Brain Research and Education: Fad or Foundation?

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If you've been involved in the field of education for any length of time, you've seen many innovations and programs come and go. Teaching machines, Time on Task programs, Epstein's plateaus of adolescent cognition and Madeline Hunter's Elements of Effective Instruction are just a few of the programs that at one time garnered many adherents only to fade into near obscurity several years later. The pendulum swings are so frequent in schools that many educators have adopted a "Sit tight, this too will pass." attitude.

The newest "break through" in education is neuroscience or brain research, a field that until recently has been foreign to educators. While many past programs generated a great deal of interest, rarely has one amassed a following so enthusiastic as this one. In the past few years numerous national educational conference have been devoted entirely to the brain. Some mention of brain research has become de rigeur in grant proposals and staff development plans. Hundreds of books tout everything from brain-compatible mathematics instruction to brain-based classroom environment. (I recently saw a book on an educational vendor's rack titled "Brain-compatible Worksheets...which may be an oxymoron!) An internet search of links that included "brain" and "education" produced over 400,000 sites.

Our fascination with the brain is not difficult to understand. We seem to have always had an innate curiosity about how our brains function, how we learn and how we remember. It's not surprising to discover throughout hundreds of years of history, theories have been generated to explain the elusive qualities of the human brain. Plato likened the brain to a ball of wax that becomes grooved as we learn and recall information over the same pathways. Aristotle thought that the heart was the source of memory and the brain served to cool the blood. In the mid 1660s, Descartes proposed that fluids in the ventricles of the brain controlled motor activity but human mental capabilities existed outside the brain in the mind. And as late as 1850, Franz Joseph Gall "reading" the innate propensities of people by feeling the lumps and bumps on their skulls, was all the rage.

We may smile at the naivete of Plato, Aristotle, Descartes, or Gall, but we have our own modern myths. For instance, the terms "right-brained" and "left-brained" are found commonly in conversation and writing. Robert Ornstein in his book, The Right Mind, calls our misunderstanding of the brain's two hemispheres dichotomania. While each hemisphere does have specialized functions, they work in concert with one another at all times. To explain a person's personality by stating that it is a preference for one hemisphere over the other is inaccurate and misleading. Another common myth is that we use only 10% of our brain. A quick look at a PET or fMRI image dispels this myth very quickly. Never will you see activity in just 10 % of the brain.

Educators are perhaps more captivated by brain research than the general public. The reason is not difficult to understand; the brain is the organ of learning but we haven't understood how it works! Our students' brains have been black boxes with their secrets locked inside. The knowledge base from which we've generated our decisions has been limited by what the behavioral sciences could provide which hasn't always been sufficient. Of necessity we've operated intuitively. Intuition has worked well in many instances but has left us without the ability to articulate our craft to others. Because of this, we've become, as Bob Sylwester puts it, a folklore profession. This lack of scientific knowledge has put us at the mercy of lay boards and politicians who have sometimes made decisions that are unrelated to what we know is best for students.

So the appeal and interest in the neuroscientific research is understandable. But where are we going with our newfound information? Will this become another fad or are we finally on the edge of acquiring a scientifically-based theory of teaching and learning? I think it has the potential to go either way. Which way depends on how we educators interpret and use the research. Unfortunately, some consultants and educators are proposing "brain-based" programs and strategies that have not been tested in classrooms. Running ahead of the research before sound clinical trials and testing of new hypotheses have been completed, makes us vulnerable to the criticism of jumping on yet another bandwagon.

Uncritical acceptance of what we read or hear in the media can be problematic. Media reports on science spare the humdrum details and sometimes exaggerate, misconstrue, and fabricate results. For example, a report in a Minneapolis newspaper reported that Fran Rauscher and Gordon Shaw at the University of California, Irvine found that 17 of 19 school children who received music lessons for 8 months "increased their IQs by an average of 46%." The actual research done by Rauscher and Shaw found that a specific type of music lesson increased spatial temporal reasoning in the students, not IQ scores.

Another article reported that Paul Gold, a researcher at the University of Virginia, had found evidence that glucose, a sugar, improves alertness and memory. The actual research on which this report was based was conducted with elderly people who drank lemonade sweetened either with glucose or with saccharin. It is true that the subjects whose lemonade was sweetened with glucose recalled almost twice as much from a narrative prose passage as their counterparts who drank the saccharin-sweetened drink. However, what was not reported was that this did not prove true for college students and that no research has been conducted with K-12 students. Yet on the basis of this newspaper article, some teachers are giving their students peppermint candy because "research proves that candy improves memory." Is it any wonder that some neuroscientists are beginning to accuse educators of engaging in pseudoscience or worse, becoming "snake-oil salesmen" for products and programs that have no real scientific foundation?

What we must do at this point is carefully and analytically sort through the data and determine which studies actually have classroom applications and which ones do not. While many studies on memory and learning are general in nature, there are some that have been conducted with student learning in mind and have strong implications for educators.

One of the most direct applications of research to the classroom can be found in the work of Paula Tallal at Rutgers University and Michael Merzenich at the University of California at San Francisco. They discovered that difficulty in learning to read in some cases stems from a language processing delay in the student's brain. Armed with this information, they developed a computer program designed to correct this delay, to actually speed up the processing of the sounds that make up the written word resulting in definite improvement in reading skills. This program, Fast Forword, is one of the first brain studies with specific applications to the classroom.

Other research is being conducted with the goal of improving students' ability to read. At the New Haven based Haskins Laboratories, researchers Sally Shaywitz, Bennett Shaywitz and Kenneth Pugh have found that the brain of someone with dyslexia functions differently from a typical brain when processing phonemes. They are working on combining brain imaging with sophisticated cognitive-behavioral work to better understand how reading failure occurs and to develop better techniques to correct it.

Gordon Shaw, mentioned earlier, is a retired physicist who became interested in the connections between music and mathematics. His research, conducted over the past several years has resulted in a program that uses piano keyboarding lessons and a computer program called STAR (Spatial Temporal Animation Reasoning) with elementary school-age children. The students in the study have made exceptional gains in proportional math and fractions, math skills that require good temporal spatial reasoning.

While these specific studies have potentially important implications for educators, so do many of the more general studies that have been conducted on memory and learning over the past decade. The following is a generally accepted list of what we have learned about the brain and what I think are the potential applications of these findings for educational practice.

1. Experience Shapes the Brain

The brain is the only organ in the body that sculpts itself from outside experience. In a sense our experience becomes biology. We used to think that the brain you were born with was the brain you were stuck with, but we now know that learning experiences change and reorganize the brain's structure and physiology. Several studies have shown actual structural changes in various parts of the brain depending on the way in which these structures were used. The changes can be observed in behavior as well as structure. It should be fairly obvious that this finding has strong implications for education. We now know that learning is a matter of making connections between brain cells and that the experiences our students have shape their brains. Obviously we do learn from reading and hearing, but the strongest connections are often made through concrete experience. Which do you think would make the most lasting changes in the brain, reading about an experiment someone conducted, or performing the experiment yourself?

2. Memory is Not Stored in a Single Location in the Brain

When an experience enters the brain, it is "deconstructed" and distributed all over the cortex. The affect (or the emotional content) is stored in the amygdala, visual images in the occipital lobes, source memory in the frontal lobes and where you were during the experience is stored in the parietal lobes. When you recall information, you have to reconstruct it. Since memories are reconstructed, the more ways students have the information represented in the brain (through seeing, hearing, being involved with, etc.) The more pathways they have for reconstructing, the richer the memory. Multimodal instruction makes a lot of sense.

3. Memory is Not Static

It would be nice if memory were a matter of experiencing something once and then retrieving it at a later date in exactly the same form as it was originally stored. But memory doesn't work that way; it is dynamic. It decays naturally over time as new experiences infiltrate older ones. Fortunately, this natural decay can be minimized by using elaborative rehearsal strategies. Visualizing, writing, symbolizing, singing, semantic mapping, simulating and devising mnemonics are strategies that can be used to reinforce and increase the likelihood of recall. They often have the added benefit of enhancing students' understanding of concepts as well as retention.

4. Memory is Not Unitary

There are two distinct types of memory each of which involves different brain structures. Declarative Memory is our everyday memory, the conscious ability to recall what you ate for breakfast yesterday, the names of your favorite musicians and the formula for finding the area of a rectangle. It is information that you can declare. Procedural Memory refers to skills and habits that you engage in without conscious recall such as driving a car, decoding words, touch typing and playing the piano. Procedural learning requires many repetitions over a period of time; in fact there is no other way to learn them. Repetition, however, generally is not an efficient way to learn or retain declarative information. Understanding the differences between these two types of memory is essential in designing classroom instruction and practice. Rote rehearsal is essential for procedural memory while elaborative rehearsal strategies are much more effective for declarative. In discussing declarative memory, Harvard psychologist Daniel Schacter writes, "For better or for worse, our recollections are largely at the mercy of our elaborations; only those aspects of experience that are targets of elaborative encoding processes have a high likelihood of being remembered subsequently."

5. Emotion is a Primary Catalyst in the Learning Process

Some of the most important findings from neuroscience have been in the area of the role of emotion in learning and memory. Two small but powerful structures deep within in each hemisphere called the amygdala regulate our emotional responses. These emotional responses have the ability to either impede or enhance learning. On the one hand, for survival purposes, our brains are hard-wired to pay attention to and remember those experiences with an emotional component, whether it is the Challenger explosion or a particularly vivid simulation in which you took part in the 8th grade. However, emotional responses can have the opposite effect if situations contain elements that a person perceives to be threatening. In these situations, the amygdala starts a chain of physiological responses (commonly called the fight or flight response) to ready the body for action. Under these conditions, emotion is dominant over cognition and the rational/thinking part of the brain is less efficient. The environment must be physically and psychologically safe for learning to occur.

I think it is important to note that there is much in the research that confirms what experienced educators have long known and used in their classrooms. What the research adds for these practices is an understanding of why certain procedures or strategies work so that we no longer have to operate intuitively but can articulate and explain the rationale for what we do. It is obvious that brain research is not the elusive "silver bullet" that will answer all our education problems. However, I do think that the new research offers educators an unparalleled opportunity for building a scientific foundation for educational practice which will allow us to make more informed decisions. To make certain that the brain research becomes a foundation rather than a fad, educators need to take a proactive stance. Here are some suggestions as to about what I think we need to do:

1. *Become literate in the general structure and function of the brain*. We don't need to become scientists, but we do need to learn the terminology they use. If you don't know what the cortex of the brain is you won't be terribly impressed to learn that it changes as the result of experience! If you are not familiar with the basic structure and function of the brain, you cannot read the literature analytically.

2. *Learn how to determine whether a study is valid or not*. Not all studies are equal. It is critical to be cautious when using the phrase, "Brain research proves......" To determine whether or not the study is valid, the following questions need to be answered. How many subjects were there in the study? What were the ages and characteristics of the subjects? Was there a control group of subjects who were matched with the subjects in the experimental group? What was the methodology used for this study? Has the study been replicated by other scientists using the same methodology? Are there similar studies that have contradictory findings? No one will consider educators true professionals unless we act like professionals in analyzing and applying the research.

3. *Be cautious when making applications of research findings to the classroom.* Eric Chudler from the University of Washington points out that there is a wide divide between bench science and the classroom. Many are working towards closing the gap but it takes time and money. Think about how a new drug gets on the market. There are animal studies to show how it works (benefits, possible side effect, etc.) Then, if the benefit to risk ratio is good, it may advance to clinical trials. These trials can take many years to insure that the drug works. Finally, the drug may go on the market. Much is being sold to teachers about the benefits of water, color, odors, etc. in the classroom that has never been put to the test in actual classrooms. Chudler suggests we question the findings of the research by asking: Will it work in actual classrooms? What specific benefit will be realized, higher math scores, reading scores, quieter classrooms? What are the side effects or problems? For example, if water increases brain functioning, for whom and how much water produces these effects?

4. *Marry the findings from neuroscience with other fields*. As important as the brain research is, we want to be certain that we don't ignore the research from other fields such as behavioral and cognitive psychology and educational

research. For example, a recent large study completed in the Chicago schools found that elementary students scored higher on math and reading skills when teachers used more interactive instruction than when they employed the more traditional didactic methods. This certainly seems to fit with what we know about how the brain learns best, but the study was conducted by educational researchers, not neuroscientists.

Too often at conferences scientists speak and educators take notes. I would like to see more of a dialogue taking place between these groups. We educators must let the scientists know what kinds of information we need to best educate all children....including theirs! Ken Kosik, physician and professor of neuroscience at Harvard, suggests that we look at the option of establishing research schools where teachers and neuroscientists work together. Stephen Hyman, director of the National Institute of Mental Health says we need a stepped-up collaboration between neuroscientists, cognitive scientists, physicists, computer scientists, physicians and teachers.

6. *Begin to incorporate in our classrooms and schools what we have learned about the brain*. The goal of brain-compatible instruction is more than high test scores. Our students need to develop an in-depth understanding of concepts to the point where they are able to use what they've learned in school in the world outside of school. Granted, there is much more to be learned from neuroscience that will assist us in making our classrooms more compatible with how the brain functions, but it would be foolish to wait until all the research is completed to begin to incorporate the knowledge we now have. As mentioned earlier, many teachers are intuitively already using many brain-compatible strategies in their classrooms such as making the environment conducive to learning, providing opportunities for interaction, engaging students in projects and problem solving, giving students hands-on concrete experiences, using music, rhyme and mnemonics, teaching students to construct graphics and opportunities to simulate events and concepts. However, these strategies need to be brought from the intuitive to the conscious level so that educators can articulate their knowledge.

Fad or foundation, which will it be? The choice is ours.

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