

Understanding a Brain-Based Approach to Learning and Teaching

Educators who become aware of recent research on how the brain learns will gain exciting ideas about conditions and environments that can optimize learning.

The greatest challenge of brain research for educators does not lie in understanding the anatomical intricacies of brain functioning but in comprehending the vastness, complexity, and potential of the human brain. What we are beginning to discover about the role of emotions, stress, and threat in learning and about memory systems and motivation is challenging basic assumptions about traditional education. Fully understood this information requires a major shift in our definitions of testing and grading and in the organizational structure of classrooms and schools.

Principles of Brain-Based Learning

We offer the following brain principles as a general theoretical foundation for brain-based learning. These principles are simple and neurologically sound. Applied to education, however, they help us to reconceptualize teaching by taking us out of traditional frames of reference and guiding us in defining and selecting appropriate programs and methodologies.

Principle One: The brain is a parallel processor.

It is always doing many things at one time (Ornstein and Sobel 1987). Thoughts, emotions, imagination, and predisposition's operate simultaneously and interact with other modes of information processing and the expansion of general social and cultural knowledge.

Implications for education

Good teaching "orchestrates" the learner's experience so that all these aspects of brain operation are addressed. Teaching must, therefore, be based on theories and methodologies that guide the teacher so as to make orchestration possible. No one method or technique can by itself adequately encompass the variations of the human brain. However, teachers do need a frame of reference that enables them to select from the vast repertoire of methods and approaches that are available.

Principle Two: Learning engages the entire physiology

The brain is a physiological organ functioning according to physiological rules. Learning is as natural as breathing, but it can be inhibited or facilitated. Neuron growth, nourishment, and interactions are integral to the perception and interpretation of experiences (Diamond 1985). Stress and threat affect the brain differently than do peace, challenge, boredom, happiness, and contentment (Ornstein and Sobel 1987). In fact some aspects of the actual "wiring" of the brain are affected by school and life experiences.

Implications for education

Everything that affects our physiological functioning affects our capacity to learn. Stress management, nutrition, exercise, and relaxation, as well as other facets of health management, must be fully incorporated into the learning process. As many drugs, both prescribed and recreational, inhibit learning, their use should be curtailed and their effects understood. Habits and beliefs are also physiologically entrenched and therefore resistant or slow to change once they become part of the personality. In addition, the timing of learning is influenced by the body's and brain's natural development as well as by individual and natural rhythms and cycles. For example, there can be a five-year difference in maturation between any two "average" children. Expecting achievement on the basis of chronological age is therefore inappropriate.

Principle Three: The search for meaning (making sense of our experiences) and the consequential need to act on our environment is automatic.

The search for meaning is survival oriented and basic to the human brain. The brain needs and automatically registers the familiar while simultaneously searching for and responding to novel stimuli (O'Keefe and Nadel 1978). This dual process is taking place every waking moment and, some contend, while sleeping. Other research confirms the notion that people are meaning makers (see chapter 8 of *Making Connections*). The search for meaning cannot be stopped, only channeled and focused.

Implications for education

The learning environment needs to provide stability and familiarity, which is part of the function of routine classroom behaviors and procedures. At the same time, provision must be made to satisfy our curiosity and hunger for novelty, discovery, and challenge. Lessons need to be generally exciting and meaningful and offer students an abundance of choices. The more positively like real life such learning is, the better. Programs for gifted children often take these implications for granted by combining a rich environment with complex and meaningful challenges. In our view most of the creative methods used for teaching gifted students should be applied to all students.

Principle Four: The search for meaning takes place by "patterning."

(Nummela and Rosengren 1986). Patterning refers to the meaningful organization and categorization of information. In a way, the brain is both artist and scientist, attempting to discern and understand patterns as they occur, and giving expression to unique and creative patterns of its own. The brain is designed to perceive and generate patterns, and it resists having meaningless patterns imposed on it. By "meaningless" we mean isolated pieces of information unrelated to what makes sense to a student. When the brain's natural capacity to integrate information is acknowledged and invoked in teaching, then vast amounts of initially unrelated or seemingly random information and activities can be presented and assimilated.

Implications for education

Learners are patterning, or perceiving and creating meanings, all the time in one way or another. We cannot stop them; we can only influence the direction. Daydreaming is a way of patterning, as are problem solving and critical thinking. Although we choose much of what students are to learn, the ideal process is to present the information in a way that allows their brains to extract patterns, rather than attempt to impose the patterns. "Time on task" does not ensure appropriate patterning, because the student may actually be engaged in busy work while the mind is somewhere else. For teaching to be really effective, a learner must be able to create meaningful and personally relevant patterns. This type of teaching is supported by those advocating a whole language approach to reading (Goodman 1986; Altweger, Edelsky, and Flores 1987), thematic teaching (Kovalik 1989), integration of the curriculum (Shalley 1988), and approaches to learning that are relevant to life outside the classroom.

Principle Five: Emotions are critical and at the heart of patterning.

We do not simply learn things. What we learn is influenced and organized by emotions and mind-sets based on expectancy, personal biases and prejudices, degree of self-esteem, and the need for social interaction. Emotions and cognition cannot be separated (Ornstein and Sobel 1987; Lakoff 1987; McGuinness and Pribram 1980; and Halgren and others 1983). Emotions are also crucial to memory because they facilitate the storage and recall of information (Rosenfield 1988). Moreover, many emotions cannot be simply switched on and off. They operate on many levels, somewhat like the weather, and they are ongoing—the emotional impact of any lesson or life experience may continue to reverberate long after the specific event.

Implications for education

Teachers need to understand that students' feelings and attitudes will be involved in and will determine future learning. As 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, by using effective communication strategies and allowing for student and teacher reflection and metacognitive processes. In general, the entire environment needs to be supportive and marked by mutual respect and acceptance both within and beyond the classroom. Some of the most significant experiences in a student's life are fleeting "moments of truth," such as a chance encounter in a corridor with a relatively unknown teacher or possibly "distant" administrator. These brief communications are often instinctive. Their emotional color depends on how "real" and profound the support for each other of teachers, administrators, and students is.

Principle Six: The brain processes parts and wholes simultaneously.

There is evidence of brain laterality, meaning that there are significant differences between left and right hemispheres of the brain (Springer and Deutsch 1985). However, in a healthy person the two hemispheres are inextricably interactive, irrespective of whether a person is dealing with words, mathematics, music, or art (Hand 1984; Hart 1975; Levy 1972). The "two brain" doctrine is most valuable as a metaphor that assists educators to acknowledge two separate but simultaneous tendencies in the brain for organizing information. One is to reduce such information into parts; the other is to perceive and work with information as a whole or a series of wholes.

Implications for education

People have enormous difficulty in learning when either parts or wholes are overlooked. Good teaching necessarily builds understanding and skills over time because learning is cumulative and developmental. However, parts and wholes are conceptually interactive. They derive meaning from and give it to each other. Thus vocabulary and grammar are best understood and mastered when incorporated in genuine, whole language experiences. Similarly, equations and scientific principles need to be dealt with in the context of living science.

Principle Seven: Learning involves both focused attention and peripheral perception.

The brain absorbs information of which it is directly aware and to which it is paying attention. It also directly absorbs information and signals that lie beyond the field of attention. Such signals may be stimuli that one perceives "out of the side of the eyes" such as gray and

unattractive walls in a classroom. Peripheral stimuli also include the very "light" or subtle signals that are within the field of attention but are still not consciously noticed (such as a hint of a smile or slight changes in body posture). The brain responds to the entire sensory context in which teaching or communication occurs (O'Keefe and Nadel 1978).

One of Lozanov's (1978) fundamental principles is that every stimulus is coded, associated, and symbolized. Thus, every sound, from a word to a siren, and every visual signal, from a blank screen to a raised finger, is packed full of complex meanings. For example, a simple knock on the door engages attention and is processed for possible meaning by reference both to much of a learner's prior knowledge and experience and to whatever is happening at the moment. Peripheral information can therefore be purposely "organized" to facilitate learning.

Implications for education

The teacher can and should organize materials that will be outside of the focus of the learner's attention. In addition to noise, temperature, and so on, peripherals include visuals such as charts, illustrations, set designs, and art, including great works of art. Barzakov (1988) recommends that art be changed frequently to reflect changes in learning focus. Educators have also begun to recognize the use of music as a way to enhance and influence more natural acquisition of information.

The subtle signals that emanate from a teacher also have a significant impact. Our inner state shows in skin color, muscular tension and posture, rate of breathing, eye movements, and so on. Teachers need to engage the interest and enthusiasm of students through their own enthusiasm, coaching, and modeling, so that the unconscious signals relating to the importance and value of what is being learned are appropriate. One reason it is important to practice what we preach and, for example, to be genuinely compassionate rather than to fake compassion, is that our actual inner state is always signaled and discerned at some level by others. Lozanov (1978) coined the term "double planeness" to describe this internal and external congruence in a person. In the same way, the design and administration of a school send messages to students that shape what is learned. In effect, every aspect of a student's life, including community, family, and technology, affects student learning.

Principle Eight: Learning always involves conscious and unconscious processes.

We learn much more than we ever consciously understand. As Campbell (1989) has noted, "What we are discovering . . . is that beneath the surface of awareness, an enormous amount of unconscious

processing is going on" (203). Most of the signals that are peripherally perceived enter the brain without the learner's awareness and interact at unconscious levels. Lozanov (1978) writes, "Having reached the brain, this information emerges in the consciousness with some delay, or it influences the motives and decisions" (18). We actually become our experiences and remember what we experience, not just what we are told. For example, a student can learn to sing on key and learn to hate singing at the same time. Teaching therefore needs to be designed in such a way as to help students benefit maximally from unconscious processing. In part, helping students benefit in this way is done by addressing the peripheral context (as described above); in part, it is done through instruction.

Implications for education

A great deal of the effort put into teaching and studying is wasted because students do not adequately process their experiences. What we call "active processing" allows students to review how and what they learn so that they begin to take charge of learning and the development of personal meanings. In part it refers to reflection and metacognitive activities. One example might be students becoming aware of their preferred learning style. Another might be the creative elaboration of procedures and theories by exploring metaphors and analogies to help reorganize material in a way that makes it personally meaningful and valuable.

Principle Nine: We have at least two different ways of organizing memory: a spatial memory system and a set of systems for rote learning.

We have a natural, spatial memory system, which does not need rehearsal and allows for "instant" memory of experiences (Nader and Wilmer 1980; Nadel, Wilmer, and Kurz 1984; Bransford and Johnson 1972). Remembering where we ate and what we had for dinner last night does not require the use of memorization techniques, because we have at least one memory system actually designed for registering our experiences in ordinary three-dimensional space (O'Keefe and Nadel 1978). The system is always engaged and is inexhaustible. It is possessed by people of both sexes and all nationalities and ethnic backgrounds. It is enriched over time as we increase the items, categories, and procedures that we take for granted. (Thus, there was a time when we did not know what a tree or a television was.) This memory system is motivated by novelty. In fact this is one of the systems that drives the search for meaning mentioned in point three above.

Facts and skills that are dealt with in isolation are organized differently by the brain and need much more practice and rehearsal. The counterpart of the spatial memory system is a set of systems specifically designed

for storing relatively unrelated information. Nonsense syllables are an extreme case. The more separated information and skills are from prior knowledge and actual experience, the more dependence there needs to be on rote memory and repetition. We can compare this memory system to the inventory of an automobile shop. The more items are available the more the shop can repair, build, and even design cars. It can also do so with greater ease and speed and less stress. At the same time, if management becomes too enamored of the stocking of inventory, and mechanics and designers fail to see how to use the materials available, then an imbalance has been created. In the same way, emphasizing the storage and recall of unconnected facts is a very inefficient use of the brain.

Implications for education

Educators are adept at the type of teaching that focuses on memorization. Common examples include multiplication tables, spelling words, and unfamiliar vocabulary at the lower levels, and abstract concepts and sets of principles in different subjects for older students and adults. Sometimes memorization is important and useful. In general, however, teaching devoted to memorization does not facilitate the transfer of learning and probably interferes with the subsequent development of understanding. By ignoring the personal world of the learner, educators actually inhibit the effective functioning

Principle Ten: We understand and remember best when facts and skills are embedded in natural, spatial memory.

Our native language is learned through multiple interactive experiences involving vocabulary and grammar. It is shaped both by internal processes and by social interaction (Vygotsky 1978). The learning of language is an example of how specific "items" are given meaning when embedded in ordinary experiences. All education can be enhanced when this type of embedding is adopted. Such embedding is the single most important element the new brain-based theories of learning have in common.

Implications for education

The embedding process is complex because it depends on all the other principles discussed above. Spatial memory is generally best invoked through experiential learning, an approach that is valued more highly in some cultures than in others. Teachers need to use a large number of real-life activities, including classroom demonstrations, projects, field trips, visual imagery of certain experiences and best performances, stories, metaphor, drama, interaction of different subjects, and so on. Students can experience vocabulary, for example, through skits. They can learn grammar in process

through stories or writing. Mathematics, science, and history can be integrated so that much more information is understood and absorbed than is presently the norm. Success depends on making use of all the senses and of orchestrating the immersion of a learner in a multitude of complex and interactive experiences. Lectures and analyses are not excluded, but they should be part of a larger experience.

Principle Eleven: The brain downshifts under perceived threats and earns optimally when appropriately challenged.

The brain will downshift under threat (Hart 1983), which involves a narrowing of the perceptual field (Combs and Snygg 1959). The learner becomes less flexible and reverts to automatic and often more primitive routine behaviors. It is roughly like a camera lens that has a reduced focus. The hippocampus, a part of the limbic system, which appears to function partially as a relay center to the rest of the brain, is the region of the brain most sensitive to stress (Jacobs and Nadel 1985). Under perceived threat, portions of our brain function suboptimally.

Implications for education

Teachers and administrators need to create a state of relaxed alertness in students. This state combines general relaxation with an atmosphere that is low in threat and high in challenge. The teacher must be in this state, and it must continuously pervade the lesson. All the methodologies that are used to orchestrate the learning context influence the state of relaxed alertness.

Principle Twelve: Each brain is unique.

Although we all have the same set of systems, including our senses and basic emotions, they are integrated differently in every brain. In addition, because learning actually changes the structure of the brain, the more we learn the more individual we become.

Implications for education

Teaching should be multifaceted in order to allow all students to express visual, tactile, emotional, or auditory preferences. There are other individual differences that also need to be taken into consideration. Choices should also be variable enough to attract individual interests. We can vary the choices in this way, but doing so may require the reshaping of schools so that they exhibit the complexity found in life. In sum, education needs to facilitate optimal brain functioning.

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