BrainWare
Learning Company

Neuroscience and Education

It may seem trivial to say the brain is what learns and that, therefore, we need to know about the brain when we consider how to improve learning outcomes. But until the late twentieth century, the brain seemed more like a black box than an organ whose processing could be understood and improved. Today however, as Leslie Hart states in *Human Brain and Human Learning*, "Anyone who does not have a thorough, holistic grasp of the brain's architecture, purposes and main ways of operating is as far behind the times as an automobile designer without a full understanding of engines."

Education informed by neuroscience can give new and real meaning to our desire as a nation to leave no child behind. Moreover, it may offer the only true opportunity for the disruptive change that education needs for current and future generations to be educated to face the challenges ahead. It can do this in several specific ways:

1. The opportunity for disruptive change in education lies in improving learning at the level of basic cognitive functioning—in improving students' capacity to learn.

Better teaching, better facilities, better technology, etc., are important, but those are external factors. What about the internal capabilities and stumbling blocks that each student brings to the learning experience? Neuroscience shows us how to impact the efficiency and effectiveness of the learning process by improving each individual's underlying mental processing – that is, by changing the experience of learning from the inside out.

One of the things we know from neuroscience is that the brain is plastic, which means it constantly changes, building new pathways and connections. We also know that every brain is unique – formed and constantly evolving through our experiences. Experience is not just about facts and declarative knowledge, but about how the brain does what it does. What one student can do or understand easily, escapes another. Neuroscience helps explain why that is and what to do about it. Science no longer accepts that intelligence is fixed. Rather, it continues to document the critical role of experience in developing intellectual ability. If the brain changes, not only is it logical that we can improve mental processing, improvement has been demonstrated in multiple situations, with a variety of cognitive skills—from attention to spatial-temporal reasoning to memory.

Parents and educators often refer to "the basics" when talking about reading and writing and math. But these basics actually involve complexes of underlying mental processes that must be operating efficiently, effectively and automatically in order for the "basics" to become something "learned."

For example, one aspect of reading is decoding the letters on the page to form words. The cognitive skills that support decoding—such as attention, visual discrimination, visual sequential processing and working memory—must be automatic for successful reading. Many struggling readers are deficient in these skills. Math struggles can also be tied to deficits in underlying cognitive skills. Moreover, as the math curriculum has changed over the last ten to fifteen years, more emphasis has been placed on communicating math ideas, interpreting data from charts and figures, and estimating. These changes mean that learning deficits in any area are more likely to impair performance in math

But despite the fact that underlying cognitive skills are essential to all learning, they are not generally taught in schools. Schools assume that every student brings the necessary cognitive skills to the learning process, or as much of those skills as they will ever have. The fact that cognitive skills are not explicitly taught in schools does not mean that they cannot be taught, however. For over half a century, techniques to develop basic cognitive skills have been known and used in various clinical therapies.

Today, neuroscience-based therapies are being delivered via computer-based programs effectively and at scale, making the delivery of cognitive training programs viable in a classroom setting. Programs designed to meet several key design criteria and that have been shown to be effective in peer-reviewed published research can increase cognitive functioning by 2 to 6 years in 12 weeks and translate to significantly better than expected academic growth, incluidng closing the gap for historically low-performing populations.

2. We can also change the effectiveness and efficiency of the learning experience by taking what we learn from neuroscience to make schools and teaching more brain-friendly.

If the mind is not a vessel to be filled but, according to Plutarch, "a fire to be ignited" (even the ancient Greeks knew this), then understanding what ignites the mind is essential in education. Here neuroscience can help us understand and change our practices in a number of ways, including:

- Better presenting information so that students' immediate sensory memory let the right information into the brain.
- Taking advantage of the relationship between working memory, where we consciously process what we learn, and long-term memory storage.
- Integrating multiple senses and media to enhance learning, since the brain processes information in multiple ways simultaneously.
- Incorporating emotion and mnemonics to aid in long-term memory consolidation
- Making curriculum meaningful, since meaning and relating new information to old are what enable new information to be stored.
- Understanding the different ways declarative memory and procedural memory are stored and used (retrieved).

The reason to engage students with more meaningful and relevant curriculum and through problems, projects and simulations is not simply because that makes learning more fun, but because it is, in fact, student engagement that results in learning. Higher levels of engagement result in more and better learning as well as the ability to apply what is learned in the real world.

3. The skills that businesses say they need—often referred to as 21st century skills—are not about content absorbed, but about the way our minds work.

Developing problem-solving ability, communication skills and creativity is fundamentally about developing the brain and its processing ability in each individual student. These are skills that cannot be taught through pure direct instruction. One wouldn't, for example, assume that explaining the principles of pole-vaulting would suddenly imbue a student with the ability to coordinate muscles, brain, strength and balance to clear a bar. The same holds true for critical thinking and other prized 21st century skills. There continues to be significant debate over how to teach these and over how to measure them. However, as we move away from measuring content absorbed and toward measuring the effectiveness of mental processes, neuroscience is likely to be indispensable.

If the United States as a country truly believes that no child should be left behind, then the only way to accomplish that is to recognize that each child's brain is unique, and to construct an education system that a) develops each child's learning capacity to the maximum, b) configures learning experiences to best take advantage of that expanded capacity, c) considers the efficiency and effectiveness of learning opportunities our education system provides, and d) measures the outcomes of education in terms of individual ability to engage in productive, value-producing activity. Applying our new-found understanding of the brain as it develops will be essential in this endeavor.

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