Experience Is the Network to Mind

Brain-Based Learning Applications in Higher Education

By DAVID LOPEZ AND LAURA ALIPOON

Why are children always asking Why? Are they trying to drive adults to distraction? In most cases, children are just asking for more input to make connections in the brain, to make sense of the world around them. This same process occurs in the minds of students when teachers present new ideas and concepts. They are trying to find meaning and make connections between lectures, books, and life.[1]

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When students cannot make these connections, teachers see all-too-familiar reactions: blank stares, long response times, and bored looks. The students are stalling for time as their brains try to process the information. However, it may not be possible to make the connections, for a variety of reasons: (1) The student did not study; (2) The question is different than what was presented in the textbook or lecture or how the student studied; or (3) The material does not seem relevant, so the student has stopped listening.

How can teachers ensure that students make these mental connections? Neuroscience research has discovered that life experiences and previous learning make learning possible and long-lasting. One of the goals of brain-based learning is to help students' brains make a neurologic file or map for storing and finding new material.[2]

Several findings from brain research will be of interest to educators. Studies have focused on the following, all of which have great potential for enhancing classroom instruction:

- Physical and psychosocial environments that maximize brain capacity;
- The effects of emotion on learning;
- Mechanisms used by the brain in deciding where to direct its attention; and
- Ways to increase memory storage and retrieval.[3]

In this article, we will examine neuroscience concepts that relate to current educational theory and offer some applications that help students learn with the brain in mind. Brain-based learning, for the purposes of this article, will be defined as educational pedagogy that incorporates neuroscience concepts in its curricula and practice.

Critiquing Brain Research

Educators must critically analyze brain research before rushing to try to apply it, for several reasons: (1) Much of the research has been done on small mammalian quadrupeds, and the leap to human physiology and function has not been established—rats do not utilize the same learning processes as humans; (2) Most brain research has a medical rather than an educational focus; and (3) The knowledge gained from neuroscience must be integrated with current educational, psychosocial, and empirical evidence from classroom experience before planning teaching strategies. For these reasons, educators must take the lead in conducting research that provides the evidence for appropriate classroom applications of neuroscience concepts.

Making Connections

The good news about brain-based learning is that many educators are already using some of these concepts. Every time a teacher

sees the light go on in a student's eyes or her head nod up and down, a connection and meaning have been created in the brain. The challenge to educators is to find and use more of these types of experiences to improve learning.

Think about a learning experience or idea that had a powerful impact on you. What created the connection that caused you to say, "Now I get it!" That experience probably included a positive environment, relevance, and previous information to which you could connect. Your brain had to make *meaning* out of chaos. For example, the first time you were exposed to calculus or physics, it probably resembled a foreign language. Once the symbols and vocabulary were explained and compared to what you had previously learned, you could more readily substitute them for concepts you already understood. However, you also needed a learning environment that allowed for exploration and experimentation.

Before being graded, students need to explore, and at times fail, to achieve optimal learning. They need to understand, not just memorize. To make sure concepts are stored and can later be retrieved, teachers need to encourage students to analyze and achieve understanding, not just "get through the material." In order for them to analyze rather than mimic, and to truly understand, all of their senses must be involved in learning.

How to Activate Your Students' Neurons

Medical investigators and educators are finding myriad applications for recent neuroscience and brain research. Some of the scientifically grounded research has come from both neuroscience and educational applications. Nerve-cell branching within the brain produces a thicker cerebral cortex and consequently, more neural connections. As a result, one can assume that the more connections available, the easier it is to process, retrieve, and store information, as well as to network and find meaning from information already filed in the brain. It is the neuron's job to communicate, interpret, and orchestrate a response: parasympathetic (fight or flight), sympathetic (feed or breed), survival, or, in the area of education, cognition and learning.[4]

Educators can take advantage of the brain's neural properties by reinforcing concepts, ideas, and even memory work using different approaches (multiple intelligences works well with this concept). This will create a stronger neural bond and enhance students' ability to retrieve the information. As an area of the cortex is repeatedly activated, the neurons create faster lines of communication, which enhances memory, meaning, and learning. The number of neural and dendritic branchings correlates to the amount of activity at those neural sites. With more activation, a neuron's dendrites can branch up to six or more generations. This increased branching has been attributed to many different causes, including novelty, repetition, and powerful learning experiences that activate most, if not all, of the senses.[5]

Neural branching also includes neural pruning. Basically, this means: "Use it or lose it." The human brain is very good at discarding items to keep its superhighway clear and open only to what it perceives as current and relevant. Diamond[6] found that rats in a boring, non-enriched environment experienced shrinkage or pruning of neural branching after only four days. The "boredom factor" in schools has major implications for memory loss, retention, and learning. For rats, reversal of this pruning effect took up to four additional days in an enriched environment.[7]

Humans are multifaceted beings. There is no one "smart gene." Instead, a complex array of interconnecting social, emotional, and environmental neural connections combine to make a total person. Students come to school with a long list of things that have either limited or enhanced their brain function: television, diet, drugs, poor health, lack of exercise, dehydration, dysfunctional family life, emotions, stresses, negative prior educational experiences, learning disabilities, inability to read, to write, do math, and lack of focus on learning. Collectively, these actions, physical influences, sensations, and memories powerfully shape function, physiology, and anatomy.[8] Based on these inputs and many more, cortical maps are created that reinforce or interfere with learning.[9]

Educational Implications

Learning is a complex activity affected by many factors: our senses, attention, emotion, experiences, and reflective thinking. The brain receives input from many sources in the environment (external and internal), in addition to the five senses of touch, taste, smell, sight, and hearing. These influence the brain's ability to learn, remember, analyze, apply, and evaluate new information.[10] Negative learning

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environments have an adverse impact on learning. For example, boredom decreases the size and number of neural connections and branching.[11]

The brain continuously shifts between external events and internal thoughts such as memories or current interests. This external-internal shift of attention seems to strengthen the neural networks that store memories and aids in long-term memory.[12]

When students listen to a lecture, their focus shifts from external to internal as comments and concepts trigger memories and the brain searches for connections and storage places for the new information. Because of this external-internal shift, students often miss parts of the information being presented, making repetition and summarization vitally important. Students also need sufficient time to process and integrate the new information.

Body Rhythms and Emotion

Students' natural body rhythmic patterns affect their ability to learn. In general, it is easier to attend to external events in the morning, especially those that demand sustained attention and precise detail. Therefore, schools should try to schedule classes like statistics or physics early in the day and more interactive classes and labs in the afternoon, when activity will increase student attention. Classroom discussion, storytelling, and role-playing can all serve to increase attention.[13]

Emotional stimulation produces a stronger activation of brain processes. Personal experiences, reflection, interpersonal discussions, and comparisons of different people's life experiences and points of view help promote cognitive, affective, and spiritual growth.

Engaging emotion can increase learning and retention, but if the emotion is too strong, this may block learning.[14] Teachers

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should not overdo the eliciting of emotion, as this can increase the risk that students may feel manipulated and tune out to avoid the draining effect of one "tear jerker" too many.

Humor has long been used in speeches and the classroom to gain attention, elicit emotion, and ease tension. Laughter increases the functioning of the entire brain simultaneously, allowing the brain to increase its capacity. This state allows the person to see both the abstract, subtle nuances of a problem and its more concrete, logical aspects at the same time.[15] One study compared two groups of students who heard the same lecture content. However, one lecture contained humor unrelated to the topic, while the other used relevant humor. The study showed that the students who heard the lecture with relevant humor scored higher in both comprehension and retention than those who attended the lecture using non-relevant humor.[16] Apparently, relevant humor helps the brain find connections and make sense of experiences.

Reflective thinking promotes learning by encouraging students to analyze their thoughts, experiences, and emotions and to create meaning. Reflective thinking leads to creativity and the potential of releasing the human spirit. It moves one away from the primary concern of product to a concern with process. It is a type of thinking that investigates connections between what is known, what is read, and what is felt.[17]

Educational Applications

Drawing on the brain-based research to date, Fishback[18] offers several pedagogical recommendations: (1) Present concepts in a global manner, offering details within the context of the whole; (2) Introduce new ideas in a logical and sequential manner to aid information storage and retrieval; (3) Allow time for students to process new information; and (4) incorporate opportunities for reflection.

Learning is also affected by environmental issues, such as room temperature, noise level, and the need for appropriate breaks for hydration and movement. Fishback[19] recommends pacing the class by allowing 20 to 30 minutes for lecture, broken up by group discussion or other interactive activities. Observing body language, and looking for signs of understanding, confusion, or fatigue can also help the teacher pace the class. Humor and attention-getters can provide novelty and increase retention. Learning will also be enhanced by using many forms of media, appealing to different senses, and repeating and summarizing materials throughout the class period.[20]

The authors of this article have found that

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incorporating ideas, concepts, and practices from other educators and professions (regardless of the level) has increased student learning and comprehension. Because both of us are educators at Loma Linda University's School of Allied Health Professions (SAHP), some of our applications are oriented to the medical field. However, many of the ideas can be applied to other levels and subjects, just as we have modified ideas from elementary and secondary educators and applied them to higher education.

Brain-Based Learning Experiences

"The brain changes physiologically as a result of experience."[21]

The Museum of Tolerance

As part of a general-education course at Loma Linda University's School of Allied Health Professions, students are expected to visit the Los Angeles Museum of Tolerance and reflect, in writing, on their experience. The museum highlights the history of the Holocaust and racial intolerance and provides opportunities for participants to examine prejudice. The visual and emotional impact of the museum combines with the reflective writing of their experience to maximize learning for the students. They learn to perceive the world through the eyes of others and are challenged to examine their beliefs and assumptions. A majority of students report that the visit is a life-changing experience.

The Hill

Lecturing and showing pictures of impending respiratory failure are one way to teach about a medical emergency. However, students may still fail to comprehend the complexities of respiratory distress. The authors have students pair up and take each other's heart and respiratory rates twice—both before and after they take a short hike up a steep hill near the school (stairs could take the place of a hill). The post-climb heart and respiratory rates are recorded amidst the sounds of panting and groaning. The students are now ready for a discussion of respiratory failure.

Picture Removed

Laboratory settings provide hands-on experience and help reinforce learning.

The students "get it" because they experience it firsthand. The learning is more effectively stored in memory because it connects previous experience with the new concept of impending respiratory failure. Multiple neural connections are established in the brain through the use of the five senses and remembered knowledge, creating a powerful learning experience.

Consulting a Skeleton

Educators have long understood the power of hands-on learning. This is why they assign experiments and laboratory experiences. One example of this can be seen in a positioning lab for radiography.

Students often have trouble understanding why a forearm should be X-rayed with the palm of the hand up instead of down. To aid comprehension, we have them manipulate a skeleton into both positions. When the students look at the skeleton with palm downward, they can see that the bones are crossed, so the obvious way to make both bones visible in the X-ray is to make sure the palm is facing upward.

Laboratory settings should, as much as possible, approximate the environment in which the learning will be applied. The health-care student can thereby achieve understanding and demonstrate proficiency prior to encountering patients.

Technology-Mediated Instruction (TMI)

Technology has increased the number of tools available to educators. TMI may include but is not limited to computers, World Wide Web-linked instruction, Internet experiences, software presentation, and other media that uses technology (multimedia presentation devices that connect video, DVD, live video, slides, overheads, etc.). The many resources

available on the Internet make possible threaded learning experiences that enhance the brain's ability to connect with previous knowledge and create new understanding.

Glow Germs

The concept of infection control can be very intimidating for many students. One approach the authors have used to teach this topic is an experiment using fluorescent powder inside latex gloves.

During the lecture on infection control, we teach and demonstrate proper handwashing and how to put on sterile gloves. As it is customary to have powder inside rubber gloves, the students are not aware that something has been added. One principle of infection control is not to touch non-sterile objects after washing one's hands for non-sterile procedures or after donning sterile gloves.

At the lab, the students practice what they have been taught, and then remove the gloves. They are warned not to allow their hands to come into contact with anything that is not sterile. Returning to the classroom, many of them unconsciously touch their faces or clothing, as well as books, chairs, and tables.

After the students take their seats, we carry an ultra-violet light (black light) up and down the aisles, which makes everything they touched glow brightly. This experience is an "eye-opener" because they were so sure they had not touched anything after removing the gloves. Long after the experience, they remember what they learned and comment that it has made them more conscious about sterility and what they touch. This experience may also be used in other areas to illustrate the unintentional spread of ideas, words, theories, spiritual concepts, principles, economy concepts, etc.

Ideas, Ideas, Ideas

Crossword puzzles can be used to teach new vocabulary. Computer software makes it easy to create a puzzle using vocabulary terms and definitions or other information. As students quiz themselves on the terms, this enhances their memory and retention. Making the activity optional and not assigning points may help to take pressure off students who are not puzzle fans.

Other ways to aid memory are to have students create mnemonics or idiotological word associations (associating an idiotic word or picture with a concept), put ideas or information to music, or use mind maps (see Figure 1) to aid in learning and recall. A mind map organizes words, images, numbers, and/or colors to graphically illustrate the relationships of the items. One way to do this is to place the main idea in a circle at the center of the page. Put related ideas in smaller shapes around it, and draw radiating lines to the main idea. Details relating to subordinate ideas can be added in the same manner. More complex diagrams can use varying colors or shapes to define the relationships between the ideas.

If given a little encouragement, students will often find new and innovative ideas and applications. Even if the teacher is not musically inclined, the students can opt to explore brain-compatible learning techniques that use music. Have students work individually or in a group and share their creations with the class. The point is to teach students how to learn and to increase their understanding, so you will want to make the activity optional, give extra credit, or grade only on the basis of materials turned in.

Learning is a complex activity affected by many factors: our senses, attention, emotion, experiences, and reflective thinking.

To help students learn relevant material, set obtainable goals and clear objectives that reflect the requirements of the course. Give frequent and meaningful feedback in addition to the assessment measures planned for the course. For instance, give pop quizzes and grade them in class, but do not record the score. Provide ample feedback on written papers without taking off points for each error. We as educators are often so focused on assessment that we forget the trial-and-error practice stage that students must go through for them to own the information.

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Students as Brain-Based Learners

Educators are not the only ones responsible for creating enriched learning experiences. Students share the responsibility for what and how they learn. For optimum learning to occur, students need to take an active role in their learning, rather than sitting by passively, hoping to absorb what they need to memorize for an exam.

Involve as many senses as possible to enhance memory and learning. Color and geometric designs can be used as memory aids. Students who are

trying to tie historical events together by date or concept can write all the connected events inside a triangle, circle, or rectangle. A red rectangle might be used to enclose concepts dealing with wars, while a triangle might be used to join three concepts, one for each point. Students will recall the ideas by visualizing the color and shape of each concept. Whenever possible, students should memorize things in groups, such as "the four concepts" or "the 10 points." Knowing that they need to recall a certain number of ideas will jog their memory.

Problem-based learning (PBL) is a strategy that places students in charge of their learning, using the educator as a facilitator. Traditionally, medical school combines two years of foundational coursework, followed by two years of didactic and clinical instruction. PBL uses the clinical scenario as a basis for teaching the medical foundation required by the medical-accreditation board. The entire curriculum is based on presenting case scenarios and having the student think of learning questions based on the case. In small groups, the students divide up the questions and assign themselves to find the answers using all available learning resources, i.e., books, the Internet, the laboratory, etc. These questions help the students arrive at a diagnosis. While the diagnosis may not lead directly to a solution, the process will help students acquire a great deal of medical information. The faculty can facilitate this process by asking questions and directing students to appropriate resources.

Conclusion

As discoveries advance in the fields of computer technology, neuroscience, and medicine, educators must apply these principles in the classroom. Many who would be skeptical about implementing new educational practices or ideas would be loathe to have 20- or 30-year-old medical knowledge and practice used on them or to settle for outdated diagnostic technology.

Educators must keep up to date on current literature, including brain-based learning, and combine what they read with their experience. Administrators also need to be aware of current research and classroom applications so that they will encourage teachers to use the new technologies and provide time and resources to facilitate these new modes of education.

As educators for a health-sciences university, we are well aware of the isolation that can occur among educators. At our School of Allied Health Professions, 26 different professions are represented. Faculty collaboration across disciplines is a brain-based experience that can decrease the isolation and improve educational practice as teachers encounter new techniques and ideas. As educators, we need to be willing to both go outside of our pedagogical traditions, and use traditional approaches to find practical applications that make learning "brain friendly."

David Lopez *has served as a member of the heart team at Loma Linda University Medical Center in Loma Linda, California, and has coordinated trips for the LLU School of Allied Health Professions. In these capacities, he has traveled to Kenya, Zimbabwe, Saudi Arabia, Myanmar, Vietnam, and China. He is currently an Assistant Professor and Director of Clinical Education for the B.S. degree for Respiratory Care in the Department of Cardiopulmonary Sciences at the School of Allied Health Professions. He is completing his doctorate in education with an emphasis in Curriculum and Instruction at La Sierra University in nearby Riverside, California.* **Laura Allpoon** *is an Assistant Professor and Program Director for the B.S. degree in the Department of Radiation Technology at the School of Allied Health Professions and teaches in LLU's A.S. and B.S. degree programs. She is completing a doctorate in education at LSU, with an emphasis in Administration and Leadership.*

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