**Introduction**

New ways of charting the brain are increasing our understanding of how humans learn (2)

CT, PET, MRI, fMRI, MEG

**Chapter 1 – Basic Brain Facts and Brain Development**

1. **Frontal Lobe**
   - front of the cerebrum
   - higher order thinking, problem solving, regulates excesses in the emotional system
   - emotional regulation is not fully functioning in adolescent brains

2. **Thalamus**
   - sensory information (except smell) goes first to the thalamus, it is then directed to other areas of the brain

3. **Cerebrum**
   - 80% of the weight of the brain
   - thinking, memory, speech, muscular movement

4. **Corpus Callosum**
   - connects the left and right hemispheres of the cerebrum

5. **Amygdala**
   - related to emotions, especially fear
<table>
<thead>
<tr>
<th>Main Points – New Info and Things I Can Use</th>
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</table>
| -believed to code for emotional messages attached to memories, whenever a memory is recalled the emotions are recalled as well  
6. Hippocampus  
-converts working memory, through electrical signals, to the long term storage  
-this process can take days, or even months  
-essential for the creation of meaning  
7. Cerebellum  
-learning, performance, and timing of complex motor tasks  
-may also store memory of rote movements (typing, etc.)  
-new findings indicate a role in cognitive processing through the coordinating and fine-tuning of thoughts, emotions, senses, and memories  
The two structures most responsible for long-term memory are in the emotional system.  
Learning takes place rapidly in children  
-As puberty is approached, useful connections are made permanent, and unused connections are eliminated (apoptosis)  
The brain seeks out novelty  
-Changes in home environment from a place of predictable monotony to a media rich environment has taken the novelty away from the school environment  
-this creates a risky situation in which adolescents seek out novelty in dangerous ways  
Brain and Mind  
-The brain is the physical organ  
-The mind operates throughout the entire body  
P.C. – Using Novelty in Lessons  
-Humor  
-Movement  
-Multi-Sensory Instruction  
-Quiz Games  
-Music |
## Chapter 2 – How the Brain Processes Information

### Information Processing Model

- **The Senses**
  - sight, hearing, and touch contribute most to our learning
- **Sensory Register**
  - thalamus and reticular activation system
  - screens incoming sensory data for importance
- **Short-Term Memory**
  - Immediate Memory
    - operates subconsciously or consciously and holds data for up to 30 seconds
    - before cognitive learning occurs students must feel physically and emotionally safe
  - Working Memory
    - conscious processing
    - working memory has a limited number of “chunks” it can work with, this varies with age and ability
    - 10-20 minutes of work time, any more can lead to boredom
- **Long-Term Storage**
  - two criteria
    - does this make sense?
    - does this have meaning?
<table>
<thead>
<tr>
<th>Title: How The Brain Learns, Second Edition</th>
<th>Author: David A. Sousa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Points – New Info and Things I Can Use</strong></td>
<td><strong>Connections / Reflections / Insights</strong></td>
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<tr>
<td>-relevant</td>
<td></td>
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<td>-contributes to cognitive belief system</td>
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<td>-the total construct of how we see the world</td>
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<td>-the human brain can combine items</td>
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<td>in many different ways</td>
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<td><strong>Self-Concept</strong></td>
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<td>-the way we view ourselves in the world</td>
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<td>-important determiner of learning</td>
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<tr>
<td>It is important to remember that we are discussing a biological process, not mechanical</td>
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<td><strong>P.C. – Using Humor to Enhance Climate…</strong></td>
<td></td>
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<tr>
<td>-gets attention</td>
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<td>-creates a positive climate</td>
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<td>-increases retention</td>
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<tr>
<td>-improves mental health and discipline</td>
<td></td>
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<tr>
<td>-keep humor positive, not sarcastic or teasing</td>
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<tr>
<td><strong>P.C. – Increasing Processing Time Through Motivation</strong></td>
<td></td>
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<tr>
<td>-generate interest</td>
<td></td>
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<tr>
<td>-establish accountability</td>
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<tr>
<td>-provide feedback</td>
<td></td>
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<td>-encourage an appropriate “level of concern”</td>
<td></td>
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<tr>
<td>-helpful anxiety (desire to do well)</td>
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<tr>
<td><strong>P.C. – Creating Meaning…</strong></td>
<td></td>
</tr>
<tr>
<td>-Modeling</td>
<td></td>
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<tr>
<td>-use examples from student’s experience</td>
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<tr>
<td>-creating artificial meaning</td>
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<tr>
<td>-mnemonic devices, etc.</td>
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<tr>
<td><strong>P.C. – Testing…</strong></td>
<td></td>
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<tr>
<td>-unannounced quizzes should be used to assess long term memory not as classroom management devices</td>
<td></td>
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<tr>
<td><strong>P.C. – Using Synergy to Enhance Learning</strong></td>
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<tr>
<td>-people working together are more effective</td>
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**Chapter 3 – Memory, Retention, and Learning**

Learning-the process of acquiring new knowledge
-the long-term storage areas change anatomically with each new learning
Main Points – New Info and Things I Can Use

- this learning combined with our particular genetic makeup creates the “expression of our individuality”

Memory - the process of retaining knowledge for future use
- Repeated firings of a neural pattern cause the neurons to become connected together so that if one fires they all fire
  + forms a memory trace, engram
  + memories are stored in pieces, at various sites throughout the cerebrum

Types of Memory
  Nondeclarative
    Procedural - how to
      - reflective (conscious thought)
      - becomes reflexive (automatic)
    - perceptual skills
      + reading
      + discriminating colors
      + tones in music
    - cognitive skills
      + procedures for problem solving

Motor Skills
  Emotional
    - flashbulb, instantaneous and long lasting memory of an event
    - gist, summary

Declarative
  Semantic (words, facts, faces)
  Episodic (autobiographical)

Retention – process in long term memory that preserves learning so it can be located, identified, and retrieved
- requires the creation of a conceptual framework, not just conscious attention

Rehearsal – there is almost no long-term retention without rehearsal
  Initial
    - should be teacher led
  Secondary
    - end of lesson, closure
  Rote
  Elaborative
Primacy-Recency Effect
- A 40 minute learning episode will have two "prime-time" segments in which student learning will be at a maximum
- Teach new material during prime time 1 and rehearse, provide closure, during the prime time 2

Block schedule classes have a large down-time in the middle of the class period
<table>
<thead>
<tr>
<th>Main Points – New Info and Things I Can Use</th>
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<tbody>
<tr>
<td>Break longer classes into 20 minute segments to maximize prime-time to down-time ratio, be sure to provide some rest between segments</td>
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<tr>
<td>Retention varies based on teaching method</td>
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</table>

**Approximate Ratio of Prime-Times to Down-Time During Learning Episode**

<table>
<thead>
<tr>
<th>Lesson Length</th>
<th>Prime-time-1</th>
<th>Prime-time-2</th>
<th>Down-time</th>
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<tbody>
<tr>
<td>20 min.</td>
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<td>40 min.</td>
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<tr>
<td>80 min.</td>
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**Average Retention Rate After 24 hours**

- Lecture: 5%
- Reading: 10%
- Audiovisual: 20%
- Demonstration: 30%
- Discussion Group: 50%
- Practice by Doing: 75%
- Teach Others/Immediate Use of Learning: 90%
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<tbody>
<tr>
<td>Perfect practice makes Perfect, use it or lose it&lt;br&gt;-Four practice conditions&lt;br&gt;  -learner must be motivated to want to improve performance&lt;br&gt;  -learner must have necessary knowledge and understanding of how to apply knowledge&lt;br&gt;  -learner must know how to apply knowledge to specific situation&lt;br&gt;  -learner must know how to analyze the results of practice so they can self-correct&lt;br&gt;-Give students adequate guided practice before independent practice&lt;br&gt;-Distribute practice over time</td>
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<td>Importance of Sleep in Learning/Memory&lt;br&gt;-Information is encoded into long-term memory during REM stage of sleep</td>
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<tr>
<td>Multiple Intelligences&lt;br&gt;-Neuroscience supports an integrated view of intelligences&lt;br&gt;-Gardner, however, moved us away from the notion that intelligence is a singular entity, fixed at birth, and displayed in vocabulary and reading skills&lt;br&gt;-Best teaching and learning occurs when we use a variety of techniques</td>
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<tr>
<td>Intelligence – the rate of learning something&lt;br&gt;-time required to acquire information or a skill with enough proficiency to use it for problem solving</td>
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<tr>
<td>Retrieval&lt;br&gt;-Recognition – matching something from the outside to information stored&lt;br&gt;-Recall – the search for information from long-term sites triggered by external cues or hints&lt;br&gt;-Factors&lt;br&gt;  +adequacy of the cues&lt;br&gt;  +mood of the retriever&lt;br&gt;  +context of the retrieval&lt;br&gt;  +system of storage&lt;br&gt;-Rate of Retrieval and Rate of Learning are not related&lt;br&gt;+be aware of artificial time allotments for</td>
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<td>Main Points – New Info and Things I Can Use</td>
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<td>-------------------------------------------</td>
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<tr>
<td>learning</td>
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<tr>
<td>Chunking – the division of information into manageable pieces of information</td>
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<tr>
<td>- allows for more information to be processed at one time</td>
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<tr>
<td>Forgetting</td>
<td></td>
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<tr>
<td>- Lose of pathway to information site</td>
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<tr>
<td> + new pathways can be formed to connect with this information</td>
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<tr>
<td>- Deterioration of information site</td>
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<tr>
<td> + memory will always be incomplete</td>
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<tr>
<td>Confabulation</td>
<td></td>
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<tr>
<td><em>Figure 3.12</em> The white triangle you may see <em>does not exist. It is a result of confabulation.</em></td>
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<tr>
<td>Memory creates a smooth, complete memory</td>
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<tr>
<td> - “the brain is always active and creative, and seems to abhor incompleteness.”</td>
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<tr>
<td> - This is not lying, as the individual is not making a conscious choice to deceive, the brain does this automatically</td>
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<tr>
<td>P.C. Using Chunking to Enhance Retention</td>
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<tr>
<td> - Pattern Chunking – break large groups into easily remembered pieces or stories</td>
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<tr>
<td> - Categorical Chunking</td>
<td></td>
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<tr>
<td> + advantages/disadvantages</td>
<td></td>
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<tr>
<td> + similarities/differences</td>
<td></td>
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<tr>
<td> + structure/function</td>
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<tr>
<td> + taxonomies, hierarchical levels</td>
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<tr>
<td> + arrays, groupings</td>
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### Chapter 4 – The Power of Transfer

Transfer is a two part process
1. past learning has an effect on new learning
2. degree that new learning will be useful in the future

The “so what?” phase of learning
If students do not see how the information or skill can/will be used in the future they will pay little attention and exert less effort

Interference
Past learning can interfere with new learning
a.k.a. negative transfer

Transfer comes from the outside
Teachers are the instruments of transfer for students

Factors Affecting Transfer

**Similarity**
Information is stored by similarity and retrieved by difference – it is the uniqueness (critical attributes) of a piece of information that makes it stand out and be recalled
- emphasize these critical attributes when teaching similar concepts at the same time

**Critical Attributes** – characteristics that make one idea unique from all others

**Association**
- All information in storage becomes a new set of branches to which new memories can attach, “the more we learn and retain, the more we can learn and retain”
- Emotional associations are very strong and can both positively and negatively affect learning

### Chapter 5 – Brain Specialization and Learning

Lateralization – or specialization – ability of certain areas of the brain to perform certain functions

Modular Model – the brain is a collection of units that work together to process information, it is not a single unit in which every part is capable of any function
Hemisphere Specialization - hemisphericity

Left Hemisphere – logical
- More gray matter
- Tightly packed neurons for intense detailed work

Right Hemisphere – intuitive
- More white matter
- Neurons with longer axons to make connections with modules farther away

Specialization Does not Mean Exclusivity
- Through the corpus callosum information is exchanged between the hemispheres
- Functions that occur in areas of specialization also occur in the opposite hemisphere

Hemisphere Preference
- Most people have a preferred hemisphere
  + This affects personality, abilities, and
### Main Points – New Info and Things I Can Use

- learning style
- However, the two hemispheres work together
- Myths
  - Handedness is related to hemisphere preference
  - Hemisphere preference influences intelligence
  - Genetics affect hemispheric preference

#### Gender

**Structural differences**
- Males have a higher percentage of gray matter in the left hemisphere than females
- Males have more neurons in the cerebral cortex, females have more connections between neurons
- Females have an additional language center in the right hemisphere

**Performance differences**
- Females are better at tests of perceptual speed, verbal fluency, etc.
- Males are better at spatial tasks, target directed motor skills, mathematical reasoning, etc.

**Avoid using hemispheric preferences to stereotype people**

**Schools tend to be structured in a way that favors left hemispheric preferences**

#### Language abilities

- The brain is hardwired for spoken language
- Television does not provide the appropriate exposure to language to adequately develop grammar and other language skills
  - TV talk is not slow, expressive, or interactive like parent’s speech tends to be
- Language and cognitive thought are separated in the brain

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**Connections / Reflections / Insights**

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Title: *How The Brain Learns, Second Edition*  
Author: David A. Sousa  

**Main Points – New Info and Things I Can Use**

- The brain has no area of specialization for reading  
  +reading is the most difficult chore we ask the brain to do

![Image of the brain and reading process](image)

**Reading Difficulties**

- **Dyslexia**
  - might really be dysphonia – an incorrect association between phoneme and grapheme

- **Irlen Syndrom**
  - problems in visual processing
  - can be made worse by the high contrast created by fluorescent lights

**P.C. – Teaching to the Whole Brain…**

- Deal with concepts verbally and visually
- Design Effective visual aids
- Discuss concepts logically and Intuitively
- Avoid Conflicting Messages
- Design activities for both hemispheres

**Chapter 6 – The Brain and the Arts**

“... We have never discovered a culture on this planet, past or present, that doesn’t have art. Yet there have been a number of cultures – even today – that don’t have reading and writing.”

**Benefits to teaching the arts**

- they have a role in human development: cognitive, emotional, and psychomotor pathways
- develop ability to perceive relationships
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<tr>
<td>- develop attention to nuance</td>
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<tr>
<td>- encourage students to develop a view of the world that allows for multiple solutions</td>
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<tr>
<td>- goal management, shifting goals in process</td>
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<td>- making decisions in the absence of rules</td>
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<tr>
<td>- imagination</td>
<td></td>
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<td>- acceptance of constraints</td>
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<tr>
<td>- aesthetic perspective</td>
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Music
- Listening to music has therapeutic benefits
- Creating music improves spatial-temporal reasoning

Visual
Imagery – affects survival and increases retention, improves the quality of life
- Imaging – the visualization of something the person has experienced
- Imagining – the visualization of something the person has not yet experienced, creative

Movement
-the cerebellum stimulates multiple areas in the cerebrum – attention, memory, spatial perception, cognitive functions – the same areas as during learning

P.C. – Including the Arts in All Lessons
Visual Arts
Music
Literary Device
Dance and Theater
Community Artists

P.C. – Using Music in the Classroom
When to Play
- Before class (set the mood)
- Up and Moving (upbeat)
- Seat work (slower, complex – facilitate learning)
- End of class (positive note)
Beats per minute
- Affects heart rate
- Avoid lyrics (in general)
**Chapter 7 – Thinking Skills and Learning**

**To teach Thinking**

The brain is designed for thinking
- so it is an arrogant position to take that we need to “teach” thinking skills

**Schools**

- Main focus is on rote memorization
- Very little higher order skills are addressed
- The goal is to teach students how to organize content in such a way that it facilitates and promotes higher-order thinking

**Dimensions of Human Thinking**

Convergent – lower order thinking
Divergent – higher order thinking

**Four major areas of thinking**

- **Basic Processes**
  - Observing
  - Finding patterns and generalizing
  - Forming conclusions Based on patterns
  - Assessing conclusions based on observation
- **Domain-specific Knowledge**
- **Metacognition**
- **Affective Domain**

**Bloom’s Taxonomy**

Lower three levels are Convergent
Upper three levels are divergent

**Five levels of affective domain**

- Receipt
- Response
- Value
- Organization
- Characterization

**Complexity vs. Difficulty**

- **Complexity** – thought process the brain uses to deal with information
- **Difficulty** – amount of effort necessary

- Time is the key factor in allowing students to achieve the higher levels of Bloom’s Taxonomy

- remove less important materials in order to
allow additional time for this process

Chapter 8 – Putting It All Together: Planning for Today and Tomorrow

General Guidelines
- Learning engages the entire person
- The human brain seeks patterns
- Emotions are an important part of learning, retention and recall
- Past experiences always affects new learning
- The brain has a limited working memory capacity
- Lecture results in the lowest degree of retention
- Rehearsal is essential for retention
- The brain is a parallel processor, performs several operations at once
- Practice does not make perfect
- Each brain is unique

Nine component of lesson design
- Anticipatory set
- Learning Objective
- Purpose
- Input
- Modeling
- Check for Understanding
- Guided Practice
- Closure
- Independent Practice

-note: not every lesson is going to require every component