sleep when they begin to feel drowsy, the quality and quantity of retained memory is superior to extending the review time any number of hours once drowsiness has set in. (Willis, 2006)

Sleep

- The dendritic branching process is also enhanced by the neurotransmitter serotonin secreted by the brain predominantly between the sixth and eighth hour of sleep.
- This recognition of the need for sleep has led researchers to test and confirm their predictions that increasing sleep time from six or less to eight hours can increase memory and alertness up to 25 percent.



Practice Makes Permanent

- If the student unknowingly practices the skill incorrectly, they will learn the incorrect method well.
- Practice should take place in short, intense periods when the working memory is running in prime-time.
- New learning should be practiced and continue to be practiced over increasingly longer time intervals (distributed practice).
- Spending a lot of time on task in and of itself is not sufficient to ensure effective learning.



feedback messages with high content caused more learning than feedback messages with low content.

In guided practice the teacher can offer corrective feedback to help students analyze and improve their practice.

Unlearning and relearning correctly is very difficult.

Distributed learning (spiraling)

“Lab”

1. Arrange in groups of three to six students.
2. Try first.
3. Compare, share and assist.



Online homework provides more practice

MyMathLab

04/22/15 11:59pm	Section 9.4 Reading Assessment
04/26/15 11:59pm	Section 9.4 Homework
04/26/15 11:59pm	Section 9.5 Reading Assessment

Navigation: << 1 2 3 4

Ex. Score: 0 of 1 pt

Add radical expressions.

$$4\sqrt[3]{32} + \sqrt[3]{256}$$

Select the correct choice

A. $4\sqrt[3]{32} + \sqrt[3]{256} = 8\sqrt[3]{4} + 2\sqrt[3]{16}$
(Simplify your answer. Type an exact answer, using radicals as needed.)

B. The expression cannot be simplified.

Sorry, that's not correct.

Two or more radical expressions that have the same indices and the same radicands are called like radicals. Begin by factoring the radicands using the greatest perfect cube factors. Then simplify and combine like radical terms.

Done



Strive for 100%

3 tries on 3 similar problem for each question.

Using 'Help me solve this' counts as one problem.


Add radical expressions.

$$4\sqrt[3]{32} + \sqrt[3]{256}$$


Select the correct choice below and, if necessary, fill in the answer box to complete your choice.

A. $4\sqrt[3]{32} + \sqrt[3]{256} = 8\sqrt[3]{4} + 4\sqrt[3]{4}$
(Simplify your answer. Type an exact answer, using radicals as needed.)

B. The expression cannot be simplified.

 **Sorry, that's not correct.**

Although your answer is equal to the correct answer, it is not in the correct form. Be sure to read any instructions given in the problem. If there are no special instructions, make sure your answer is fully simplified.



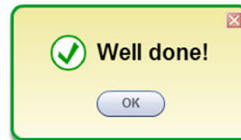
feedback messages
with high content caused more learning than feedback
messages with low content.

Add radical expressions.

$$4\sqrt[3]{32} + \sqrt[3]{256}$$

Select the correct choice below and, if necessary, fill in the answer box to complete your choice.

- A. $4\sqrt[3]{32} + \sqrt[3]{256} = 12\sqrt[3]{4}$
(Simplify your answer. Type an exact answer, using radicals as needed.)
- B. The expression cannot be simplified.



Learning

- Learning consists of reinforcing the connections between neurons.
- The more ways something is learned, the more memory pathways are built.
- The more regions of the brain that store data about a subject, the more interconnection there is.
- Once information is successfully retrieved, it still needs to be reviewed between four and seven times to ensure retention.




Students need to monitor their learning and actively evaluate their strategies and their current levels of understanding.

Stimulating the growth of more dendrites and synaptic connections is one of the best things teachers can learn to do for the brains of their students.


The more regions of the brain that store data about a subject, the more interconnection there is. This redundancy means students will have more opportunities to pull up all those related bits of data from multiple storage areas in response to a single cue. This cross-referencing of data strengthens the data into something we've learned rather than just memorized. (Willis, 2006)
When students build their working memories through a

variety of activities, they are stimulating multiple sensory intake centers in their brains. (Willis, 2006)



The person who thinks, learns.


- Increase student engagement.
- Encourage them to try first and then ask for assistance.
- *If students can always get immediate help, they may become dependent and never learn to solve problems for themselves.*



The best way to learn something well is to prepare to teach it. In other words, whoever explains, learns.

(Sousa, How the Brain Learns, 2011)

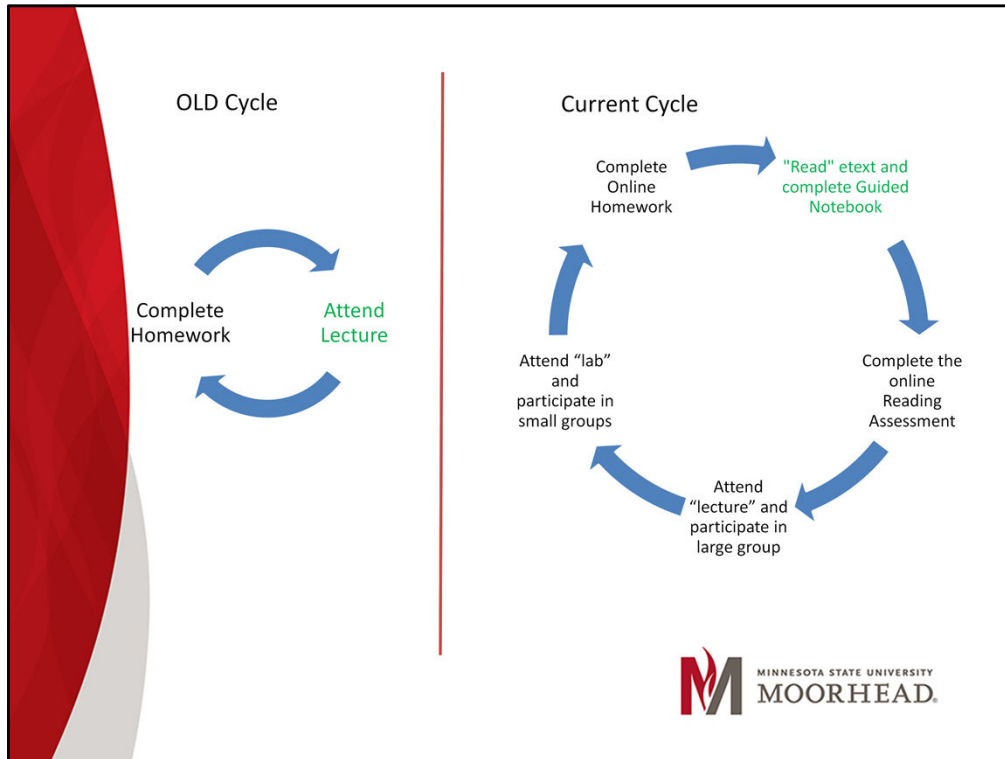
In order for learners to gain insight into their learning and their understanding, frequent feedback is critical: students need to monitor their learning and actively evaluate their strategies and their current levels of understanding. (National Research Council, 2000)



4. Illustrate the study cycle for your students.

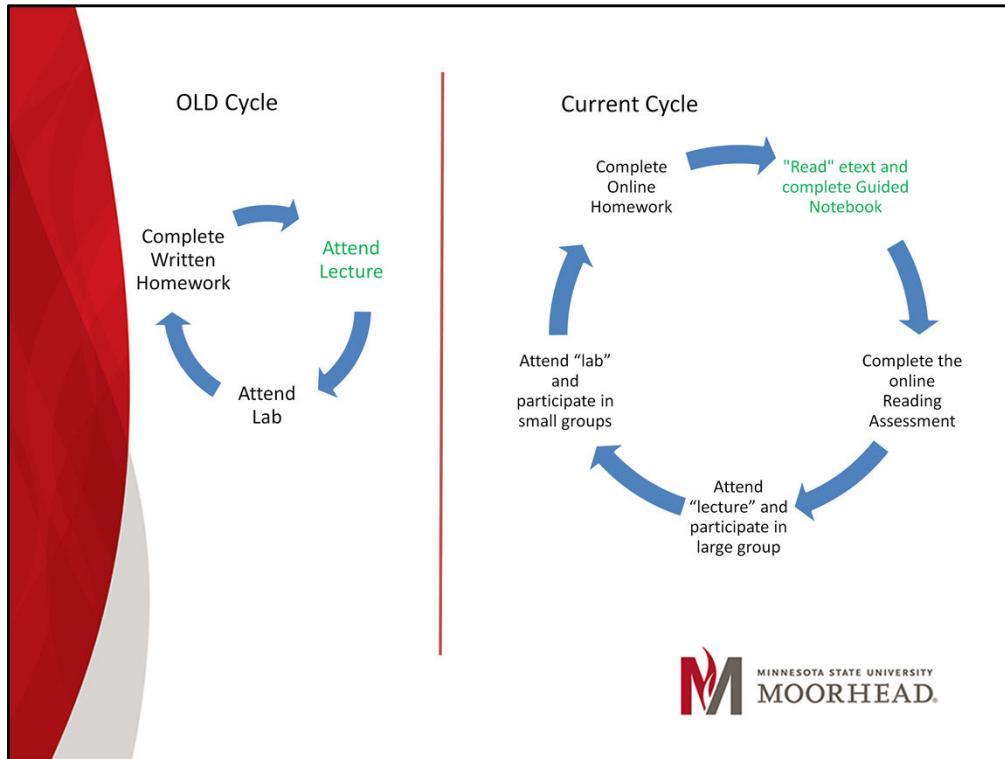


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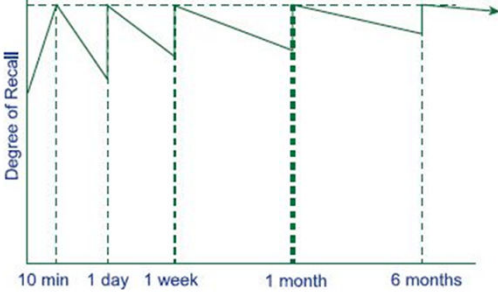
4. Draw Cycle

Old cycle vs. new cycle




4. Draw Cycle

Old cycle vs. new cycle



Sustained practice over time, called distributed practice or the spacing effect, is the key to retention and is the rationale behind the idea of spiral curriculum.

(Sousa, 2011)



Spiral curriculum, where critical information and skills are reviewed at regular intervals within and over several grade levels.

Interleaving

- Whereas blocking involves practicing once skill at a time, in interleaving one mixes, or interleaves, practice on several related skills together.
- Vs. blocked or massed practice.
- Rote responses don't work. Your brain must continuously focus on searching for different solutions.
- Continually engages at retrieving different responses and bringing them into short-term memory, reinforcing neural connections.



Did it 35 years ago...Saxon text


The [spacing effect](#) was first described by Hermann Ebbinghaus in 1885.

“AAABBBCCC” vs. “ABCABCABC”

“Making it Stick”

Block practice allows a student to get into a groove and get a false sense that they understand it.

Saxon has used interleaving for years.




Section 15.7 Solving Polynomial Equations by Factoring

15.7.1 *	15.7.2 *	15.7.3
15.7.4	15.7.5	15.7.6 *
15.7.7	15.7.8	15.7.9
15.7.10 *	15.7.11	15.7.12
15.7.13	15.7.14 *	15.7.15
15.7.16	15.7.17	15.7.18 *
15.7.19	15.7.20	15.7.21
15.7.22 *	15.7.23	15.7.24
15.7.25	15.7.26 *	15.7.27
15.7.28	15.7.29	15.7.30 *
15.7.31	15.7.32	15.7.33
15.7.34 *	15.7.35	15.7.36
15.7.37	15.7.38 *	15.7.39
15.7.40		

Section 15.7 Applications of Quadratic Equations

15.8.1 *	15.8.2 *	15.8.3
15.8.4	15.8.5	15.8.6 *
15.8.7	15.8.8	15.8.9
15.8.10 *	15.8.11	15.8.12 *
15.8.13	15.8.14 *	15.8.15 *
15.8.16 *	15.8.17	15.8.18
15.8.19	15.8.20 *	15.8.21



Topic 1: 20 problems
Blocked, or mass, practice

Section 15.7 Solving Polynomial Equations by Factoring


15.7.1	1	15.7.2	2	15.7.3	3
15.7.4	1	15.7.5	2	15.7.6	3
15.7.7		15.7.8	2	15.7.9	3
15.7.10	4	15.7.11	5	15.7.12	6
15.7.13		15.7.14		15.7.15	
15.7.16		15.7.17	5	15.7.18	6
15.7.19		15.7.20		15.7.21	
15.7.22		15.7.23		15.7.24	
15.7.25	1	15.7.26	2	15.7.27	5
15.7.28	1	15.7.29	4	15.7.30	
15.7.31		15.7.32	2	15.7.33	
15.7.34	5	15.7.35	6	15.7.36	
15.7.37	6	15.7.38		15.7.39	
15.7.40					

Section 15.7 Applications of Quadratic Equations

15.8.1	1	15.8.2	2	15.8.3	
15.8.4		15.8.5	5	15.8.6	1
15.8.7	2	15.8.8	4	15.8.9	1
15.8.10		15.8.11	4	15.8.12	
15.8.13		15.8.14		15.8.15	1
15.8.16	2	15.8.17	3	15.8.18	6
15.8.19		15.8.20		15.8.21	

[Homework 1](#)

[Homework 2](#)



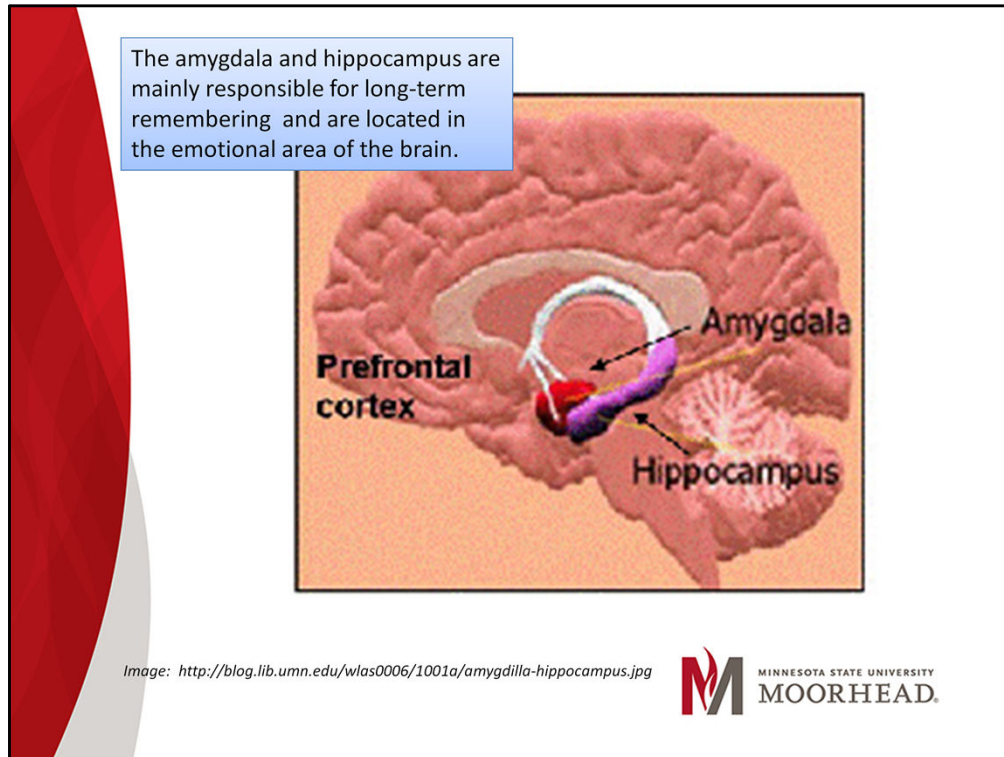
Topic 1: 8 problems, 4 review problems

Topic 2: Includes 11 problems from topic 2, 8 topic 1 topics, 2 review

Topic 3: 10 topic 3, 6 topic 1, 11 topic 2

Topic 4: 15 topic 4, 3 topic 1, 9 topic 3

Assignment 5 and 6 are just on current topics because there are also reviews assigned.



Sensory receptor areas of the brain must travel through the amygdala to get into the hippocampus, from where it can be sent to the executive function and long-term memory storage area of the frontal lobe.

The Hippocampus plays a major role in consolidating learning and in converting information from working memory via electrical signals to the long-term storage regions, a process that may take days to months. It constantly checks information to relayed to working memory and compares it to stored experiences. This process is essential to the creation of meaning. --- The hippocampus is susceptible to stress hormones that can inhibit cognitive functioning and long-term memory. (Sousa, How the Brain Learns, 2011)

Mathematical thinking is a perfect example of the higher-order thinking that is unique to the **prefrontal cortex**. The executive functions of the **PFC** – including personal responsibility, emotional response control, planning, prioritizing, organization, creative problem solving, critical analysis, judgment, prediction, and self-motivation ... (Willis, 2010)

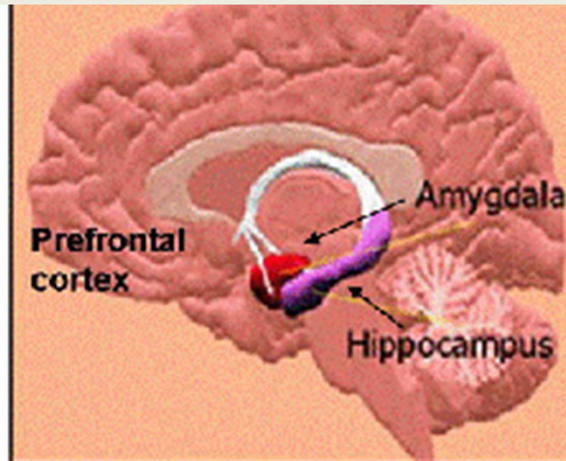



Image: <http://blog.lib.umn.edu/wlas0006/1001a/amygdilla-hippocampus.jpg>



Information has to get past the brains' emotional filters located in the amygdala to get to the conscious thinking and long-term memory parts of the PFC.


The prefrontal cortex is the front part of the frontal lobe.
Frontal lobe

- matures slowly – it continues to mature into early adulthood. The capability of the frontal lobe to control the excesses of the emotional system is not operational during adolescence.
- most of working memory is located here...it is where focus occurs



Remember neurotransmitters? Brain chemicals that bathe the brain cells and either permit signals to pass between them or inhibit them.

When people feel positive about a learning situation, chemicals called endorphins and dopamine become active. Dopamine stimulates the prefrontal cortex, keeping the individual attentive, interactive and likely to remember what they experience. Negative feelings cause the hormone cortisol to enter the bloodstream. Cortisol puts the brain into survival mode; this shifts the brain's attention away from learning so it can deal with the source of stress. (Educational Leadership, 2009)

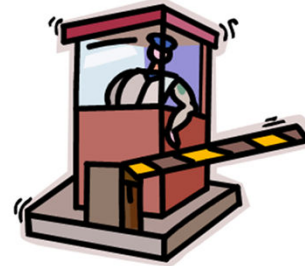


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Stress in the classroom or elsewhere, especially when associated with anxiety or fear, releases a chemical called TMT, or trimethyltin, into the brain. TMT disrupts brain cell development. In the hippocampus region, through which data must pass to be encoded as memory, stress-related release of TMT – both acute and chronic – suppresses the growth of dendrites and maintenance of neuron health. (Willis, 2006)

Amygdala

- Sensory receptor areas of the brain must travel through the amygdala to get to the prefrontal cortex.
- When the amygdala is in a state of stress, new information coming through the sensory intake areas of the brain cannot pass through the amygdala to gain access to the memory circuits.



Subsequent research revealed that after presentation of pleasurable, comforting, positively reinforcing, intrinsically motivating stimuli, the amygdala could be moderately stimulated or warmed up to the alert state that actually facilitates active processing and neuronal transport of information. (Willis, 2006)

Amygdala hijacking – negative feelings cause the hormone cortisol to enter the bloodstream. Cortisol puts the brain into survival mode; this shifts the brain's attention away from learning so it can deal with the source of stress... Stress in the classroom or elsewhere, especially when associated with anxiety or fear, releases a chemical called TMT, or trimethyltin, into the brain. TMT disrupts brains cell development. In the

hippocampus region, through which data must pass to be encoded as memory, stress-related release of TMT – both acute and chronic – suppresses the growth of dendrites and maintenance of neuron health.

When students feel positive about a learning situation, chemicals called endorphins (provide feeling of euphoria) and dopamine (stimulates the prefrontal cortex) become active.

A stress state happens when a lesson is tedious, not relevant to their lives, confusing, or anxiety-provoking.


Stress

- Stress may build if a student doesn't [understand a concept](#) and the teacher continues on while they are lost.
- Boredom can cause stress.
- But it is also important to provide mild-to-moderate challenge to stimulate authentic curiosity which brings the students into the lessons.
- Students need a certain level of concern to stimulate their efforts to learn.




There is also helpful stress (desire to do well). Boredom is also a cause of stress.

The **guided notebook** provides some organization to prepare for class and offer some familiarity to topics before lecture.



We can't avoid all stressful situations and stress is not always bad. We can help the students learn how to better deal with or avoid stress.

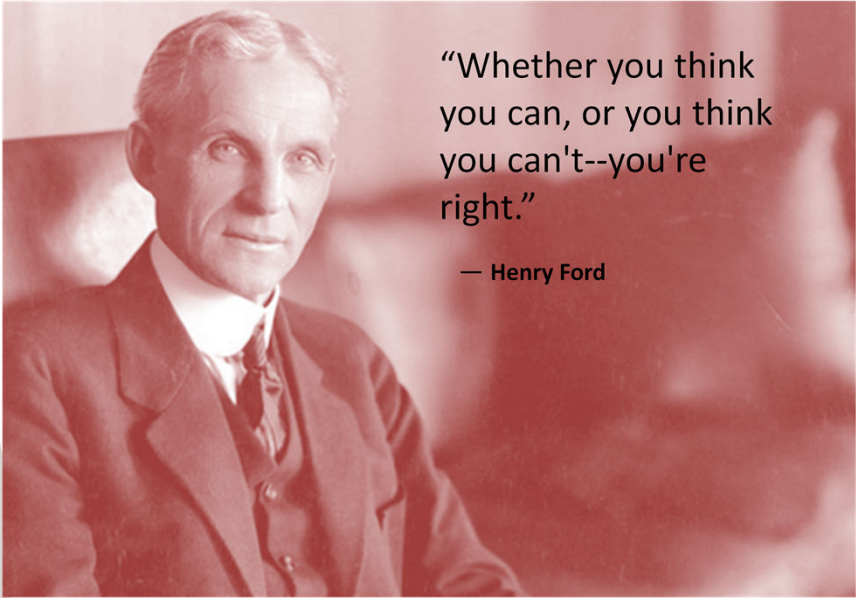
This can be done by helping them understand [how their brain works](#) and why their brain needs exercise, nutrition and sleep.



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Brain lessons were incorporated into their Guided Notebook beginning Fall 2015. Also included will be pages to help improve their metacognition skills...learning how to learn.

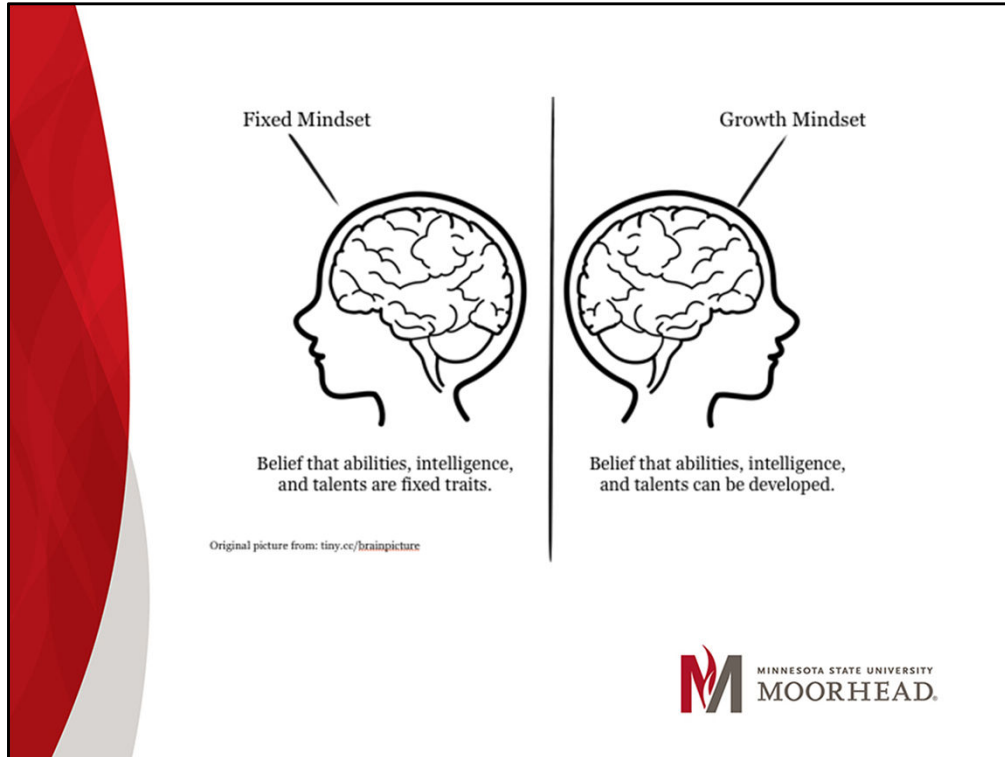
Brain Lessons




“Whether you think
you can, or you think
you can't--you're
right.”

— Henry Ford






Mindset plays a key role in student's persistence and view of one's capabilities. Carol Dweck



Until freshmen year, I had a fixed mindset that I was bad at math. Ever since a young age, I was embarrassed of myself because I struggled in math. My mom had always told me it wasn't my best subject, and my fifth grade teacher told me that I was "stupid" in math (yes, she actually called me stupid!). Then, in middle and high school I placed into "regular" math classes. All of these factors were latent socialization and contributed to my fixed mindset that I was bad at math. But my freshmen year, my math teacher changed my mindset. He never told any one that they were good or bad at math and he always made us answer our own questions by asking us questions. The major factor though that changed my mindset was when I shared an answer and got it wrong. He didn't say, "That's okay" but rather he complemented me on how interesting of an approach I took to solve the problem. That's when my math mindset changed. If parents and teachers become more mindful of how they phrase things, like my teacher, students will have the capacity to have a mindset that will allow them to try their best and grow

<http://matts-sociology-blog.blogspot.com/>




[http://matts-sociology-
blog.blogspot.com/2011/10/mathematical-mindset.html](http://matts-sociology-blog.blogspot.com/2011/10/mathematical-mindset.html)
The Serendipity of Sociology




Frequent Feedback is Critical

- Recent imaging studies have shown that brain regions associated with motivation are more active in subjects who are learning tasks and receiving feedback than in subjects doing the same tasks with no feedback.
- Feedback is a key contributor to motivation.
- Effective feedback is timely.
- Good feedback is also specific.
- Positive feedback stimulates the prefrontal cortex to reflect on ways to improve.



- 
- Establish a climate where students feel they are treated fairly and feel free to express their opinions.
 - Encourage students to make connections and be an active learner.
 - Establish responsibility and accountability.
 - Provide feedback.
 - Educate students on how the brain learns.





How have we applied neuroscience research to our developmental mathematics courses?

1. Moved lab days to directly follow lecture day.
2. Incorporate information about [how the brain learns](#) and [metacognition](#) activities (students reflect on the learning process) in the guided notebook.
3. Developed (and continue to revise) tutor training incorporating questioning techniques and pedagogies to make the tutee an active learner.
4. Incorporating interleaving versus blocking as an approach to homework.



5. Points of interest to be investigated or implemented.

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Dr. David A. Sousa is an international consultant in educational neuroscience and author of 15 books that suggest ways that educators and parents can translate current brain research into strategies for improving learning.

Dr. Judy Willis, a board-certified neurologist in Santa Barbara, California, has combined her 15 years as a practicing adult and child neurologist with her teacher education training and years of classroom experience.

ASCD (Association for Supervision and Curriculum Development) Resource

Carol Dweck, a professor of psychology at Stanford, researches mindsets; fixed mindset vs. growth mindset and how a particular mindset can affect all areas of your life.

Henry Roediger, Mark McDaneil and Peter Brown, are two cognitive scientists and one story teller summarizes empirical research of how learning and memory work.