Southern Legislative Conference
Education Committee

Application of Neuroscience on Education Policy

Dr. Mariale M. Hardiman
Vice Dean of Academic Affairs; Professor of Education
Co-Founder & Director, Neuro-Education Initiative
Johns Hopkins University
Neuro-Education Initiative

**bridging brain science and education**

*School of Education*
*School of Medicine*
*School of Public Health*
*Mind/Brain Institute*
*Brain Science Institute*
*Kennedy Krieger Institute*

*Dept of Psychology and Brain Science*
*Dept of Cognitive Sciences*

**Mind, Brain, & Teaching**

**Graduate Certificate**

[education.jhu.edu](http://education.jhu.edu)
Linking Research with Educational Practices & Policies

The Brain Sciences

Brain-Targeted Teaching Model

Education Practices and Policies
What Should Teachers Know from the Brain Sciences?
**Plasticity**: Experience changes the brain’s structure and chemistry.

**Neurogenesis**: The brain grows new cells at any age.

**Emotions and Learning**: Emotions can enhance or shut down learning.

**Sensitive Periods**: Windows of opportunity exist for critical brain changes.
Learning and Memory: Memory for content can be strengthened.

Physical Health and Learning: Exercise, hydration and sleep have enormous influence on learning.

Arts and Cognition: The visual and performing arts can enhance attention and memory.

Attention and Learning: Attention can be enhanced through the physical environment and specific training.
“[I]f you remember anything of this book, it will be because your brain is slightly different after you have finished reading it.” (p. 276)
WHAT SHOULD TEACHERS KNOW IS NOT TRUE ABOUT LEARNING AND THE BRAIN?
There are critical periods when certain things MUST be taught and learned.

You only use 10% of your brain.

I’m left-brained - you’re right-brained.

Because of hormones during puberty, teenagers can’t learn.

Listening to Mozart will make your baby smarter.

Multi-tasking is a good way to get work done.

Teachers should teach to each child’s individual learning style.
Research on Neuroeducation

What are the effects of knowledge of the learning sciences on teachers’ attitudes and practices?
Research

How does knowledge of brain science influence teaching practices?

Cohort 1:

- **Participants:**
  - Teachers in Baltimore City School (1st cohort)

- **Intervention:**
  - PD that provides participants with 1) brain science knowledge about the learning process, & 2) a pedagogical model (Brain-Targeted Teaching) that aids in applying this knowledge in the classroom

- **Measure:**
  - Pre/post surveys of knowledge, attitudes & practices relating to the use of brain science research in teaching; pre/post classroom observations; interviews

- **Findings:**
  - Training leads to changes in teacher practice as well as significant differences in teacher perceptions of using relevant findings from cognitive science and neuroscience in teaching and knowledge about research that supports the model.
Research on the Brain-Targeted Teaching Model

What are the effects of knowledge and use of the BTT Model on teachers’ general and personal efficacy?
GENERAL TEACHER EFFICACY: I BELIEVE ALL CHILDREN CAN LEARN FROM GOOD TEACHING

PERSONAL TEACHER EFFICACY: I BELIEVE I HAVE THE SKILLS TO TEACH

• 3 more groups of teachers trained on knowledge of brain science and BTT
• 30 hours of face-to-face training
• 15 hours of collaborative work on BTT learning units
• Groups 2-4 – measured teacher efficacy
  – Group 2 – Compared to control sample of 600 teachers from Virginia and matched sample
  – Groups 3 and 4 – Pre- and Post-surveys
Personal Teaching Efficacy: When I really try, I can get through to most difficult students.

- 92% of BTT trained teachers agree or strongly agree with this statement.
- 76% of the matched control and 68% of the full control groups agree or strongly agree.
- That leaves 25 – 32% of the control teachers uncertain or in disagreement with this statement. 1 out of 4 teachers or 1 out of 3 teachers feels uncertain.
**Personal Teaching Efficacy:** If a student did not remember information I gave in a previous lesson I would know how to increase his/her retention.

- **92%** of BTT trained teachers agree or strongly agree with this statement.
- **48%** of the matched control and **48%** of the full control groups agree or strongly agree.
- That leaves more than **50%** of the control teachers uncertain or in disagreement with this statement.
**General Teaching Efficacy:** A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement.

- 70% of BTT trained teachers disagree or strongly disagree with this statement.
- 55% of the matched control and 39% of the full control groups disagree or strongly disagree.
- That leaves 45 - 61% of the control teachers **uncertain** or **in agreement** with this statement.
**General Teaching Efficacy:** The influences of a student’s home experiences can be overcome by good teaching.

- **85%** of BTT trained teachers agree or strongly agree with this statement.
- **41%** of the matched control and **37%** of the full control groups agree or strongly agree.
- That leaves **59 – 63%** of the control teachers **uncertain** or in disagreement with this statement.
• **Personal Teaching Efficacy increased** from 10 – 15% across all groups.
• **General Teaching Efficacy increased** in both Spring groups more than 10%. The summer group had very high general teaching efficacy from the beginning of the course.
Research on the Brain-Targeted Teaching Model
What are the possible effects of use of the BTT model on student achievement?
Research on Brain-Targeted Teaching™

Doctoral research study conducted at Johnson & Wales University

Dr. Peter Bertucci (2006) conducted a mixed-method qualitative case study as well as a quantitative ex post facto study of the Brain-Targeted Teaching™ Model.
Dr. Bertucci Study on BTT
MSA ADVANCED Reading for FARMS Population

© 2011 M. M. Hardiman
BRAIN-TARGETED TEACHING® Model

- Evaluating Learning
- Emotional Climate
- Physical Environment
- Teaching for Application
- Teaching for Mastery
- Learning Design

© 2011 M. M. Hardiman
Toxic stress impedes learning (Schwabe & Wolf, 2010) and affects brain structures such as the hippocampus and executive function (McEwen & Sapolsky, 1995; Shonkoff, Boyce, & McEwen, 2009).

Positive emotions have been shown to increase subjects’ scope of attention, global thinking, and thought-action responses. (Fredrickson & Branigan, 2005)
The Effects of Poverty on Neurological Development

Longitudinal study of children enrolled in Head Start programs: children from lower SES backgrounds displayed significant deficits compared to more affluent peers in executive functioning:

- working memory
- IQ
- self-regulation
- language
- attention spans

(Neville, 2011)
Novelty in the environment triggers the alerting and orienting systems (Posner & Rothbart, 2007). The same stimulus presented for a long period of time produces a reduction of interest or even boredom (Ariga & Lleras, 2011).
Studies show the effects of:

- **optimal lighting** on learning (Edwards & Torcellini, 2002)
- **noise** in the environment may impair recall (Hygge, 2003)
- **scents** in an environment produce improvement in attention-related task (Barker et al., 2003)
- **exercise** strongly influences cognition (John Ratey, 2008); sleep affects memory (Geidd, 2009)
- **order and beauty** - Montessori and Reggio Emilia philosophies posit that learning is optimized when children are in environments that are free from clutter and are aesthetically pleasing (Lillard, 2005; Cadwell, 2003)
How Common Is This?
Knowledge is not a list of facts and formulas but is organized around core concepts or **big ideas** that shape thinking (Bransford, 2000);

Understanding **connections among elements** assists with abstract thinking and understanding relationships among disparate chunks of information (Byrnes, 2008). Graphic organizers can help students see overarching themes.
Study of Hatchet by Gary Paulson

Surviving Alone in the Wilderness

- Learning to use the natural environment
- Nature Walks
- Natural objects

- Listening to one’s inner voice
- Journal entries

- Becoming a different kind of observer
- Observation and field drawings

GUIDEBOOK/BOX

© 2011 M. M. Hardiman
Like twin stars, learning and memory are intricately connected.
Hey Charlie Brown, guess what... I taught Woodstock to whistle...
That’s funny... Woodstock can’t whistle.
No, stupid, I said I TAUGHT Woodstock to whistle...

I DIDN'T SAY HE LEARNED IT!
What improves recall?
Rehearsal/repetition and Elaborations

- The most important factor in determining how well we remember information is the degree to which we **rehearse and repeat** that information (Squire, 2002).

- Memory depends on the number and richness of **elaborations** on information (Bradshaw & Anderson, 1982).
The arts provide ample opportunities for students to **rehearse** and **elaborate** on information through the visual and performing art activities within classroom instruction (Rinne, Gregory, Yarmolinskaya & Hardiman, 2011).
This sounds great. But is there any real evidence that arts integration improves retention?

- We did a randomized control trial with 100 students in a Baltimore City Public School.
- We developed 5th grade units in ecology and astronomy:
  - One version was conventional, the other incorporated artistic activity, and the two were matched for content and timing.
- Measures included pre-, post-, and delayed post-tests.
- Results showed improvements in retention for lessons that incorporated artistic activity.
<table>
<thead>
<tr>
<th>5 E Activity</th>
<th>Control- Astronomy Day 3</th>
<th>Treatment- Astronomy Day 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening (2 Minutes):</td>
<td>Both groups review the guiding question and the vocabulary words.</td>
<td>Both groups review the guiding question and the vocabulary words.</td>
</tr>
<tr>
<td>Engage (10 Minutes):</td>
<td>Students use <strong>sentence strips to explain</strong> Big Bang.</td>
<td>Students become “<strong>actors</strong>” and role play the Big Bang.</td>
</tr>
<tr>
<td>Explore (5 Minutes):</td>
<td>Students analyze word chart of animals to discuss classification.</td>
<td>Students analyze picture chart of animals to discuss classification.</td>
</tr>
<tr>
<td>Explain (10 Minutes):</td>
<td>Students use tuning fork diagram to review galaxy shapes. <strong>Students trace the diagram with their pencil.</strong></td>
<td>Students use tuning fork diagram to review galaxy shapes. Students <strong>make dance movements with their arms</strong> to match description of galaxies.</td>
</tr>
<tr>
<td>Elaborate (20 Minutes):</td>
<td>Teacher poses questions and describes 4 types of galaxies to model classification; Students <strong>use verbal response</strong> to describe or name galaxy. From different photos of galaxies, students use tuning fork to classify in journal. Then they select one from a group of galaxies and <strong>describe it in journal.</strong></td>
<td>Teacher poses questions and describes 4 types of galaxies to model classification; Students use verbal response to describe or name galaxy. Students use <strong>dance movement to describe galaxies.</strong> Then they select one from a group of galaxies and <strong>draw it in journal.</strong></td>
</tr>
<tr>
<td>Evaluate (5 Minutes):</td>
<td>Students <strong>describe</strong> all four galaxies using vocabulary in chart in journal.</td>
<td>Students <strong>sketch</strong> all four galaxies in labeled boxes in journal.</td>
</tr>
</tbody>
</table>
ALL STUDENTS:
PERCENT OF INFORMATION RETAINED FROM POST TEST TO DELAYED TEST

- Control Retention
- AI Retention
STUDENTS SCORING BASIC IN READING:
PERCENT OF INFORMATION RETAINED FROM POST TEST TO DELAYED TEST
Brain Target Five -
Teaching for Application: Creative Problem-Solving

Extension of Knowledge in Creative Problem-Solving Tasks
21st Century Skills: Innovation, Creativity, Collaborative Learning, Problem-Solving
"Just a darn minute! Yesterday you said X equals two!"
Engagement in creative activities can lead to measurable changes in brain volume, structure, and function as well as increased performance on cognitive tests (Andreasen, 2005).
Traditional vs. Creative Teaching

Midchapter Review

Estimate. Then measure.

1. about 2 inches
2. about 1 inches
3. about 5 inches
4. about 3 cm
5. about 2 inches
6. about 6 cm

Measure each path.

7. 10 cm
8. 8 cm

Measure. Add to find the perimeter.

9. A map shows a square garden. There is a big tree in each corner. There are 2 small trees between each big tree. How many trees are in the garden?


How do you estimate the length of an object? Do a good guess.

Use your own paper.
Feedback; Active Retrieval; Spacing; Performance Assessment
Learning is enhanced through assessments that:

1. provide students with frequent and useful feedback (e.g., Pashler, Cepeda, Wixted, & Rohrer, 2005);
2. allow students to actively retrieve information (Karpicke & Roediger, 2008);
3. are spaced over specified time periods (e.g., Kornell, Castel, Eich, & Bjork, 2010); and
4. allow for artistic thinking and problem-solving (Hardiman, in press).
Area and Perimeter on a Farm Rubric

Give yourself one 😊 for each item you included in your drawing.

______ I drew pens for at least 4 animals.
______ I found the perimeter of each pen.
______ I found the area of each pen.
______ I remembered to record the perimeter and area for each pen on my map.
______ I added details to my map.

I gave myself ________ 😊’s

Your teacher will check your work and give you one 😊 for each item you included.

______ You drew pens for at least 4 animals.
______ You found the perimeter of each pen.
______ You found the area of each pen.
______ You remembered to record the perimeter and area for each pen on your map.
______ You added details to your map.

Your teacher gave you ________ 😊’s.

© 2011 M. M. Hardiman
NCLB: What Happened to These Subjects in Schools?
Test Protesters in NYC
What Are Parents Saying?
Kqed.org/mindshift/2013

“...as state standardized tests become a prominent part of the curriculum, their children are losing interest in school.”

“This discovery is leading many of them to opt out of the tests altogether.”
What Are Teachers Saying?

“The stress level around testing time is amazing. Our 5th grade had a melt down. If only those who make decisions, could experience this, they might make other decisions.”

(Educators from Florida. **Brain-Targeted Teaching for 21st Century Schools**, Eduplanet21).
How did we get here?
Measurement of student learning?
Accountability for teachers?
Accountability for principals & district leaders?
Pricing homes in a community?
Brain-Targeted Teaching Model

**BT-1** Positive emotional climate and emotional connection to content promotes learning

**BT-2** Physical environment engages attention

**BT-3** Big picture concepts provide schema and enhances conceptual development

**BT-4** Mastery of skills, content, & concepts through repeated rehearsals and elaboration; arts integration as a strategy

**BT-5** Application through creative problem-solving in real world contexts

**BT-6** Evaluation as a way to reinforce learning
thank you so much
The Brain-Targeted Teaching® Model
for 21st Century Schools

www.braintargetedteaching.org

Reading Companion and Study Guide