Brain Based Teaching
Making Connections for Long-Term Memory and Recall

Goals

- To explore neuroscience and educational research as it relates to education, teaching, and learning

Objectives

- To invite all learners to participate
- To cause all learners to process sufficiently for memory
- To create multiple pathways for transfer and recall
Brain Based Teaching
Making Connections for Long-Term Memory and Recall

Long-Term Memory ~ Personal Meaning ~ Processing Strategies

Instructional Frameworks that Foster Greater Learner Retention

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**Brain Based Teaching**

*Making Connections for Long-Term Memory and Recall*

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**The Barn**

Long-Term Memory Level

**Desktop Processing**

Working Memory Level

**Sensory Input & Integration**

Sensory Memory Level

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**Input**

Some inputs are processed more thoroughly than others.

**Integration**

Our nervous system filters and regulates the inputs into our working memory.

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**Elaboration**

How interconnected is the information? How strong are the connections?

**Recall**

Where is the information stored?

**Process**

When we draw on what is in the barn in the processing phase, we enhance the likelihood that the new information or skills will make their way into the barn.

Most inputs depart quickly.

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Memory is Divided into a Multiple Level Process

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NATURAL LEARNING SYSTEMS
a la Barbara Given

Premise: The brain has "natural" learning systems: Cognitive, Emotive, Social, Physical, and Reflective

Cognitive Learning System
- Interprets, stores, and retrieves information via patterns and pictures
- Establishes integrated circuits of knowledge and skill
  - Caveat: Can be overrun by the stress response system and other perceived priorities

Emotional Learning System
- Personal meaning ~ relevance ~ accelerate learning
- Empowers and energizes or depresses and stifles all other learning systems
- Manages a learner's motivation, demeanor and creativity
  - Caveat: Operates internal stress response activities and generates powerful vehicles for enhancing memory ~ or likewise powerful inhibitors and blockers

Social Learning System
- Governs interactions and communications with others
- Teamwork and team accomplishment are integral to integrated systems
- Working together in pairs or small groups to problem solve integrates systems
  - Caveat: Acquiring skills to work effectively with all other types of people is crucial to reducing inefficiencies and increasing long-term productivity

Physical Learning System
- Gathers information through all senses
- Distributes information throughout the brain and they body
- Converts input into action ~ physical encoding and engagement promotes connection and ownership
  - Caveat: Takes longer to establish, however is sustained ~ like riding a bike

Reflective Learning System
- Weighs past, present, and future projections
- Interprets verbal and nonverbal cues ~ monitoring mechanisms
- Meta-cognates: "Under this circumstance, in this environment, what do I need to do to increase my understanding?" ~ performance
  - Caveat: Cognitive, Emotive, and Physical Systems always operate within a context. An environment that exists either physically or perceptually in the mind.

Barbara Given: "Teaching to the Brain's Natural Learning Systems" ASCD 2002
### Categories of Instructional Strategies That Affect Student Achievement

**Figure 1.3, p.7**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>AVERAGE EFFECT SIZE (ES)</th>
<th>PERCENTILE GAIN</th>
<th>NUMBER OF STUDIES</th>
<th>STANDARD DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Similarities and Differences</td>
<td>1.61</td>
<td>45%</td>
<td>31</td>
<td>0.31</td>
</tr>
<tr>
<td>Summarizing and Note Taking</td>
<td>1.00</td>
<td>34%</td>
<td>21</td>
<td>0.50</td>
</tr>
<tr>
<td>Reinforcing Effort and Providing Recognition</td>
<td>0.80</td>
<td>29%</td>
<td>21</td>
<td>0.35</td>
</tr>
<tr>
<td>Homework and Practice</td>
<td>0.77</td>
<td>28%</td>
<td>134</td>
<td>0.36</td>
</tr>
<tr>
<td>Nonlinguistic Representation</td>
<td>0.75</td>
<td>27%</td>
<td>246</td>
<td>0.40</td>
</tr>
<tr>
<td>Cooperative Learning</td>
<td>0.73</td>
<td>27%</td>
<td>122</td>
<td>0.40</td>
</tr>
<tr>
<td>Setting Objectives and Providing Feedback</td>
<td>0.61</td>
<td>23%</td>
<td>63</td>
<td>0.79</td>
</tr>
<tr>
<td>Generating and Testing Hypotheses</td>
<td>0.61</td>
<td>23%</td>
<td>63</td>
<td>0.79</td>
</tr>
<tr>
<td>Questions, Cues, and Advance Organizers</td>
<td>0.59</td>
<td>22%</td>
<td>1,251</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Marzano, Pickering, & Pollock, "Classroom Instruction that Works," ASCD Yearbook 2001
WAIT ~ PAUSE ~ REFLECTION TIMES

Defined: Short, intermittent pauses in the instructional flow designed to provide time for learners to recall, think, process, discuss, and organize current knowledge and ideas with prior understandings and information.


Research  The average teacher pause after a query is 0.7 to 1.4 seconds, before comment, redirect, prompt, continuation, or redirect.

Strategy 1st WAIT TIME (after a teacher question)
- Method ~ Allow 3-5 seconds of uninterrupted silence after a prompt to allow students to consider/recall responses.
- Caution ~ Too much time after imprecise questions can increase confusion. More often this is a period for “recall” requiring less processing.

Strategy 2nd WAIT TIME (after a student response)
- Method ~ Provide uninterrupted silence after a prompt to allow students to consider/recall responses. Allows other students to consider whether to add to the response or offer a response of their own. This provides an opportunity for the brain to process, search, connect, organize.

Strategy REFLECTIVE "PAUSE" TIME (before, after, or within commentary)
- Method ~ Deliberately pause for 3-5 seconds after a student question, before responding or in the middle of a statement... allowing students to consolidate thinking - requesting no input from them. This provides time to consider information in a smaller “chunk” rather than in mass.
- Method ~ Extend the pause time to 1-2 minutes, asking students to think an idea carefully through or to write ideas down. Reflection is vital to long term memory and understanding.

Strategy WORK-WAIT TIME (brief think/do task)
- Method ~ Individuals or pairs to remain on task to complete a 30 second to 2 minute activity (silently or quietly in pairs). For Example: pairs interactions ask learners to apply skill, concept, or knowledge immediately after explanation or discussion.
LEARNER GENERATED QUESTIONS

Topic Prompt:

<table>
<thead>
<tr>
<th>Things I (we) already know</th>
<th>Things I (we) would like to know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effects of Self Generated vs. Instructor Generated Examples on Retention

Gorrell, Jeffrey; & Hunter, Downing
Effects of Self-Generated Examples on Retention of Selected Concepts
Presented at the Meeting of the Mid-South Educational Research Association
RESEARCH RESULTS FOR NONLINGUISTIC REPRESENTATION

<table>
<thead>
<tr>
<th>Author of the Study</th>
<th>Average Effect Size</th>
<th>Percentile Gain in Student Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayer, 1989</td>
<td>1.02 1.31</td>
<td>34% 40%</td>
</tr>
<tr>
<td>Powell, 1980</td>
<td>1.01</td>
<td>34%</td>
</tr>
<tr>
<td>Hattie, 1996</td>
<td>0.91</td>
<td>32%</td>
</tr>
<tr>
<td>Walberg, 1999</td>
<td>1.04 0.56</td>
<td>34% 21%</td>
</tr>
<tr>
<td>Fletcher, 1990</td>
<td>0.50</td>
<td>20%</td>
</tr>
<tr>
<td>Guzzetti, Snyder, &amp; Glass, 1993</td>
<td>0.51</td>
<td>20%</td>
</tr>
</tbody>
</table>

Research: +27% impact on student performance outcomes

- Variety of ways to accomplish the production of imagery in minds (NLRs)
  - Graphic representations created on paper or other medium.
  - Physical Models: commonly thought of as manipulatives or ways to engage learners in concrete representations of the idea, info, skill, pattern or process.
  - Mental Pictures: Symbolic of the construct being learned, ways to help learners “feel” or consider circumstances regarding the topic/situation.
  - Drawing and Pictographs: Mind mapping, a la Buzan, or Clustering a la Rico - symbolic images/drawings that represent relationship, meaning, or importance relative to other factors or information.
  - Kinesthetics: Using physical movement or positioning to demonstrate or replicate an idea, context or flow of activity.

- Nonlinguistic Representations should elaborate knowledge, devising mental models to approximate concrete forms.
### LESSON DESIGN ~ TIME

#### METHODS OR APPROACHES
- Mini-Lesson
- Lecture
- Q & A
- Practice
- LAB
- Discussion
- Readings
- Group Work
- Projects
- Activities
- Debate

#### TRANSITION ~ SHIFT

#### TRANSITIONS OR SHIFTS
- Ask a Neighbor
- Write a Response Before we Discuss this Further
- Q & A
- Debate
- 1-2 Students as Individuals or in Pairs
- 3-5 Students in a Group Discussion
- Whole Class
- Role Play
- Stand and ...
- Relaxation Response Break
- Illustrate
- Put Information into a Graphic Organizer
- Develop an Analogy or Metaphor
- Review and Code Notes
- Review Last 15 Minutes Major Points
- Stop and Think of a Question
- Move!
- Assume a Position (easy) and Explain a Point
- Play Soft Music in Background During...
- Demonstration

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UNIT DESIGN

<table>
<thead>
<tr>
<th>Concept or Context</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson Design with Intermittent Shifts or Transitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key</td>
<td>Social Learning System ~ Pairs Talk</td>
<td>Reflective Learning System</td>
<td>Emotional Learning System</td>
<td>Physical Learning System</td>
<td>Bi-Modal Packets ~ Visual / Verbal Links</td>
<td>Note Taking</td>
<td>Similar / Different ~ Compare / Contrast</td>
</tr>
</tbody>
</table>

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Effects of Illustration & Analogy on Written Prose Recall

Effects of the Use of Analogies in Learning
Gick, Mary & Holyoak, Kieth

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SUMMARIZATION ~ NOTE TAKING

Defined: The process of selecting what to keep, delete, or alter. Delete trivia and redundancy. Alter common terms into a category. Keep main idea.

Research  
+34% impact on student performance outcomes

- Explicit practice with instructor demonstration can prove to be very effective.
- When students capture essential notes from an essay, it is helpful that they understand its information structure. For example: how an introduction or summary is constructed and why, the use of tense, or phrasing strategies.
- Templates with “rule-based” strategies frames can be key in enabling students to capture the important information.
- Note-worthy information can be derived from many forms: narrative, specific illustration, definition, argument, problem/solution, or conversation.
- Using reciprocal teaching techniques such as summarizing, questioning, clarifying, or predicting can also serve as productive note taking tools.
- Verbatim note taking is NOT effective.
- Remind your students that notes are a work in progress to be reviewed, reorganized, and referenced, and that they too provide feedback and reflection.
- Quantity of notes is more effective than efficiency of notes.

Notes Strategies

- Informal Outline: focus on major ideas and related details.
- Clustering, webbing, or mind mapping: encircling main ideas in a nonlinear manner, drawing lines to related information, the use of color to organize like information, or illustrations to tell stories.
- Templates: prepared nonlinguistic forms to support the collection and organization of information and related detail.
## Assignment

Provide basic categories that prompt students to “look” for information can help them identify main ideas and details that serve to organize information for later use in projects, writing, and other appropriate purposes. The number of major topics will vary by unit and could include one or more that students select.

<table>
<thead>
<tr>
<th>Title of the Story, Event, or Item</th>
<th>History</th>
<th>Geography</th>
<th>Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
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<td></td>
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<tr>
<td>1.</td>
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<td></td>
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<tr>
<td>2.</td>
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<td></td>
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</tr>
</tbody>
</table>
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## Unit Planner: Multipurpose

**Assignment and Variations**
This organizer intends to prompt thinking about aspects of an upcoming unit that will be important for a student to keep in mind - elements that will support organization, memory, and ultimate learning. Components may be altered to suit any specific unit of study and its commensurate objectives aimed at what a learner must know and be able to do as a result of the unit.

<table>
<thead>
<tr>
<th>Unit Name or Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary Concept or Essential Question</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main Ideas and Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key FACTS, Knowledge, or Process Components</th>
<th>Critical Vocabulary</th>
<th>Teacher Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.</td>
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<td></td>
<td>4.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional Vocabulary</th>
<th>Student Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
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<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>

| Analogy / Metaphor | |
|-------------------| |
| 1.                | |
| 2.                | |
| 3.                | |
| 4.                | |
| 5.                | |
# LESSON REVIEW PATTERNS FOR LONG-TERM MEMORY

*al la Schenck*

<table>
<thead>
<tr>
<th>TYPICAL Test Review</th>
<th>Teach</th>
<th>Day of or Before Review</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRAMMING for a Test</th>
<th>Units are Taught</th>
<th>“Night Before&quot; Student Cram Review</th>
<th>Mid-Term Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Broad Range of Material Covered Prior to Assessment ~ Several Chapters, etc.

<table>
<thead>
<tr>
<th>LONG-TERM MEMORY Friendly Review</th>
<th>Unit is Taught</th>
<th>Intermittent Reviews with Increasing Time Separation</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time for Proteins to Build and Strengthen Long-Term Memory

Source: Dr. Jeb Schenck: "Learning, Teaching, and the Brain" [Knowa@Wyodino.org](mailto:Knowa@Wyodino.org)
Thermopolis, WY 82443 307.864.3982
Brain Based Teaching
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MEMORY AND METHOD
al la Schenck

Source: Dr. Jeb Schenck: "Learning, Teaching, and the Brain" Knowa@Wyodino.org
Thermopolis, WY 82443 307.864.3982
DIET... AND THE BRAIN

Amino Acid & Tryptophan

Travel Together

Tyrosine

Serotonin
Calming
Contentment
Increased Sleep

Norepinephrine
& Dopamine
Alertness
Increased Activity

BI-MODAL PACKETS & Effective Processing of Information

Effective Processing Depends on Certain Critical Activities

1. STRENGTH Memory records are assumed to have "Strength" which increases with repeated practice. Nuthall ('95) ~ four exposures in no more than two days apart

2. DEPTH OF PROCESSING Identify characteristics of topic or subtopics or provide and explore detail

3. ELABORATION variety of associations made with information or making varied connections

VERBAL Text ~ Sequential ~ Linear

VISUAL Simultaneous ~ Sequential ~ All Parts

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TRIANGLE OF SUCCESS OR MEDIOCRITY

ENVIRONMENT
Class Management

WHO ARE YOU?

METHODOLOGY
via Content, Concept, or Skill

RELATIONSHIPS
Teacher ~ Student
Student ~ Student
School ~ Home
Teacher ~ Teacher
Teacher ~ Class
LINKING BRAIN AND BEHAVIOR
in Sleep Dependent Learning and Memory Consolidation

Stickgold, Fosse, and Walker Study
PNAS, December 24, 2002, v.99 n.26  16519-16521

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NUMBER OF DAYS LATER (0 = Same Day)

= Sleep Deprived (night after training)  
Group Tested Day #3

= Groups tested 0,1,2,3,4, and 7 days after training

IMPROVEMENT in Scores

0  5  10  15  20  25  30

0  1  2  3  4  7
RESOURCES

- Greenleaf Article: “A Neuroscience Overview”
- Greenleaf Article: “Proposed Study with the Military on Brain Based Learning Methods.
- Barbara Given: “Teaching to the Brain’s Natural Learning Systems” ASCD 2002
- Marian Cleeves Diamond, “The Brain . . . Use It or Lose It,” Mindshift Connection (v.1, no.1), Zephyr Press
- John T. Bruer, McDonnell Foundation. “In Search of Brain-based Education; A Bridge Too Far.” Phi Delta Kappan, v80, no9, 1999. ISSN: 00317217
- Ken Pugh: pugh@tom.haskins.yale.edu
- Shaywitz, Sally & Bennett, Yale University, ASCD: Educational Leadership, April 2003, p.6
- Phonological Principals and Implications for Reading http://idea.uoregon.edu/~ncite/documents/techrep/tech21.html
- G.Reid Lyon. NIH. Child Development and Behavior, National Institute of Child Health and Human Development
- Arturo Hernandez (Bilingual) at: hernande@psych.ucsb.edu
- Kathi Kohnert-Rice (Bilingual) at: kkoehnert@crl.ucsd.edu
- John P. Rickards study
Mary Budd Rowe (1978), University of Florida studies
Robert J. Stahl (1990) on think time
Tobin & Capie (1987) on wait time
William Wilen (1987) Question Techniques
Research Report: Adolescent Sleep Needs and Patterns
Article by Carskadan http://cgi-user.brown.edu/research/sleeplab
Minneapolis Public Schools
Allan Hobson: Harvard Medical School, Learning and Brain Conference April 2003

Websites:
www.newhorizons.org
http://www.sleepforscience.org/bradley/
http://www.nature.com/login/login.taf
http://trochim.human.cornell.edu/gallery/young/emotion.htm
http://www.jneurosci.org/all.shtml
http://www.sfn.org/
http://cognet.mit.edu/user-new-3.tcl
http://WWW.NATURE.COM/
http://garyphillips.com/
http://www.psych.ucsb.edu/fac/hernande.htm
http://www.newhorizons.org/blab.html
http://www.dana.org/dana/dpress.html
http://www-hbp.scripps.edu/
http://www.gg.caltech.edu/hbp/
http://search.epnet.com/comm_generic.asp
http://www.pbs.org/wnet/brain/about.html
http://trochim.human.cornell.edu/gallery/young/emotion.htm
http://www.mhs.com/
http://www.neuroscienceforkids.com/
http://www.medialfamily.org/facts/facts_effect.shtml