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Feature

Neuroscience in Schools

Improving learning capacity for young students.

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Also in this article

For generations, teachers in the early elementary years have urged their young pupils to use their brains. They're still offering the same encouragement, but nowadays they can know even more about what they're talking about.

Recent advances in neuroscience—from detailed scans of the brain to ongoing research on teaching methods that increase cognitive development—have ushered in a new era of "brain-based" education.

Terms such as the neo-cortex, hippocampus and amygdala have largely been the province of biology textbooks, and cognitive processes such as working memory and executive functioning been the burning topics of neuroscience conferences. But they are beginning to make their way into the everyday vocabulary and professional

development of teachers at elementary schools around the country.

A new understanding of the brain is increasingly being linked to increases in student achievement in the elementary grades. There is even some discussion among the experts that there “needs to be cognitive development standards in K12,” according to William Jenkins, a neuroscientist and co-founder of Scientific Learning Corp., a company that makes software programs that work on changing how the brain learns.

“There is the beginning of the recognition at the policy level that these aspects [cognitive standards] are important,” he adds. Educators must “focus on good teaching and good content, but also you have to focus on the process of learning and making sure kids have the skills necessary to learn rapidly and efficiently.”

For starters, researchers and educators alike have discovered that the human brain is not simply hard-wired from early childhood. Kurt Fischer, a neuroscience researcher at the Harvard Education School, points to one of the most important discoveries. “There’s been a big change in our understanding of the brain: It is more plastic than anybody realized,” Fischer notes. It is “now very clear that the brain is malleable. It can change,” agrees Betsy Hill, president and chief operating officer of Learning Enhancement Corporation, which produces an online program that reinforces children’s cognitive skills. “We’ve made great gains in the last 15 years, and they’re accelerating. We now have the ability to improve kids’ capacity to learn.”

Jenkins adds that more recent studies have shown changes in brain myelination, even for young adults. Myelin is insulation material around axons, the part of a nerve cell that conveys information from one part of the brain to another part of the brain, and myelination enables nerve cells to transmit information faster and allows for more complex brain processes. Science states that it’s “critical for young children to get exposed to the kind of activities that have them set goals, plan, and focus on the activities that help them reach those goals,” Jenkins says. These kinds of activities often require kids to use their working memory to solve problems, require attention and focus and apply appropriate rules to a sequence of activities that help them reach their goals.

Some computer programs have been designed specifically to exercise these kinds of cognitive skills. Such skills include working memory, attention, inhibitory control and flexibility in following rules appropriate for tasks, which are referred to as cognitive flexibility, and collectively, these skills are often called executive function skills, Jenkins says. “These cognitive abilities at a young age are more predictive of future academic success than knowledge of numbers and letters are early on,” says Jenkins.

Students at the Jacob Shapiro Brain-Based Laboratory School in Oshkosh Area Public Schools make angles with their arms for math lessons.

But science also proves that the socio-economic status of children can also determine their ability to learn. The pupils in low socio-economic areas are not necessarily less intelligent or less capable of learning than students in higher socio-economic areas. But there are factors such as stress, sadness, loneliness and poor physical fitness that can contribute to poor cognitive functioning and poor academic performance that impede their cognitive abilities and their ability to learn. Schools can provide role models and activities that build these cognitive skills and also provide an environment that is safe, non-stressful, that engage children in fun activities and also build their physical fitness. Jenkins adds that “one of the hottest research areas for early learners in cognitive science is focused on the development of executive function skills, or those skills that enable us to control impulses, make plans and stay focused and accomplish our goals.”

And more remarkably, students can do more than what school district leaders have them doing now. “They can be doing so much more than we’ve been having them do,” adds Lou Whitaker, the principal at Pope John Paul II Catholic School in Lecanto, Fla.

The World of Brain-Based Education

Training teachers in brain-based education is just what Leslie Owen Wilson—an education professor at the University of Wisconsin at Whitewater—has been doing for the past decade. “It was long overdue,” she says about the movement toward brain-based education. “As early as the 1970s and ’80s, researchers in neurosciences were

looking at data from PET scans (images of organs and tissues), CAT scans, and MRIs of the brain. All these little pieces were out there and the time had come" to turn them to educational use.

The principles that Wilson teaches graduate students include understanding the brain is social and develops better in concert with other brains; that the search for meaning comes through patterning; and that learning engages the whole body.

While approaches like these may already be familiar to some classrooms, brain-based education advocates, including Wilson, insist they should be more widely practiced. Matthew Peterson, the co-founder and senior scientist at the MIND Research Institute, a neuroscience and education non-profit, explains that much of learning "does not happen unless you are active, not by passively watching television or listening to a teacher lecture."

That activity—which can range from doing a puzzle to manipulating objects in the surrounding environment to physically moving the body—engages the neo-cortex, the outer layer of the brain responsible for such functions as cognition, problem solving, and abstraction.

Elementary teachers at the Pope John Paul II school use "reciprocal teaching" to keep the kids mentally active. "Once the students learn something, they have to teach it to another child," explains Whitaker. "Every day, the teacher will cover a 15-minute lesson and then say, 'Now turn to your partner, and explain what you just learned. Now switch."

That lesson may cover a reading passage, a science exercise, or a way of doing math problems, but Whitaker stresses that being able to mentally organize and then verbalize that learning makes a big difference in the students' learning. "The more parts of the brain they engage, the better their chance of remembering the lesson."

Teachers at the school also take a multi-sensory approach, the better to activate the brain, Whitaker says—by presenting content in various colors, playing music in the classrooms and having young students sing—the alphabet song is popular—and even adding a kinesthetic dimension by having them write the letters of the alphabet in shaving cream.

"The letters become more memorable that way,"" Whitaker says. The school even educates its youngest students on the parts of the brain and how they function so they better understand the learning approaches that improve that function. At a recent open house, students and their parents could walk through an oversized model of the brain with the key components on display. "We even had dendrites hanging there," Whitaker recalls.

Building Memory

At Pope John Paul II catholic school in Florida, students learn how important the brain is and learn how to use multiple senses to retain lessons.

At Jacob Shapiro Brain-Based Instruction Laboratory School, a 6-year-old elementary charter in the Oshkosh (Wis.) Area Public Schools, the teachers are trained in the biology and psychology of the brain. Such knowledge is invaluable in closely observing and questioning individual students to make sure they are ready to learn, emphasizes Principal Lynn Brown, who adds that angry or unhappy students do not make good learners.

Teachers focus on moving student brain activity from the limbic region (the seat of those angry or unhappy feelings) to the pre-cortex, with its abilities to solve problems and retain learning. “If students are not in that state, we have to move them there,” Brown explains. “A teacher might start by saying to a kid, ‘You seem frustrated,’ and talking about what happened to create that feeling.”

With that task accomplished, she adds, students are more ready to remember what they are supposed to learn. And while taking that approach might be standard practice for some classrooms in other schools, the Shapiro staff practices it across the board to improve memory. While 38 percent of the students at Shapiro School started as special education students, that rate had dropped to 25 percent by the time they were fifth graders, Brown reports. “The programs we have based on neuroscience have made the difference,” she says.

They use other methods of stimulating memory, as well. “We’re teaching kids how to analyze their mistakes. We know that the brain learns more from an error and going back,” Brown notes, adding that the repetition of revisiting problems helps.

The key to enhancing student memory and learning in the Hale (Mich.) Area Schools,

says Superintendent Ron Kraft, is helping them recognize patterns. “Rhyming words, prefixes, and suffixes, adding and multiplying, and converting fractions into ratios are all patterns,” he explains. “The better our students handle patterns, the better the right and left hemispheres are working together.”

If a youngster does not solve a math problem or read a sentence correctly, going back with guidance from the teacher to find where the solving or reading process went wrong creates a powerful learning moment.

The Role of Technology

While the left side of the brain is logical, responsible for language and sequential order, the right side is creative, more visual and intuitive. Along those lines, elementary-age students at Hale practice for 45 minutes, five days a week on the more than 160 activities in BrainWare Safari, the online program created by Learning Enhancement. In one activity, which is set against the background of a lushly depicted jungle with the sound of wild birds chirping, users have to recreate patterns of connected dots after they appear and disappear from the screen.

The dots appear on a grid that looks like a spider web, and the cursor the children use in recreating them looks like a tiny spider. To expand memory, subsequent levels of the exercise require users to wait longer before connecting their own dots after the original pattern disappears.

Teachers continue to reinforce patterns throughout the day, Kraft says. “If we’re multiplying by three on a given day, that’s our pattern.”

The Chicago-based MIND Research Institute has developed its own online program—ST Math—for young students. “They learn by playing games and having to problem solve along the way,” says Chief Operating Officer and Senior Scientist

Matthew Peterson.

AT the Hale (Mich.) Area Schools, an elementary teacher helps students use Brainware software to help with ELA and math concepts.
For instance, Peterson explains, young students may learn to interact with numbers by manipulating on-screen blocks and arranging them into groups of 10. They can further combine the groups into larger numbers or divide them up to create such results as 10-block units with a remainder of five blocks.

Peterson adds that the immediate response that students get from online programs like his makes a difference. “You need instant feedback. Your brain is expecting it,” he emphasizes. “A paper and pencil exercise that the teacher has to grade interferes with the feedback loop.”

If a student answer is incorrect, adds Mary Grace, the assistant superintendent of educational services for Anaheim (Calif.) City Schools, the program leads him or her through the correction. “It shows you where the mistake was made and it shows you the path to fixing your errors,” she says.

Approaches like these have led to considerable gains in student math scores, Peterson reports. “We’re getting double the rate of growth in math achievement at the elementary level (compared to students who did not take the program.) We’re talking about hundreds of thousands of students.” In the 2010-11 school year, the company reports that elementary students in major districts—from Chicago and Los Angeles to Orlando and Dallas—averaged more than 7 percentage points better in math proficiency compared to the results of students who had not received the online math program.

At Murray County (Ga.) Schools, all students, including K2, are using two software programs that provide proven brain exercises: Scientific Learning’s Fast ForWord and Reading Assistant to help them either read on grade level by the end of grade 3 and/or be ahead of their grade level in reading.

The district, which has 10 schools and whose students range from having wealthy parents to disadvantaged immigrant working parents, started to use the Fast ForWord program in 2010 for dozens of high school students who were at risk of dropping out, says Allison Oxford, assistant superintendent of instructional services. In the end, 81 percent of the students were saved from dropping out. “We were [so] blown away by the results that we implemented” two software programs districtwide for reading, Oxford says. “Our hope is that everyone will be on reading level.”

Fast ForWord works on brain fitness and targets memory, attention, processing, and sequencing. “We have seen kids whose math, science and social studies scores soared because their brain was rewired with sequencing and processing, and the switch is turned on and they get it, ” due to the programs, Oxford says.

Reading Assistant is like having an individual reading tutor, as it reads to students a passage and then students must read the passage themselves, and whatever words they stumble over or can't verbalize, the computer program repeats the word and rereads the sentence for them. The computer program also helps students discriminate certain sounds of words, which humans cannot do. "This is the missing link with kids with reading," Oxford says. "We [teachers] can't affect brain neuropathways [for certain reading sounds]. It takes a computer program."

Early Adopters

For all the breakthroughs in neuroscience, it's fallen to the early adopters to make the most of them, says Hill. "Most teachers do not have the basic understanding of the brain and how it works," she admits. "When they realize that the brain changes every day and that they can make a difference, they get excited."

Still, she says, ongoing brain research and its lessons for the classroom are well worth embracing. "We still have no idea what the theoretical possibilities are for expanding minds,"" she says. "But the field has great promise. We can improve the cognitive skills of everybody."

Ron Schachter is a contributing writer to District Administration.

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