



The Neuroscience of Joyful Education

Brain research tells us that when the fun stops, learning often stops too.

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Most children can't wait to start kindergarten and approach the beginning of school with awe and anticipation. Kindergartners and 1st graders often talk passionately about what they learn and do in school. Unfortunately, the current emphasis on standardized testing and rote learning encroaches upon many students' joy. In their zeal to raise test scores, too many policymakers wrongly assume that students who are laughing, interacting in groups, or being creative with art, music, or dance are not doing *real* academic work. The result is that some teachers feel pressure to preside over more sedate classrooms with students on the same page in the same book, sitting in straight rows, facing straight ahead.

Supporting Good Teaching Practices with Neuroscience

The truth is that when we scrub joy and comfort from the classroom, we distance our students from effective information processing and long-term memory storage. Instead of taking pleasure from learning, students become bored, anxious, and anything but engaged. They ultimately learn to feel bad about school and lose the joy they once felt.

My own experience as a neurologist and classroom teacher has shown me the benefits of joy in the classroom. Neuroimaging studies and measurement of brain chemical transmitters reveal that students' comfort level can influence information transmission and storage in the brain (Thanos et al., 1999). When students are engaged and motivated and feel minimal stress, information flows freely through the affective filter in the amygdala and they achieve higher levels of cognition, make connections, and experience "aha" moments. Such learning comes not from quiet classrooms and directed lectures, but from classrooms with an atmosphere of exuberant discovery (Kohn, 2004).

The Brain-Based Research

Neuroimaging and neurochemical research support an education model in which stress and anxiety are not pervasive (Chugani, 1998; Pawlak, Magarinos, Melchor, McEwan, & Strickland, 2003). This research suggests that superior learning takes place when classroom experiences are enjoyable and relevant to students' lives, interests, and experiences.

Many education theorists (Dulay & Burt, 1977; Krashen, 1982) have proposed that students

retain what they learn when the learning is associated with strong positive emotion. Cognitive psychology studies provide clinical evidence that stress, boredom, confusion, low motivation, and anxiety can individually, and more profoundly in combination, interfere with learning (Christianson, 1992).

Neuroimaging and measurement of brain chemicals (neurotransmitters) show us what happens in the brain during stressful emotional states. By reading glucose or oxygen use and blood flow, positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) indicate activity in identifiable regions of the brain. These scans demonstrate that under stressful conditions information is blocked from entering the brain's areas of higher cognitive memory consolidation and storage. In other words, when stress activates the brain's affective filters, information flow to the higher cognitive networks is limited and the learning process grinds to a halt.

Neuroimaging and electroencephalography (EEG) brain mapping of subjects in the process of learning new information reveal that the most active areas of the brain when new sensory information is received are the somatosensory cortex areas. Input from each individual sense (hearing, touch, taste, vision, smell) is delivered to these areas and then matched with previously stored related memories.

For example, the brain appears to link new words about cars with previously stored data in the category of transportation. Simultaneously, the limbic system, comprising parts of the temporal lobe, hippocampus, amygdala, and prefrontal cortex (front part of the frontal lobe), adds emotional significance to the information (sour flavor is tasty in lemon sherbet but unpleasant in spoiled juice). Such relational memories appear to enhance storage of the new information in long-term memory (Andreasen et al., 1999).

Mapping studies of the electrical activity (EEG or brain waves) and neuroimaging show the synchronization of brain activity as information passes from the somatosensory cortex areas to the limbic system (Andreasen et al., 1999). For example, bursts of brain activity from the somatosensory cortex are followed milliseconds later by bursts of electrical activity in the hippocampus, amygdala, and then the other parts of the limbic system (Sowell et al., 2003). This enables us to evaluate which strategies either stimulate or impede communication among the various parts of the brain (Shadmehr & Holcomb, 1997).

RAD Lessons for the Classroom

A common theme in brain research is that superior cognitive input to the executive function networks is more likely when stress is low and learning experiences are relevant to students. Lessons that are stimulating and challenging are more likely to pass through the reticular activating system (a filter in the lower brain that focuses attention on novel changes perceived in the environment). Classroom experiences that are free of intimidation may help information pass through the amygdala's affective filter. In addition, when classroom activities are pleasurable, the brain releases dopamine, a neurotransmitter that stimulates the memory centers and promotes the release of acetylcholinem, which increases focused attention.

The acronym RAD can remind educators of three important neuroscience concepts to consider

when preparing lessons:

- Novelty promotes information transmission through the **R**eticular activating system.
- Stress-free classrooms propel data through the **A**mygdala's affective filter.
- Pleasurable associations linked with learning are more likely to release more **D**opamine.

There are no neuroimaging or brain wave analysis data that demonstrate a negative effect of joy and exuberance in classrooms, yet some schools have unspoken mandates against these valuable components of the classroom experience. Now that hard science proves the negative effects of stress and anxiety, teachers can more confidently promote enthusiasm in their classrooms.

Planning for the Ideal Emotional Atmosphere

Although it is valuable for teachers to be familiar with neuroscientific research and pass relevant findings along to education stakeholders, it is crucial that educators use classroom strategies that reflect what we know about the brain and learning. So how can teachers create environments where anxiety is low while providing enough challenge and novelty for suitable brain stimulation?

Make it relevant.

When stress in the classroom is getting high, it is often because a lesson is overly abstract or seems irrelevant to students. Teachers can reduce this type of stress by making the lesson more personally interesting and motivating. Ideally, students should be able to answer the question, "Why are we learning about this?" at any point in a lesson.

Teachers can find valuable background materials and human interest connections in textbooks published in the 1990s, before many publishers dropped such information to make room for practice test questions. The Internet is a source of many teacher-shared lesson plans and links to Web sites that provide resources for student activities and information databases that bring the more fact-heavy lessons to life. These are just a few Web sites that teachers can mine for ideas:

- The Jason Project: a multimedia, interdisciplinary science program for grades 4–9, www.jasonproject.org
- NASA Education: resources and information for K–12 teachers, <http://education.nasa.gov>
- PBS Teachers: multimedia resources for preK–12 educators, www.pbs.org/teachersource
- A to Z Teacher Stuff: a teacher-created site designed to help teachers find online resources, <http://atozteacherstuff.com>
- Edhelper: theme units, lesson plans, and worksheets, www.edhelper.com

It is not always possible to explain the immediate relevance of every lesson. In math, for example, students must master certain skills before they can go on to investigate larger, more clearly relevant topics. One way to increase the emotional connection is by adapting word

problems so that they include the names of students, popular celebrities, historical figures, or sports heroes. Similarly, problems about interest rates can relate to purchasing something the students would want to buy, such as an iPod or new sneakers. Students can learn about decimal place values by calculating batting averages to the thousandth place.

Language arts teachers can combine lessons on formal letter writing with a study of ethics or advertising. Students select a television commercial or print ad they judge to be misleading and write a letter expressing that opinion to the company in question. Students can compare historical fact and fiction by reading texts, examining primary sources, and viewing movies.

In science classes dealing with the differences between mixtures and solutions, students can predict which liquids in their homes are mixtures and which are solutions. At home, they test their predictions by seeing which items are in separate layers until shaken. Or instead of just studying facts about pollution, students can learn to take and test water samples (www.baylink.org/lessons/3fr_pollution.html).

When a lesson or block of lessons is full of facts to memorize, students will often feel less stress when they see an intrinsic reward for their efforts, such as using the facts they've mastered as a tool for participating in a more appealing activity. For example, when students know the metric to standard measurement conversions, they can "translate" a recipe from a cookbook that uses metric measures into the quantities they need in U.S. standard measurements to prepare cookie dough in class.

Give them a break.

Just like adults, students can reduce stress by enjoying hobbies, time with friends, exercise, or music. Even though schools are shortening recess, physical education, art, drama, and even lunchtime to add more time for core subjects, teachers can give students a three-minute vacation to reduce stress. Any pleasurable activity used as a brief break can give the amygdala a chance to cool down and the neurotransmitters time to rebuild.

Create positive associations.

Eliminating all stress from students' lives is impossible. However, even if previous classroom experiences have led to associations that link certain activities, such as memorizing multiplication tables, to a stress response from the amygdala, students can benefit from revisiting the activity without something negative happening. By avoiding stressful practices like calling on students who have not raised their hands, teachers can dampen the stress association.

Students can develop positive associations with multiplication by practicing it with a positively reinforcing strategy. For example, they might first review the table for multiplying by eight, then fill in blanks on a worksheet and immediately check each written answer with a calculator. If the answer is correct, the student experiences instant positive reinforcement. If the answer is incorrect, the student sees the right answer on the calculator—a much more pleasurable experience than hearing a classmate call out the answer before the student can even begin to compute it.

In a similar way, students can build on their neurochemical memories of positive feelings if they have opportunities to recognize and savor their successes. A posted “Personal Goal Achievement” list, for example, acknowledges all students' successes. Students set personal goals, such as learning a specific multiplication table, and their names go on this list when they achieve their goals. Unlike the more typical competitive list of scores or lists of students who have mastered specific skills, this goal achievement list includes only the names of students who have met their goals, not the actual goals themselves.

Prioritize information.

It is helpful for teachers to guide students in learning how to prioritize information—how to decide what facts are worthy of writing down and reviewing when studying. When teachers demonstrate and explain how they determine which facts are important, students see how to make those judgments for themselves as they read texts and study. Helping students learn how to prioritize and therefore reduce the amount of information they need to deal with is a valuable stress-buster.

Allow independent discovery learning.

Thanks to dopamine release and the consolidation of relational memories, students are more likely to remember and understand what they learn if they find it compelling or have a part in figuring it out for themselves. In addition, when students have some choices in the way they will study or report on something, their motivation will increase and stress will diminish. They will be more accepting of their errors, motivated to try again, and less self-conscious about asking questions.

A Safe Haven

Classrooms can be the safe haven where academic practices and classroom strategies provide students with emotional comfort and pleasure as well as knowledge. When teachers use strategies to reduce stress and build a positive emotional environment, students gain emotional resilience and learn more efficiently and at higher levels of cognition. Brain-imaging studies support this relationship.

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