How the Brain Learns: New and Exciting Findings

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Presenter: Dr. David A. Sousa
Emergence of EDUCATIONAL NEUROSCIENCE (or Mind, Brain, and Education)
Human Brain Development

Neural Connections for Different Functions Develop Sequentially

200 billion neurons

Sensory Pathways (Vision, Hearing)

Language

FIRST YEAR

-8 -7 -6 -5 -4 -3 -2 -1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Birth (Months) (Years)

Most Exciting Discovery in Recent Years
Neurogenesis

The growth of new neurons
Olfactory (smell) lobe

Area for learning and for memory formation
Neurogenesis can be affected by:

- Diet
- Restricting calories
- Low Fat
Neurogenesis can be affected by:

**EXERCISE**

Brain-derived Neurotrophic Factor (BDNF)
Neurogenesis can be affected by: SLEEP LOSS
The Nature/Nurture Debate

The role of Innate and Inherited features

The role of the Environment and Nurturing
Brain’s Plasticity

Its ability to continually learn and reorganize itself as a result of input from the environment
Rational area

Frontal Lobe

Prefrontal cortex: Decision making, problem solving, etc.

Limbic area

(Processes emotional information and responses)

Cerebellum
(learned motor skills)
Development of the Brain’s Limbic Area and Frontal Lobes

% Development

Age in Years

Limbic
Frontal
Brief mention of gender differences
Gender variations in acquiring spoken language and other skills

- **Boys**
  More young boys acquire *visual, spatial, and temporal* skills faster and easier than more young girls.

- **Girls**
  More young girls acquire *spoken language* skills faster and easier than more young boys.
Greatest environmental impact on teaching and learning in recent years is: Technology
Research studies show technology increases student:

- Attention
- Retention
- Interest
- Achievement
Technology is rewiring the brain, affecting

- Cognitive
- Emotional
- Social behavior.
What Is Teaching?

Only profession whose job is to change the human brain every day!

Teachers are BRAIN-CHANGERS!
A Quick Look at Memory Development
WORKING MEMORY:

Cognitive Capacity:
- 5-13 years: 5 ± 2 Chunks
- 14+ years: 7 ± 2 Chunks

3-4, range unknown

Incoming information

Working (temporary) memory (minutes to ?)
Is technology affecting students’ attention span?

NOT YET

But *demands* on attention are increasing!
3 experiments compared students who wrote notes on paper to those who took laptop notes.
Students who wrote out their notes:

• Had greater conceptual understanding of material
• Were more successful at integrating new material with what they already knew
• Were more successful at applying their new understandings
• Remembered more of the new learning
What happened here?

- Writing by hand is slower

- Brain has to listen, process, and jot down summary

- These cerebral processes enhance understanding and retention

Hmmm…that makes sense.
Lesson to learn?

• Technology may be faster, but that doesn’t mean students will learn the content better.

One interesting thing I learned in this session so far is: ___ ??? _____
Beware the Curse of Too Much Information
How much information is enough?

Too much information at one time hinders cognitive processing . . .

. . . Emotions take over
Practice “Satisficing”

Coping strategy: Take in just enough information to meet a specific need and ignore the rest.
Prioritize Curriculum So Teachers Can Distinguish Between:

- Enduring Understandings to Remember
- Important to Know and Do
- Worth Being Familiar With
- Be Able to Find
Students today are “digital natives”: They have never lived in a time without all this technology.
Impact of Social(?) Media

The pros and cons

Pro: Students can contact their peers anywhere in the world to share information, stories, research, etc.

Con: Can say anything about anyone, anywhere, any time, without fear of repercussion. What kind of social behavior is this?
Impact of Social(?!) Media
The pros and cons

Pro: Cell phones give students immediate access to information and messages, no need to wait.

Cons:
- Attention turns immediately to buzzing phone and away from other person. This behavior leads to addiction of “being in the know” right now!
- Less attentive in class and to other school activities
- No tolerance for delayed gratification.
Higher Order Thinking Skills

1. Remembering
   - Copy
   - Find
   - Listen

2. Understanding
   - Give examples
   - Explain
   - Discuss

3. Applying
   - Use
   - Change
   - Apply

4. Analysing
   - Argue
   - Classify
   - Compare

5. Evaluating
   - Judge
   - Compare
   - Combine

6. Creating
   - Plan
   - Modify
   - Adapt

Color-coding:
- Red: Analysing
- Orange: Applying
- Yellow: Understanding
- White: Remembering
- Blue: Creating
- Green: Evaluating
- Turquoise: Analysing
- Purple: Understanding
- Pink: Remembering
Levels of Bloom's Revised Taxonomy
Difficulty and Complexity

Difficulty: Amount of effort expended within a level

Complexity: Thought process involved
Incoming information

WORKING MEMORY:

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Working memory (minutes to ?)

Long-term memory (days to ?)

Long-term storage

more likely with:

SENSE:
Do I understand it?

and MEANING:
What’s it got to do with ME?

Higher-order processing
Creativity:
As measured by solving open-ended problems

Intelligence:
As measured by solving closed-end problems

We can teach people to be more creative!
Devise unique tests
Offer unique explanations
Distinguish between cause and effect
Formulate unique questions
No. of student questions raised per class period

How well can you multi-task?
Multi-tasking: Same areas of the brain accomplishing two different goals simultaneously
The brain cannot successfully perform 2 or more cognitive tasks simultaneously!
Alternates tasks  

Sequences tasks

Always some interference

Always some loss
Better to complete one topic/project before moving to another.
Educational Neuroscience

- Brain growth & development
- How learning occurs in the brain
- How teachers can be successful with more students
Thank You

Enjoy the conference!

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