What Should You Know About the Developing Brain?

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The Kindergarten Teacher’s Creed
by Betty Peck

I bring the gift of myself to this celebration of life we call the Kindergarten.
I come each day to be refined, smoothed, and tempered, for I hold in my hands with wonder and gratitude the future!
The seeds of the future are in the oneness of all nature, all people in tune with the divine to be found in our hearts that I give through the joy and beauty of love.
Our students come in a variety of colors, but all brains are basically gray. It is only the gray matter that truly matters in learning and neuroscience.

Boosting achievement and maximizing student potential hinges on educators developing a respectable knowledge reservoir for teaching with only the brain in mind.
The Developing Brain

• The astonishing young brain and how we can nurture its full development

• What works for all young learners? Why do some types of learning endure, while others fade more quickly?

• What are the preferred teaching strategies by which we can incorporate brain research into the early learning experience? (making connections)

Quick writes and table-talks
The illiterates of the future are not those who cannot read or write, but those who cannot learn, un-learn, and re-learn.

--Alvin Toffler

Change
By Adding Just *One* Degree

212°

instead of

211°
The brain is without doubt our most fascinating organ. Parents, educators, and society as a whole have a tremendous power to shape the wrinkly universe inside each child's head, and, with it, the kind of person he or she will turn out to be. We owe it to our children to help them grow the best brains possible.

-- What is Going in There?
Lise Eliot

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What Teachers Must Know, Must Do, and Must Know How To Do Today
From the College of Education, We Became Familiar with...

<table>
<thead>
<tr>
<th>Learning theorists:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Piaget</strong>: Stages of development</td>
<td><strong>Kolb</strong>: Experiential learning</td>
</tr>
<tr>
<td><strong>Bruner</strong>: Discovery learning</td>
<td><strong>Gardner</strong>: Multiple Intelligences</td>
</tr>
<tr>
<td><strong>Von Glasersfeld</strong>: Constructivism</td>
<td><strong>Levine</strong>: Schools attuned</td>
</tr>
<tr>
<td><strong>Bloom</strong>: Taxonomy of L’</td>
<td><strong>Holt</strong>: Un-schooling</td>
</tr>
<tr>
<td><strong>Vygotsky</strong>: Zones of proximal development</td>
<td><strong>Goleman</strong>: Emotional intelligence</td>
</tr>
<tr>
<td><strong>Fleming</strong>: Learning styles</td>
<td><strong>Montessori</strong>: Montessori education</td>
</tr>
<tr>
<td><strong>Lave &amp; Wenger</strong>: Communities of practice</td>
<td><strong>Hargreaves</strong>: Interpersonal relations</td>
</tr>
<tr>
<td><strong>Ausubel</strong>: Meaningful learning</td>
<td><strong>Pask</strong>: Conservation theory</td>
</tr>
<tr>
<td><strong>Dewey</strong>: Experiential learning</td>
<td><strong>Pavlov</strong>: Classical conditioning</td>
</tr>
<tr>
<td><strong>Freire</strong>: Critical pedagogy</td>
<td><strong>Thorndike</strong>: Memory theory</td>
</tr>
</tbody>
</table>

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Teachers Memorized 40+ Different Types of Memory and Memory systems

- associative memory
- auditory memory
- autobiographical memory
- conceptual memory
- conditional memory
- declarative memory
- echoic memory
- emotional memory
- episodic memory
- explicit memory
- flashbulb memories
- iconic memory
- implicit memory
- informational memory (which isn’t a survival mechanism
- long-term memory
- motor memory
- permanent memory
- primary memory
- procedural memory
- reflective memory
- secondary memory
- semantic memory
- sensory memory
- short-term memory
- source memory
- state-dependent memory
- working memory

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What Teachers Are Required to Know Today - 3

- Hueristics
- Dialectics
- Mnemonics
- Didactics
- Problem solving
- Cognitive structures
- Metacognition
- Epistemic cognition

Thinking Skills
Study Skills
Learning to Learn
 Depths of Knowledge
Student Learning Objectives
Learning paradigms

Intentional Talk
Accountable Talk
Strategic Reasoning
Artificial Intelligence
Logic
Induction
Deduction
IQ

Multi-sensory learning
Active Learning
Hands-on learning
Standards-based learning
Brain-considerate learning
What Teachers Are Required to Know Today - 5

Hemisphericity
Periodicity
Autoplasticity

Procedural Knowledge
Noetics
Time-on-task

Socratics
Inquiry Learning
Mind-mapping
Semantic-mapping
Brain-storming
Schema theory

Differentiated instruction
Data-driven decision-making

Structures of Intelligence
Instrumental Enrichment
The Innovative sciences
Teaching across the Curriculum
Interdisciplinary teaching
Executive function skills

Authentic Assessment
Alternative Assessment
Performance Assessment
Portfolio Assessment

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What Teachers Are Required to Know Today - 6

Interpersonal relations  Behavior modification
Educational objectives Situated learning
Multiple intelligences Learning communities
Conversation theory Educational objectives
Direct instruction Learning communities
Scaffolding Procedural knowledge
Critical Thinking Learning styles
Lateral Thinking Instructivism
Remedial Thinking Behavior modification
Flexibility in Thinking Process vs. Content
Platooning Process vs. Product
Transitional Pre-K Whole class vs. Facilitator

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What Teachers Are Required to Know Today - 7

H.O.T.S.  
B.Y.O.D.  
M.O.O.C.s  
1-to-1 Classrooms  
Flipped Classrooms  
Digital literacy  
e-Books  
Coding  
Interactive Whiteboards  
Smart Boards  
Computer-Assisted L’ng  
Gamification  
On-line Educational Resources (OERs)

21st Century Skills  
College and Career Readiness  
STEM or S.T².R.E.A.M.  
(Common Core State Standards  
for Reading/Language Arts  
Common Core State Standards  
for Mathematics  
English Language Development Standards  
The Next Generation Science Standards  
National Core Arts Standards

Cognitive Overload!

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“This (educational) revolution arises from ongoing and compelling research on how children and adults learn (i.e., a science of learning). The old model of teaching as simply telling, and of learning as passive sit-and-get listening will not meet the needs of tomorrow’s citizens.”

Science for the Next Generation: Preparing for the New Standards
Thomas O’Brien, Professor of Science Education.
Binghamton University
The New Generation Gap

We are living in a uniquely historical time relative to our ability to shape the human brain.

We are neurologically shaping young brains for a future that is vastly unlike our own recent past – constantly inventing new ways to solve problems (which are also re-shaping the brain)

Teaching is “Applied Neuroscience”

Teachers = Neuro-plasticians

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Our best efforts in teaching requires a shift from...

“What am *I* supposed to *teach*?”

to

“How do *my students* learn?”

and

“How do I prepare them for a new and unknown world?
Lecturing, the 2\textsuperscript{nd} oldest form of teaching, comes from the Latin \textit{lecture}, meaning "to read aloud." Books - the earliest form of ed-tech (few and $$), so they were combined with the lecture ("\textit{Audi} – torium" not a "\textit{Thinka}-torium")

Who is more inclined to say the others “talk too much!” – Teachers or students?

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Creative Thinkers Learners

• **Agricultural Age**
  → **Industrial Age**
  → **Information Age**

• **Moving from the Information Age**
  → The **Innovation Age**
The US Is Prospering

• The nation produces 28% of the world’s economic product with less than 5% of the world’s population.

• America’s economy has been creating nearly 2 million net new jobs a year.

• *Business Week* ranks 8 US firms in the top 10 “most innovative” companies in the world.

• America has a gross domestic product close to $13 trillion and has contributed one-third of the growth in global output over the most recent 15-year period.

• Its household net worth is now over $55 trillion.

• U.S. universities employ 70% of the world’s Nobel Laureates.
Because we are “online most of our lives,” the constant use of technology is chipping away at our capacity for concentration, contemplation, and reflection. Instead, our lives are bombarded by eBay, Amazon, MP3s, broadband, dish TV, Napster, Google, iPods, Wi-Fi, YouTube, blogging, smart phones, netbooks, blogging, tweets, and streaming video has become an American *tidal wave*.

Technology: the more we use it, the more it alters the way we *work and think* (modifying existing brain circuitry).
Technology in the 21st Century

Caveat #1
Technology will not replace the need to be literate.

--Rebecca Alber, UCLA

Caveat #2
“I’ve seen students with i-Pads and the novelty is there and the engagement is there, but it’s not clear that novelty and engagement will lead to increased academic achievement.”

--Larry Cuban, Stanford University
Over The Last 20 Years, Research From Cognitive Science Indicates That...

- People learn best through real-world first-hand experiences, not through memorization.
- Children are born investigators.
- Understanding builds over time, not in one sitting.
- The human brain learns everywhere it goes and during every moment of the day (awake or asleep).
Old learning paradigm of the S-R Learning and New Model Based on Neuroscience
Aristotle (384-322 B.C.)

- **Cardiocentric** view of cognition
  
  The heart = central to cognitive responsibilities including **morality** and higher **intelligence**

- **Contemporary phraseology** - successfully memorized information as content **we know “by heart”**

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Expanding the Traditional Model of Thinking and Learning

Does the name “Pavlov” ring a bell?

Stimulus → Response

S → R

Teaching → Learning
## Factors Influencing Stimulus → Response

In addition to desires, tendencies, appetites, instincts, inclinations...

<table>
<thead>
<tr>
<th>Genetics</th>
<th>+Epigenetics and early nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>+Pre-natal care</td>
<td>+Age</td>
</tr>
<tr>
<td>+Early development (0-3)</td>
<td>+Emotions/emotional state</td>
</tr>
<tr>
<td>+Parenting</td>
<td>+Gender</td>
</tr>
<tr>
<td>+Physical history</td>
<td>+Perception/expectations</td>
</tr>
<tr>
<td>+Neuro-physiology</td>
<td>+Memory</td>
</tr>
<tr>
<td>+Prior learning (situated L’)</td>
<td>+Diet</td>
</tr>
<tr>
<td>+Prior experiences</td>
<td>+Self-esteem</td>
</tr>
<tr>
<td>+Need state</td>
<td>+Disability</td>
</tr>
<tr>
<td>+Strengths</td>
<td>+Neural circuitry/plasticity*</td>
</tr>
<tr>
<td>+Formal Education</td>
<td>+Stress factors</td>
</tr>
</tbody>
</table>

### Learning/Behavior

*Neural plasticity*: The flexible nature of the brain to modify structures, alter its functioning and re-route neural circuitry as a response to new stimuli and ongoing learning experiences.
There are five BC elements that the human brain seeks while processing incoming stimuli for personal “meaning,” which makes the information “memorable” and worth remembering.

(1) **Patterns** (derivatives of experience)  
(2) **Emotions**  
(3) **Relevance**  
(4) **Context, Content, and Cognitively-appropriate**  
(5) **Sense-making → Problem-solving**

Patterns, emotions, relevance, context, content and sense-making are critical factors in driving (1) attention, (2) motivation, (3) learning, (4) memory formation, and (5) recall. Collectively, these 5 factors are the primary criteria for transfer into long-term memory storage.
Hemisphericity

Are some people “left-brained,” while others should be considered “right-brained”?

a. Yes

b. No

Corpus Callosum
Do you know your brain?

What percent of our brain do we use?

a. 10%
b. 20%
c. 50%
d. 100%
Why is Hands-on Learning Effective?
Developmental Neurobiology

In the “digital age,” it is critical that educators remember that the 10 digits on your hands were the first human digital devices (and remain the most powerful).

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Cognitive Rehearsals

The hand is where thought, movement, touch, feeling and abstract thinking all *intersect* during active experiences.

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What is the difference between knowing and understanding?

1. Experiencing/doing
2. Distinguishing “what” from “why?”
3. “Learning about” vs. application(s)
“If you hold a cat by the tail, you learn things you can’t learn any other way.”

-- Mark Twain
The 4 E’s of Cognition and (LT) Learning

1. Emotions – ↑dopamine (essential to activating the brain’s reward circuitry – mesolimbic dopamine system)

2. Enthusiasm – feedback → confidence to move forward

3. Experience – builds the brain circuitry that represent who we are, what we know and what we are capable of doing

4. Engagement – hands-on, minds-on, hearts-in learning experiences
Better Than Eating: Reaching the Emotional Apex in Student Engagement

• Whether we *label* the active learning experience as play, exploration, thinking, building, constructing, etc., ↑ levels of student engagement →

“Maximum Harmonious State” in the brain (“flow”)

• That is when students reach *learning at its highest attentional level*, they will frequently rather stay, play and learn **than to eat**. The **drive to learn** can become **greater** than the **drive to eat** or the need for food.

• How often do *your* students get to the **Maximum Harmonious State** of learning?

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Astonishing Potential for Learning and Processing

Neurons and synapses.

The number of *neurons* (the information processing cells) inside your brain is approximately equivalent to all of the trees found in the Amazon rain forest (100,000,000,000). The # of plausible permutations and combinations of brain activity > the # of elementary particles in the universe.

They operate by making connections with one another. The number of *connections (synapses)* inside your brain is comparable to all of the *leaves* on all of the *trees* in the Amazon rain forest (approx. 62 trillion connections among the 100 billion brain cells.)

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## Chemicals and Behavior

<table>
<thead>
<tr>
<th>Type of Medication</th>
<th>Brand Name</th>
<th>Generic Name</th>
<th>Approved Age</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stimulant Medications</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Adderall</td>
<td>amphetamines</td>
<td>3 and older</td>
<td></td>
</tr>
<tr>
<td>Concerta</td>
<td>methylphenidate</td>
<td>6 and older</td>
<td></td>
</tr>
<tr>
<td>Cylert*</td>
<td>pemoline</td>
<td>6 and older</td>
<td></td>
</tr>
<tr>
<td>Dexedrine</td>
<td>dextroamphetamine</td>
<td>3 and older</td>
<td></td>
</tr>
<tr>
<td>Dextrostat</td>
<td>dextroamphetamine</td>
<td>3 and older</td>
<td></td>
</tr>
<tr>
<td>Ritalin</td>
<td>methylphenidate</td>
<td>6 and older</td>
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</tbody>
</table>
Emotions, Attention and the Brain

• Emotions → attention → learning

• Our attention is (personally) “selective” because *our* emotions determine what we attend to.

• It is *neurologically impossible* to learn and remember information to which the brain has *not* paid attention.

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“Sawu bona”

I see you, I am taking you in, and I like it.

“Sikhona”

I am here now (because of you).

A person is a person, because of our relationships with other people.
"Tak for sidst"  *(Tock fah seest)*

Thank you for the last time we were together.

*The current status of any relationship is determined by the summation (the “+ and –” summative qualities of the last 5 encounters of those members composing the relationship.)*
The 4th “R”

• High-quality interactions with students → high-quality relationships with students

(“My students don’t listen.” We can’t attentively listen to people who we consciously do not like.)
The Brain and “Input”

• Brain cells process approximately 40,000 stimuli/sec.

• Fortunately (unfortunately?) the brain cannot consciously attend to more than one dominant entry at a time. It can attend to (pay attention to) countless different types of information at one time -- the “Cocktail Party” effect.

• A vital responsibility of the developing brain is learning how to effectively attend to relevant environmental information and to simultaneously screen out unimportant stimuli.

• How do we distinguish the relevant from the trivial or superfluous?
Attention Span:

Ages 2-3 - Have attention span 3 - 4 minutes

Ages 4-5 - between 5 - 10 minutes

Ages 6-8 - 15 - 20 minutes

Ages 9-12 – 22 - 35 minutes
Headline:

“Pres. Obama Snubbed”

My arm is...

Performance avoidance
Brain-sight: Seeing With the Mind’s Eye
Why aren’t we spending more instructional time on drawing, abstract thinking and visualization?
N.C.L.B.

Non-educators Consumed by Legislation and Bureaucracy

No Considerations for human Learning and Behavior

Neuroscience, Cognition, Learning and the human Brain

testing testing

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Innovation and Creativity

Human beings are the only animal on the planet that looks for problems and for problems to solve. In the late 1800s to the mid-20th century, highly creative minds were needed to solve contemporary challenges. If a problem that was frequently encountered, someone visualized, designed and produced a tool to solve that problem.
Abstract Thinking
Using your Reflexes
(Each takes 0.05 – 0.1 sec.)

(1) Eyes → sight  (2) visual cortex – vision → (3) association cortex - meaning → (4) frontal lobes – plan of action → (5) PfC – prepares response → (6) motor cortex – takes an action
Reflexes: In the Mind
(Each takes 0.05 – 0.1 sec.)

(1) PfC – prepares response
(2) Ears → hearing → (3) motor cortex – takes an action
Reflexes: Visualization
(Each takes 0.05 – 0.1 sec.)

1. Eyes → sight → visual cortex → vision → (3) association cortex → meaning → (4) frontal lobes – plan of action → (5) PfC – prepares response → (6) motor cortex – takes an action
Students who lack ability . . .

to create visual images when reading, often experience comprehension difficulties.

They cannot describe the pictures in their minds as they read.

Learners who were instructed to create mental images of events...learned two to three times as much as learners who read aloud the sentences repeatedly. (Anderson, 1971)
The Evolution of Human Reading

• We were never born to read.

• We were born to learn.
Circles, spheres, squares, blocks, cylinders, cones, etc., are among the 24 basic “geons” (geometric forms) -- the natural environment.

Simplistic “stick” representations (straight or curved-lines) of these concrete objects elicit a mental reminiscence of the “real thing.”
Clown in hat

Ice cream cone

Car
“But, he can’t write.”
The “Drawing-Initial Writing” Connection
The “Drawing-Initial Writing” Connection
(If s/he can draw, s/he can write.)
• Encourage early learners to \textit{draw} as often as you encourage them to \textit{write}, preferably combining the two.

• To \textit{monitor} growth and development, \textit{date} each art piece and all student writing. You will notice growth…
  
  o from \textit{scribbling} $\rightarrow$ clearly written words
  
  o from \textit{stick figures} “me” $\rightarrow$ full-bodied forms

  o Objects (e.g., cars) will transform from \textit{rectangular blocks} to cars with more realistic, stylish and even creative forms.
Drawing does for the brain during the day, what

Dreaming does for the brain at night.
Child development –
the Greatest Show On Earth!
Reflections

“We don’t learn from experience, we learn by reflecting on it.”

John Dewey

24 hours: Compose two “I will” reflections on this morning’s experience together.
Now let’s take today’s ideas - Extra 1°

It’s time to...
turn up the heat.

212°

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Be a visionary and a Dream-maker

Susan Boyle
Each year, new findings in cognitive psychology and neuroscience will be infused into teacher preparation, curriculum, instruction, student assessment, and the classroom environment. The works of Howard Gardner ("Multiple Intelligences"), Daniel Goleman ("Emotional Intelligence"), Kenneth Wesson ("Brain-considerate Learning"), and others have already been influential in reshaping the independent school classroom, while programs like Mel Levine’s Schools Attuned are assisting educators in using neurodevelopmental content in their classrooms to create success at learning and to provide hope and satisfaction for all students.

Forecasting Independent Education to 2025
-- NAIS
What Should You Know About the Developing Brain?

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