RENATE M. NUMMELA AND TENNES M. ROSENGREN

What's Happening in Students' Brains May Redefine Teaching

Harmonizing new experiences with old in a rich, nonthreatening environment helps students learn more naturally and fully.

Timmy is learning to fly his kite on the beach. Carefully he makes sure that he has the appropriate tension on the string, that the wind is at his back, and that the kite remains steady. Every movement requires him to call on motor and visual skills, some only remotely related to what he is doing.

Although Timmy's progress may appear to be inefficient, he is actually involved in a remarkable feat: focusing and using his brain. His brain is calling up stored "program structures," building on them, and creating new ones. As the natural environment and the present experience provide Timmy with intricate feedback about wind velocity, angles, and spatial relationships, he uses his motor and physical skills to adjust to the new data and to refocus his efforts.

As Timmy is totally absorbed in kite flying, what is he thinking about? Would his "internal messages" give us any clue to the degree of his involvement? How would this internal processing differ from sitting and listening to someone's explanation of the finer points of kite flying? Can his brain's involvement in the learning process be assessed by checking what he is thinking?

We believe such internal thoughts can provide feedback about the degree to which the brain is involved in doing what it does naturally—making sense of and seeing meaning (looking for cause and effect relationships) in what it is experiencing. Beyond providing feedback on specific aspects of kite flying, Timmy's mental processing is much more complex: unspecified, unlimited, and at multiple levels. Although all his thoughts and actions are focused on kite flying, his *peripheral* experiences include feeling the sand under his feet, smelling the ocean, seeing and hearing the waves, and much more.

Can teachers approximate such learning situations? Can teachers teach to develop this total involvement? We believe that the most comprehensive learning includes an absence of threat, careful orchestration of multidimensional teaching strategies, real-life experiences, and an understanding of barriers to learning.

The Brain's Natural Process

Brain research and information-processing theory are providing exciting insights into the learning process, inviting us to observe learning as a natural phenomenon—similar to the heart beating and the lungs taking in air. By stepping back and looking at what happens inside students as they receive information, we can begin to recognize teaching strategies that go beyond superficial learning.

Logic tells us that during the teaching/learning process, students inevitably receive external sensory input followed by internal processing. Examples of external sensory input could be a lecture, a film, a text reading, a field trip or, for that matter, any event taking place in the real world. Each of these exposures to external stimuli ultimately requires some form of internal processing for the brain to make sense of external input. Brain theory tells us that the brain is continually attempting to categorize and pattern new information with what is already stored (Hart 1983, Luria 1975, MacLean 1978, Pribram 1971). In other words, in an attempt to store new information, the brain "calls up" or matches, compares, and patterns incoming information with similar or perceived-to-be similar factors already stored in an individual's memory. This is done at a very high rate of speed (Hart 1975) and apparently in random order on both conscious and unconscious levels. Thus, every externally experienced learning event will result in the calling up of meaningful, related information stored within each student's brain. (If you stop yourself as you read this article to observe your own behavior, you can identify this process yourself. Very likely, you have been calling on familiar information to make sense of what has been said so far.)

"The most comprehensive learning includes an absence of threat, careful orchestration of multidimensional teaching strategies, real-life experiences, and an understanding of barriers to learning."

Whether it is experiencing a random event or a carefully orchestrated classroom experience, the brain functions the same way. We suggest that the more meaningful, relevant, and complex the external sensory input is, the more actively the brain will attempt to integrate and develop what Hart (1983) calls "program structures" or "prosters." He defines these as "a collection of stored programs, related to a particular pattern, such as walking, running, letter recognition and related concepts which can be used as alternatives" (Hart 1983, p. 95). According to this definition, the most effective learning occurs when external sensory input challenges the student's brain to (1) "call up" the greatest number of appropriate programs, (2) expand an already existing program, and (3) develop new programs.

How Stimuli Affect the Brain

The brain is actively engaged in calling up old prosters or creating new ones regardless of the external presentations. In other words, the brain does not remain inactive when not fully engaged in learning specific information. We speculate that when a student is not involved in specific learning, the brain is involved in less focused patterning—random thoughts, feelings, physical sensations, daydreams, and "escape" fantasies, which could lead to inappropriate behavior. This type of internal processing seems to occur when external sensory input is not sufficiently organized, motivating, or meaningful to stimulate a desired proster activity.

Thus we need to redefine "attention" to include the internal world of students. A lesson with too little challenge, too much threat, or a lack of necessary complexity will not involve students in the lesson and will, in fact, cause their attention to be diverted to whatever else is available. The teaching process becomes a matter of orchestrating the entire lesson to influence related and focused internal processing.

Lozanov (1978), the controversial Bulgarian psychiatrist and learning theorist whose work is only now beginning to have some impact in the United States, discusses the powerful influence of peripheral stimuli—such as the temperature in the room, the teacher's appearance, the student's perceived meaning of the significance of the lesson, posters on the walls—or perceived threat. He supports the notion that learning occurs constantly at both the conscious and unconscious levels, and when meaningful, comprehensive learning does not occur, the brain continues to engage in personally meaningful activity not necessarily related to the lesson or what the teacher is teaching. The brain continues to pattern and categorize, influenced by random stimuli in the room. Instead of focusing on the lecture on railroad conglomerates or the multiplication table, for instance, a student may focus on the teacher's blue shirt and be reminded of what to wear to the dance next Friday or mother's favorite dress and what she's making for dinner. Thus, the student continues to match and pattern but in a direction not intended by the teacher.

Teaching Methods for Internal Processing

What kind of teaching and teaching methods lead to a more comprehensive and desired focusing, patterning, and creation of new program structures? We know already that the more senses we involve in the learning process, the more complex the matching and developing of programs. As Hart (1983, p. 77) put it: "Because the ordinary classroom does not provide this richness in learning and, in most instances, limits what the brain can do, students become addicted or habituated to this limited, sequential approach."

> **"Learning occurs constantly at both the conscious and unconscious levels, and when meaningful, comprehensive learning does not occur, the brain continues to engage in personally meaningful activity not necessarily related to the lesson or what the teacher is teaching."**

Limited, sequential school learning, unlike real-life learning, asks very little of students. Much more could be available. As an example, we could contrast history classes whose teachers focus on isolated facts and dates with teachers who give personally meaningful details. By using a story format describing actual events, suffering, and dilemmas experienced by those living during the period students are studying, emotions as well as cognitive intents are generated, and thus both the left and right brain hemispheres are engaged. According to Levy (1983), "If students are emotionally engaged, both sides of the brain will participate in the educational process regardless of subject matter." In addition, stories tend to relax students and may stimulate more efficient functioning of the entire neocortex (Hart 1983), leading to an "open" state more receptive to existing prosters. Lozanov comments on the importance of creating a more relaxed, "child-like" receptive-learning state in the classroom. In *Suggestology and Outlines of Suggestopedy* (1978), he writes:

> In childhood, new things are memorized more easily and, what is more important, without strain and effort. The memorization process itself takes an unconscious course in normal, calm perception. However, if the teaching is misguided, this normally spontaneous process in the individual development can involve great effort and strain. The natural mechanism of memorization is deformed. The maxim that everything can be acquired through work, although fundamentally true, is incorrectly understood and students get the idea that they must make extreme efforts to memorize (p. 197).

This child-like state is exceptionally receptive to incoming information; it supports the notion that a supportive environment and the absence of threat stimulates learning (the formation of new prosters). As Hart (1983) explains, the brain tends to "downshift" under threat. Shifting down means activating the older, more primitive brain that deals with reflexive behaviors and emotions (MacLean 1978). Old brain-programmed behaviors and responses allow little room for reflection, insight, foresight, and other more complex learning associated with the neocortex and development of new prosters.

Teaching for Child-like Learning

Strategies for creating the child-like state and methods encouraging the use of both hemispheres can be taught in teacher education programs. However, creating a true child-like state that is free of threat is far more complex than might be assumed. Lozanov takes into account both conscious and unconscious characteristics that the teacher presents to the student.

"Teacher prestige," for instance, is a measure of the degree of respect and admiration the teacher can command. The word *command*—here it means "without overt demand"—is a natural outgrowth of teachers' ability to express their knowledge of the subject matter and to show its relationship to other subjects and life experiences.

Additionally, Ivan Barzakov, a former master teacher in Lozanov Schools, states that all teachers, actors, physicians—that is, those working with the public—must have what he refers to as the "dual plane" (Optimalearning [TM] Workshop 1983). The dual plane is a term used to describe a very complex set of characteristics, including the teacher's ability to generate trust and affection. This ability stems from the sense of genuineness, of "realness," of deep concern and integrity which the teacher projects. When these elements are detected by the student, they become powerful invitations to learning. Students become far more open to what is being said and done in the classroom, and the teacher functions as a "magnet," encouraging appropriate patterning.

Ivan Barzakov has expanded on Lozanov's theories of teaching. His teaching model, which is beyond the scope of this article, includes several "brain-compatible" features.[1] As an example, teaching is done in a series of "movements" where material to be learned is presented in a constant flow from the inductive to the deductive and back to the inductive.

The teacher begins with what Barzakov calls "pre-exposure" to the subject. The Optimalearning (TM) pre-exposure acts as introduction and primary motivator and has some of the characteristics of Ausubel's "abstract organizer" (Ausubel 1968). The pre-exposure could be a story, an experience, a guided imagery or concert reading (a practiced reading to baroque or other classical music). Using careful transitions, the teacher then moves on to the "exposure." The exposure introduces the subject more clearly, usually through a multidimensional experience, which is then further developed in the third phase, the "expansion." The final "re-creation" creates experiences that allow students to express and use what they have learned, and subtly introduces the next lesson. Teaching moves like a symphony, with its major theme repeated numerous times, always in a slightly different context. Material is repeated in a variety of ways, leading to long-term storage and bypassing rote memorization or "forced" instruction. Additionally, the teacher uses all methods that aid in the experiential acquisition of material, including a broad incorporation of the arts.

"The sense of genuineness, of 'realness,' of deep concern and integrity which the teacher projects . . . becomes a powerful invitation to learning."

This teaching model calls for the teacher to orchestrate complex, "real-world" teaching environments. What may appear to be a spontaneous learning environment is, in fact, the result of precise planning. Such planning focuses almost entirely on how the classroom can create "here and now" experiences for the student, rather than on expected outcomes. The expected outcomes are goals that guide the lesson from pre-exposure to re-creation, but they are not the focus of planning. This is important because it virtually eliminates the threat of meeting specified outcomes, and it allows what Barzakov calls "educative feedback to guide learning." Both student and teacher look upon learning as an expansion of knowledge similar to Hart's acquisition of prosters and not as the accomplishment of goals to be evaluated and rewarded.

Barriers to Desired Internal Processing

To summarize thus far, we suggest that specific teacher characteristics, various teaching methods, and peripheral stimuli (external setting) all help to activate the internal states in the appropriate or desired direction. In each case, the brain's natural function of comparing, patterning, and categorizing is being optimally activated.

There are also, however, particular events and teacher behaviors that block learning by creating internal states that are incompatible with the acquisition of new prosters. Both Lozanov and Barzakov identify such events. According to Lozanov, these "barriers" to learning are alerted automatically, are self-protective, and relate to the external source of information, or to the information itself. These three barriers are the intuitive/affective barrier, the critical/logical barrier, and the ethical barrier.

The *intuitive/affective barrier* is aroused when students experience real or imagined threat in the classroom, such as fear or mistrust of the teacher. When this occurs, students cease to be involved in the learning process and reflexively focus on themselves to defend against the perceived threat. Sarason's (1982) research with high-anxious students describes the type of thinking these students do when threatened. Their thoughts move away from the task and focus on their own failure: "I can't do this"; "I'm dumb." Their less-anxious counterparts, on the other hand, can focus on the exam questions and invoke their problem-solving skills. In terms of brain theory, we may be seeing an example of "downshifting" of the brain in the high-anxious students. The higher brain functions of reasoning and problem solving are abandoned; overpowering emotions characterized by the subcortical limbic system or older brain take over.

The *critical/logical barrier* refers to new information that does not make logical sense or creates cognitive dissonance. Lozanov (1978) suggests that "when suggestion (i.e. learning) with a greater or smaller conscious ingredient falls within the field of the consciousness of critical thinking, it is weighed up carefully in all its aspects before being accepted." In terms of Hart's brain theory (1978), the incoming information is critically evaluated by whatever information is stored within that particular brain. If incoming information is contrary to already established programs, the learner will resist it. This resistance will take the form of internal conflicts leading to rejection of the new information. In any event, the student no longer participates in the lesson until the conflict is resolved.

Learners do not experience this barrier until they move into Piaget's formal operational thinking. At this point, learners analyze information on the basis of hypothesis, "fit," and future application. Events that were previously dealt with on the intuitive/affective level are now processed intellectually through reasoning and logic. If new information does not meet the individual student's existing complex intellectual prosters, such information must be challenged or aborted. Unless students are provided with immediate access to further information through questioning or some other means, they will cease to listen or actively focus on events in the classroom. Instead, they will dwell on the conflict, thinking about ways they are right or wrong and about resolving the discrepancy. The most productive learning involves meaningful feedback within a flexible and safe environment, which includes an understanding of internal as well as external focusing. It is critical that the teacher acknowledge the critical/logical barrier by addressing the issues and being sensitive to pupil behavior.

Ethical barriers are aroused when information is contradictory to the individual's principles, values, or religious or cultural beliefs. Any external sensory input which violates the learner's values or personal beliefs will raise the ethical barrier.

Harmonizing Conflicts for Orchestrated Learning

These barriers interact, and quite often it is impossible to separate them. It is important to remember that barriers are natural, protective, and quite spontaneous, and they may result in a very rapid downshifting of the brain. Teachers may avoid raising unnecessary barriers but can never fully avoid doing so for all students. Factors outside of the school—arguments with parents or a friend, and other "unfinished business"—may also raise barri-

"Teaching moves like a symphony, with its major theme repeated numerous times, always in a slightly different context."

ers. In each case, the teacher's ability to "harmonize" with the barriers (Hughes 1983) becomes the most appropriate way to lower them and return the student to more desired external and internal focusing.

We would include physical factors as an additional distractor for both external and internal focusing. Although neither Lozanov nor Barzakov consider this barrier, we suspect that room temperature, fatigue, ill health, and hunger, as well as other environmental distractors, prevent students' full focusing on learning. Phenomenologists (Combs et al. 1976) have identified many of the perceptual distractors (which, properly mastered and orchestrated, can become "attractors" and motivators) to desired focusing, and brain research is providing additional data.

In conclusion, we believe that internal processing can be orchestrated by providing for the most efficient method of "calling up" old programs and providing for the creation of new ones. Such learning is stimulated by reducing threat and increasing challenge, presenting multidimensional teaching strategies and experiences, and understanding barriers to learning. Internal processing, which is a gauge to measure when the brain is actively focused, is a critical part of the learning process. It is imperative that teacher education include strategies and methods that acknowledge internal processing as a major aspect of learning.☐

1. Readers who wish to learn more about Barzakov's work should contact the Barzak Educational Institute in San Francisco.

References

Ausubel, D. P. *Educational Psychology: A Cognitive View*. New York: Holt, Reinhart and Winston, 1968.

Barzakov, I. Personal Communication. 18 July 1983.

Combs, A. W., A. C. Richards, and F. Richards. *Perceptual Psychology: A Humanistic Approach to the Study of Persons*. New York: Harper & Row, 1976.

Hart, L. A. *Human Brain and Human Learning*. New York: Longman Inc., 1983.

Hart, L. A. *How the Brain Works*. New York: Basic Books, Inc., 1975.

Hughes, M. "Using the Means of Suggestion to Harmonize with Barriers." *The Journal of the Society for Accelerative Learning and Teaching* 7 (Spring 1983): 70–81.

Levy, J. "Research Synthesis on Right and Left Hemispheres: We Think With Both Sides of The Brain." In *Educational Leadership* 40 (January 1983): 66–71.

Lozanov, G. *Suggestology and Outlines of Suggestopedy*. New York: Gordon and Breach, 1978.

Luria, A. R. *The Working Brain*. New York: Basic Books, 1974.

MacLean, P. "A Mind of Three Minds: Educating the Truine Brain." *Education and the Brain, 77th Yearbook of the National Society for the Study of Education*. Chicago: University of Chicago Press, 1978.

Pribram, K. H. *Languages of the Brain*. Monterey, Calif.: Brooks/Cole, 1971.

Sarason, I. G. *Stress, Anxiety, and Cognitive Interference: Reactions to Tests* (Report CO-ONR-005). Department of Psychology, NI-25, University of Washington, Seattle. April 1982.

Renate M. Nummela is associate professor of education, California State University, 5500 State College Parkway, San Bernardino, CA 92407. **Tennes M. Rosengren** is a psychologist, Alvord Unified School District, 10365 Keller Dr., Riverside, CA 92503.