Pennsylvania Association for Gifted Education

PAGE BULLETIN

Brain Research and the Gifted and Talented Student

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When we consider Robert Sylwester's brief description (see below) of the human brain it may be surprising to realize that much of what we know about the brain and how it really functions has only been discovered in the last twenty years. In fact, the last decade has witnessed the nearly doubling of our knowledge in spite of the fact that the brain has been a key focus of science and philosophy for more than three millennia. The brain (and especially the concept of the mind) still holds many unrevealed mysteries, but advancements in technology have supplied us with tools to "view the brain at work" where previously only intuitive judgments were possible. Advances in chemistry, microbiology, and genetic research have all contributed to our understanding. Two key technologies, Computerized Axial Tomography (CAT scans) and Magnetic Resonance Imaging (MRI) have now allowed a more complete and accurate mapping of the brain.

Science has begun to identify the role of specific neurotransmitters and proteins; to catalogue the organization of features and structure of the brain, even at the genetic level, and to map more accurately which of these structures relate to speech, hearing, and emotions. However, we have barely begun to delve into what Richard Restak correctly calls the most complex organism known—the human brain.

Working in close collaboration with the pioneers in neuroscience have been cognitive scientists and educational researchers who have thoughtfully extended these discoveries by applying and testing their applications in classrooms. Noted scholars such as David Perkins, Robert Sternberg, and Barry Beyer have devised ways of approaching teaching and learning that create knowledge and cognitive skills for application and transfer. The ideas posited by these and other writers have been tested and reformulated by many leading educators. It is now time to apply these principles to instruction for the gifted.

The following pages contain a number of suggestions specifically for gifted learners and classroom teachers on this body of work. It seems that we truly stand

At the Edge of a Major Transformation

The human brain is the best organized, most functional three pounds of matter in the known universe. It's responsible for Beethoven's Ninth Symphony, computers, the Sistine Chapel, automobiles, the Second World War, Hamlet, apple pie, and a whole lot more. Our brain has always defined the education profession, yet educators haven't really understood it or paid much attention to it.

For a long time, scientists didn't understand the brain either. Our skull hides a bewildering array of electrochemical activity, so our brain's awesome complexity is its own major barrier to understanding itself. Our brain's cellular units are tiny, their numbers are immense, and everything is connected.

At the cellular level, our brain's three-pint, three-pound mass is divided somewhat evenly between tens of billions of nerve cells, or neurons, that regulate cognitive activity, and the much smaller and ten-times-more-numerous glial cells that support, insulate, and nourish the neurons.

Brain cells are very small and highly interconnected. Thirty thousand neurons (or 300,000 glial cells) can fit into a space the size of a pinhead. Neurons connect to other neurons, muscles, or glands via sending and receiving extensions; and although most sending connections are in the millimeter range, the extensions connecting some motor neurons to muscles can reach a meter in length. A neuron may connect to thousands of other cells, so the chemical information in a neuron is only a few neurons away from any other neuron. If you think that's implausible, consider our world's one billion telephones—and the relatively simple coding system of about a dozen digits that can rapidly connect any two of them.

Enter into a single neuron and the complexity increases. For example, a cell's nucleus contains DNA (deoxyribonucleic acid), a relatively large molecule that is the cell's recipe book for manufacturing cellular materials and regulating cellular processes. In human neurons the unraveled ladder-shaped DNA molecule is a meter long—in a cell 1/30,000 the size of a pinhead!

R. Sylwester, 1995

Understanding a Brain-Based Approach to Learning and Teaching

The challenge for teachers and parents is to sort through the latest research and discoveries about how the human brain functions, and then make sense out of these complex and far-reaching findings—and what they mean for teaching and learning for the gifted.

In their article, *Brain Research and Student Learning,* Renate Nummela Caine and Geoffrey Caine offer the following brain principles as a foundation for brain-based learning. These sound, but understandable concepts, help parents and educators recognize useful strategies and practices that will assist students' learning. Some of the underlying principles the authors discuss to make this work in classrooms are:

The brain is a parallel processor

The brain processes many functions simultaneously. It integrates emotions, thoughts, imagination, and predispositions with the development of knowledge. For the classroom this means the teacher needs to orchestrate an array of strategies in order to address many dimensions of brain capability.

Learning engages the entire physiology

Though learning is as natural as breathing, it is possible to either inhibit or facilitate it. Neuron growth, nourishment, and synaptic interactions are stimulated by experience. Stress, threat and boredom can shut down the brain's response to the environment while peace, motivation and challenge encourage learning. The entire "wiring" of the brain is the result of life and school experience. For the classroom that means, that the level of maturation of children may differ as much as five years depending on each child's early experiences. It therefore makes no sense to measure achievement in relation to chronological age.

The search for meaning is innate

Research confirms that people are meaning makers whose brains constantly gauge the familiar and seek the novel. For classrooms that means providing a level of stability and newness in order to satisfy the innately curious young brains of learners. In other words, like the programs for gifted and talented, classrooms need to combine complex, meaningful challenge for all learners.

Meaning occurs through patterning

The brain constantly seeks new patterns and then invents its own. It resists imposed, meaningless patterns unrelated to its own needs. In classrooms where ideas are presented thematically, where curriculum is integrated, student's interest is maintained because their brains will seek out the patterns teachers weave into their day. "Busywork" does little to nourish focused brain activity.

Emotions are critical to patterning

Emotions are central to organizing information, and to facilitating memory. The emotional impact of any lesson or life experience will continue to be fresh long after the event that triggered it. Classrooms that combine a supportive climate of mutual respect, and student-teacher reflection on schoolwork enhance the student's learning.

Every brain simultaneously perceives and creates parts and whole

In healthy people, the left and right brain are inextricably interactive regardless of whether they are dealing with word, music, numbers or art. Good teaching builds skills and understanding over time because it recognizes that knowledge is cumulative. Good lessons have a context in real life.

Brain uses spatial memory and rote learning

Motivated by novelty, spatial memory occurs automatically, because it registers experience in three dimensions. Remembering what we had for dinner is an example of memory from the experience of eating it, as opposed from memorizing what was on the menu. Rote memory stores isolated facts and skills that are unrelated to actual experience. Generally, rote memorization is an inefficient use of the brain. Overemphasis on memorized facts in school work probably interferes with the development of understanding and may inhibit the effective functioning of the brain.

Each brain is unique

Though all human brains have the same systems including our senses and basic emotions, they are integrated differently. In fact, learning changes the structure of the brain; the more one learns, the more unique one becomes. Choices in the classroom attract students to learning based on their unique set of interests.

Student-centered classrooms

Classrooms built on brain-based learning theory have three interactive elements: relaxed alertness, immersion, and active processing. *Relaxed alertness* is found in a classroom that combines a supportive environment with significant challenge. *Immersion* is found in classrooms where the curriculum and the life of the school are merged into real life experiences that allow students to make sense of what they are learning in the context of their lives together. *Active processing* encourages learners to take ownership of their learning in a way that is personally meaningful.

What Should Brain-Compatible Curriculum for Gifted Learners Include?

- ✓ Meaning-based experiences which emphasize depth rather than breadth
- ✓ Higher order thinking in all content areas
- ✓ Intra and interdisciplinary connections which focus on concepts and issues
- ✓ Development of students' metacognitive abilities by reflection on learning processes
- ✓ Cultivation of habits of mind
- ✓ Hands-on, active learning
- ✓ Technology
- ✓ Authentic assessments

—adapted from Joyce VanTassel-Baska

Model Classrooms for Gifted Students Provide

- ✓ Variations in pace, levels and grouping
- ✓ Student choice, participation and involvement
- ✓ A responsive learning environment
- ✓ Complex and challenging cognitive activities
- ✓ Empowering language and behavior
- ✓ Students choice and perceived control
- ✓ Relaxation and tension reduction
- ✓ Movement and physical encoding
- ✓ Attention to intuition and integration

A Brain-Compatible Classroom is Based on the Following Notions

- ✓ Intelligence is a function of experience.
- ✓ We have more than seven intelligences, not just one!
- ✓ The process of learning involves the extraction of meaning from confusion.
- ✓ Once meaning is detected, the learner must be helped to build a program for an action or behavior.
- ✓ Academic learning can only take place in an environment that is free of threat, provides content that is meaningful to the student in an enriched environment, and allows time, choice, and feedback for the learner!

Role of Emotions in Learning

When one is embarrassed, scared, or feeling threatened, there is a decrease in the ability to learn. A non-threatening environment enables the neocortex to operate most efficiently.

What is Brain-Compatible Learning?

Brain-compatible learning involves acknowledging the brain's rules for meaningful learning and organizing teaching with those rules in mind.

Caine and Caine

Brain Research
Implications for Good Teaching

1. **Good teaching** orchestrates the learner's experience so that all aspects of brain operation are addressed (i.e., emotions, imagination, analytical thinking, etc.).

2. **Everything that affects our physiological functioning** affects our capacity to learn. We need to be sensitive to physical needs and the maturation continuum.

3. **The learning environment** needs to provide stability and familiarity; at the same time, provision must be made to satisfy students' curiosity and hunger for novelty, discovery, and challenge.

4. **Learners are patterning**, or perceiving and creating meanings, all the time in one way or another. Ideally, teaching should present information in a way that allows brains to extract patterns, rather than attempt to impose them.

5. **Because it is impossible to isolate the cognitive** from the affective domain, the emotional climate in the school and classroom must be monitored on a consistent basis, using effective communication strategies and allowing for student and teacher reflection and metacognitive processing.

6. **Good teaching** builds understanding and skills over time because learning is cumulative and developmental. Learning occurs best in authentic, meaningful contexts that allow the student to relate new information to previous learning and experiences.

Much of what has been taught about learning and teaching is wrong!

7. **Peripheral information** can be purposely organized to facilitate learning. Teachers need to engage the interests and enthusiasm of students through their own enthusiasm, coaching, and modeling, so that the unconscious signals appropriately to the importance and value of what is being learned.

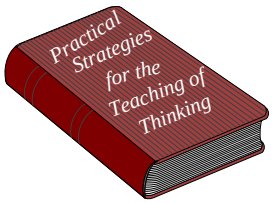
8. **Active processing** allows students to review how and what they learned so that they begin to take charge of learning and the development of personal meanings. Active processing refers to reflection and metacognitive activities.

9. **We understand and remember best** when facts and skills are embedded in natural, spatial memory. Teachers should also reduce the amount of times learners have to learn material by rote, or they should embed this material in conceptual/thematic contexts to reinforce its meaning and relevance.

10. **The brain downshifts** under perceived threats, and learns optimally when appropriately challenged. Teachers and administrators need to create a state of relaxed alertness in students. This combines general relaxation with an atmosphere that is low in threat and high in challenge.

11. **Since each brain is unique**, teaching should be multifaceted to allow all students to express visual, tactile, emotional, and auditory preferences.

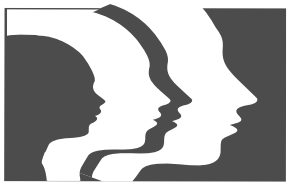
R.N. Caine and G. Caine. (1991)



Guidelines for Introducing a Thinking Skill or Strategy

- Be sure that students understand the lesson objective: learning a thinking skill or strategy.
- Spend four to five minutes introducing the skill or strategy, including stating synonyms, examples, and a working definition, if possible.
- Use media and content or subject matter with which students are already familiar, drawn from their own experiences or previously studied. Do *not* introduce a new skill with new data.
- Keep the application or "doing it" parts of the lesson short —six to eight minutes each, at best.
- Eliminate or at least minimize the interference caused by:
  - other skills or strategies,
  - emotional or value-laden content, and
  - subject matter discussion
- Focus on the major components of the skill or strategy being introduced, especially on *how* the operation is executed and *why*.
- Devote up to one-third of the lesson time to a reflective reporting, discussing and sharing what the students did in their heads to execute the skill.
- In ending the lesson, involve the students in reviewing the key skill procedures, rules, and criteria identified so far and, if possible, provide a mnemonic device to assist them in remembering these.
- Help students identify opportunities for using this skill or strategy in their out-of-school activities as well as in their academic work.

— Barry K. Beyer



How Brain-Compatible is your School?

_____ Is there a rich environment of materials for students to explore?

_____ Do student responses to the environment provide many of the starting points for learning?

_____ With guidance from the teacher, do students plan their own activities, drawing from a range of relevant choices?

_____ Is each student encouraged to explore an interest deeply and also allowed to disengage when an activity no longer seems appropriate?

_____ Are there a variety of activities going on simultaneously with each student working in ways best suited to interests and intelligences?

_____ Are there few obvious barriers between subjects and is much of students' work, in fact, integrated?

_____ Do students talk with each other about their work and often work together?

_____ Are all forms of expressive representation in the arts and in movement, as well as language, considered valid and important?

_____ Are student groupings kept flexible and not based on fixed criteria such as age or ability?

_____ Does the teacher serve in a supportive role, guiding the students instead of a commanding role, giving directives?

—adapted from "A Plan for Continuing Growth" by David Armington

Recommended Books for Further Information

Beyer, Barry, *Practical Strategies for the Teaching of Thinking*, Allyn and Bacon, Inc., 1987.

Caine, Renate and Geoffrey Caine, *Education on the Edge of Possibility*, Association for Supervision and Curriculum Development (ASCD), 1997.

Caine, Renate and Geoffrey Caine, *Making Connections: Teaching and the Human Brain*, Addison and Wesley, 1995.

Goleman, Daniel, *Emotional Intelligence: Why it Can Matter More Than IQ*, Bantam, 1995.

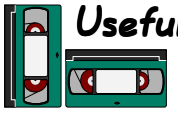
Jensen, Eric, *Teaching with the Brain in Mind*, Association for Supervision and Curriculum Development (ASCD), 1998.

Jensen, Eric, *How the Brain Learns*, National Association of Secondary School Principals (NASSP), 1995.

Sousa, David, *How the Brain Learns*, Corwin Press, Inc., 1998

Sylwester, Robert, *A Biological Brain in a Cultural Classroom*, Corwin Press, Inc., 2000.

Sylwester, Robert, *A Celebration of Neurons: An Educator's Guide to the Human Brain*, Association for Supervision and Curriculum Development (ASCD).



Useful Videos for Professional Staff Development

Bringing Brain Research Into Classroom Practice Series, Video Journal of Education, 1997 (Program I, *Bringing Learning into Long-Term Memory*, Program II, *An Enriched Environment for Learning*, and Program III, *How the Brain Works While Learning).*

Impacting Teaching and Learning with Brain Research: Middle and Elementary Schools Editions, Video Journal of Education, Winter, 2001 (Program I, *The Implications of Brain Research in Education*, Program II, *Brain and Body Cycles That Affect Learning*, Program III, *Educating the Brain of Today's Youth*).

The Brain and Learning Series, Association for Supervision and Curriculum Development (ASCD), 1998 (Program I, *New Knowledge & Understanding*, Program II, *Classroom Applications*, Program III, *Changing Schools to Reflect New Knowledge*, and Program IV, *What Parents Need to Know*).

Website

A Teachers Tales and Links, www.loloville.com/brain_based_learning.htm

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