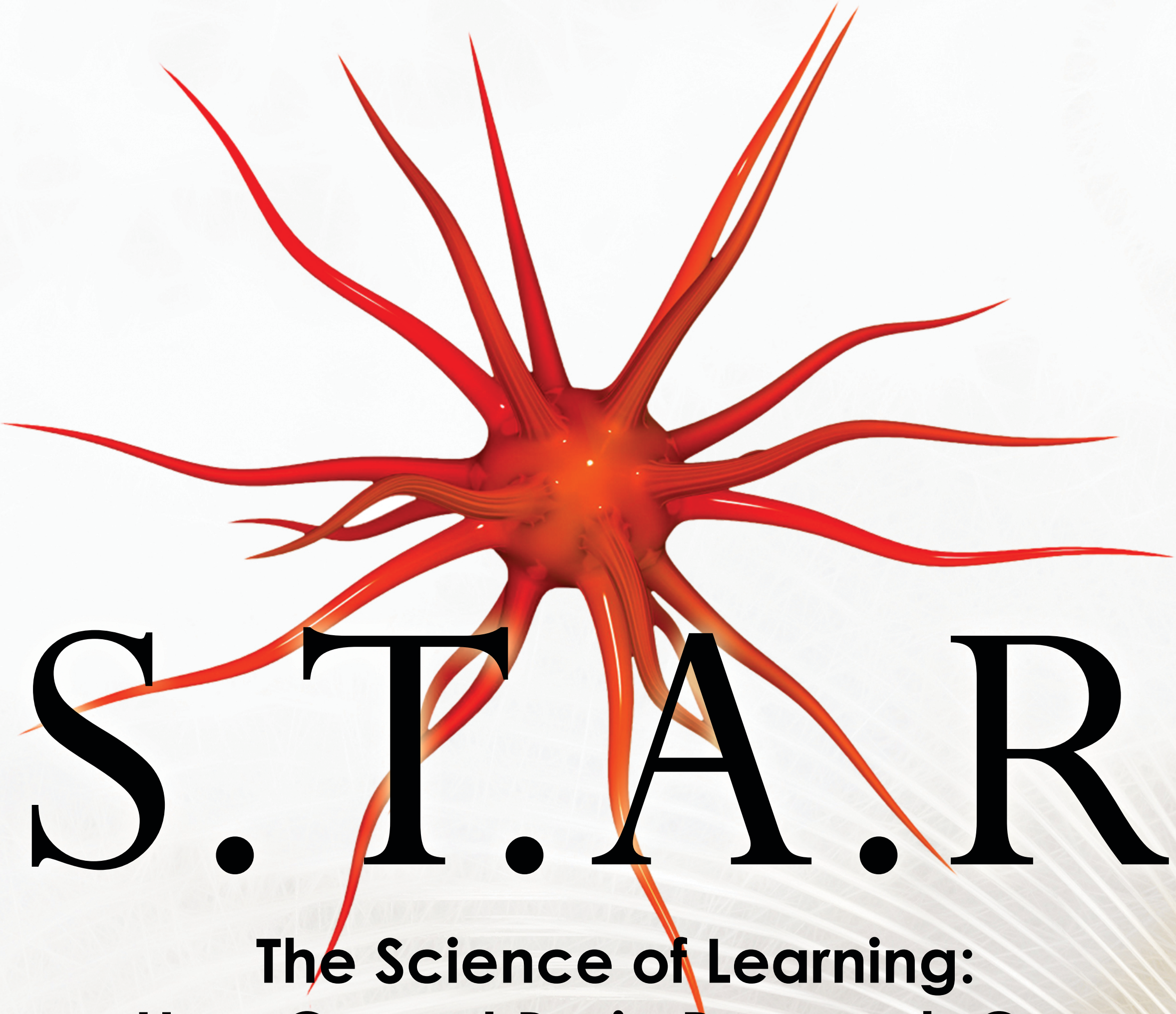

S.T.A.R.

The Science of Learning: How Current Brain Research Can Improve Education

eSchool Media Inc.
"Empowering Today's Ed-Tech Leader"

Dear Reader,

Technology in education doesn't always have to apply to in-classroom devices such as whiteboards and 3D projectors—it also can contribute to student and teacher success by revealing insights into how the mind works.

Modern technologies that enable techniques such as brain mapping are helping researchers determine not only what the best conditions are for optimal learning, but also what makes different learning styles effective and for which types of students. They're also helping researchers diagnose early signs of autism and evaluate the positive and negative effects of gaming on young learners.

In this latest School Technology Action Report, "The Science of Learning: How Current Brain Research Can Improve Education"—part of a series of **STAR** documents from *eSchool Media*: timely collections of news stories, case studies, white papers, and industry reports and surveys on pressing issues and relevant topics in education technology—you'll find a collection of reports and resources that breaks down what scientists are saying about learning and the brain, and you'll discover just what effects reading, physical fitness, multimedia, and much more have on the mind.

Thank you for reading this latest report, and be sure to check back soon for another **STAR** on a new topic.

Sincerely,

The editors at ***eSchool Media***

Dennis Pierce, Laura Devaney, Meris Stansbury, Dennis Carter, Jenna Zwang

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The Big Picture

Before learning about how different stimuli and exercises can affect specific functions of the brain, it's helpful to start with the basics: being able to find pertinent and reliable research, and understanding current techniques in brain scanning that provide new insights into the human mind.

Overview: What educators can learn from brain research

As technology advances, new discoveries based on brain mapping are helping researchers understand how students learn. And those discoveries, in turn, are enriching and informing classroom practices in a growing number of schools.

Thanks to functional Magnetic Resonance Imaging (fMRI)–a type of non-invasive, low-radiation brain scan that measures neural activity in response to certain stimuli, and the most recently developed forms of neuroimaging–researchers are learning more about how we learn than many thought possible.

For example, perhaps the most shocking revelation in neuroscience is that the brain's structure is more flexible than previously thought–a concept called neuroplasticity, meaning that the brain can still learn new concepts after various ages, and that every student can be taught many different ways. In a sense, the brain can be rewired.

Other studies have begun to measure reading aptitudes, the causes of and workings of attention-deficit disorder, and the way the brain processes mathematics.

Yet, with all this new research, it's important to remember that a single study alone is not definitive–and the best research is tied to classroom practice.

Michael Atherton, a researcher in the Department of Educational Psychology at the University of Minnesota, believes educators should look only at specific types of studies when considering implementation strategies.

"Education is an applied field, like engineering," said Atherton. "If there's no connection to practice, then that research is best left to basic researchers in the cognitive neurosciences."

In Atherton's report titled "Education and fMRI: Promise and Cautions," he describes detailed research techniques used in fMRI studies as the foundation for a methodological framework that can be used by educators to assess how applicable a study might be for classroom implementation.

This framework has three progressive stages:

- **Discovery**. This type of study is a good foundational study, but it's too broad at its current stage to have any direct implications for education. These studies typically focus on one area of the brain in relation to a specific cognitive function. For example, general intelligence seems to be localized in the lateral front cortex.

- **Functional analysis**. This type of study moves from a generalization to a more focused study of brain activations. For example, if a discovery study researched which parts of the brain were stimulated while playing chess, the functional analysis study would now investigate how these parts of the brain function differently when someone is a novice or an expert. Another example might try to answer the question: "What is it that good readers do that poor readers do not?" Atherton says educators can derive good understanding from these studies, but they still should be cautious.

- **Pedagogical evaluation**. If studies have shown which activations are associated with high levels of performance, the next phase asks: "Which pedagogical method results in students achieving higher levels of performance?" Studies that can answer this question can be used to guide instructional design, Atherton believes.

Emotions count

Mary Helen Immordino-Yang, assistant professor of education at the Rossier School of Education and assistant professor of psychology at the Brain and Creativity Institute at the University of Southern California, is a cognitive neuroscientist and educational psychologist who studies the brain bases of emotion, social interaction, and culture and their implications for student development.

She also helps educators understand current research studies and practices.

Thanks to her exploratory, yet detailed, work, she is helping spread the word about how the brain affects social interactions–and policy makers are listening.

In her study, "Neural correlates of admiration and compassion," Immordino-Yang discovered, through fMRI scans, that when the emotion of admiration is evoked, the entire body is stimulated in response.

"Basically, when you feel admiration, the brain has a heightened self-awareness. This affects the body's basic performances in a positive way, leading to better overall performance. It's a startling discovery with many educational implications," she said.

Immordino-Yang believes this study is important not because it reveals how the brain works, but because it exposes a basic nature that can't be learned in the classroom alone. "Some things are just below the level of consciousness, so you can't just ask kids why they perform better at some times and sometimes they perform worse," she said.

She also believes her study leads to a basic conclusion that could change traditional educational practices.

"Students are taught that rational decision-making is devoid of all emotions. This is clearly not true," she said. "If you try to dissociate from your emotions, the worse your decision-making will be. This could be a useful lesson for standardized tests and curriculum makers. Educators should try and help kids analyze their emotions during tests, not put them aside."

Immordino-Yang notes that her study is not speculation. She tested many different groups of students–a process that took two years and still continues.

The quality and extent of her research has captured the attention of her peers, as well as governors nationwide. Recently, Immordino-Yang visited a University of Texas council that advises governors, and she was a keynote speaker at this year's Harvard Institute convention, "Connecting the Mind, Brain, and Education," which ran June 29 to July 3.

Neuro-Education Initiative

Another source for neuroscience and education information is the recently developed Johns Hopkins School of Education's Neuro-Education Initiative, a program supported by the Johns Hopkins University Brain Science Institute.

In partnership with the School of Medicine and the Kennedy-Krieger Institute, the program's mission is to foster dialogue among educators and brain science researchers to develop joint research projects.

Mariele Hardiman, co-director of the initiative and assistant dean and chair of the Department of Interdisciplinary Studies, is a former teacher and school principal who realized there wasn't enough information available to educators on how to successfully process neuroscience research for the classroom.

After publishing her book, *Connecting Brain-Research with Effective Teaching: Brain Targeted Teaching Model*, she decided to try and connect the hundreds of researchers at Johns Hopkins to the many professors on campus.

"I thought to myself: How can we help these educators, and what new research can be done on their behalf? Wouldn't it be nice to have educators suggest what they're interested in, what they've noticed, hear their input, and then start constructing research projects? We need to focus on what educators need," she said.

One of the biggest areas of research the initiative is exploring in more depth is brain plasticity. Hardiman believes this research can have a big impact on teaching, because if teachers know "how the brain works, and how it can adapt, they will begin to look differently at their students," she said. "Whether they're older kids, lower-income kids, et cetera, the teachers will know that they don't have to treat these kids differently. [The students] can adapt and learn just like everyone else."

Hardiman said the initiative's research will not stop at plasticity, and many topics have been discussed for the future, such as ideal lesson times, memory, the effects of stress on learning, and more.

The initiative, which began last year, started with a think tank lunch between educators and researchers and has grown into a full conference that launched this past spring.

The inaugural summit was called "Learning, Arts, and the Brain," and researchers presented findings on how arts training has been associated with higher academic performance. For example, specific links exist between high levels of music training and the ability to manipulate information in both working and long-term memory; these links extend beyond the domain of music training. Also, in children, there appear to be specific links between the practice of music and skills in geometrical representation, though not in other forms of numerical representation.

Researchers say these findings now allow for a deeper understanding of how to define and evaluate the possible causal relationships between arts training and the ability of the brain to learn in other cognitive domains.

The Neuro-Education Initiative also offers educators a Mind, Brain, and Teaching Certificate. This 15-credit graduate certificate is designed for K-12 teachers, administrators, and student-support personnel who seek to explore how neuroscience research informs educational practice. The certificate program started this summer, and online courses will be available in 2010.

Brain plasticity and reading acquisition

One area where the notion of brain plasticity already is having a profound effect on learning is reading acquisition–and one of the many reading software companies that specializes in implementing neuroscience concepts is Scientific Learning Corp.

The origins of the company go back more than 30 years to the work conducted by research scientists Michael Merzenich and Bill Jenkins at the University of California, San Francisco, and Paula Tallal and Steven Miller at Rutgers University.

Their research collaboration established several key findings: (1) The core cognitive and linguistic attributes that allow a student to learn can be improved through intensive intervention; (2) acoustically modified speech technology can help build a wide range of critical language and reading skills; and (3) computers can be used to create interactive, adaptive learning interventions based on a neuroscience foundation that yield years of growth in as little as a few weeks.

Based on this research, the Fast ForWord family of reading intervention products was created.

In March 1997, after an extensive field trial with 500 children at 35 sites, the first Fast ForWord product, Fast ForWord Language, was launched. Later that year, a second field trial replicated earlier results, showing gains, on average, of one to two years in as little as eight to 12 weeks.

“We know that what works in the lab doesn’t necessarily lend itself well to the classroom. Even after clinical trials, sometimes it just doesn’t work,” said Jenkins. “That’s why it’s taken over 30 years from the research to get this to an actual product, but the results we’ve seen have been worth it.”

According to the company, there are basics to how the brain learns:

- Critical tasks must be practiced at an appropriate frequency and intensity;
- Practice must take place at the right skill level for the individual student–a skill level that continuously adapts to keep the student challenged, but not frustrated;
- Multiple skills must be “cross-trained” at the same time for lasting improvement;
- Rewards must build as a student progresses, maximizing motivation;
- The learning environment must feel “safe,” so students are encouraged to take risks; and
- The content must be age-appropriate and engaging.

For Jenkins, success is measured not just by high-stakes test scores, but by schools’ own internal studies of the software. To date, more than 100 school districts in the United States and Canada have done their own independent evaluation of their student populations for an unbiased assessment.

So far, around 1,000 districts are using Scientific Learning’s products.

Using spatial reasoning to understand math

The nonprofit MIND Research Institute also develops educational software based on the latest neuroscience research–in this case, software that takes a visual approach to learning math.

MIND's software engages the learner's spatial temporal reasoning abilities to explain, understand, and solve multi-step problems, the organization says. Aligned with state standards, MIND's math games are language-independent, self-paced, and use visuals to convey math concepts.

When students make mistakes, the software illustrates the mathematical consequences of those mistakes visually to provide insight into why the action was incorrect. MIND says its software was developed this way because research has shown that basic facts of arithmetic are more effectively learned and retained if the student first understands the conceptual meaning behind the procedures and facts.

Currently, 450 schools across the United States are using MIND's math software.

Each year, the MIND Research Institute evaluates its entire customer database, and a consistent pattern has emerged: Schools that implement more than 50 percent of the program have fewer students at the lowest performance levels. Schools with student populations below 50 percent proficiency in math to begin with have averaged 15- to 20-point gains in proficiency within two years.

"We believe that neuroscience findings can play a part in the design of educational products and practices, but they shouldn't be the only basis," said Matthew R. Peterson, co-founder of the MIND Research Institute and author of MIND's curriculum. "One needs to conduct lots and lots of field studies of any program with actual teachers and students."

He added: "From our perspective, it's an iterative process. We design something. We go out and test it with actual teachers and students. Some of it works, some of it doesn't work. Sometimes there are gaps that need to be filled. We fix the stuff that doesn't work and go out and test it again."

Brain-mapping project could illuminate how students learn

Human brains are stunningly diverse. No two are identical, not even those of identical twins. So when scientists are looking at a brain, how do they know when they are looking at one that is normal?

It's a question that has baffled scientists for years. But now, researchers say a newly compiled online atlas that contains digitally mapped images of 7,000 human brains will be instrumental in helping them understand what constitutes a "normal" brain–and, in the process, could lead to important discoveries about how students learn.

Use of the atlas will allow researchers to compare and contrast these brain images, captured from all sorts of people living in seven nations on four continents. Most are between the ages of 20 and 40, but some are as young as 7 and as old as 90.

Along with the brain images of "normal" people are those of people suffering from Alzheimer's, fetal alcohol syndrome, autism, and schizophrenia. More data are continually being added.

"This is a project born of frustration, basically. For many years, all of us who study brain structure and function have struggled with the fact that no two brains are the same–not in shape or size and certainly not in function," said Dr. John Mazziotta of the International Consortium for Brain Mapping, based at the University of California, Los Angeles. "But how different they were and how to compare them was not known."

His colleague, Dr. Arthur Toga, says the plan is to quantify the differences between brains. Understanding the variations should provide "a good index between normal populations and a diseased population," Toga said.

A decade in the making, the brain mapping project quietly debuted this summer. The resulting atlas–freely available to registered users over the internet–maps the brains in multiple dimensions. It charts brain activity, pinpointing the seat of functions such as speech, memory, emotion, and language and highlighting how those locations can vary among individuals and populations.

A researcher using this resource can call up any number of combinations of brains–say, those of a group of left-handed, 20-year-old Asian women–and compare them with another population to illustrate their similarities and differences.

"Might they be different from 90-year-old, left-handed men?" Toga asked.

Findings from other types of comparisons also might lead in some surprising directions, Toga suggests, such as tweaking primary school curricula.

Some data suggest the brain is more receptive to learning some skills at certain stages of development, so it should be useful to map the growth of regions of the brain connected to specific skills, he said.

And because all of the brain images have been stretched, shrunken, or otherwise manipulated to fit a standard reference, researchers can make apples-to-apples comparisons.

That sort of big-picture view gives clarity that individual snapshots cannot, said Michael J. Ackerman of the National Library of Medicine.

“When you’re able to put it together and work with it, you begin to see things that weren’t there when it was in individual pieces. That’s the beauty of an amalgamated project,” said Ackerman, who spearheaded the Visible Human Project, a digital atlas of detailed, three-dimensional representations of the human body.

Even so, drawing conclusions about the brain is tricky.

Individual differences may foil even the broadest efforts to generalize, said Stephen Hanson of Rutgers University, who is not connected with the brain-mapping project.

“It’s very hard to say, that part of tissue is doing that, and that is not doing that.’ Different tissues might be recruited at different times–like Tinkertoys,” said Hanson, who is co-director of the Rutgers Mind/Brain Analysis Center.

Toga, however, says the comparisons can tell a researcher where a certain structure or activity is most likely to occur–even if the precise location varies from person to person.

“I have to use statistics to be sensitive to what clearly are very subtle differences,” Toga said.

For more 'Big Picture' information on the brain and education:

The Dana Foundation's Neuroeducation website—News, events, and commentary on bridging neuroscience and education. http://www.dana.org/neuroeducation/

Newsweek, "Can You Build a Better Brain?"—Blueberries and crossword puzzles aren't going to do it. But as neuroscientists discover the mechanisms of intelligence, they are identifying what really works. http://www.newsweek.com/2011/01/03/can-you-build-a-better-brain.html#

New York Times, "Studying Young Minds and How to Teach Them."—Cognitive neuroscience is helping to clarify when young brains are best able to grasp fundamental concepts. http://www.nytimes.com/2009/12/21/health/research/21brain.html?_r=1&ref=education

Bioscience Technology, "Pace of Brain Development Still Strong in Late Teens."—Some of the brain re-sculpting that characterizes the decade of adolescence may still be going as strong as ever, according to findings in a new study that measured brainwaves of subjects in their mid-teens and again in their late teens. http://www.biosciencetechnology.com/News/2011/05/Pace-of-Brain-Development-Still-Strong-in-Late-Teens/

Seminar from Inside the School, titled *Brain-Based Teaching Methods*—After participating in *Brain-Based Teaching Methods***,** Inside the School says participants will learn strategies and tools to better align student instruction, behavioral plans, and individual students' understanding with regard to raising test scores and closing learning gaps. http://www.insidetheschool.com/cds-transcripts/brain-based-teaching-methods/?utm_source=cheetah&utm_medium=email&utm_campaign=3/31BrainBased

Stimulation

“The mind works best when it’s stimulated” might seem like common sense, but researchers are proving that stimulation can happen in many forms, such as using visual aids, memory tricks, classroom multimedia, and even getting a little exercise during the day—and it can affect different aspects of learning.

‘Physically active learning’ improves test scores, sharpens concentration

Tabatha Gayle crab-walked across the classroom last week, racing two other students to a pile of papers listing different diseases, set in the middle of the floor in Ms. Forcucci’s health class.

While her teammates cheered, Tabatha picked up a piece of paper and scuttled it over to the whiteboard, dropping it into one of five pathogen categories lined up there. Then she ran back to the team, laughing.

Amanda Forcucci’s class at Hamden High School in Hamden, Conn., is doing something called “physically active learning” in the classroom. The idea is to get kids up and moving around during regular academic classes to improve their ability to concentrate.

“It’s fun, and moving around actually will help me remember the types of pathogens,” said Tabatha, 15. “Plus it helped me to get out of a bad mood.”

At a time when recess time is shrinking, childhood obesity is expanding, and everyone’s worried about the academic achievement gap, some experts believe that physical learning could pay serious dividends in the classroom.

The concept is that short bursts of exercise during class can help students stay engaged, concentrate better, and do better on tests.

As a result, the Connecticut Department of Education is trying to get the message out and encourage teachers to include these exercise bursts in their classrooms. The department has been sending a cadre of physical education trainers around the state to show teachers how to incorporate physical activity in their lessons.

Physically active learning doesn’t mean recess or gym class or activities before or after school. It involves taking a short break in class to move around or incorporating physical activity in a lesson.

Portland High School teacher Lisa James, for example, sometimes introduces a game of musical chairs into her lesson. After students read a story, she’ll make true and false statements about the story, and her students race to sit down when they hear a false one.

“It’s more fun that way, but they’re also more focused and more engaged, and their behavior is better,” James said.

Emerging research is finding strong ties between physical fitness and academic performance. The idea is that exercise makes the heart beat faster, pumping oxygen to the brain and improving the ability to think.

"Research is showing us very persuasively that if students exercise for sustained periods of time before they do challenging work, they perform cognitive tasks better, they remember things better, they can apply their skills better," said Jean Mee, a physical education and school health education consultant for the state Department of Education.

Jeremi Yakerson, 15, one of Forcucci's students, said staying active in class helps him stay alert and remember the material better.

"I think it really helps me when it comes to quizzes and stuff like that," he said.

Some schools are starting to see the possibility of using exercise to improve test scores. The principal at Portland High School was so inspired by James' physically active "brain breaks," that she decided to have all sophomores exercise right before they took their CAPT test this year.

"When you show people that it's doable and that it's purposeful, a lot of teachers really take to it," Mee said.

The approach also has been shown to improve attendance and student behavior and reduce discipline referrals. It is particularly beneficial for wiggly students who have a hard time sitting still and focusing.

Forcucci also had students doing jumping jacks and switching desks in her class. By the end of it the students looked a little flushed, and they laughed and were engaged the entire time.

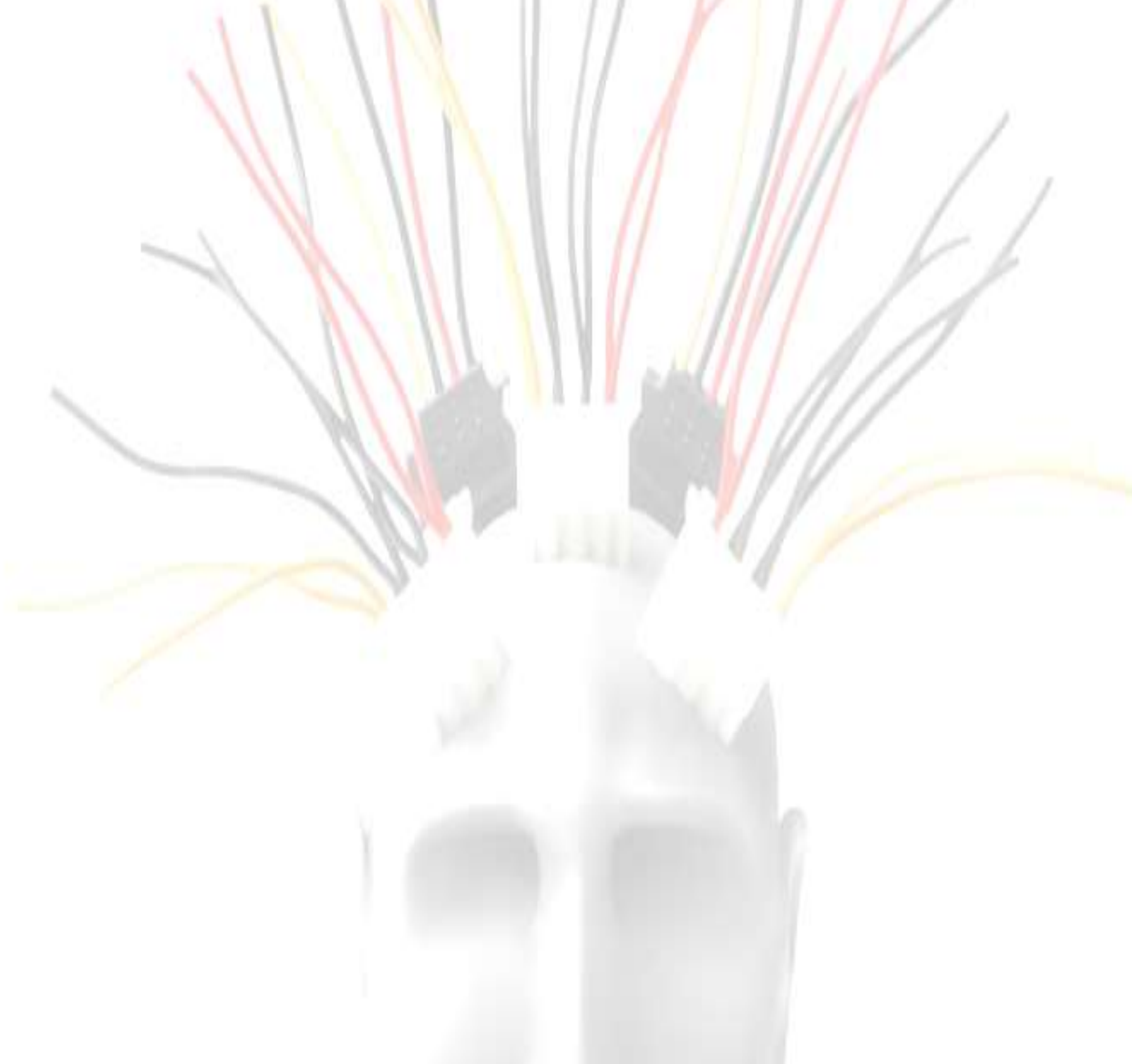
In Connecticut, as in other states, the focus on mastery test drilling and other demands on teachers and principals have eroded recess time and gym class in many schools.

Only 75 percent of schools in Connecticut provide 20 minutes of recess daily. At the same time, physical education has dwindled to an average of one hour a week. That is less than half the national standard of 2.5 hours a week for elementary-age students and 3.75 hours a week for middle- and high school age students. Not surprisingly, students' physical fitness scores have remained flat as well.

"One of the main things we need to do is to remind administrators of the logic of this approach, so they are more encouraging of it," Mee said. "This is shifting the paradigm. It takes planning, but it's highly doable."

While Connecticut is just getting the word out, the physical learning movement has swept through some other states in one form or another. From Maine to Mississippi, kids are sitting on exercise balls instead of desk chairs, using them to help kids sit up straight, be less antsy and focus better. In Fairport, N.Y., elementary school kids do jumping jacks and jump rope between lessons. In Olympia, Wash., elementary school students take mini exercise breaks to dance across the floor, roll their shoulders and reach for the sky to refocus.

“Many people have been encouraging more exercise in classrooms for a long time, but there hasn’t been a focused message,” Mee said. “Now we are trying to broadcast it as a really big message.”



Visual learning a key strategy for helping students succeed

Software that takes a visual approach to teaching math has led to double-digit gains in the test scores of Orange County, Calif., students—and the software's maker was one of several ed-tech companies demonstrating new visual learning products at the 2010 Florida Education Technology Conference (FETC) in Orlando.

At FETC, the nonprofit MIND Research Institute discussed findings of a 2009 study suggesting that students using the group's ST Math software experienced dramatic learning gains.

ST Math is a supplemental program for students in grades K-5 that is based on decades of neuroscience research at the University of California, Irvine. The software taps into the brain's innate "spatial temporal" reasoning ability to visualize and solve math concepts and problems, its makers say.

Students solve math problems presented as visual puzzles, before they are ever introduced to abstract math language and symbols. Through a carefully engineered sequence of fun-to-play software "games," students work at their own pace to solve increasingly difficult problems that eventually require them to think multiple steps ahead in space and time—and they receive instant feedback about why a solution works or doesn't.

More than 15,000 students enrolled in 64 elementary schools are taking part in the Orange County Math Initiative, a five-year community partnership involving Orange County schools, leaders in the business community, UC Irvine, and MIND. The 64 participating schools are in the lowest-performing 30 percent of California elementary schools; 80 percent of their students qualify for free or reduced-price lunches, and 60 percent are English-language learners.

Yet the percentage of these students who tested at the Proficient or Advanced level on California's most recent state exam increased by more than 12 percentage points, MIND said, compared with the state average of 4.5 points.

"We've seen what can be done with the benefit of a tool like this," said Andrew R. Coulson, president of MIND's education division. Now, Coulson said, his organization is trying to make the software even better.

At FETC, the institute previewed its fourth generation of ST Math. Earlier versions of the software used a one-size-fits-all pacing, Coulson said; version 4 changes that, allowing educators to customize the pace and sequencing of lessons to better align them with whatever core curriculum their school is using.

Users can edit the software's sequencing calendar with a drag-and-drop feature, and the new version includes pre- and post-tests to check students' progress.

MIND also introduced a new math fluency program at FETC, called ST Math Fluency, which uses visualization strategies and interactive animations to reinforce basic math facts. To achieve optimal results, students should use the software programs for at least two sessions per week, Coulson said, with each session lasting 45 minutes.

Another company that makes visual learning programs for schools is Inspiration Software. At FETC, Inspiration debuted version 9 of its popular self-titled software, which helps students develop critical thinking and organizational skills through the use of visual representations. The program reportedly is used in more than 25 million schools worldwide.

Responding to a frequent request from teachers, Inspiration 9 adds new presentation capabilities to the software, said company president and co-founder Mona Westhaver. With just a few mouse clicks, students now can create a presentation from an outline they've constructed.

For schools that choose not to upgrade to the full version 9, a presentation applet that adds the same functionality is available for downloading. But Inspiration 9 adds several other new capabilities that are useful as well, Westhaver said.

These include the ability to add video and sound to outlines; a menu of choices for labeling how various concepts are linked in a concept map, making it easier for students to understand the relationships between concepts; and a new map view for creating Mind Maps, a method of note-taking in non-linear fashion developed by Tony Buzan in the 1970s.

A single copy of Inspiration 9 sells for $69, with volume and site licenses available. For schools upgrading from earlier versions of the software, the cost is $29.95 through June 30 and $39.95 thereafter.

For the past several years, Inspiration Software has offered grants for teachers to learn how to incorporate visual learning strategies in their classrooms. Applications for these Inspired Teacher Scholarships typically were due in late January, but this year the company didn't issue a call for applications.

Westhaver explained that the company is restructuring the program to incorporate student projects, too—and the new grant program will be announced later this year.

How multimedia can improve learning

An analysis of existing research supports a notion that already has begun to transform instruction in schools from coast to coast: that multimodal learning–using many modes and strategies that cater to individual learners' needs and capacities–is more effective than traditional, unimodal learning, which uses a single mode or strategy.

According to a new report commissioned by Cisco Systems, adding visuals to verbal (textual and/or auditory) instruction can result in significant gains in basic or higher-order learning, if applied appropriately. Students using a well-designed combination of visuals and text learn more than students who use only text, the report says.

It also provides insights into when interactivity strengthens the multimodal learning of moderate to complex topics, and when it's advantageous for students to work individually when learning.

"There is a lot of misinformation circulating about the effectiveness of multimodal learning," said Charles Fadel, Cisco's global education leader. "As curriculum designers embrace multimedia and technology wholeheartedly, we considered it important to set the record straight, in the interest of the most effective teaching and learning."

The report, titled *Multimodal Learning through Media: What the Research Says*, was conducted by the Metiri Group, which serves the education community through a broad range of consulting services. It is the third in a series of meta-studies that address "what the research says" about various topics in education; prior reports tackled technology in schools and education and economic growth.

Information was gathered for the report using meta-analysis, or combining the results of several studies that address a set of related research hypotheses. Only studies published after 1997 and addressing the use of multimedia in education were considered.

"The real challenge before educators today is to establish learning environments, teaching practices, curricula, and resources that leverage what we know about the limitations of human physiology and the capacity explained by the cognitive sciences to augment deep learning in students," says the study.

How students learn

New information about how we acquire knowledge is now available through functional magnetic resonance imaging (fMRI) of the human brain at work and rapid sampling techniques that reveal the pattern of brain activity over time as people read, listen, talk, observe, think, multitask, and perform other mental tasks.

In its introduction, the Metiri Group report indicates that the brain has three types of memory: sensory memory, working memory, and long-term memory.

Working memory is where thinking gets done and is dual-coded with a buffer for storage of verbal or text elements, and a second buffer for visual or spatial elements. Short-term memory is thought to be limited to approximately four objects that can be simultaneously stored in visual or spatial memory and about seven objects that can be simultaneously stored in verbal memory.

Within working memory, verbal/text memory and visual/spatial memory work together, without interference, to strengthen understanding. However, overfilling either buffer can result in cognitive overload and weaken learning.

Recent studies also suggest that convergence, or sensory input combined with new information at the same time, has positive effects on memory retrieval. It creates linked memories, so that the triggering of any aspect of the experience will bring to consciousness the entire memory.

Sensory memory is caused by experiencing anything through the five senses (sight, sound, taste, smell, and touch) and is involuntarily stored in long-term memory as episodic knowledge. However, these sensory memories degrade very quickly, and it's only when the person pays attention to elements of sensory memory that these experiences get introduced into working memory. Once an experience is in a student's working memory, the learner then can consciously hold that experience in his or her memory and can think about it in context.

Long-term memory is nearly unlimited, and it's estimated that a person can store up to 10 to the 20^{th} power bits of information over a lifetime–equivalent to 50,000 times the text in the U.S. Library of Congress (30 million cataloged books; 58 million manuscripts).

The brain has two types of long-term memory: episodic and semantic. Episodic comes from sensory input and is involuntary. Semantic memory stores memory traces from working memory, including ideas, thoughts, schema (chunks of multiple individual units of memory that are linked into a system of understanding), and processes that result from the thinking accomplished in working memory.

To show how a student might use all types of memory when learning, the report cites a female student in a science lab, working as part of a team on the development of an architectural design. All sensory activity is involuntarily encoded in her memory through dual sensory channels: The student's verbal/text memory might include side conversations, noise from other teams, and so on, while the visual/spatial memory might include the current architectural drawings on the screen or paper, facial expressions, and physical movements by others.

Only if she consciously considers each sensory input, or contemplates further about a particular side conversation (such as about the traffic patterns associated with various building designs), will the memory move from short to long term. As the student considers this side conversation about traffic patterns, she will be able to cue up memories from her personal experiences stored in long-term memory that have enriched her thinking.

It's important to understand that while this learning is occurring, the student could become distracted by something (such as an office announcement) and might experience "attention blink," thereby losing sight of everything else around her owing to cognitive overload.

This cognitive overload won't prevent the student from continuing to register input involuntarily, but these experiences will be stored only in short-term memory and so won't last long.

Furthermore, as the student consciously considers each sensory input, her cognitive control function limits attention to serial consideration of ideas and concepts–meaning that her cognitive ability is slowed down and multitasking is inefficient. Thinking, decision-making, and cueing of long-term memories require the central cognitive processor, which only works serially. Therefore, the more sensory input there is, the greater the risk of overload–and the greater the risk of leaving information out of long-term memory.

The report concludes its overview of cognitive science by citing the principles listed by the National Academy of Sciences from its 2001 publication, *How People Learn*:

* Student preconceptions of curriculum must be engaged in the learning process. Only when the student has the opportunity to correct misconceptions, build on prior knowledge, and create schemas of understanding a topic will learning be optimized.

* Expertise is developed through deep understanding. Students learn more when the concepts are personally meaningful to them. This translates into a need for authentic learning in classrooms–deep learning, relevant to those outside the classroom, and involving students' use of the key ideas in a production.

* Learning is optimized when students develop "metacognitive" strategies. To be metacognitive is to be constantly "thinking about one's own thinking." Students who are metacognitive are

students who approach problems by automatically trying to predict outcomes, explaining ideas to themselves, noting and learning from failures, and activating prior knowledge.

Multimedia and learning

So, what does the science of learning tell us about the use of multimedia during instruction? As the report suggests, multimedia is one modality of learning that can help students learn more efficiently when applied properly, because convergence–or sensory input simultaneously combined with new information–has positive effects on memory retrieval. But too much sensory input can lead to cognitive overload, the report cautions, so educators must be careful to use multimedia appropriately.

Based on the work of Richard Mayer, Roxanne Moreno, and other researchers, the Metiri Group report synthesized a list of learning principles for multimedia:

* Multimedia Principle: Retention is improved through words and pictures rather than through words alone.

* Spatial Contiguity Principle: Students learn better when corresponding words and pictures are presented near each other, rather than far from each other on the page or screen.

* Temporal Contiguity Principle: Students learn better when corresponding words and pictures are presented simultaneously rather than successively.

* Coherence Principle: Students learn better when extraneous words, pictures, and sounds are excluded rather than included.

* Modality Principle: Students learn better from animation and narration than from animation and on-screen text.

* Individual Differences Principle: Design effects are higher for low-knowledge learners than for high-knowledge learners. Also, design effects are higher for high-spatial learners than for low-spatial learners.

* Direct Manipulation Principle: As the complexity of the materials increases, the impact of direct manipulation (animation, pacing) of the learning materials on the transfer of knowledge also increases.

Therefore, students engaged in learning that incorporates multimodal designs, on average, outperform students who learn using traditional approaches with single modes, the report says.

For example, based on meta-analysis, the average student's scores on basic skills assessments increase by 21 percentiles when engaged in non-interactive, multimodal learning (which includes using text with visual input, text with audio input, and watching and listening to animations or lectures that effectively use visuals) in comparison with traditional, single-mode learning.

When students shift from non-interactive multimodal to interactive multimodal learning (such as engagement in simulations, modeling, and real-world experiences–most often in collaborative teams or groups), results are not quite as high, with average gains at 9 percentiles.

However, when the average student is engaged in higher-order thinking using multimedia in interactive situations, on average, that student's percentage ranking on higher-order or transfer skills increases by 32 percentile points over what the student would have accomplished with traditional learning.

When the context shifts from interactive to non-interactive multimodal learning, the result is 20 percentile points over traditional means.

Based on these principles and statistics, the report lists a few tips for educators on how to teach students using multimedia:

(1) Know the importance of the attention and motivation of the learner. The "scaffolding" of learning–the act of providing learners with assistance or support to perform a task beyond their own reach–by reducing extraneous diversions and focusing the learner's attention on appropriate elements aligned to the topic has proven effective.

(2) Know the importance of separating the media from the instructional approach. A recent meta-analysis in which more than 650 empirical studies compared media-enabled distance learning to conventional learning found pedagogy to be more strongly correlated to achievement than media. The media and pedagogy must be defined separately.

Where to go from here

While the report's analysis provides a clear rationale for using multimedia in learning, the research in this field is evolving, its authors say. Recent articles suggest that efficacy, motivation, and volition of learners, as well as the type of learning task and the level of instructional scaffolding, can weigh heavily on learning outcomes from the use of multimedia.

Future research will focus on the social affordances that multimedia representations provide, the scaffolding required to prepare students to effectively use multimedia representations, and the learning designs necessary to minimize cognitive overload, the report suggests.

The report concludes by noting: "The convergence of the cognitive sciences and neurosciences provides insights into the field of multimodal learning through Web 2.0 tools. The combination will yield important guideposts in the research and development of eLearning using emergent, high-tech environments."

Memory training helps with problem solving

Training a child to hold a whole cluster of items in his or her memory for even a short time might feel like trying to hold a wave on the sand. But a study published June 13 says it's a drill that can yield lasting benefits.

Children who've had such training have better abstract reasoning and solve problems more creatively than kids who haven't, the study found.

But these drills, the scientists found, pay the greatest dividends for children who actually need them and who find the escalating challenge of the games fun, not frustrating.

For others, "it might be difficult if you push your kid too much," said lead author Susanne M. Jaeggi, a psychology professor at the University of Michigan. "It's like a parent pushing a child to do sports or learn a musical instrument: There's always this delicate balance between too much or too little."

The training program used by Jaeggi and her co-workers focused on ramping up working memory: the ability to hold in mind a handful of information bits briefly, and to update them as needed.

Cognitive scientists consider working memory a key component of intelligence. But they have long debated whether strengthening short-term memory capacity will boost a person's overall intellectual function—and whether it will do so even after the brain-training sessions are over.

It can, and it does, according to this new research, published in the Proceedings of the National Academy of Sciences.

The study put 32 elementary and middle school children through a rigorous month-long regimen of computer games designed to test, challenge, and strengthen their working memory. An additional 30 children trained on a computer program that involved answering general knowledge and vocabulary questions.

The working-memory programs—adapted from a brain game designed for older users—required children to follow and remember a sequence of positions on a grid and, shortly after seeing the pattern, to answer questions about it. When a child did well on a game, the next sequence would become longer, increasingly challenging the child's ability to hold in mind the sequence and spatial information.

The task requires a child's rapt attention for as long as a minute and emphasizes the ability to screen out distractions while focusing on a single task. The child must recall where and in what order items appeared on a screen, then work backward through that remembered information to answer questions correctly.

Jaeggi called the task, known as the "n-back test" by psychologists, "really devilish. If you lose track just a little bit, you're completely out of it and you have to start anew."

When the children were tested at the end of the month of training, the Michigan researchers at first found scant differences between the group that got the working-memory training and the general knowledge group. Although those who had received working-memory training were better at holding several items in mind for a short while, on a test of abstract reasoning—fluid intelligence—they were, as a group, no smarter than the control group.

But then the researchers took a closer look and noticed a clear pattern: The children who had improved the most on the memory-training task did, indeed, perform better on the fluid intelligence test. And three months later, they still did better as a group than both the control group and the children who hadn't improved.

The study comes against the backdrop of explosive growth in the business of brain-training programs for children. Increasingly, designers of brain games—a roughly $300-million-a-year business that has sprung up in less than a decade—are aiming at intellectually ambitious parents bent on supplying their progeny all the cognitive advantages money can buy.

Alvaro Fernandez, who teaches the science of brain health at San Francisco State University and is the founder of SharpBrains, a company that tracks the brain fitness business, said about $75 million a year of the brain-training business was focused on school-age children.

In a deal certain to accelerate that trend, the educational publishing giant Pearson last year bought Cogmed, a Swedish start-up company that has pioneered the development of brain-training programs focused on working memory.

"They'll have a sales force in every school district in the country," Fernandez predicted.

For school children, the result could be an influx in video-based training programs that could put eye-popping graphics and engaging gamesmanship in the service of academic skill-building. Many of the newest programs have emerged from a mind meld of neuroscientists and video game designers. The resulting products adapt to their users' progress, dispensing virtual prizes and increasing the level of difficulty to keep a young player motivated and challenged.

“It’s train but don’t strain your brain,” said UCLA psychiatrist Dr. Gary Small, author of “The Memory Bible” and creator of a new training program called Memory Power. “You’ve got to find the sweet spot—we know that.”

That formula—fun and challenging, but not so challenging as to be frustrating—turned out to be crucial in the new study. Those children who saw significant and lasting improvements in abstract reasoning were far more likely to be the ones who rated the games as challenging but not overwhelming, Jaeggi said.

She likened the mental exercise of building working memory to a would-be athlete embarking on a regimen of aerobic exercise: A workout that’s too easy can lead an athlete to plateau, and one that’s too hard can discourage and cause injury.

Other studies have found stronger evidence that working-memory training has the power to help a person not only to remember a shopping list but to be a more agile thinker as well, said Torkel Klingberg, a Swedish neuroscientist who founded Cogmed and has been a pioneer in working-memory research.

Patricia Schwarz, who teaches fifth-graders at Los Angeles’ Solano Avenue Elementary School, says her children run the gamut from those who hear instructions once and remember them till the task is done to those who get “befuddled” by the time they get to step two.

“There are a lot of kids who need instructions and graphics and words written on the blackboard. It just doesn’t work for them the way it does with others,” said Schwarz, a 24-year veteran of teaching. Any brain training that works “would be fantastic,” she said at the end of a long day of teaching photosynthesis.

For more information on ‘Stimulation’ and the brain:

New York Times, “Digital Devices Deprive Brain of Needed Downtime.”—When people keep their brains busy with digital input, they are forfeiting downtime that could allow them to better learn and remember information, or come up with new ideas.
http://www.nytimes.com/2010/08/25/technology/25brain.html?_r=2&ref=technology

New York Times, “Brain Calisthenics for Abstract Ideas.”—Recent research has found that true experts have something at least as valuable as a mastery of the rules: gut instinct, an instantaneous grasp of the type of problem they’re up against.
http://www.nytimes.com/2011/06/07/health/07learn.html?_r=1&emc=eta1

Arts & Language Arts

Extra memory exercises and engaging students in exercise are certainly some no-brainer ways to help the mind learn, but what some educators might not know is that the arts and simple activities, such as reading, can help students think in different ways, stimulating areas of the mind that affect 21st-century skills like problem-solving.

Arts integration improves reasoning, general intelligence

Although No Child Left Behind has prompted many districts to focus on core subject areas and ignore or cut arts education programs, a new federal report suggests that's a wrong approach.

Released May 6, the report reveals that arts education might help student achievement in these core areas and is essential to the nation's future competitiveness—and it urges school leaders to try creative approaches to arts education during the school day.

Compiled by the President's Committee on the Arts and the Humanities (PCAH), the report is titled "Reinvesting in Arts Education: Winning America's Future Through Creative Schools." It is the first federal analysis of arts education data of its kind in a decade.

"To succeed today and in the future, America's children will need to be inventive, resourceful, and imaginative," Education Secretary Arne Duncan wrote in the report's foreword. "The best way to foster that creativity is through arts education."

Developed in response to President Obama's Arts Policy Campaign Platform, the report presents five recommendations to help schools incorporate the arts into other disciplines:

1. Build robust collaborations among different approaches to arts education.
2. Develop the field of arts integration.
3. Expand in-school opportunities for teaching artists.
4. Use federal and state policies to reinforce the place of arts in K-12 education.
5. Widen the focus of evidence gathering about arts education.

"Imagine more science classrooms where kids learned about sound waves by playing the flute, or understood mathematical relationships by creating digital designs," said Dennis Scholl, vice president of the arts at the Knight Foundation. "Integrating arts into our everyday lives and learning is essential."

Data highlighted in the report show that low-income students who participate in arts education are four times more likely to have high academic achievement and three times more likely to have high attendance than those who don't, with these results continuing into college. Schools that participated in an arts-integration model had consistently higher average scores on district reading and math assessments.

Neuroscience studies demonstrate that arts education can have a significant impact on brain development. Music training helps with the development of phonological awareness and spatial-temporal reasoning, helping with reading skills, while children who practiced a specific art form improved their attention skills and general intelligence. Links also exist between high levels of music training and the ability to manipulate information in both working memory and long-term memory.

Studies cited in the report show that arts integration leads to better attendance and fewer discipline problems, as well as increased graduation rates, especially for economically disadvantaged students. This information comes at a time when the national dropout rate has fluctuated between 25 and 30 percent since 2001, while some demographic groups have far higher rates. Approximately 50 percent of males from economically disadvantaged groups are estimated to leave high school before graduation, while 2 million students attend what federal officials call “dropout factories.”

PCAH developed the report after 18 months of school visits, interviews with educational leaders, and reviews of recent research. The panel concluded that arts education is a boon for the private sector—business leaders are looking for innovation and creativity from their employees—and is an important way to prepare today’s students for tomorrow’s careers.

“We know that education is key to winning the future and that, to compete, we must challenge ourselves to improve educational outcomes for our children,” said Melody Barnes, director of the White House Domestic Policy Council. “The administration recognizes the powerful role that the arts education strategies presented in this report can play in closing the achievement gap, improving student engagement, and building creativity and innovative thinking skills.”

PCAH plans to spend the next year presenting the report’s findings to policy makers, superintendents, principals, and educators and exploring ways to implement its recommendations.

Reading boosts brain pathways, affects multiple disciplines

Recent research shows that reading has a massive impact on brain function and can actually affect understanding in nearly all school subjects.

Neuroscientist Stanislaus Dehaene conducted research on the brain function of Portuguese-speaking Brazilian adults, both those who had learned to read and those who were illiterate. Dehaene chose Brazil because of its lack of compulsory education laws. Some of the population voluntarily forewent education, while others lacked access. The adults were matched for socio-economic status (SES) so the results would not be biased by educational or income level.

Martha Burns, an associate professor at Northwestern University and a speech and language pathologist, recently examined Dehaene's studies in a blog post.

"A person who is a reader actually listens better," said Burns. "They actually listen to speech and process speech faster and in more detail."

Dehaene then proceeded to teach the illiterate adults to read, and found astonishing results, which Burns expanded on in her blog.

"Lo and behold, their brains changed dramatically in the same way the literate adults who had read their whole lives changed. Their visual perceptual skills improved, their auditory listening skills improved, and their ability to drive this whole left hemisphere symbolic problem-solving way of syncing changed," Burns said.

This crux of the study has significant implications for educators.

"The reason [that it's] so important for our educators to know [this] is that educators change brains. They don't just teach content, they don't just improve the brain that I already have by giving me information that I hold on to. They actually change the way that the human brain processes information," said Burns.

Such a massive change occurs as a result of how the brain is structured. The left hemisphere of the brain enables humans to perceive the internal details of words, such as the "b" sound in book, so they can then make the conversion between the sound and letter. The front lobe contains a segment that enables the sequencing of sounds, so you can remember how words are pronounced (i.e., "animal," and not "aminal"). These two areas are connected by a huge superhighway of fiber.

"The brain builds based on what it does. So children who have lots of language exposure build this pathway very precisely, and then when they get into school reading is easy," Burns said. However, children who lack language exposure during their early development have a less defined pathway and language structure in their brains.

"If that superhighway system is weak, that doesn't mean the child doesn't have potential, that doesn't mean the child isn't smart. It just means that it hasn't been exercised as much," said Burns.

When this connection is weak, it makes it difficult for children to link letters and sounds, in turn making it hard to sequence words. This causes complications when learning grammar, which entirely revolves around sequencing. When this problem isn't addressed, students fail to learn to read at all.

But a lack of literacy doesn't just affect literature-based subjects.

"When students are struggling and they don't learn how to read, that then interferes with their ability to learn visually, it interferes with their ability to problem solve, and it interferes with their ability to listen to teachers, so they're getting further and further behind, which we've known but we haven't really known why," Burns said. "It turns out that the key is the ability to read, which I think changes our emphasis to, 'let's find these children early, and let's get them reading—and let's use neuroscience-based intervention that boosts their capacity to learn to read.'"

If reading skills are improved and the connection between the left hemisphere and frontal lobe strengthens, studies show that not only do reading scores improve, but so do social studies scores, math scores, and science scores.

"If you get reading—and the underlying processes that support reading—in shape so that a child can learn and benefit from classroom instruction, it can boost all academic areas," said Burns.

Burns emphasized that the process for building these stronger pathways starts at home, and she encouraged parents to talk to their children.

"It's hard to reach the parents who don't talk to their kids, because those are the very parents who are working two jobs, who are single-parent homes, who didn't have a lot of speech in their home when they were little," Burns said, adding that children from low SES families are exposed to a 32 million-word gap compared to children from a higher SES.

Because the brain is a quantity analyzer and processes more based on receiving more data, this gap can cause serious issues.

“The message we want to get out to parents everywhere is: Talk to your children. Reading is fine, too, read to your children. But I’m not so concerned about reading, because that architecture will build itself once a child learns to read; I’m more concerned about language in general,” Burns said. “Get [children] off the TV, get them away from screen time before two years of age, just talk, talk, talk.”

For more information on 'Arts & Language Arts' and the brain:

NPR, "Being Bilingual May Boost Your Brain Power."—Research suggests that the growing numbers of bilingual speakers may have an advantage that goes beyond communication: It turns out that being bilingual is also good for your brain.
http://www.npr.org/2011/04/04/135043787/being-bilingual-may-boost-your-brain-power?sc=17&f=1001

Mind Games

By now, most everyone's heard the reports and studies that show youth are drawn to video games—and these can be used as tools for learning. But besides being fun to play and, therefore, engaging to students, are video games affecting the way the brain processes information? And if so, do teaching practices have to change in order to stay in the game?

Can gaming change education?

As video games continue to permeate our culture, schools and students are increasingly interested in using video games for learning. This interest has prompted universities and neurologists to explore what makes a successful educational game, what the current barriers to adoption are, and how gaming as a whole affects the brain.

According to a recent paper by the Massachusetts Institute of Technology (MIT), games, when developed correctly and used appropriately, can engage players in learning that is specifically applicable to school curriculum—and teachers can leverage the learning in these games without disrupting the worlds of either “play” or school.

“Moving Learning Games Forward: Obstacles, Opportunities, and Openness,” by Eric Klopfer, Scot Osterweil, and Katie Salen of the Education Arcade, an MIT research division that explores games that promote learning through play, explains why educational games have seen an increase in popularity: mainly owing to the advances in consumer games.

For example, commercial games have not only exposed new audiences to gaming but have expanded the range of education games, growing the conceptual areas they can reach. This, the paper states, is partly a result of greater experimentation with content and game mechanics that stems from new technologies and gaming genres.

“Consumer games are also changing the perception of the nature of video games, making them more accepted in a greater diversity of places. For example, gaming is becoming part of … the activities in senior centers, libraries, museums,” and the workplace, says the report. “They are also providing cheaper and easier ways to reach everyone, making open access to games a reality.”

The report credits new gaming platforms and a “sinking edutainment ship” as factors that have led to an increased education interest in gaming.

Thanks to advances in technology, cheaper prices, and a growing market for video games, children and young adults are playing video games more than ever.

A report from the Joan Ganz Cooney Center, “Game Changer: Investing in digital play to advance children’s learning and health,” claims that on an average day, children as young as eight spend as many hours engaged in media activity as they spend in school. Seventy-five percent of American children play computer and video games, it says.

The report, said Michael Levine, executive director of the Joan Ganz Cooney Center at Sesame Workshop, aims to help answer the question: "Can digital games, especially well-designed education games, help reshape our nation's approach to learning and growing?"

The center, which supports research, innovation, and investment in digital media technologies to advance children's learning, interviewed experts in learning, health, and civic participation games–as well as scholarly skeptics, says Levine–who are directly involved in research, design, and policy development in the field of gaming.

The report analyzed issues raised by the interviewees through a review of current literature and news sources.

"We conclude that current approaches to solving key education and child-health challenges insufficiently leverage the ubiquitous digital media that currently pervade children's lives," said Levine. "[We] believe that the demonstrated potential of digital media wisely guided by caring adults could become a 'game changer' in advancing children's prospects in the decade ahead."

The report says that children can learn content and 21st-century skills, create media, and think of systems as a whole through successful digital games.

Games don't just affect enthusiasm

With so many children and young adults playing video games each day, researchers are exploring how exposure to consistent game playing affects brain functions and brain plasticity–the brain's ability to change throughout life.

Daphne Bavelier, professor of Brain and Cognitive Sciences at the University of Rochester in New York and a recent presenter at the National Center for Technology Innovation's annual Technology Innovators Conference, says her research suggests that playing action video games on a regular basis can alter a player's attention skills.

"We have recently shown that playing first-person point of view action video games affects several aspects of perception, attention, and cognition," said Bavelier.

Skills that are enhanced by action video game training, Bavelier said, include low-level vision owing to enhanced contrast sensitivity function; various aspects of attention, such as monitoring several objects at once or searching through a cluttered scene; more complex task constructs such as multi-tasking and task-switching; and a general speeding up of perceptual processing.

"This work illustrates how skilled performance in a variety of processing domains can be enhanced by a single training regimen. Practical implications of this finding, such as vocational training (e.g., for laparoscopic surgeons) or clinical rehabilitation are being investigated," she said.

"In our most recent study, we aimed at answering the question, 'Are gamers better than non-gamers at not getting visually distracted because of gaming?' And when we did the control study, we found that yes, it's true–gamers have better focus and better visually selective attention," Bavelier said.

Bavelier added that while these brain functions could develop with all video games, action games push the speed of learning.

"Action games have diverse environments that don't let gamers lose attention. They also let gamers explore their environments, and this is good. Most also have a reward system for completing actions successfully, which has been shown to be a strong motivator to playing," said Bavelier.

By studying how various video games affect brain function, Bavelier and her colleagues at the University of Rochester hope to determine how performance can be altered by experience (the length of game playing) and to characterize the factors that favor the transfer of learning (in other words, to identify the aspects of video games help people to learn). These ongoing behavioral investigations are combined with brain imaging techniques, including MRI and fMRI, to allow for a more direct characterization of the brain systems that are modified by video-game playing.

In "The development of attention skills in action video game players," Bavelier's most recent study, Bavelier and her colleagues use the Attentional Network Test (ANT) to illustrate how action video game players of all ages have enhanced attentional skills, thereby helping them make faster correct responses to targets.

Bavelier said while she has not yet studied how increased attentional skills and other brain functions affected by action video-game playing can translate into classroom learning, other researchers at the University of Oregon have begun those studies.

"In terms of education, the next step should be [to] take the violence out of action video games and use the same brain-building characteristics in these action video games to make [high] quality education games," said Bavelier.

At the University of Oregon, researchers are studying how the brain functions affected by video games in turn can affect learning.

Helen Neville, director of the university's Brain Development Lab, is using MRI and electrophysiological techniques to study the brain's development and plasticity.

Specifically, Neville and her colleagues have begun a program of research on the effects of different types of training on brain development and cognition in typically-developing children of different ages.

In one series of studies, Neville is targeting the most changeable and vulnerable brain systems in three- to five-year-old Head Start preschoolers whom she studies before and after eight weeks of daily attention training, or eight weeks during which their parents receive training in parenting skills, or a combination of the two types of training.

"These studies can contribute information of practical significance in the design and implementation of educational programs," Neville said.

Barriers to gaming

Even though students play video games at home, and current research now suggests that certain games can enhance brain functions, many educators trying to redesign their curriculum for the 21st century are still hesitant to bring video games into the classroom.

"Recognizing the types of barriers facing the educational games space is important," says the MIT report, "for while not insurmountable, these barriers pose significant challenges and can only be overcome by a coordinated effort by funders, developers, schools, parents, and kids."

The barriers mentioned include:

- Barriers to adoption: These include curriculum requirements, attitudes of parents and educators, logistics of game integration in the classroom, support for teachers, assessment, evidence that games make a difference in learning, limited uses of games for all subjects, limited views of the games currently available today, and social and cultural structures that hinder school innovation.

- Barriers to design and development: These include high development costs for games, a labor-intensive development process that normally doesn't include input from teachers or education specialists, the lack of pilots in schools, and limited sources of funding to develop educational games.

- Barriers to sustainability: These include fickle gamer loyalty to games for long periods of time, quickly outdated technology, and maintenance and support funding from schools.

- Barriers to innovation: These include limited data of how games affect learning in schools, limited pedagogical paradigms, limited research, and limited ambition on all fronts.

"Experts in the field agree that kids love playing [video games], but the research has not fully demonstrated with precision why or how they work, as well as how to design them for specific learning goals," says the Joan Ganz Cooney report.

The report lists issues that educators and game developers need to address, such as deepening knowledge about the benefits and limitations of games for children's learning; designing games that increase learning, whether about health, literacy, science, history, or problem-solving; identifying what elements (which setting, program interventions, or types of adult guidance) make game-playing more effective; and determining how games can best be integrated into the classroom and other learning environments.

Specifically, the report notes that research and investment in video game-playing needs to establish priorities for the research or student, or scale up the innovation in this area, and disseminate evidence of what works—more than just what's in scientific journals.

Solid design for better learning

While more research is needed on gaming in education, researchers are learning what constitutes good gaming design, especially for education. However, many products claiming to be educational gaming for students today might not be the best solutions.

According to MIT's report, the process of designing and creating educational games can be much like the baking process.

"There are many attempts by a growing number of health-conscious cooks to make things that are both yummy and healthy. It isn't easy to balance these two qualities … and there is likely no universal solution," the report says. "Some recipes work really well for some groups of people, in certain contexts, with certain expectations. Similarly, in creating experiences that are both fun and filled with learning, the success of different recipes, such as mixing media, immersion, game styles, learning goals, and mixtures of content, depends quite a bit on the audience, context, content, goals, and facilitation."

The report warns that injecting content learning into a game where it doesn't fit might create experiences that are entertaining, but their educational value is suspect.

"If your spaceship requires you to answer a math problem before you can use your blasters, chances are you'll hate the game and the math. This is the strategy taken by most of the legacy edutainment games (*Math Blaster*), as well as many of the new attempts to create commercially viable learning games today (immersive 3-D math game, *Dimension M*)," the report says.

Another mistake game developers make, says the MIT report, is to take educational content and make it look like a game; for example, putting algebra problems in a 3-D virtual world, or placing the periodic table of elements in a shooting arcade.

When creating games, there are a number of principles that must be followed, the MIT researchers say:

1. Choose wisely.
2. Think small (sometimes).
3. Educational games don't always equal entertainment games.
4. Put learning and game play first.
5. Find the game in the content.
6. Break the mold for where educational games are played.
7. Harness the "soft skill" learning from games but connect it with content.
8. Don't ignore, nor be limited by, teacher training and readiness.
9. Play everywhere and anywhere.
10. Reduce, reuse, and recycle.
11. Define the learning goals.
12. Forge partnerships.
13. Don't ignore or be too constrained by academic/state standards.
14. Not just who but what, where, when, and why.

Click here for a more detailed list of recommendations.

Ntiedo Etuk, chairman and CEO of Tabula Digita, the company that created *Dimension M*, takes issue with MIT's report. In an interview with *eSchool News*, he pointed to evidence of *DimensionM*'s success and said the MIT researchers were dealing with a different issue than his own game's objective.

"MIT is talking about ideal design objectives and what would be a game that could teach the subject matter entirely. This is not what we do," Etuk said. "For example, if a teacher were going to teach fractions that week, we'd tell her to have her students play the game first, and then as they need help or don't get problems right, that's where the teacher comes in to actually teach. We designed our games to lead up to the teachable moment. We help students with the concept and practice and help teachers with assessments with our assessment tool."

Etuk said his company has completed multiple studies on what makes an educational game successful, and "with games that wanted to teach the whole subject, many teachers needed extensive professional development so that they could play the game as well. In a large school system, that's just not scalable," he said.

The difference of opinion reflects the fact that researchers are still in the early stages of trying to determine what works and what doesn't when it comes to educational gaming design.

Where to go from here?

As researchers begin to build the pieces of what makes a good educational game, and why and how gaming affects learning, the Joan Ganz Cooney report has a set of recommendations to jump-start a national "game-changing" action plan that addresses gaming in education.

According to the report, research on digital media needs to be coordinated, and research and development needs to be initiated at federal and state levels. Innovative partnerships also should be created to help fund and stimulate creative networks that have varying levels of expertise. Support and guidance for children's digital activities must be encouraged, and public media should be modernized to fit the needs and interests of kids living in the digital age. Finally, a broad public dialog about digital media and games should be started.

"In order to advance the cause of educational games, we should be wary of overreaching by claiming that games single-handedly teach the subject matter, at least in the way the word 'teach' is commonly understood," cautions the MIT report.

"Games [promote] understanding, motivation, and enjoyment and are terrific at immersing players in complex, feedback-rich problem spaces. And while they are most often not sufficient in and of themselves for a course of study, they can help many students advance beyond the temporary memorization of facts and procedures, attainments that are usually lost when classes stop."

Even violent video games can be learning tools

You're at the front lines shooting Nazis before they shoot you. Or, you're a futuristic gladiator in a death match with robots. Either way, you're playing a video game—and you might be improving your vision and other brain functions, according to research presented May 27 at a New York University conference on games as a learning tool.

"People that play these fast-paced games have better vision, better attention, and better cognition," said Daphne Bavelier, an assistant professor in the department of brain and cognitive science at the University of Rochester.

Bavelier was a presenter at a daylong symposium on the educational uses of video and computer games from NYU's Games for Learning Institute. The event was another indication that electronic games are gaining legitimacy in the classroom. (The University of Wisconsin-Madison also hosts an annual conference on educational gaming.)

President Barack Obama recently identified the creation of good educational software as one of the "grand challenges for American innovation," and the federal Department of Education's assistant deputy secretary for the Office of Innovation and Improvement, Jim Shelton, attended the conference as well.

Panelists discussed how people learn and how games can be engineered to be even more educational.

"People do learn from games," said J. Dexter Fletcher of the Institute for Defense Analyses.

Sigmund Tobias of the State University of New York at Albany said an Israeli air force study found that students who played the game "Space Fortress" had better rankings in their pilot training than students who did not.

He added that students who played "pro-social" games that promote cooperation were more likely than others to help out in real-life situations, such as intervening when someone is being harassed.

Bavelier's research has focused on so-called first-person shooter games like "Unreal Tournament" and "Medal of Honor," in which the player is an Allied solder during World War II.

"You have to jump into vehicles, you have to crouch and hide," said Tammy Schachter, a spokeswoman for game developer Electronic Arts Inc.

Bavelier said playing the kill-or-be-killed games can improve peripheral vision and the ability to see objects at dusk, and the games can even be used to treat amblyopia, or lazy eye, a disorder characterized by indistinct vision in one eye.

She said she believes the games can improve math performance and other brain tasks as well.

“We are testing this hypothesis that when you play an action video game, what you do is you learn to better allocate your resources,” she said. “In a sense you learn to learn. … You become very good at adapting to whatever is asked of you.”

Bavelier believes the games eventually will become part of school curricula, but “it’s going to take a generation.”

Schachter said the purpose of “Medal of Honor” and other games is to have fun, and any educational benefits are a bonus.

“Through entertainment, these games test your memory skills, your eye-hand coordination, your ability to detect small activities on the screen and interact with them,” she said.

Not everyone is a fan. Gavin McKiernan, the national grassroots director for the Parents Television Council, an advocacy group concerned about sex and violence in the media, said that when it comes to violent video games, any positive effects are outweighed by the negative.

“You are not just passively watching Scarface blow away people,” McKiernan said. “You are actually participating. Doing these things over and over again is going to have an effect.”

Bavelier said games could be developed that would harness the positive effects of the first-person shooter games without the violence.

“As you know, most of us females just hate those action video games,” she said. “You don’t have to use shooting. You can use, for example, a princess [who] has a magic wand, and whenever she touches something, it turns into a butterfly and sparkles.”

For more information on gaming and the brain:

Associated Press, “Brain games don’t make you smarter.”—Researchers say getting some exercise, rather than playing games marketed by companies like Nintendo, can help with brain training. Physical activity can spark new connections between neurons and produce new brain cells, say experts.
http://www.huffingtonpost.com/2010/04/21/study-brain-games-dont-ma_n_546168.html

Educational Games Research—Research and discussion concerning instructional video games.
http://www.edugamesresearch.com/

MacArthur Foundation Series on Digital Media and Learning found in MIT Press Journals—This series examines the effect of digital media tools on how people learn, network, communicate, and play, and how growing up with these tools may affect a person’s sense of self, how they express themselves, and their ability to learn, exercise judgment, and think systematically.
http://www.mitpressjournals.org/toc/dmal/-/3

Early Childhood

&

Disabilities

Knowing how the mind works and implementing effective strategies to support learning are never more important than when the brain is in its earliest stages of development. In this section, you'll find resources that explore how educators can nurture the mind in early childhood learning, as well as resources that cover another frontier of the mind: learning disabilities. Researchers are coming closer to understanding how conditions like autism work, and what parents and educators can do to help children.

Study shows long-term benefits of preschool

Preschool has surprisingly enduring benefits that last well into adulthood, according to one of the biggest, longest follow-up studies of its kind.

Better jobs, less drug abuse, and fewer arrests are among advantages found in the study that tracked more than 1,000 low-income, mostly black Chicago kids for up to 25 years.

Michael Washington was one of them. Now a 31-year-old heating and air conditioning contractor, Washington attended a year of preschool at Chicago's intensive Child-Parent Center Education Program when he was 4.

The ongoing, publicly funded program focuses on language development, scholastic skills, and building self-confidence. It involves one or two years of half-day preschool, and up to four additional years of educational and family services in grade school. Preschool teachers have college degrees and are certified in early childhood education, and parents are encouraged to be involved in the classes.

Washington lived in an impoverished West Side community and has strong memories of preschool field trips to the library, zoo, and planetarium, where he learned to love science. He says he'll never forget the strong influence of his preschool teachers.

"You expect your mom and dad to care for you. But when a stranger, who has no ties to you whatsoever, takes the time to invest in you, takes the time to listen, that makes you open your eyes bigger," said Washington, now living in Blue Island, Ill. "It was real cool."

Washington got good grades in elementary and high school and he attended two years of college at Chicago State University. Unlike other kids he knew from the neighborhood who didn't attend preschool, he says he never tried drugs and was never arrested.

The study tracked nearly 900 children into adulthood who attended the program in the early 1980s, and compared them to almost 500 low-income Chicago youngsters, most of whom didn't attend preschool.

The results were published June 9 in the online version of the journal *Science*. They bolster findings from similar, smaller studies and show that high-quality preschool "gives you your biggest bang for the buck," said Dr. Pamela High, chair of an American Academy of Pediatrics committee that deals with early childhood issues. She was not involved in the study.

Though many preschool kids also got extra services in grade school, including intensive reading instruction, the researchers found the most enduring effects—particularly for non-academic success—were owing to one or two years of preschool. The authors theorize that those intensive early childhood experiences built intellectual skills, social adjustment, and motivation that helped children better navigate their high-risk environments.

To be sure, the challenges facing the children in both groups were still insurmountable to many. As adults, the average annual income for those who went to preschool is less than $12,000—and almost half of them had been arrested as adults. As dismal as those outcomes are, the numbers were still better than for the group that didn't attend preschool. And experts not involved in the study called the results impressive.

"To still show really any advantage for such a long period of time is remarkable and noteworthy," said Kyle Snow, director of the National Association for the Education of Young Children's applied research center.

The study's lead researcher, Arthur Reynolds of the University of Minnesota, said the differences between the groups are meaningful and translate to big savings to society for kids who attended preschool.

The average cost per child for 18 months of preschool in 2011 is $9,000, but Reynolds' cost-benefit analysis suggests that leads to at least $90,000 in benefits per child in terms of increased earnings, tax revenue, less criminal behavior, reduced mental health costs, and other measures, he said.

"No other social program for children and youth has been shown to have that level of return on investment," he said.

Among the study results:

• 80 percent of the preschool group finished high school, versus 75 percent of the others;

• Nearly 15 percent of the preschool group attended a four-year college, versus 11 percent of the others;

• 28 percent of the preschool group had skilled jobs requiring post-high school training, versus 21 percent of the others;

• Average annual adult income for the preschool group was about $11,600, versus $10,800 for the others. The low average incomes include zero earnings for those in prison and close to that for adults who were still in college or studying elsewhere.

• 14 percent of the preschool group had abused drugs in adulthood, versus 19 percent of the others;

• 48 percent of the preschool group had been arrested in adulthood and 15 percent had been incarcerated, versus 54 percent of the others arrested and 21 percent incarcerated.

The results are based on public records, administrative data, and interviews with study participants.

Kaspar the friendly robot helps autistic kids

Eden Sawczenko used to recoil when other little girls held her hand and turned stiff when they hugged her. This year, the 4-year-old autistic girl began playing with a robot that teaches about emotions and physical contact–and now she hugs everyone.

“She’s a lot more affectionate with her friends now and will even initiate the embrace,” said Claire Sawczenko, Eden’s mother.

The girl attends a pre-school for autistic children in Stevenage, north of London, where researchers bring in a human-looking, child-sized robot once a week for a supervised session. The children, whose autism ranges from mild to severe, play with the robot for up to 10 minutes alongside a scientist who controls the robot with a remote control.

The robot, named Kaspar, is programmed to do things like smile, frown, laugh, blink and wave his arms. He has shaggy black hair, a baseball cap, a few wires protruding from his neck, and striped red socks. He was built by scientists at the University of Hertfordshire at a cost of about 1,300 pounds (US $2,118).

There are several versions of Kaspar, including one advanced enough to play Nintendo Wii. The robot’s still in the experimental stage, and researchers hope he could be mass-produced one day for a few hundred dollars.

“Children with autism don’t react well to people because they don’t understand facial expressions,” said Ben Robins, a senior research fellow in computer science at the University of Hertfordshire who specializes in working with autistic children.

“Robots are much safer for them because there’s less for them to interpret and they are very predictable.”

There are similar projects in Canada, Japan and the U.S., but the British one is the most advanced according to other European robot researchers not connected with the project.

Scientists at the University of Hertfordshire first began using a version of Kaspar in 1998. The newest model is covered in silicone patches that feel like skin to help children become more comfortable with touching people. So far, almost 300 kids in Britain with autism, a disorder that affects development of social interaction and communication, have played with a Kaspar robot as part of scientific research.

The robot has only a handful of tricks, like saying “Hello, my name is Kaspar. Let’s play together,” laughing when his sides or feet are touched, raising his arms up and down, or hiding his face with his hands and crying out “Ouch. This hurts,” when he’s slapped too hard.

But that is enough to keep autistic children enthralled. Ronnie Arloff, 4, was so eager to see Kaspar he banged on the door and shouted his name. Arloff opened his arms wide just like the robot. He also recognized facial expressions, saying “happy” when Kaspar was smiling and “sad” when he frowned.

Nan Cannon-Jones, an autism consultant at the school, said the robot helps children understand emotions and language. “After Kaspar says ‘haha’ when he’s tickled, the children learn that’s what laughing is,” she said. Two of the 12 to 17 kids who attend the pre-school have refused to play with Kaspar outright.

The school also uses speech and music therapy. “You can’t teach children to speak or play using a robot, but it helps reinforce what we’re teaching them already, like how to share and be nice to people,” Cannon-Jones said.

Experts not linked to the project said it was a promising idea.

“Autistic children like things that are made up of different parts, like a robot, so they may process what the robot does more easily than a real person,” said Dr. Abigail San, a childhood clinical psychologist in London and spokeswoman for the British Psychological Society.

She thought it was possible that skills children learned with the robot at the pre-school could be transferred to their homes or the playground. But San warned that experts and parents shouldn’t rely on robots too much. “We don’t want children with autism to get too used to playing with robots,” she said. “Ultimately, they need to be able to relate to other people.”

Kerstin Dautenhahn, the senior researcher at the University of Hertfordshire behind the Kaspar project, said she and colleagues don’t have enough data to know if playing with Kaspar has sped up social skills in autistic children. They have published case studies describing improvements in up to a dozen children but no long-term trials.

Researchers say prospects for a comprehensive study depend on funding and teacher-parent participation, since they would have to track the kids for years–but they would like to carry one out.

She said it might also be possible to modify Kaspar to help children with other developmental problems, like Down syndrome.

Uta Frith, an emeritus professor of cognitive development at University College London, said the robot was valuable in providing children with social interactions, but doubted a machine was necessary.

“What’s important for autistic kids is that they learn how to play imaginatively,” she said. “And for that, you could use cooking pots or a shoe box.”

But Eden Sawczenko’s mom says Kaspar’s weekly visits seem to be helping.

“Before, Eden would make a smiley face no matter what emotion you asked her to show,” she said. “But now she is starting to put the right emotion with the right face. That’s really nice to see.”

For more information on early childhood, disabilities and the brain:

Education Commission of the States (ECS) "Brain Research and Education: Neuroscience Research Has Impact for Education Policy."—What neuroscience reveals about early childhood development and learning and how this research can affect education policy.
http://ruby.fgcu.edu/courses/ehyun/10041/brain_research_and__educat.htm

Reuters, "Study finds first evidence that ADHD is genetic."—British scientists have found the first direct evidence that attention deficit/hyperactivity disorder (ADHD) is a genetic disorder and say their research could eventually lead to better treatments for the condition.
http://www.reuters.com/article/2010/09/30/us-adhd-genes-idUSTRE68S5UD20100930

CNN, "Scientists look to help children with autism find a voice."—A new research project is scientifically evaluating programs designed to help kids with autism learn to speak, including sensory integration therapy.
http://www.cnn.com/2010/HEALTH/03/01/autism.speech.learning/index.html?hpt=Sbin

TIME, "Could Brain Scans Help Spot Autism?"—Currently, autism is diagnosed based on subjective evaluations of a child's behavioral and developmental deficits, but researchers at Columbia say using brain scans may offer more objective indicators of the condition.
http://healthland.time.com/2011/06/01/study-could-brain-scans-help-spot-autism/?artId=34689?contType=article?chn=us

Free archived webinar series from BrainWare SAFARI that includes the latest findings on brain research, focusing on neuroscience and students with learning disabilities.
http://mybrainware.com/education/EducationWebinarSeries.htm

Links and Bibliography

Links (In alphabetical order)

Brain and Cognitive Sciences at the University of Rochester

The Brain Development Lab at the University of Oregon

Cisco Systems

Connecting the Mind, Brain, and Education Conference

Daphne Bavelier

"Game Changer" (PDF)

Games for Learning Institute

International Consortium for Brain Mapping

Joan Ganz Cooney Center

Johns Hopkins Neuro-Education Initiative

Learning, Arts, and the Brain Summit

Mary Helen Immordino-Yang

The Metiri Group

Michael Atherton

MIND Research Institute

MIT's Education Arcade

"Moving Learning Games Forward" (PDF)

Multimodal Learning through Media: What the Research Says (PDF)

National Center for Technology Innovation

Parents Television Council

Rutgers Mind/Brain Analysis Center

Scientific Learning

Bibliography

Big Picture

"What educators can learn from brain research." *eSchool Media*. 21 July. 2009.

"Brain-mapping could illuminate how students learn." *eSchool Media*. 1 Sept. 2003.

Stimulation

"Physically active learning improves test scores, sharpens concentration." Copyright (c) 2011, *The Hartford Courant*. To see more of *The Hartford Courant*, or to subscribe to the newspaper, go to http://www.courant.com/. Distributed by McClatchy-Tribune Information Services.

"Visual learning a key strategy for helping students succeed." *eSchool Media*. 28 Jan. 2010.

"Analysis: How multimedia can improve learning." *eSchool Media*. 26 Mar. 2008.

"Memory training improves intelligence in some children." Copyright (c) 2011, *Los Angeles Times*. To see more of the *Los Angeles Times*, or to subscribe to the newspaper, go to http://www.latimes.com. Distributed by McClatchy-Tribune Information Services.

Arts & Language Arts

"New report cites need for more arts integration." *eSchool Media*. 6 May. 2011.

"Reading boosts brain pathways, affects multiple disciplines." *eSchool Media*. 3 May. 2011.

Mind Games

"Can gaming change education?" *eSchool Media*. 9 Dec. 2009.

"Researchers: Even violent video games can be learning tools." *eSchool Media*. 28 May. 2010.

Early Childhood & Disabilities

"Study shows long-term benefits of preschool." *eSchool Media*. 9 June. 2011.

"Kaspar the friendly robot helps autistic kids." *eSchool Media*. 8 March. 2011.

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