

The Scientifically Substantiated Art of Teaching

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- “Designing educational experiences without an understanding of the brain is like designing a glove without an understanding of the human hand.”

-Leslie Hart
(1983)



“Education is not the filling of a pail, but the lighting of a fire.”

-William Butler
Yeates (1923)



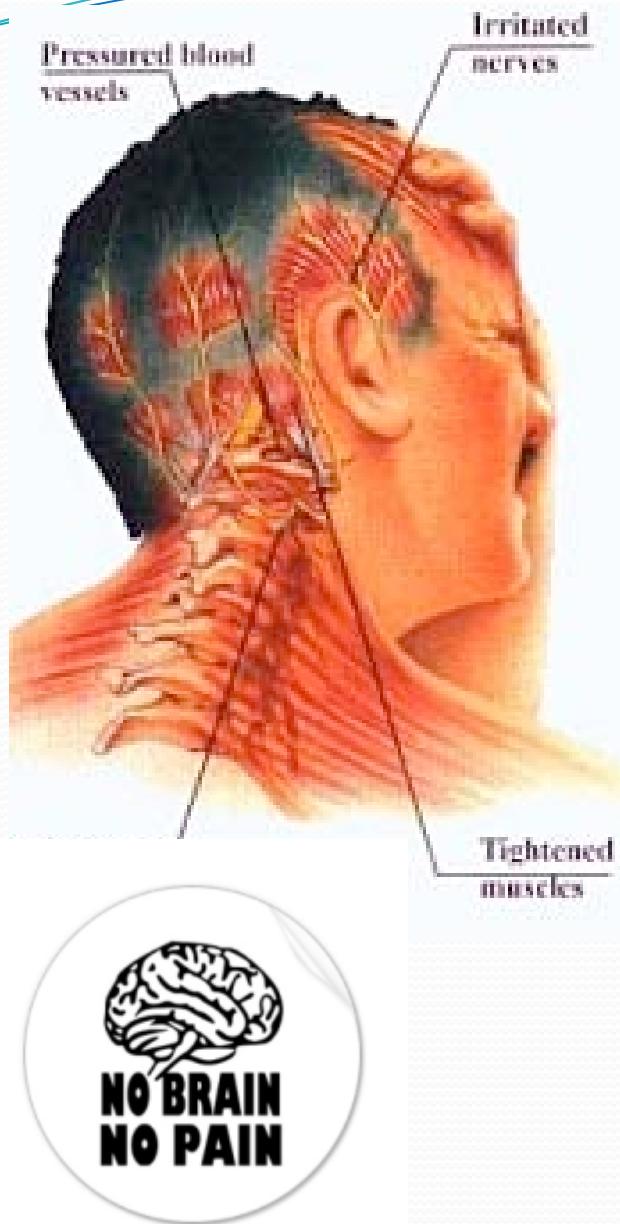


Two additions...

Question:

- Of all the organs in your body, the brain is the only one that does NOT...
 - a. have blood.
 - b. have oxygen.
 - c. have pain receptors.
 - d. change in size.

c. Pain receptors
(your brain doesn't feel pain).



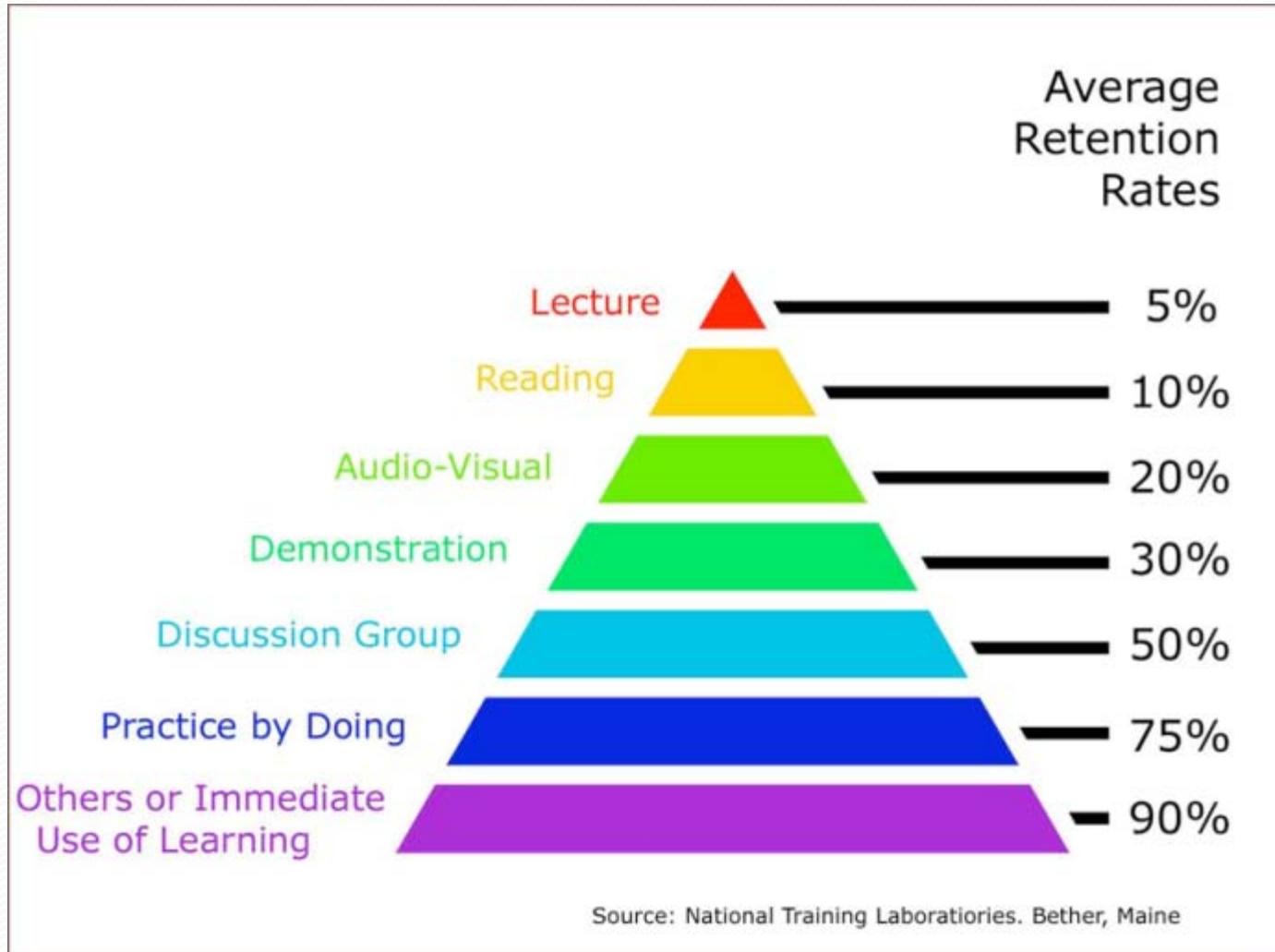
c. Pain receptors
(your brain doesn't
feel pain).





What is the best (worst)
way to learn?

Retention varies with method:



National Training Laboratories, Maine, as cited in Sousa (2000). NOTE: NO ORIGINAL SOURCE

One Minute Paper: “The brain and learning”

- “I KNOW”

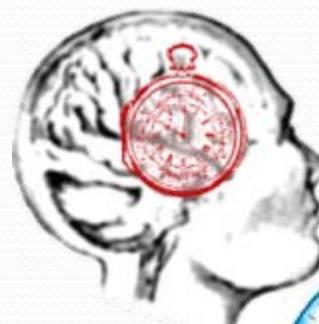


- “I QUESTION”



Today's focus

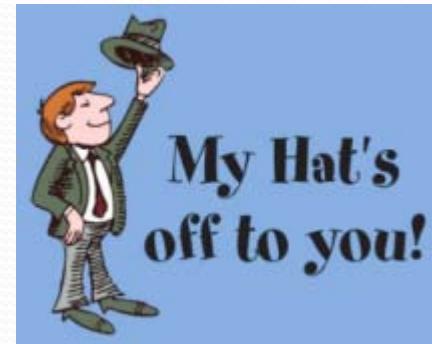
1. Objectives, premises and biases
2. New Model: MBE Science
 - a. Educational concepts
 - i. "Well-established"
 - ii. "Probably so"
 - iii. "Intelligent speculation"
 - iv. "Neuromyths"
3. Surprising discoveries
4. How Does This Change the Way We Teach?
 - i. Principles, Tenets and Instructional Guidelines



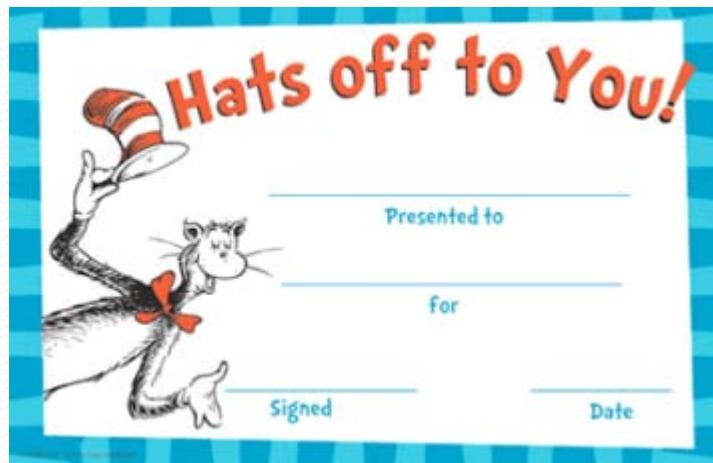
Today's objectives

1. Confirm great teaching, inspire average teaching (teaching is “teachable”)
2. Give you reason to believe that MBE science is the “new” brain-based learning.
3. Convince (recruit? invite?) you to wear the MBE hat and embrace its shared goals of improving teaching through a better understanding of how the brain learns.
4. Distinguish “neuromyths” from “well-established” beliefs in educational practice.
5. Share: What is “inspiring education” to me

Congratulations!



- Teachers...who do the hardest job in society.
- And teachers' jobs are changing...



Rip van Winkle and 20th Century Learning

- Transportation
- Banks
- Government
- Supermarkets
- Schools....?

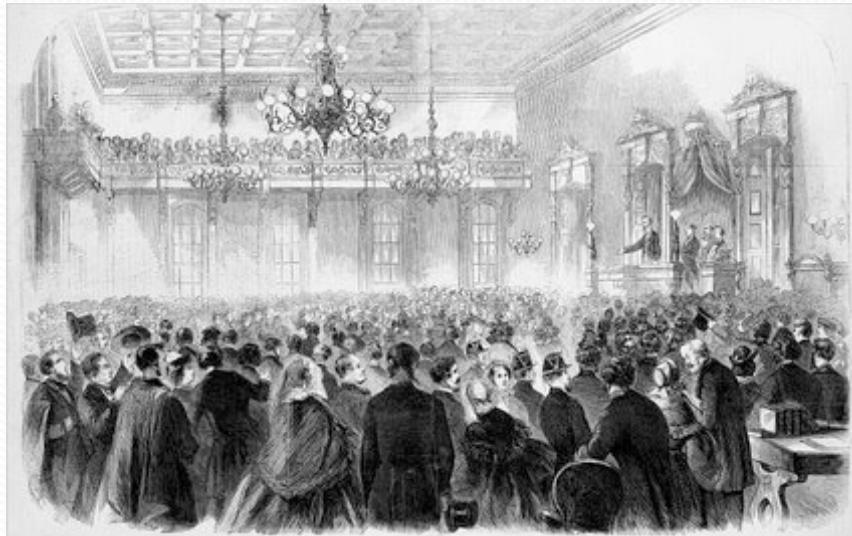
Transportation



Banks



Government



twitter

Home Profile Find People Settings Help Sign out

Question about the economy? Ask President Obama:
<http://whitehouse.gov/OpenF...>

about 5 hours ago from web

BarackObama
Barack Obama

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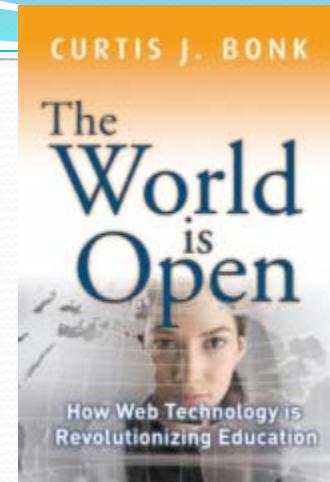
Supermarkets



Schools....

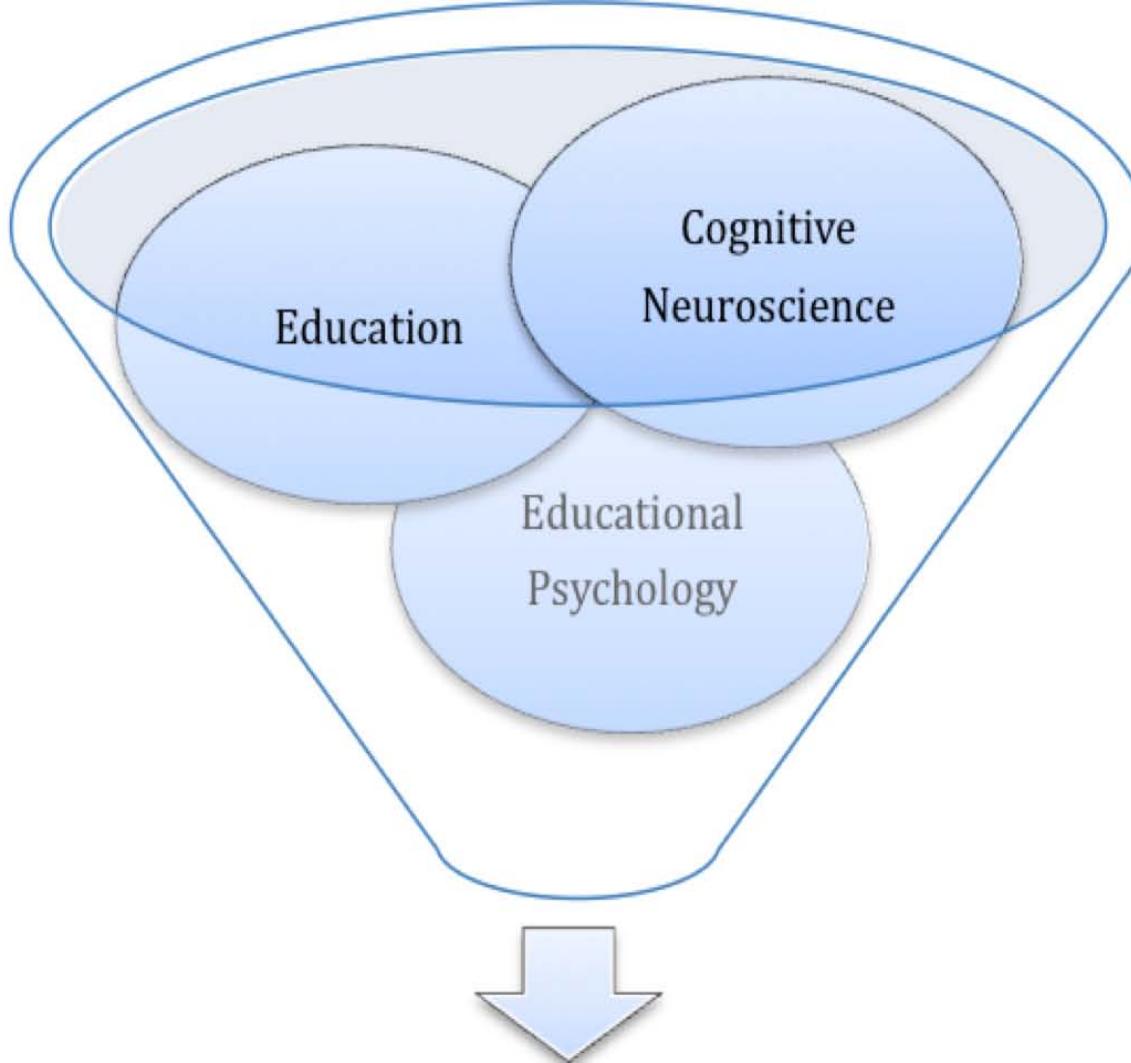


“Shift happens”

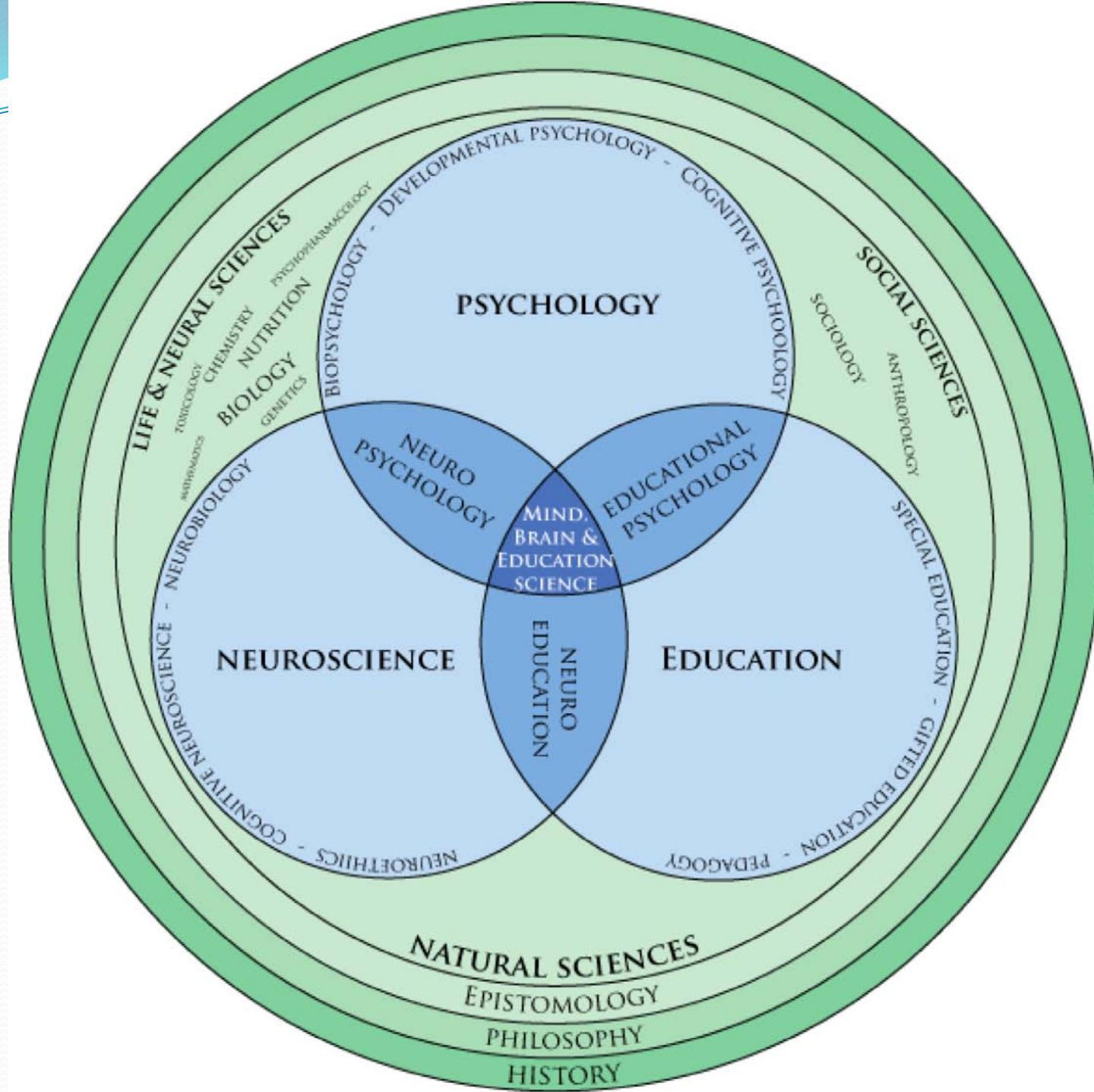


- Karl Fisch
- Curt Bonk: *The World is Open*
- Ian Jukes: 21st Century Fluency Project" (www.fluency21.com) and "TTWWADI"

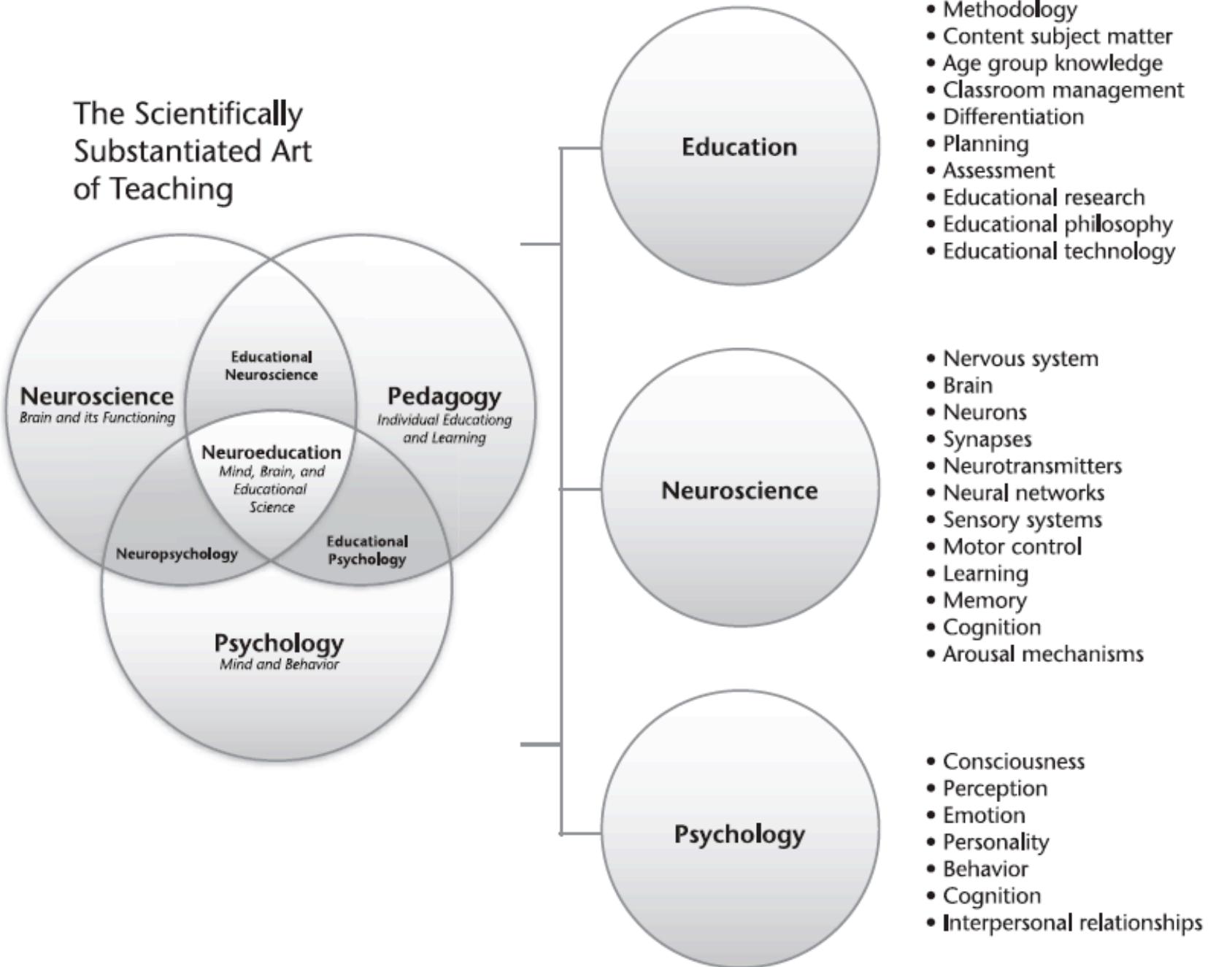




Mind, Brain, and Education Science

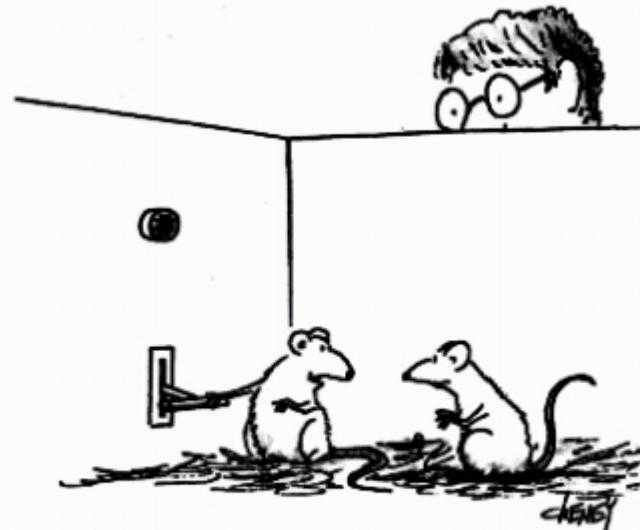
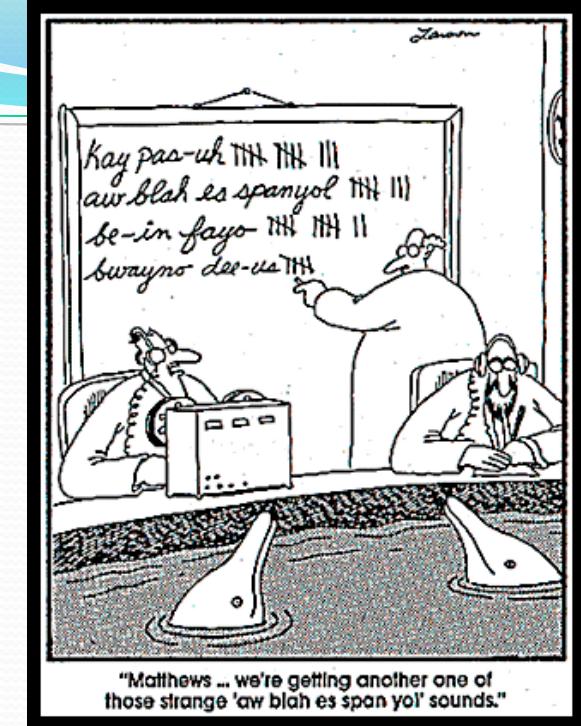


The Scientifically Substantiated Art of Teaching



“Mind, Brain, and Education scientist”:

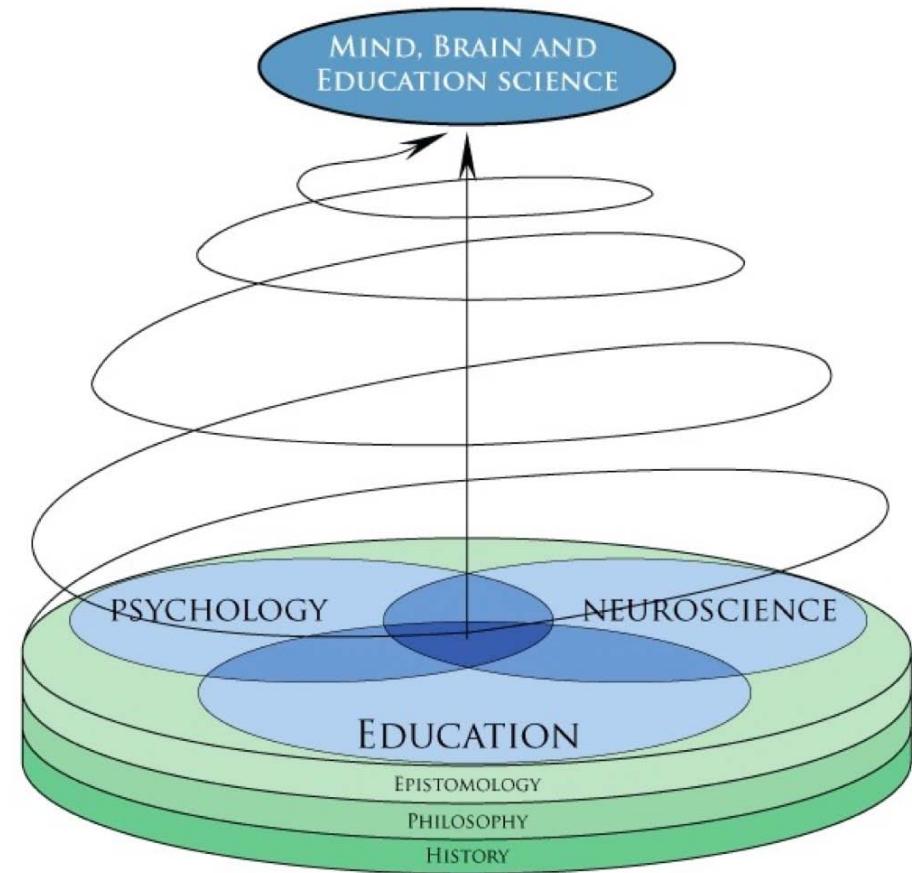
- In some instances this label will mean **teachers** who are integrating cognitive neuroscience and psychological foundations into their practice.
- In other cases it will mean **psychologists** who seek to bridge the hard and soft sciences.
- In yet others it will mean **neuroscientists** who dare to bring laboratory findings into the classroom.



It's a rather interesting phenomenon. Every time I press this lever, that post-graduate student breathes a sigh of relief.

“Mind, Brain, and Education scientist”:

- Work as a “purist” is not any less valuable than work in the transdisciplinary discipline of MBE science; it does, however, **acknowledge the need for new professionals who speak the language, walk the talk, and can work seamlessly as MBE specialists as well.**



Why switch to the MBE mentality?

- Begin with the premise that solutions to problems in education today require the more sophisticated and complex approach offered by MBE science.
- Despite 150 years of “good efforts” educational practice (initial formation and continued training) are not complete ...Problems in education still persist.
- More “varied” brains enter our classrooms every day.
- Teaching is more complex than ever.

Premise: “Do no harm”

1. The first rule in education is to “Do no harm”
2. The greatest goal in education:
 - Form critical thinkers
 - Form life-long learners

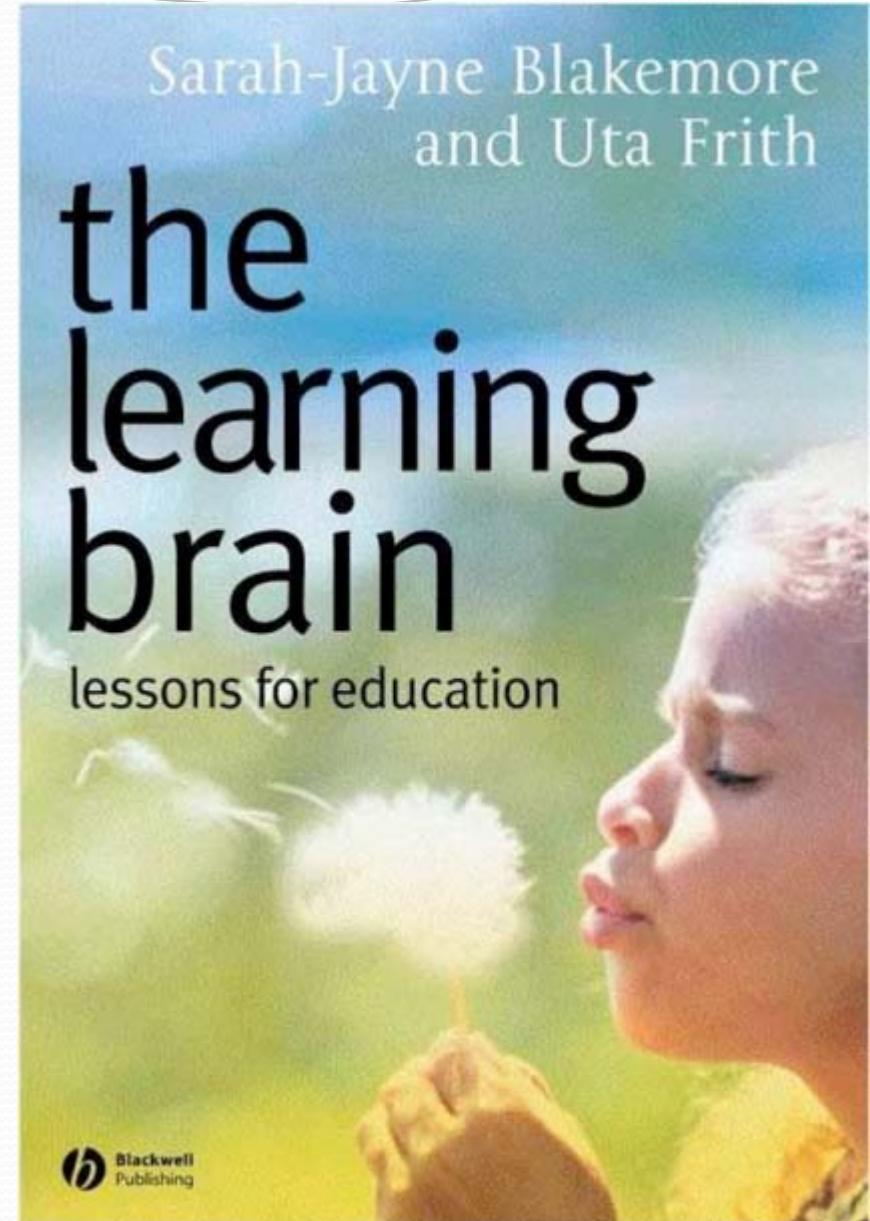


Premises

1. The new academic discipline in discussion is the intersection of neuroscience, education and psychology.
2. Education is not a “one-size-fits-all” practice (recipe approach).
3. The first rule of Education is the same as that of Medicine: “Do no harm.”
4. The focus is equally balanced between knowledge of how humans learn and how best to teach.

MBE: Balance between learning and teaching

- "We know a little of what goes on in the brain when we learn, but hardly anything about what goes on in the brain when we teach," (Blakemore & Frith, 2008, p.118).



Author biases

The Process: A critical thinking guide

- 1. Unite** all the information
- 2. Understand** all the concepts
- 3. Ask** where the information came from (biases)
- 4. Analyze** the source of information (credibility)
- 5. Doubt** the conclusions
- 6. Accustom** oneself to **uncertainty**
- 7. Exam** the whole
- 8. (Generate new or distinct ideas/information)**

Where does this information come from?

Began as a Ph.D Dissertation

1. Grounded Theory development based on a meta-analysis of the literature (1977-2008), over 4,500 documents reviewed (2,266).
2. New Model developed.
3. Delphi expert panel (21 experts from 6 countries) discussed 11 topics (26; 7) in three rounds.
4. New Model modified.
5. Comparison with existing literature.

Delphi Participants

- Daniel Ansari
 - Michael Atherton
 - Jane Bernstein
 - Sarah Jayne Blakemore
 - Renate Nummela-Caine
 - Donna Coch
 - David Daniel
 - Stanislas Dehaene
 - Marian Diamond
 - Kurt Fischer
 - John Geake
 - Usha Goswami
 - Christina Hinton
 - Mary Helen Immordino-Yang
 - Eric Jensen
 - Jelle Jolles
 - Michael Posner
 - Marc Schwartz
 - Rita Smilkstein
 - David Sousa
 - Judy Willis
- Virginia Berninger
 - John T. Bruer
 - Howard Gardner
 - ★ Paul Howard-Jones
 - Hideaki Koizumi
- Neuroscientists
Psychologists
Educators

Topics Researched in Mind, Brain, and Science Education

1. Neuroimaging
2. Neurotransmitters and Chemicals
3. Neurogenesis and Plasticity
4. Theories of Consciousness
5. Beliefs about Intelligence
6. New Learning Theories
7. Neuroethics
8. Learning Differences
9. Mind-Body Connection
 - a. Sleep
 - b. Physical Exercise
 - c. Nutrition

Major Brain Functions in the Research

School Subjects

1. Art
2. Creativity
3. Language
4. Reading
5. Math
6. Music
7. Science

Life Skills

1. Affect and Empathy
2. Emotions
3. Motivation
4. Attention
5. Executive Functions and/or Decision-Making
6. Facial Recognition and Interpretation
7. Memory
8. Social Cognition
9. Spatial Management
10. Time Management

Eleven Areas Discussed by the Experts

1. Name of the emerging field;
2. Academic roots;
3. Definition of terms;
4. The overarching research, practice and policy goals of the emerging field;
5. History;
6. Thought leaders;
7. Steps to judging quality information;
8. Organizations and societies qualified to judge the information;
9. BELIEFS AND NEUROMYTHS (today's focus);
10. Enhanced communication between professionals in the parent disciplines;
11. Design of a new Master's program to meet the needs of new professionals in the emerging field.

Findings: Comparison with existing literature....(bad info)

- A large percentage of what teachers are exposed to in literature and on the Internet was based on neuromyths rather than “well-established” sources.
- *Ex.: Teachers were told to sit in a circle and pass around a candle before class in order to get boys to focus—needed because of their primitive instincts; boys aren’t meant to sit in our typical classrooms (Costa Rican teachers conference).*

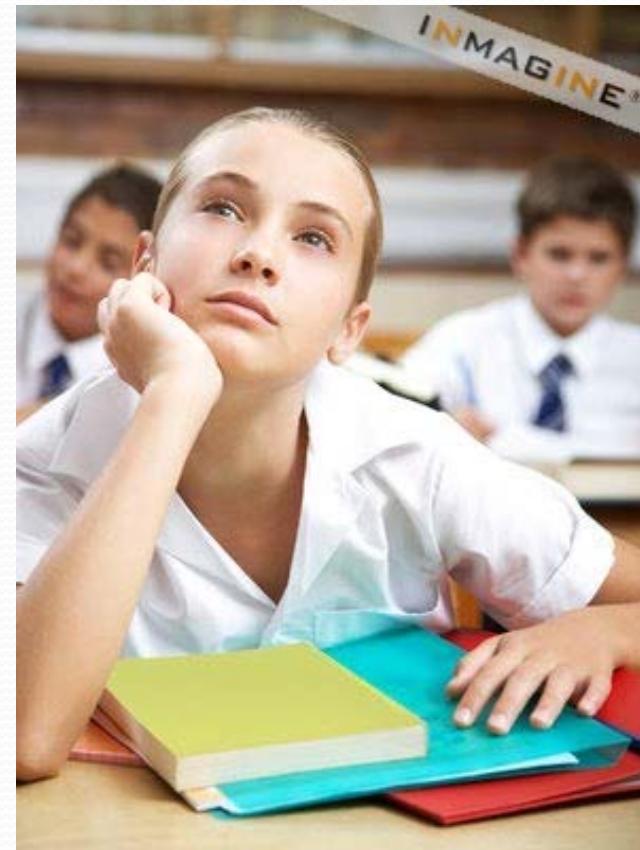
Training needs to be rethought...

Three examples of possible new additions (good info):

1. Emotions → Motivation → Time-on-task → Learning
2. How (non-verbal) communication (faces, body, intonation) impacts the perception of teacher self-efficacy → Student confidence in teacher → Student learning
3. Attention spans as they relate to different methodologies

True or false?

“Attention + Memory
= Learning?”



(Oversimplified, but...) TRUE! Without Attention and Memory there is no Learning

- To learn something new means you have to pay attention to it as well as remember it.



Best Practice

by Steven Zemelman, Harvey Daniels, and Arthur Hyde (2005):

1. Student centered
2. Active
3. Holistic
4. Authentic
5. Expressive
6. Reflexive
7. Social
8. Collaborative
9. Democratic
10. Cognitive
11. Developmental
12. Constructivist
13. Challenging
14. (Fun)



Selective attention

- <http://youtu.be/vJG698U2Mvo><iframe width="425" height="349" src="http://www.youtube.com/embed/vJG698U2Mvo" frameborder="0" allowfullscreen></iframe>

True or false?

“Students can pay attention for a full class period (40-90 minutes).”

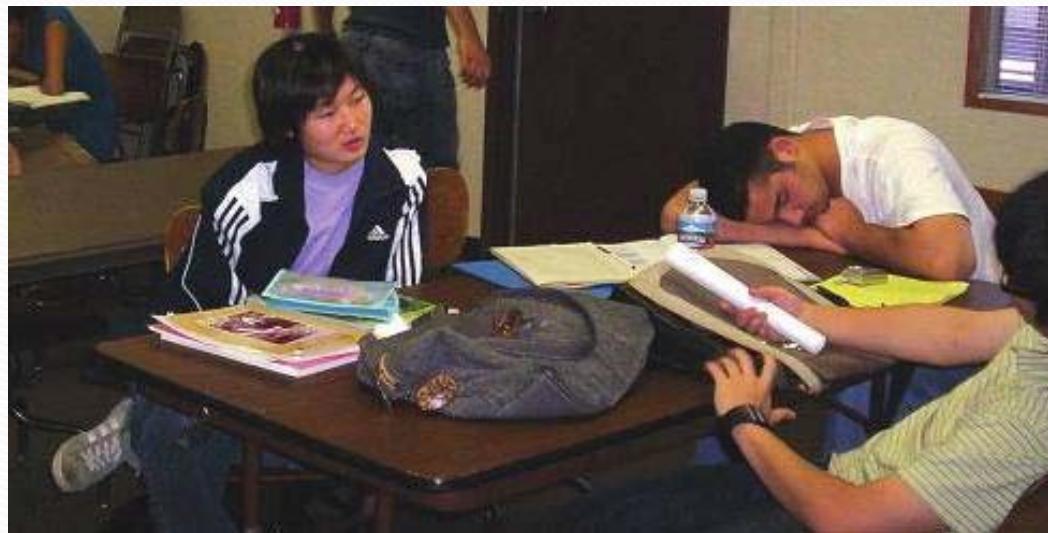
FALSE! The human attention span is limited

Attention spans

- Recognize that students have an average 10-20 minute maximum attention span.

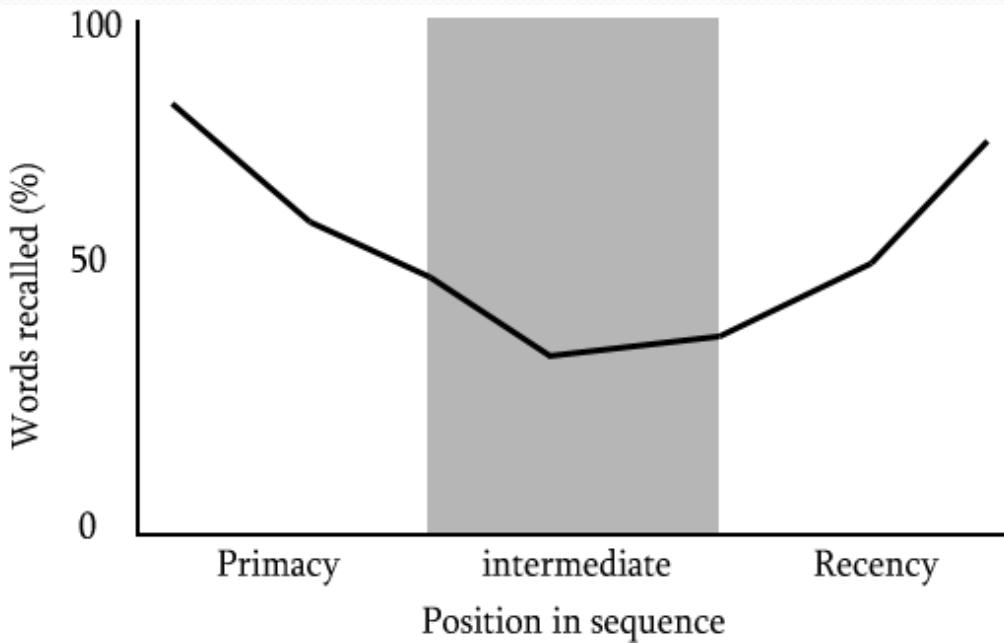


In practice:



- This means that teachers need to change the **person, place or activity** every 10-20 minutes to maintain a high level of attention.

“Primacy-Recency”



The Primacy-Recency Effect

- People remember best what happens first, second best what happens last, and least what happens in the middle.

In practice:

- This means that moments in the “middle” should be dedicated to student-centered practice.

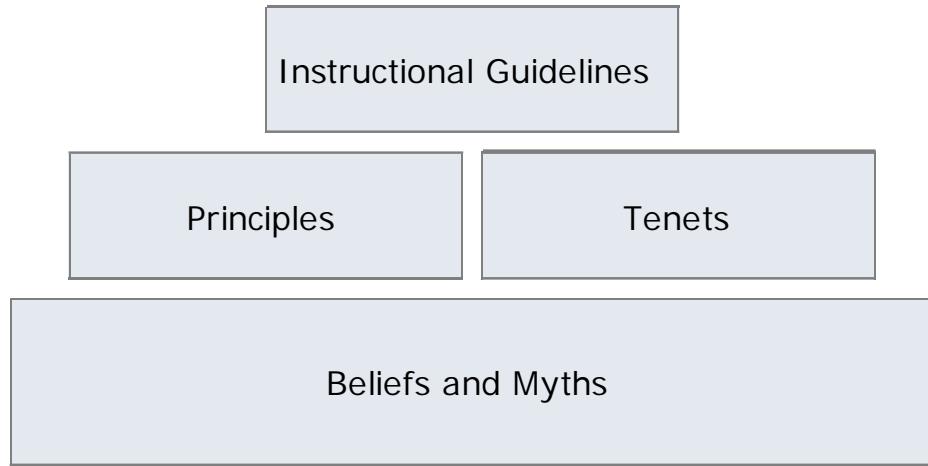


In practice:



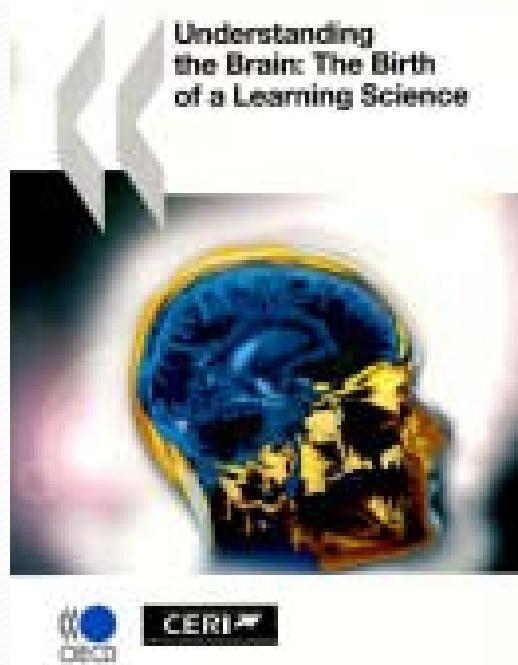
- The last part of the class should be dedicated to summarizing important concepts and bridging to next class.

The New Model:



- The categorization of concepts (**neuromyths** to the **well-established beliefs**) agreed upon by the Delphi expert panel pointed to the main tenets and principles of Mind, Brain, and Education science.
- **Tenets** are relative to each **individual learner** while the **principles** are important in the **same way for all learners**.
- The tenets and principles define the **instructional guidelines** of the field.

Categorization criteria



In *Understanding the brain: The birth of a learning science*, (OECD, 2002)* the authors propose a continuum of four categories of information quality.

*OECD= 30 countries (Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxemburg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

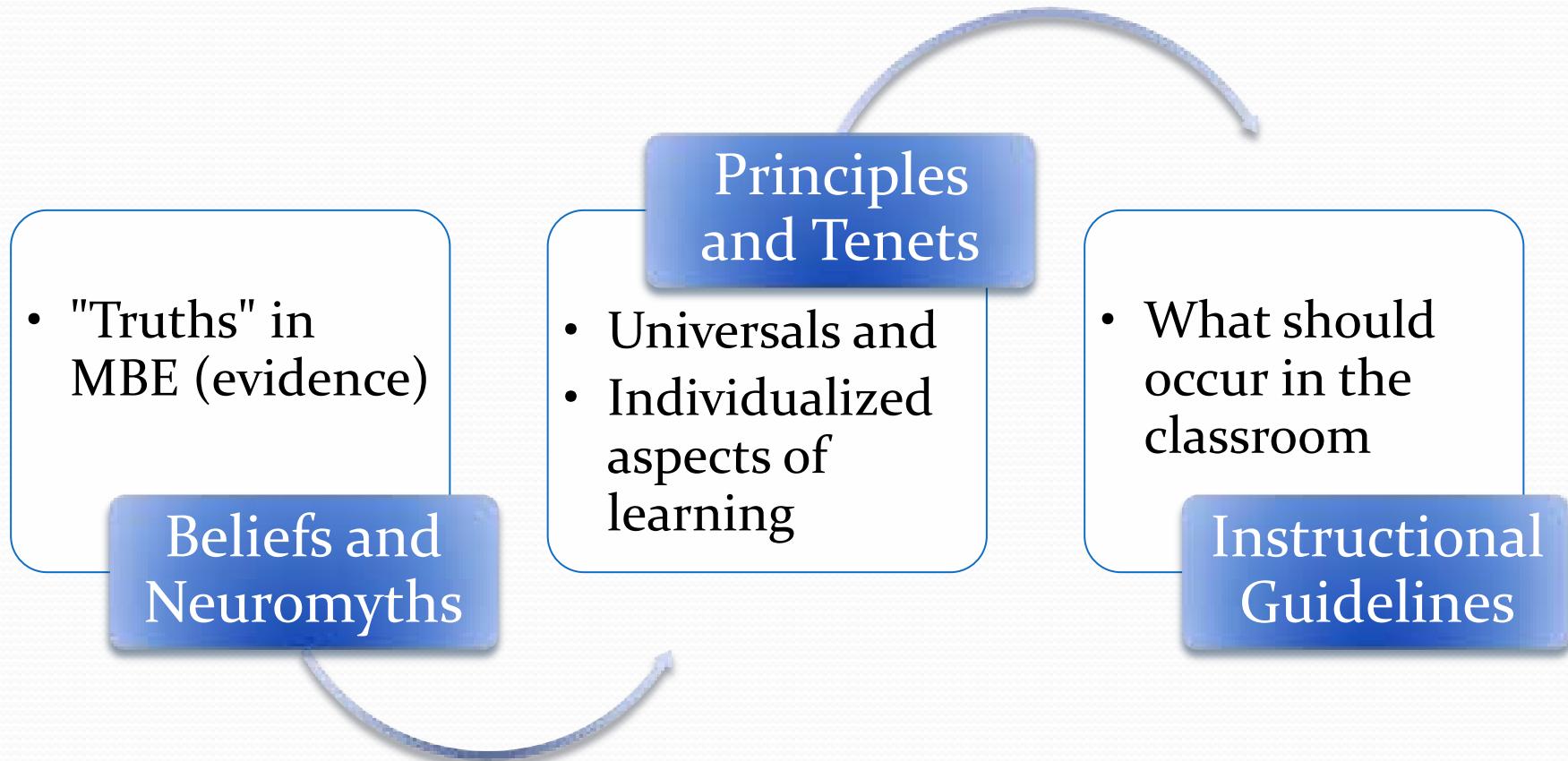
Criteria used to categorize concepts

Categories:

- A.What is **well-established** (i.e. *plasticity*, which now has hundreds of credible human studies behind it);
- B.What is **probably so** (i.e., *sensitive periods*, which has hundreds of studies behind it, though not all conducted on humans);
- C.What is **intelligent speculation** (i.e., *gender differences*, which has thousands of studies behind it, albeit of mixed quality and sometimes with contradictory findings); and
- D.What is popular misconception or a **neuromyth** (i.e., "*right brain*" and "*left brain*" discussion, which has been the target of thousands of books and articles, some of which promote the term, but most of which criticize the lack of factual accuracy of the claim).

WHAT IS WELL-ESTABLISHED

Four Categories of Information in the Emerging Field of Educational Neuroscience / Mind, Brain, and Education Science	Best Evidence Encyclopedia	What Works Clearinghouse
<p>WHAT IS WELL-ESTABLISHED</p> <p>A1. “Human brains are as unique as faces; while the basic structure is the same, there are no two which are identical. While there are general patterns of organization in how different people learn and which brain areas are involved, each brain is unique and uniquely organized.” (A1)</p>	<p>STRONG EVIDENCE OF EFFECTIVENESS</p> <p>At least one large randomized or randomized quasi-experimental study, or multiple smaller studies, with a median effect size of at least +0.20. A large study is defined as one in which at least 10 classes or schools, or 250 students, were assigned to treatments. Smaller studies are counted as equivalent to a large study if their collective sample sizes are at least 250 students. If randomized studies have a median effect of at least +0.20, the total set of studies need not have a median effect size.</p>	<p>POSITIVE EFFECTS</p> <p>Strong evidence of a positive effect with no overriding contrary evidence.</p> <p>To or more studies showing statistically significant positive effects, at least one of which met WWC evidence standards for a strong design.</p> <p>No studies showing statistically significant or substantively important negative effects.</p>

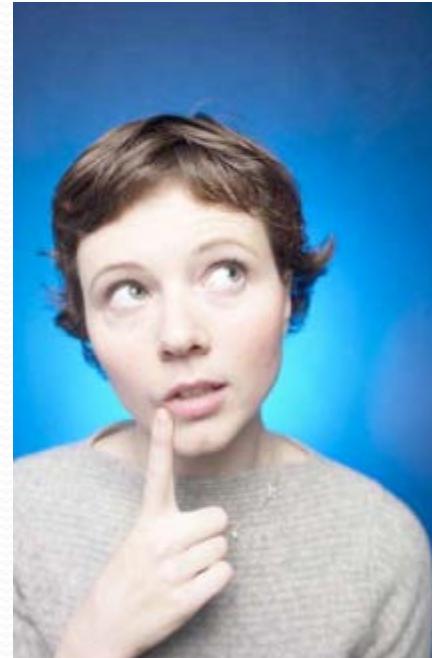


76 Educational Concepts

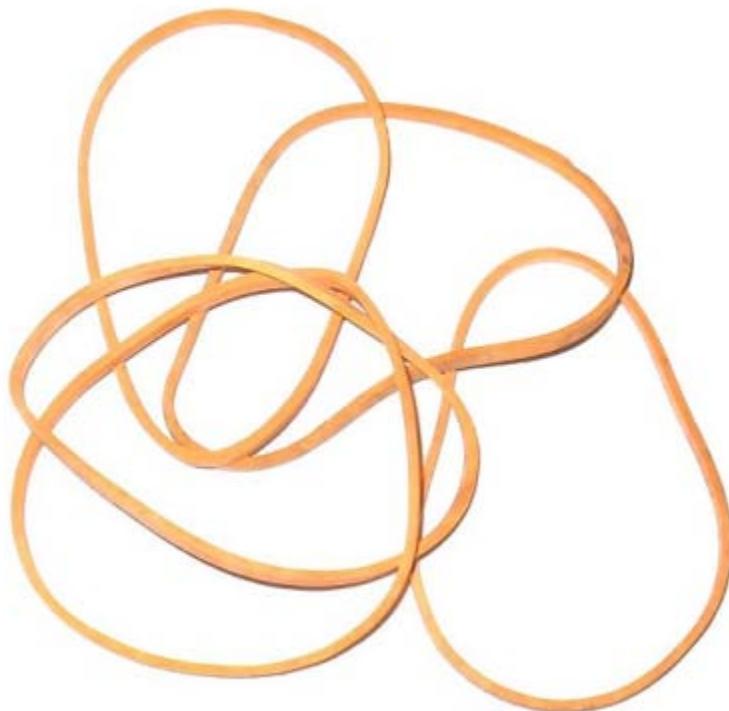
Well-established	Probably so	Intelligent speculation	Neuromyth
5	19	24	28
concepts	concepts	concepts	concepts
“universals”	“individual”		

Quiz!

1. Review questions and the evidence behind their answers.
2. Consider how the answers to the questions point to useable knowledge in the classroom.

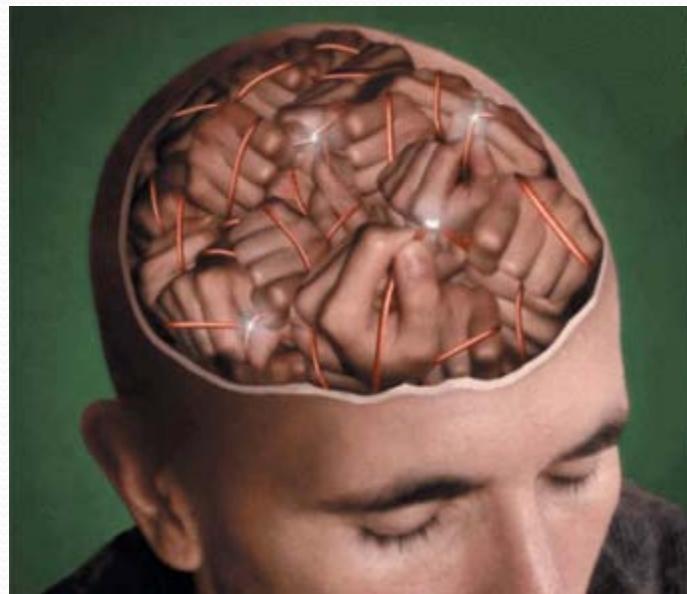


True or false?



“The brain is highly plastic (flexible).”

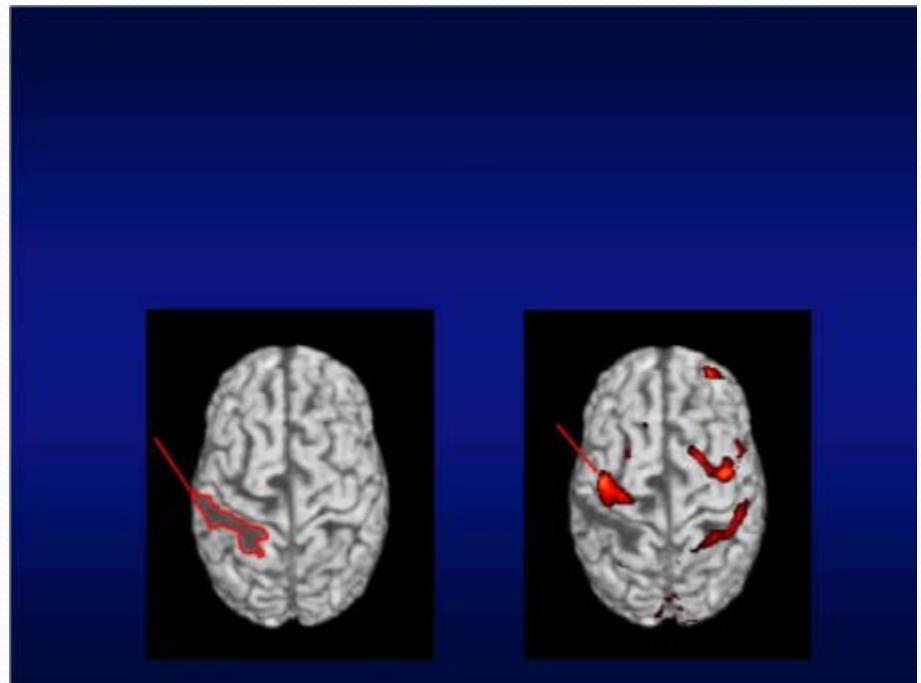
TRUE! Plasticity is the essence of learning itself



- Human brains have a high degree of plasticity.
- The brain can often “fix itself” with practice.

(Neuro) plasticity:

- The ability of the brain to re-wire itself using non-traditional pathways if a “normal” route is damaged or blocked.



Plasticity

We now know that....

- “we see with our brains, not with our eyes.”*
Example: Seeing with tongue (Bach-y-Rita).
- “Children are not always stuck with the mental abilities they are born with; that the damaged brain can often reorganize itself so that when one part fails, another can often substitute; that is brain cells die, they can at times be replaced; that many ‘circuits’ and even basic reflexes that we think are hardwired are not.”**
- Michel Merzenich; Norman Doidge; Paul Bach-y-Rita



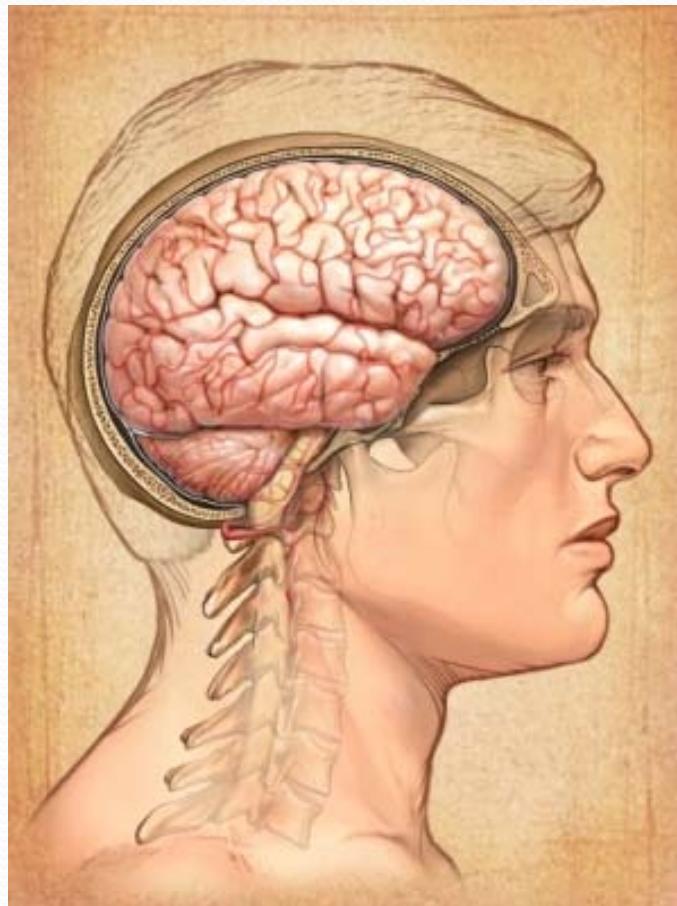
*Doidge (2007, p.14).; ** Doidge (2007, p.xv).

Myth: Plasticity is due to good pedagogy

- This is a myth because plasticity is a natural neural process and occurs with or without good pedagogy.
- Examples: addiction, racism.
- “Your brain adjusts to what it does most.”
(What does this mean re Technology?)



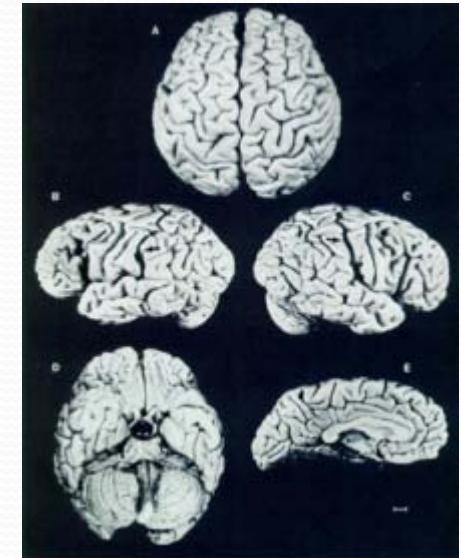
True or false?



“Human brains are
as unique as human
faces.”

TRUE! Human brains are as unique as faces

- While the basic structure of all human brains is the same, there are no two that are identical.
- While there are general patterns of organization in how different people learn and which brain areas are involved, each brain is unique and uniquely organized (...but why?)



Principle

How does this information impact teaching?

- Differentiation?
- The natural spectrum of learning abilities
- “Disability learning” (Swedish example)

True or false?

- “All brains are equally prepared for all tasks.”



FALSE! Brains are not equal in their ability to solve all problems.

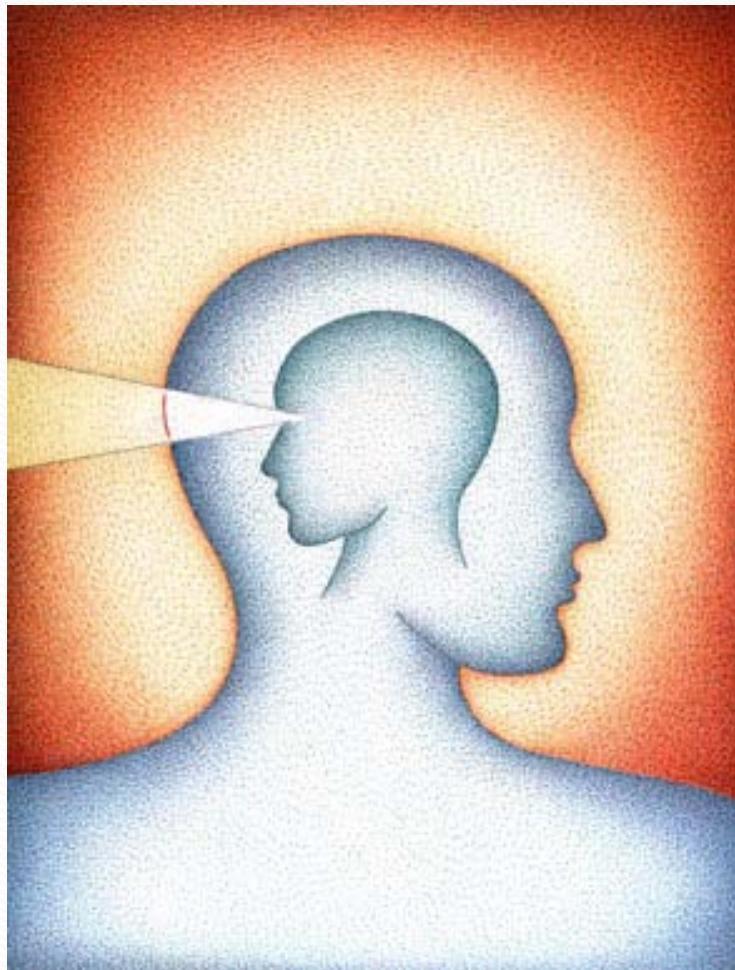


- Brains are not equal in their ability to solve all problems. Context as well as ability influence learning. Context includes the learning environment, motivation for the topic of new learning, and prior knowledge.
- Different people are born with different abilities, which they can improve upon or lose depending on the stimuli. The stimulus one receives is impacted by what the learner brings to the context, including past experience and prior knowledge.

How does this information impact teaching?

- Testing requirements?

True or false?



“Past information influences how we learn something new.”

TRUE! Prior knowledge influences new learning

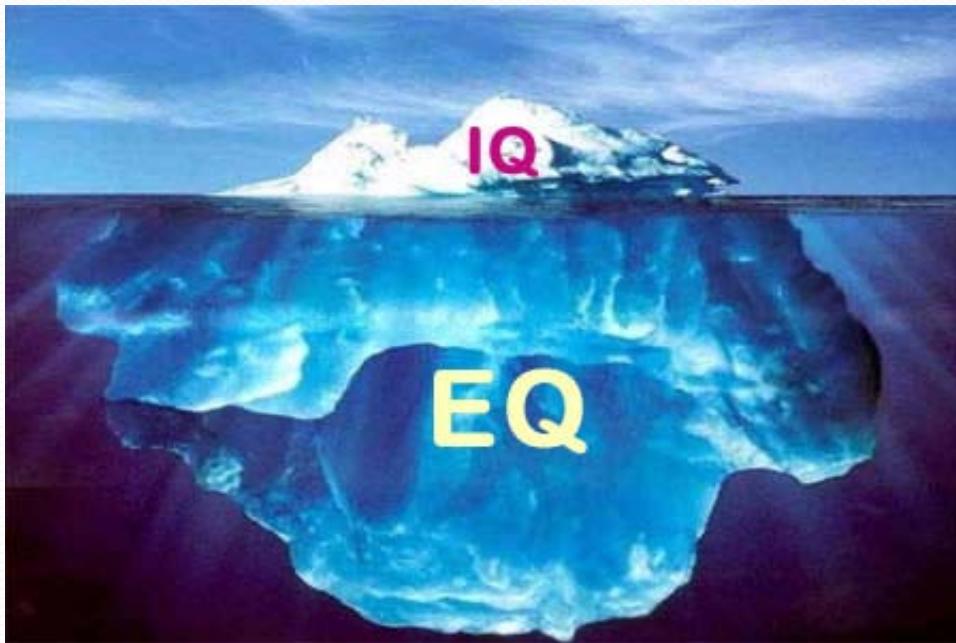


- Connecting new information to prior knowledge facilitates learning.
- We learn better and faster when we relate new information to things that we already know.

How does this information impact teaching?

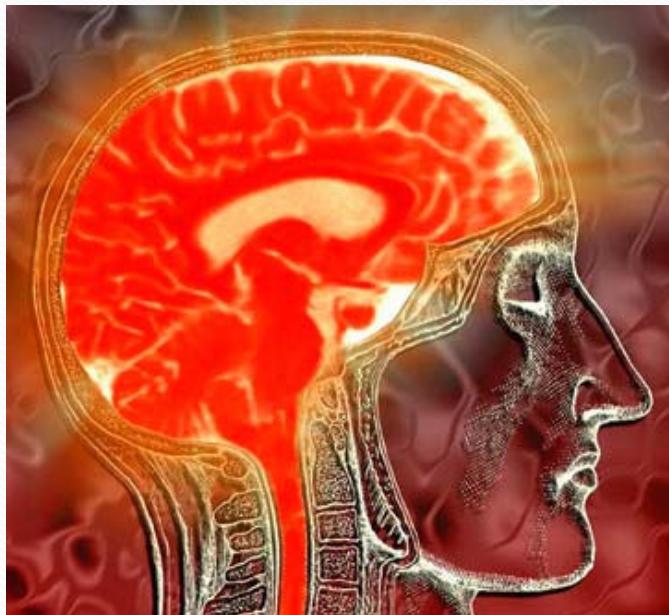
- Do you know your students well enough to capitalize on their past experiences and make the teaching moment authentic in their lives?
- Role of analogies in teaching (i.e., Case Studies; Problem Based Learning, etc.)

True or false?



“Making decisions with ‘a cool head’ and without emotions helps you think better.”

FALSE! It is impossible to separate emotions and reasoning in the brain



- Emotions are critical in decision-making.
- Even though emotions and reasoning seem like opposites, they are actually complementary processes.
- There are ***no*** decisions without emotions.

How does this information impact teaching?

- Are you creating the appropriate learning environment in class to ensure that positive emotions rein and that negative ones are reduced to a minimum?

True or false?

“People judge each other’s faces and tones of voice immediately and almost unconsciously.”

TRUE! Faces and Voices



Tenet: While proven in psychology, not yet well-established because documentation in school contexts is sparse.

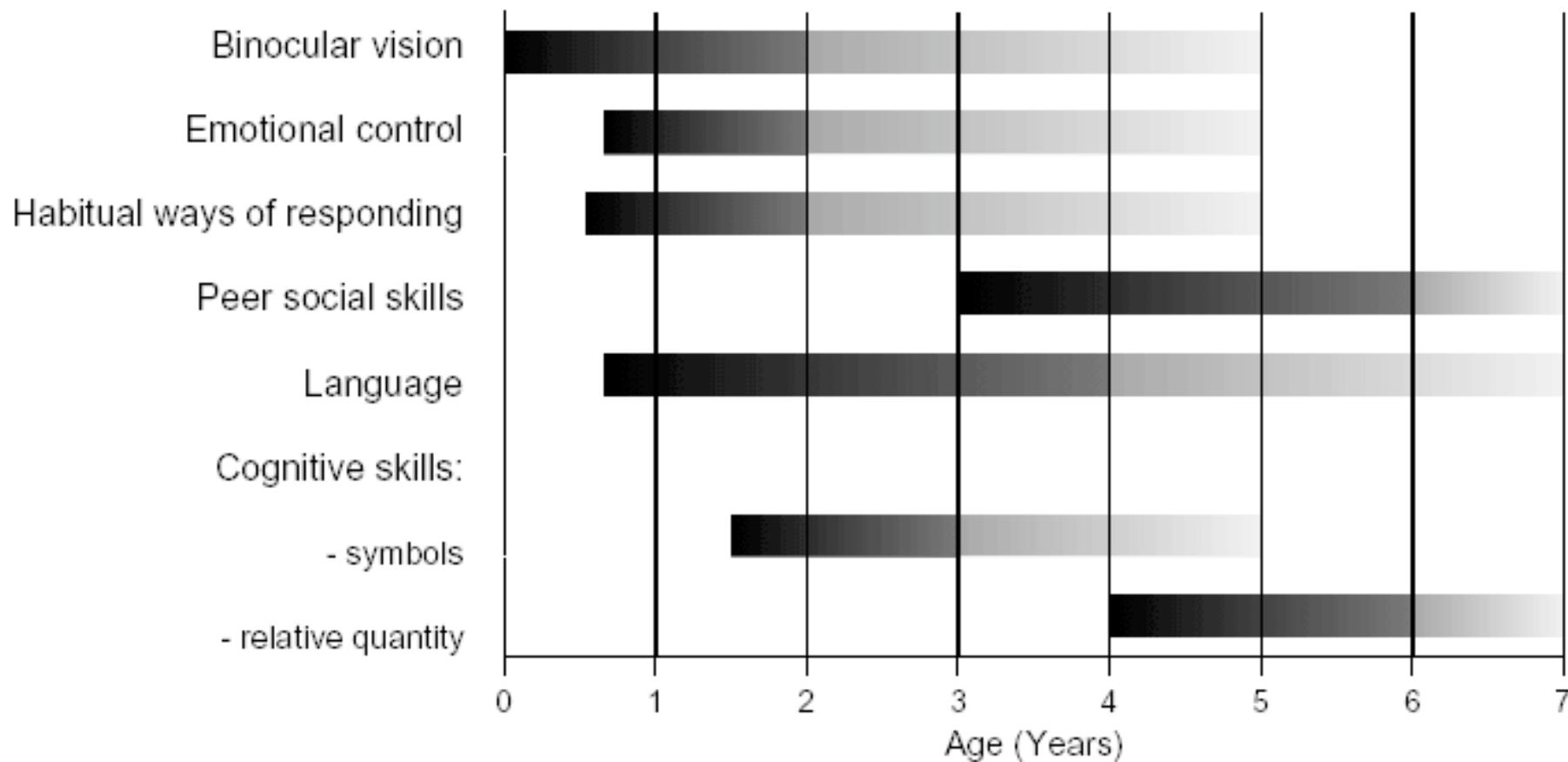
- The human brain judges others' faces and tones of voices for threat levels in a rapid and often unconscious way, influencing the way information from these sources is perceived (i.e., valid, invalid, trustworthy, untrustworthy, etc.)
- Students determine the level of teacher self-efficacy (and their confidence in their abilities) in part through their facial expressions and their voices.
- According to researchers, when a student feels that her teacher doesn't believe in her abilities to learn—because the teacher "looked at her funny" or his voice seemed condescending—then the student's actual performance is impaired.
- Even if the student misinterprets facial expressions, what students think their teacher thinks about her influences her performance.

How does this information impact teaching?

- Are teachers explicitly taught how to manage their body and voices? Should they be?
- Often it is not *what* is said, but *how* it is said.

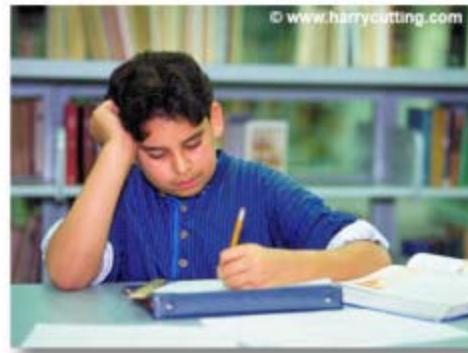
True or false?

“There are ‘critical periods’ for learning certain skills.”



TRUE and FALSE!

- Great teachers recognize that while there may be *sensitive periods* for learning some **academic** skills, there are no *critical periods* that limit opportunities to do so;
- The **order** in which skills are learned is more important than the age at which they are learned.



- There are no critical periods for any academic skill (e.g., math, reading). That is to say that if addition is not learned by age 6, then it can still be learned by 7, 8, 9, or 90 years of age.
- There may be critical periods for nonacademic skills, however, such as learning to walk or to speak one's first language.



Sensitive periods:



- Term coined by the Dutch geneticist Hugo de Vries and adopted by the Italian educator Maria Montessori to refer to important periods of childhood development.
- Montessori believed that every human being goes through a series of quantum leaps in learning during the preschool years.
- Drawing on the work of de Vries, she attributed these behaviors to the development of specific areas of the human brain, which she called *nebulae*.
- Commonly used nowadays in place of *critical periods*.

Learning across the lifespan



- The brain has the ability to learn across the lifespan.
- For this reason, while it is important to take advantage of sensitive periods in childhood, we should also recognize that we can learn into old age.

How does this information impact teaching?

- Social promotion?
- Should classrooms be divided based on age?

True or false?

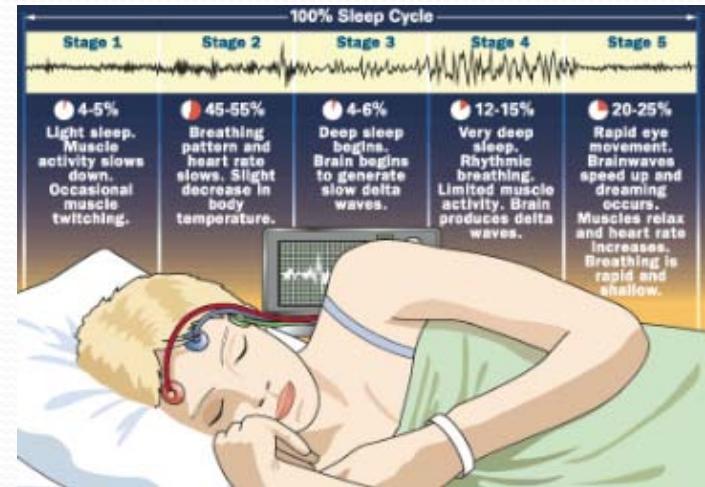
“Sleep is
important for
learning (*why?*).”



TRUE! Your brain works while you are asleep. Both Sleep as well as Dreaming impact learning

- Sleep: Sleep deprivation also has a negative impact on attention spans.
- Dreaming: Memory consolidation depends on REM sleep (dreaming)

Why only “probably so”? Do you need the same amount of sleep as your neighbor? Not yet well-established because there are only a few studies available on school-age populations. Carskadon

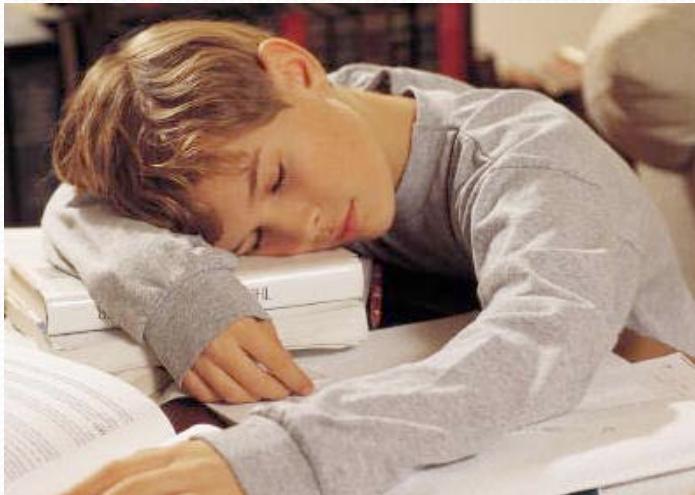


Question:

- To really learn something, information needs to get to long-term memory. To get to long-term memory, what do you need?
 - a. Rest and eat
 - b. Review and sleep
 - c. Sleep and eat
 - d. Do exercise and sleep
 - e. Do exercise and eat.

ALL! However, by both reviewing then sleeping well students can improve their learning

- While some memories can be created without sleep, long-term declarative memory depends on sleep.



How does this information impact teaching?

- Are students and parents aware of this information?
Do schools (teachers) work close enough with the home (parents) to encourage good sleep habits?

True or false?

“Stress impacts learning.”

TRUE: Both positively and negatively

- Stress impacts learning: ‘good’ stress (*eustress*) heightens attention and helps learning, while ‘bad’ stress detracts from learning potential.
- When students feel negative stress, parts of their brain actually block the uptake of new information and new learning. However, a certain level of stress is needed to help focus and pay attention.
- This is equivalent to the sprinter at the starting line who needs a certain level of stress (adrenaline) to start on time; too much stress, however, and he will either jump the gun or waste his energy.
- *Eustress* involves keeping students “on their toes” without creating panic.



While proven in education, neuroscience and psychology, not yet well-established because documentation in school contexts is missing.

How does this information impact teaching?

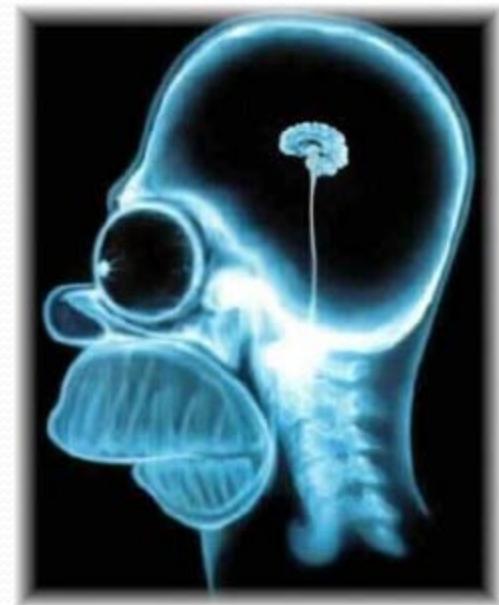
- Are teachers taught how to create the “good” stress” and avoid the “bad” (or do we presume they will “pick it up with experience”?)
- Is the classroom environment conducive to the right kind of stress level for optimal learning?

True or false?

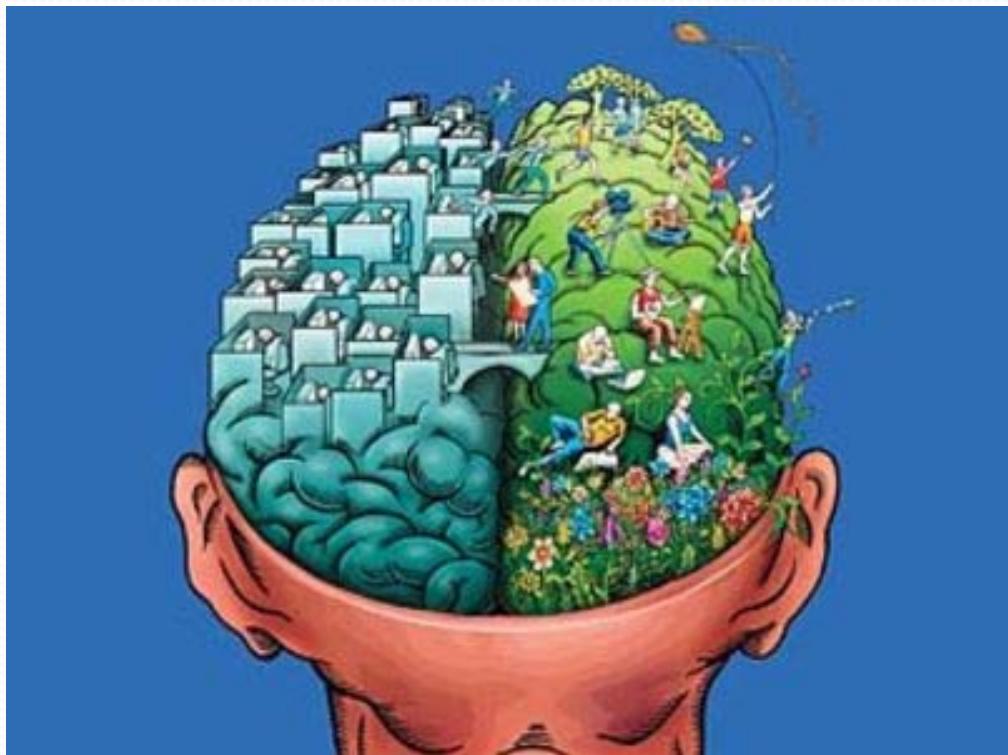
“Humans only use about 10% of their brain potential.”

UNKNOWN, however...

- No exact percentage can be assigned to brain usage; the more we learn about the brain, the less it appears we are using!
- However, it is now known that not all areas of the brain are meant to be linked to one another in the first place; so suggesting that lack of use is a reflection of potential is unreasonable.
- This percentage is based on the estimated number of synapses in the brain and instances of brain imaging during a specific activity.

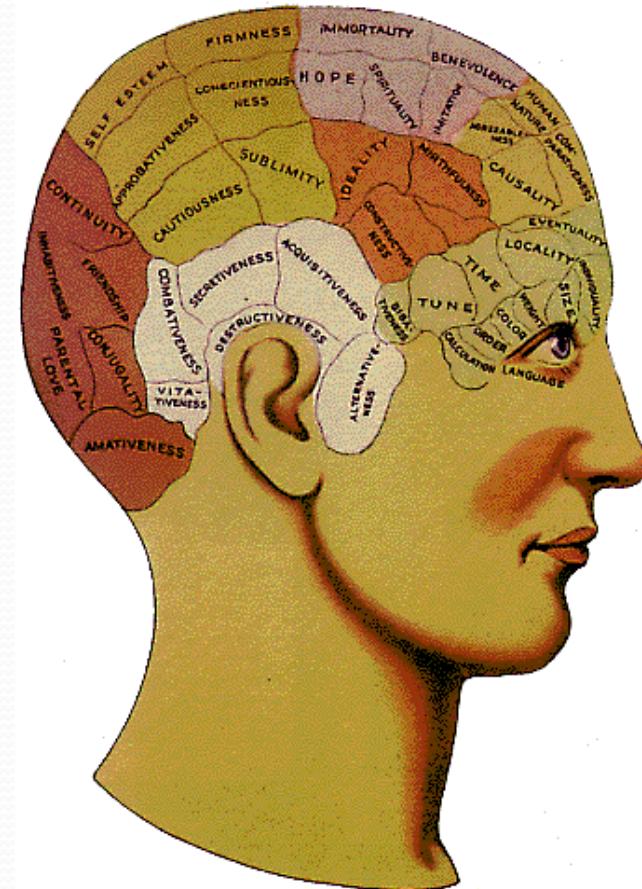


True or false?



- “Some people are more right-brained and others more left-brained.”
- “Brain parts work in isolation.”

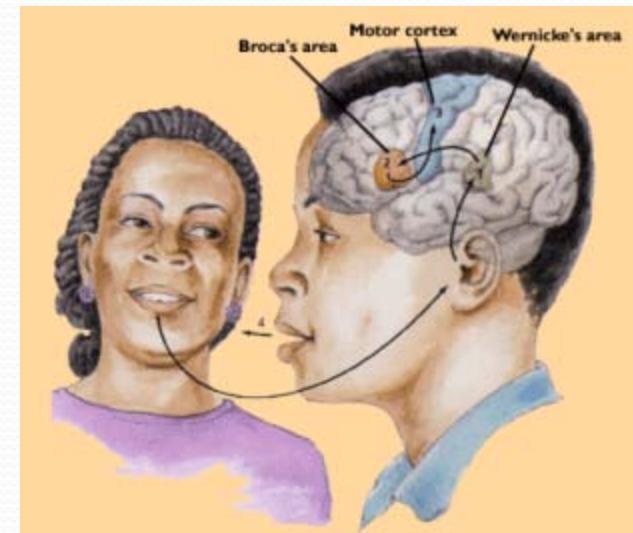
FALSE! Brain areas do NOT act in isolation



- Most brain functions involve complicated systems that involve both right and left hemispheres.
 - (against localizationism)

NEUROMYTH “Language is located in the ‘left brain’ and spatial abilities are in the ‘right brain.’”

- Broca’s and Wernicke’s areas tend to be located in the left hemisphere of the brain.
- However, five percent of right-handed people and thirty percent of left-handed people either have these two language systems in the right hemisphere, or language is divided amongst the hemispheres.
- To complicate matters, some aspects of language, such as comprehension of metaphors, analogies, some aspects of humor and some aspects of intonation are typically found in the right hemisphere.
- The “language system” in the brain is in both hemispheres.

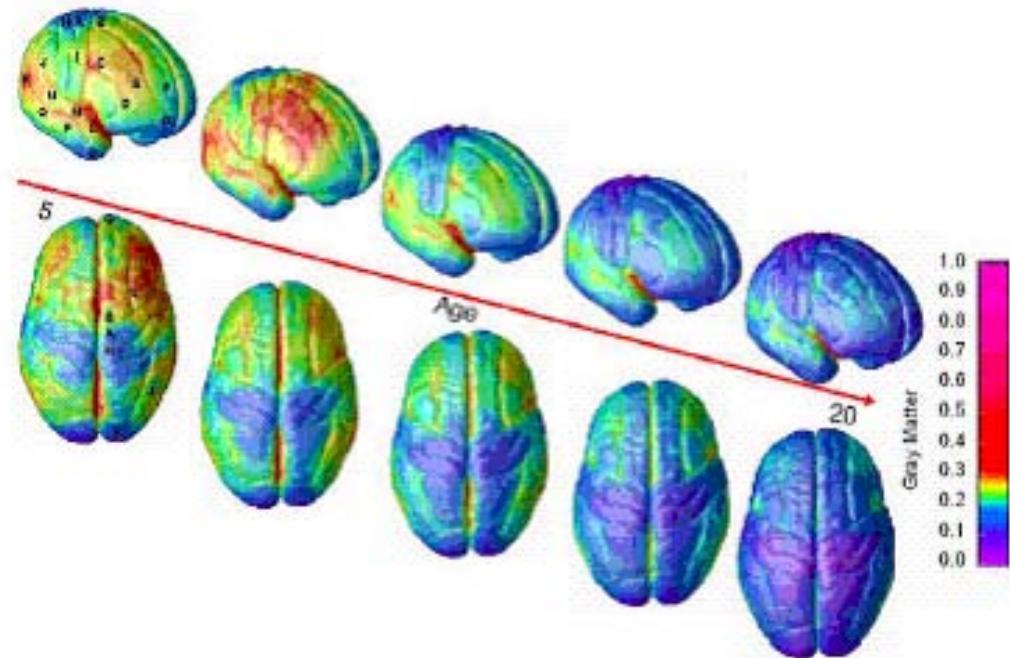




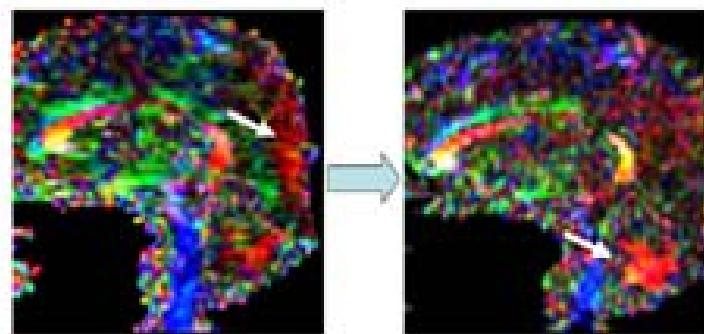
How does this information impact
teaching?

True or false?

“The brain
changes
constantly
with
experience.”



TRUE! The brain changes constantly due to new experiences



- The brain is a complex, dynamic, and integrated system that is constantly changed by experience, though most of this change is only evident at a microscopic level.
- In fact, the brain often changes before behavior does.



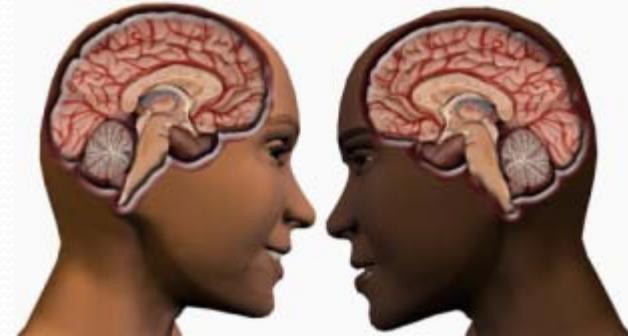
How does this information impact
teaching?

True or false?

“Boys’ and girls’ brains learn differently.”

UNDETERMINED

Brains, no
Hormones, yes



- Neuroscientists have noted that a small area of both the prefrontal cortex, a part of the limbic system (the hypothalamus), and the corpus callosum are larger in women. On the other hand, a small area of the amygdala related to arousal and threat response is larger in men. There is also a difference in overall weight and size, with men's brains being slightly larger than women's.
- NO firm evidence linking these differences in physiology to behavior
- Boys and girls do appear to take in information in different ways, though it is not clear how and why this occurs. School achievement scores show a difference in how boys and girls score on tests, but do not explain how the brain is wired.

Not yet well-established because the correlation between physiology, learning and academic achievement by gender is sparse.

TRUE: Individual differences outweigh gender differences when it comes to learning abilities.

- While there are documented differences in the brain based on gender, there is far greater variation in the human repertoire of skills across learning disabilities than gender.





How does this information impact
teaching?

3-2-1

- 1.** Three things you learned.
- 2.** Two things you will share.
- 3.** One thing you will change.

Challenges to Teachers

- Much of what we hold to be “truths” in our practices is without scientific foundation.

Inspiring (“putting the spirit in....”) education...

- Is the awe that neuroscience brings to education;
- Means nurturing education with other disciplines;
- The possibility that we can better our “diagnosis” and therefore “treat” students better;
- Maximize the potential of every learner.

Inspiring education

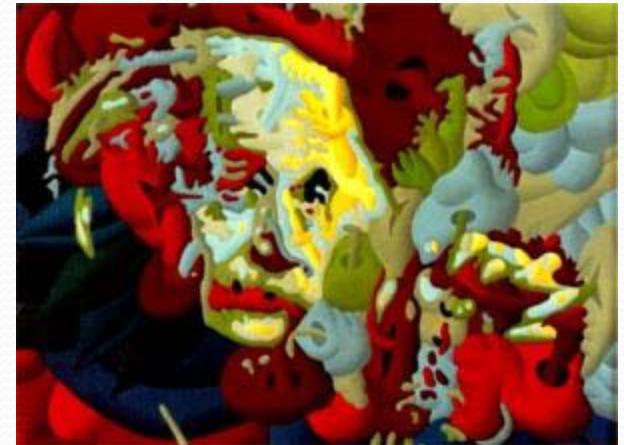
MBE reminds us...

- To be more critical consumers of good information.
- To stay away from neuromyths.
- “The biologizing of cognition...” needs to be balanced with the ‘art’ of teaching.

**Brown & Bjorklund (1998)

Inspiring education

- “*Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted*” (Einstein).
- Share. Question. Doubt. Reflect. Confirm. Investigate.
- “He who dares to teach must never cease to learn.”



*As quoted in Patton (2008, p. 420); *John Cotton Dana (1856–1929). *Respectfully quoted: A dictionary of quotations* (1989)

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