# Applying Principles of Brain Research to Maximize Every Child's Learning Potential

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For the last 10 years research investigating the organization, operation, and functions of the brain have enabled neuroscientists to observe and analyze the activity of the conscious brain. Using magnetic resonance imagining (MRI) machines and position emission topology (PET) scanners, scientists are mapping and tracking how specific parts of the brain relate to one another and work together to focus and sustain our attention. As a result of this research, neuroscientists have proven that there is an emotional dimension to learning and remembering that cannot be separated from the cognitive dimension.

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Despite this advancement in neuroscience, American education largely ignores the emotional origins of learning. Individual differences in how young children learn are not taken into account unless they are extreme enough for the child to be labeled learning disabled, developmentally delayed, or emotionally disturbed, or to be identified as having attention deficit disorder (ADD) with or without hyperactivity (ADHD). While paying lip service to helping children who are having reading difficulty, many educators pay little attention to the emotionally based generative aspects of thinking and learning. Pediatricians, psychologists, classroom teachers, and special education teachers observe routinely, however, the impact of repeated failure and emotional stress on children's ability to learn. Attending to the emotional side of learning is important to all learners, especially those who struggle.

I wrote the book *Teaching Struggling Readers: How to Use Brain-Based Research to Maximize Learning* because I believe strongly that teachers will create more positive experiences for struggling children once they know how to meet their emotional, social, and cognitive needs. In this article, five fundamental principles about learning and the workings of the brain are introduced. For each of the five, I discuss the principle, explain why the principle is important, and then present practical educational implications for each.

## Principle 1: The Brain Is an Adaptive and Plastic Working System.

The brain is an adaptive and plastic working assembly of neurons that interact to form our thoughts and actions. Different regions and components of the brain are interacting at the same time on information coming through our five senses to produce thoughts, emotions, memories, and imagination. Each of us is endowed with a highly complex, inborn circuitry of neurons with branching pathways called dendrites that are formed through various experiences from birth.

Infants are born with an excess number of neurons, many of which are

uncommitted and have not made any connections. When an infant engages in an activity such as trying to reach a rattle on the floor, the brain stimulates itself to repeat the neural relays involved to reach the rattle. The growth and development of the brain's neural system depends on the number and kinds of connections the neurons make.

Since experience plays a major role in how the brain grows and develops, some types of neurons are stimulated at the expense of others. Fortunately, due to the plasticity and adaptability of the brain's working system of neurons, some redistribution of functions occurs. Similar cortical neurons may learn to stand in for a missing performer. The most dramatic evidence of the brain's plasticity comes from the long-term study of children who as infants had an entire half of their brain removed because they were born having epileptic seizures. To the researchers' amazement, many of the children developed the functions normally served by both hemispheres (Mate, 1999).

Beginning shortly after conception and lasting throughout a lifetime, the neural system is dynamically changing. Neuroscientists used to think that neural adaptability and flexibility diminished gradually with age, when rerouting became impossible. Studies of men and women from 70 to 100 years old, however, prove this theory wrong.

Recent research investigating the mental processing of senior citizens reveals that neural cells are capable of dividing and becoming healthy new neurons during the learning process. This discovery is even more dramatic because these viable new cells were found in the hippocampus, a brain region crucial to learning and memory (McKhann & Albert, 2002).

Neurological adaptability and plasticity may also be seen in the recovery many people make from a stroke. MRI studies of hundreds of stroke patients revealed that the brain often compensates for damage to the portion of the neural network affected by rerouting neurons to establish new pathways.

I have a personal experience that supports this finding. My mother had a severe stroke when she was 72 years old. The damage was on her left side of the brain, which suggested that she would have some paralysis on the right side of her body. Mom could not lift her right arm or put weight on her right leg. Damage to the left cerebral hemisphere also interfered with her capacity to speak.

After hearing this news, I asked Dad to bring photo albums of our annual family vacation to the hospital to share with Mom. His immediate response was, "What for, she is in a coma and I would be talking to myself." I reassured him that Mom would probably hear and process his one-way conversation. At the time, I was working at the brain behavior laboratory at The Ohio State University Department of Neurology and witnessed the emotional responses stroke patients exhibited while looking at family photos. Dad reluctantly agreed to do what I had suggested.

Following this conversation, I arranged my travel to the hospital. As soon as I stepped off the hospital elevator, I could hear Dad's booming voice. I had the surprise of my life when I walked into the room and saw the slide projector and screen. Mom's eyes were closed, but the expression on her face showed understanding. She was smiling as Dad discussed the photos of our annual game of charades.

Dad explained that after two hours of talking to himself while leafing through the family album, Mom's eyes started to flutter and a slight smile came across her lips. He immediately

*A critical factor in determining how successful children are in doing cognitive tasks is the competence of adults to scaffold their thinking.*

called the neurologist, who speculated that her intact emotional right hemisphere was responding to the family photos, triggering pleasant memories. She was showing signs of coming out of the coma, which the doctor had not expected in such a short amount of time given the extent of damage to her left hemisphere. Dad's response to this good news had been to race home to get the slide projector and screen. He thought the more stimulation Mom received, the quicker she would recover. He was probably right.

Mom was released from the hospital 6 weeks after her stroke, just in time to come again on our family vacation. She thoroughly enjoyed the 2 days she was able to spend with us. Mom was in a rehabilitation facility for 3 months. She gained approximately 90% of her ability to walk and speak. The neurons of Mom's undamaged right hemisphere rerouted and reorganized to enable her to walk and talk again. It has been 17 years since her initial stroke and to this day, she has never missed our annual family vacation.

*The Importance of Understanding the Adaptability and Plasticity of the Brain*

Parents and educators understand that children's experiences, especially interactions with others, greatly impact how the brain grows and develops. Additionally, the most phenomenal attribute of the brain is the ability of the neural tissue to change in response to an enriched environment. The adaptability and neural plasticity of the brain enable individuals to learn and to adapt in response to new stimulation—to relearn. Detailed videotaped analyses of effective Reading Recovery teachers show vividly that enriched social interactions and learning opportunities can result in positive changes in the behavior and learning of the most difficult-to-teach children (Lyons, 2003).

*Educational Implications*

Experience determines how neurons in the brain connect, organize, and reorganize. Activities such as reading and writing, focusing attention, comprehending what one hears, and remembering what we have learned requires the combined efforts of millions of neural connections. Nature has constituted the child's brain so that it is remarkably plastic. The good news for parents and teachers is that there are many routes through which brain development may occur; if one part is not doing its job, other areas will take over. New or alternative neurons may form naturally if learning is blocked for any reason.

Current research offers an optimistic view of our chances to help every child become a successful learner (Lyons, 2003). Since there are individual differences in learning, there is no one best way to teach children to read and write. In many primary classrooms, children who do not learn required material in a specified amount of time or way are considered to have a deficit; that is, there is something wrong with their brains. Educators begin to look for reasons for their student's learning problems. Parents and teachers oftentimes do not expect much from struggling children. Some parents and teachers believe that children who struggle are born without enough brainpower to learn.

If the neurons of infants who have had one-half of their brains removed can reorganize and redevelop, how can we not believe that every child can learn to read and write if provided the necessary experiences and instruction? If neuronal cells can divide and reproduce anew in the hippocampus region of the brain in individuals who have been traumatized by a stroke or reached their senior years, certainly the undamaged brains of children who struggle to learn can reorganize and generate new neurons. It is critical that parents and teachers realize

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- every child has the potential to learn,
- environmental factors affect learning, and
- the brain has great plasticity and can be altered when the learning environment is enriched.

## Principle 2: The Brain Is Social and Emotional.

The second critical new insight from recent brain research reveals that social and emotional relationships and interactions with others profoundly influence learning. For the first 2 years of life, infants' brains are in the most flexible, pliable, impressionable, and accepting state that they will ever be. The social learning that takes place in infancy through the mutual expression of affection between parent and child impacts the child's future learning

Well-intentioned parents and teachers may unwittingly short-circuit the neural pathways to skill development by creating a learning environment that is frustrating and puts the child at a disadvantage.

potential. Furthermore, attunement, which involves sharing emotional space, effects the development of affective communication and emotional connectedness with others.

Most mothers can recognize differences in infants' varying states of mind when they cry. A demanding sharp cry may suggest that the child is hungry or wet. A loud shrill cry could indicate frustration or anger. A continuous monotone cry may mean that the infant is tired. Parents are generally attuned to the emotional state of mind of their children. In some cases this attunement lasts through adulthood. I can still tell from the tone and urgency in my 32-year-old son's voice if he is troubled about something.

*The Importance of Understanding That the Brain Is Social and Emotional*

Using sophisticated brain maps, neurologists have found that implicit emotional memories processed by the amygdala, which is a part of the limbic system of the brain, greatly impact how one learns and what is learned. (See Lyons, 2003 for more information about the amygdala and limbic system of the brain).

When social interactions and conversations between a parent or teacher and a child are traumatic, the implicit emotional memory processing system operating through the amygdala is likely to inhibit learning: the child's emotions will take over, and the child will not be able to focus and sustain attention. Conversely, when interactions are positive, emotional connectivity occurs and learning is enhanced. The following example illustrates this point.

Gail, a graduate student in one of my classes, was worried about her 8-year-old son who had difficulty relating to his classmates and learning in school. At the age of 3, Mark was diagnosed with hearing difficulties, delays in language acquisition, and gross motor delays. Mark experienced learning difficulties in all subject areas—except reading— since first grade. Gail wanted to know how to help her son become a better student and hopefully learn to enjoy school and his classmates.

Concerned about the recommendation from a new psychiatrist who thought Ritalin and antidepressants would improve Mark's grades and help him adjust socially and academically, Gail asked what I thought about drug therapy. I suggested she seek a second opinion from a pediatric neurologist. Gail agreed.

After a battery of tests, which included an MRI, the pediatric neurologist said that Mark was developmentally delayed and approximately 2 years behind his peers socially and academically in all subject areas except reading. His performance on a standardized reading assessment indicated that Mark was reading above grade level. Gail asked the doctor to explain why Mark's development in reading was better than average. The pediatric neurologist hypothesized that his advanced placement was the result of a strong emotional attachment to reading, which probably started early on in his life. Gail explained that she had read to Mark every night since he was born.

The neurologist hypothesized that reading to Mark was the *ultimate intervention*. The emotional bonding between mother and son that took place during bedtime reading helped Mark to acquire the cognitive skills necessary to read. Providing a positive emotional climate and encouraging Mark to express feelings and opinions about the many children's literature books they read together every day helped Mark to regulate and sustain attention and thus learn. Gail had provided a nurturing environment that was safe, consistent, motivating, and challenging—the ultimate intervention.

Today Mark is a sophomore in high school. Mark still experiences some learning difficulties; however, he has several good friends and standardized tests scores place his reading ability at the college level. Gail attributes her son's school success to the fact that he can read well and enjoys books. The nightly bedtime reading rituals started in infancy enabled Mark to feel successful and probably prevented years of emotional trauma as he progressed through the grades.

*Educational Implications*

Learning occurs best when positive emotions facilitate the chemical secretions required in the brain to connect neurons. These secretions, called neurotransmitters, help children remain secure, motivated, and in control. This condition can only occur when social interactions are positive and children feel that they can succeed. Well-intentioned parents and teachers

may unwittingly short-circuit the neural pathways to skill development by creating a learning environment that is frustrating and puts the child at a disadvantage.

In recent research, scientists used PET scans to monitor the neural processing of children living in impoverished surroundings (e.g., orphanages, third-world countries). They found that the children had different brain structures than children who have experienced enriched environments. Yet, once removed from the impoverished environment, they acquired more neurons and developed a more integral neural network. The research also showed increases in brain tissue when parts of the brain were stimulated after having been neglected (Levine, 2002). This is incredible information and positive news for the thousands of parents and teachers working with children struggling to learn. Parents and teachers need to

- stay attuned to and respond to the emotional side of learning;
- create many opportunities for children to succeed and feel successful; and
- provide supportive, calm, and positive learning environments.

## Principle 3: Emotions and Thoughts Interact, Shape Each Other, and Cannot Be Separated.

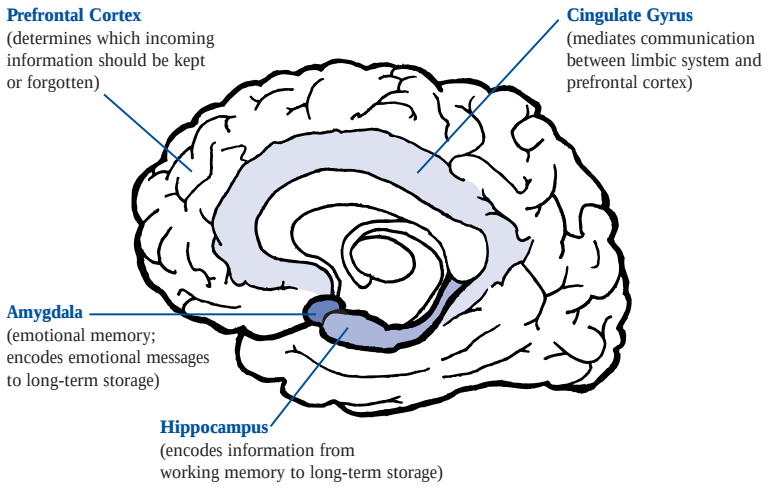
Until recently, the majority of books that focus on cognitive development did not mention the interplay of emotion and cognition. This glaring omission reflects an almost complete failure to recognize any affective streak in cognitive development. Research in neuroscience has proven that what children learn is heavily influenced and organized by emotions and that emotions color how information is received, assembled, interpreted, and understood. Furthermore, these positive or negative emotional reactions to events are observable in infancy and preschool and continue throughout life. In the following example, a 3-year-old girl and boy learn two different lessons from their fathers.

Kelly is frustrated putting a puzzle together and asks her busy father for help. Her father stops what he is doing immediately and with excitement in his voice asks, "How can I help you?" The father's response suggests that Kelly's needs are more important than the task he is currently doing and that he will help to alleviate her frustration as quickly as possible. Kelly learns that she can count on her father to help when she is experiencing difficulty.

Michael's father, on the other hand, has a different reaction and response to his son's frustrated call for help while putting the puzzle together. He looks at his son and says in a loud, angry voice, "Don't bother me now. Can't you see that I am busy? I have many more important things to do than help you with a puzzle. Figure it out for yourself." This father's response suggests that the job he is doing now is more important than helping Michael put the puzzle together. Michael learns that when he is experiencing difficulty, he is expected to figure out a solution independently.

Children who routinely receive the second response begin to believe this to be typical behavior from adults, and it may mold the child's emotional expectations about relationships for many years or until another adult or peer changes the child's expectations. If a father is not able to stop what he is doing when a child asks for help, a better response is, "Please wait a few minutes until I am done working on the lawn mower, and I will be happy to help you."

Figure 1.




*Information is processed first by the amygdala, which is the site of emotion, before it is sent to the hippocampus (the cognitive dimension), and they become totally dependent on each other for learning.*

Emotional memory takes precedence over any kind of memory. The brain always gives priority to emotions.

*The Importance of Understanding How Emotions and Cognition Commingle*

MRI studies provide convincing hard data to show that thinking (reasoning) cannot be separated from emotion (Damasio, 2000). Information is processed first by the amygdala (see Figure 1, page 5), which is the site of emotion, before it is sent to the hippocampus (the cognitive dimension), and they become totally dependent on each other for learning. There is a fusion between emotion and thought. Emotional responses

- are formed without any cognitive participation at all,
- are formed from emotional events, and
- can impede or foster memory required for retrieval and comprehension.

Children who struggle to learn tend to be most sensitive and react negatively or positively to parents' and teachers' nonverbal cues. Emotional memory takes precedence over any kind of memory. The brain always gives priority to emotions.

*Educational Implications*

What teachers and parents do and say has an impact on children's motivation to learn, what they learn, and how much they learn. Parents and teachers may not be able to change their feelings due to a myriad of reasons, but they should pay attention to the emotional message their conversations and interactions send to each child they teach.

Positive affective social environments are critical in the development of complex thinking processes required to read and write. The connectedness of the cognitive and emotional areas of the brain implies that there is an intimate and immediate interplay between emotion and cognition in both short-term and long-term interactions that take place throughout a child's life, even through adulthood. Teachers must understand the following:

- What children learn depends on how they communicate verbally and nonverbally.
- Adults reveal their inner attitudes, beliefs, and prejudices every time they interact with children.
- Social exchanges and interactions have a powerful impact on children's abilities to attend and sustain attention while thinking and learning.

## Principle 4: Learning Is a Constructive Process.

The fourth principle supported by research investigating the workings of the brain is that learning is a complex constructive process. The constructive learner engages in many different kinds of self-initiated and self-directed activities. Additionally, children are affected by what happens after they act. A baby, for example, may crawl to a brightly colored ball on the floor and discover what happens if he tries to reach for it. The reaction may be positive (a smile) because he has caused the ball to roll, or negative (a cry) because the ball is out of reach. Children independently construct an internal representation of their world early in life. They begin to understand what day-to-day experiences and social interactions with others mean. They learn how to make a response and get feedback. Thus, in daily interactions, the child's mind is inseparably joined with other minds. And out of this interconnection, children become constructive learners, develop intrinsic motivation, and become independent.

*The Importance of Understanding the Nature of Learning*

Children develop conceptual knowledge only within the constructive process of learning. Parents and teachers cannot do it for them. When children learn a concept, they are able to self-organize and independently generalize the learned concept to another context or situation.

Children must teach themselves many of the concepts about learning to read. For example, the child must learn the concept of directionality; that is, in order to read, one most read from the left to right on the page and that there are distinctive features of the letter *b* which distinguish it from the letter *h*.

Parents and teachers are in ideal positions to create environments that engage children in meaningful, problem-solving activities that enable them to construct concepts, raise their own questions, and develop their own strategies to problem-solve. A critical factor in determining how successful children are in doing these cognitive tasks is the competence of adults to scaffold their thinking.

When interacting with children who are learning, teachers and parents should actively engage children and respond to what they think a child is

attempting to construct in his or her mind. In the following example, Mom is trying to support her 3-year-old daughter Jenny's attempts to read a line of print and gain meaning from the text.

Mom: The puppy is looking for food.
Jenny: I want to read!
Mom: OK. Give me your pointing finger. I will help you read the words. (Mom and Jenny point to each word on the page while reading together.)
The puppy is looking for food.
Jenny: Let me read it by myself.
The puppy is looking for food.
Mom: Very good job, Jenny. You pointed to every word that you read. Do you think the puppy will find the food?
Jenny: I don't think so because I don't see any dog food.
Mom: Where would your puppy Sammy look for his food?
Jenny: On the floor next to the sink. But there is no dog dish next to the sink in this story.
Mom: Where else do you think the puppy could look for his food?
Jenny: He could look in the laundry room.
Mom: That's a good idea. What made you think of that?
Jenny: Sometimes we put Sammy's food in the laundry room. Let's turn the page and see if I am right. (Jenny turns the page and points to the picture.)
The puppy won't be able to see his food.
Mom: Why? What is the problem?
Jenny: The puppy can't see it because it is on the table. He is too short. He can't even jump that high. If the puppy was bigger he could tell that the food is on the table.
Mom: You have good ideas, Jenny. What can the puppy do?
Jenny: Maybe if he jumped on a chair he would see it. Or he could bark so the kids will know that something is wrong. Hurry up and read the page so that we can find out what happened.
Mom: Will you help me read the page?
Jenny: OK. (Jenny gives her pointing finger to Mom.)

In this vignette, Jenny's mother is engaging her child in a constructive process. She is helping Jenny to actively contribute to her literacy learning in several important ways. First, by taking the child's finger and reading while pointing to the words on the page, Mom is helping Jenny learn that the left page is read before the right page and that you read each line of print from the left to the right. She is helping Jenny to develop the concept of directionality.

Second, Mom's questions are helping Jenny to actively respond to the meaningfulness of the story. Jenny is learning that the message is important. She is also learning that illustrations can be used to comprehend the text.

Third, the conversation between Jenny and her mother is not a question-and-answer format. They are having an authentic conversation that takes several minutes. To construct their own understandings, children must engage in a sustained, focused conversation. The process that leads to such capability is not one of telling, but a gradual process that helps both mother and child understand each others' ideas and perspective.

Fourth, the mother's question, "Where would your puppy Sammy look for his food?" provides an opportunity for Jenny to use prior experiences she has had feeding her puppy to predict where the dog dish might be found. The mother has seized an opportunity to teach the child concepts critical to becoming literate, that is, how to use prior knowledge to anticipate, predict, and infer what might happen in a story. Once parents and teachers understand the nature of the constructive process, they will realize that learning new information must occur within the context of what an individual already knows and be assimilated into previously learned information so that it can be used in a different situation.

Finally, Jenny's mother accepted and valued her daughter's ideas and comments. Parents' and teachers' conversations with children play a vital role in their effort and learning. In a study of 1,600 elementary and middle school pupils followed over a 3-year period, researchers found that children who viewed their teachers as warm and supportive, because they provided helpful learning conditions, worked harder on assignments and partici-

pated more in class. Effort and participation predicted better academic performance in the future. In contrast, children who regarded their teachers as unsupportive were more likely to disengage, stop trying, and show declines in achievement. These negative outcomes led children to doubt their own abilities, which perpetuated their reduced efforts in school and poor academic performance (Berk, 1999).

Some educators might question that if learning involves self-organization and internal self-structuring of an assembly of neurons in the brain, what role does social interaction and language play in learning? The simple answer is, everything—provided the instructional context engages the learner in problem-solving experiences. It is the kind of scaffold that helps children develop more complex reasoning and become independent.

When teachers and parents understand that learning is a constructive process, not a maturation process, they modify their attitudes about teaching. They begin to realize that children may perceive their environment in ways that are very different from that intended by the teacher or parent.

One teacher described an incident when she asked the child to show her the first part of the word, and the child showed her the first letter of the word. When she said, "No, that isn't the first part of the word, that is the first letter of the word," the child replied angrily, "Well, how many letters are in the first part…two, three, four?" After the student's question, the teacher realized that she had assumed that the child knew what she meant when she said, "Show me the first part of the word." That question forced the teacher to rethink the language she used and the tasks she asked children to do. The teacher also realized the importance of showing or demonstrating a concept before expecting the child to respond successfully.

*Educational Implications*

Parents and teachers who operate from a constructive perspective understand that meanings are constructed through social interaction and conversation while children actively engage in an activity. Their actions counter the widespread myth that conceptual knowledge can be directly transferred from teacher to students in the same prescribed sequence and structured way for every child in any context. Specific ways to create a constructive environment for learning follow.

- *Make many attempts to ascertain children's current levels of understanding.* If a child cannot explain what he or she means, ask the child to show you or give you an example. When teachers or parents are able to take children's perspectives and understand their reasons for thinking, they are more likely to facilitate changes in their ways of thinking.
- *Choose your language to scaffold children's learning carefully.* Language is a tool that enables teachers and parents to orient children's construction of concepts by providing multiple opportunities for them to construct new and more complex understandings. Their words are chosen carefully and are designed to elicit a response or action that gives the child direction for thinking. Remember to be positive in your comments so that you are meeting the emotional needs of the learner as well.
- *Create challenging learning environments.* Challenging experiences stimulate thought, provide children opportunities to generate and explore possibilities, and promote inquiry. When students are challenged, however, they are also more likely to make errors. Mistakes or errors are to be valued and perceived as opportunities to stretch children's thinking, not as something to be avoided. It is through partially correct responses that teachers know what children can do independently. Using what is partially known enables teachers to demonstrate how to help children successfully resolve conflicts and complete their processing (Clay, 2001).

## Principle 5: Children's Self-Esteem Determines Their Motivation to Learn.

The final principle derived from research in neuroscience is related to the development of children's self-esteem. Self-esteem is dependent on children's evaluations, or judgments, of their own worth as well as the affective reactions and feelings associated with those judgments. While many factors affect self-esteem, early relationships and reflective feedback from significant others are major influences on children's self-esteem.

Children with high self-esteem are satisfied with their competencies and achievements. They have self-confidence and self-respect. Children with low self-esteem do not think very highly of themselves and exhibit opposite kinds of behaviors.

Infant studies reveal that the quality and characteristics of children's early experiences with their caregivers shape their emerging self-esteem in fundamental ways. Children who experi-

ence responsive caring relationships develop a positive self-image which influences and impacts their later social interactions and relationships.

Children who have histories of sensitive care and have securely attached to their caregivers see themselves as worthy. They consistently behave in a confident, independent manner, suggesting that they have good self-images. They also have realistic appraisals of their current knowledge and skills, and when faced with difficulty, they are motivated to try harder to surmount challenges. They tend to be more positive and confident in their interactions with others, show empathy, and are more motivated to engage in conversations and interactions with others (Levine, 2002).

Attachment studies reveal that children with histories of insensitive care see themselves as unworthy. They tend to avoid interactions with others, lack empathy, and are less confident and resourceful. These children generally exhibit behavior that suggests they have low self-worth and poor self-images. They expect rejection and tend to elicit rejection from others. These children are passive and less likely to engage in conversation with adults or peers and may be hostile, defiant, and aggressive (Mate, 1999).

*The Importance of Understanding How Self-Concept Impacts Motivation*

Early experiences with caregivers impact young children's self-concept and self-esteem. For children with low self-esteem, adults' positive reassurances for any successes will permeate their thinking and motivate them to continue to engage with adults in learning activities. Moreover, the sooner they experience positive reinforcement for their efforts, the more likely their attitudes and beliefs about their self-worth will escalate.

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One Reading Recovery teacher commented, "He was so unsure of himself during the first few weeks of lessons that he would always check my face to see if his self-corrections were right. As soon as I reassured him that he was correct, he sat up taller, spoke louder, and seemed to gain a surge of energy. The look of determination on his face was inspiring."

As discussed earlier in this article, research in neuroscience confirms that experience shapes and organizes the brain. Due to the brain's great plasticity, positive experiences will reroute and reorganize its structure. The emotional feeling of success during positive interactions with parents and teachers stimulates growth of nerve cells in the brain and releases neurotransmitters—endorphins, dopamine, and seratonin— that directly impact learning; each of these promote the development of new connections in the prefrontal cortex of the brain (Damasio, 2000).

These *reward* chemicals are released when children experience joy after they have successfully learned something they initially found difficult. These kinds of experiences will greatly improve children's self-esteem and self-concept. The more often children feel successful and competent, the more motivated they are to continue working.

*Educational Implications*

The likelihood that children struggling to learn to read and write have low self-esteem and poor self-concepts is generally high because they have probably experienced failure many times. When teachers and parents create environments that incorporate the following four suggestions, they will motivate children to persevere until

they are successful and in the process greatly improve their self-esteem and self-concept.

1. *Provide a safe learning environment.* All learning takes place within the context of a relationship with another. Unless children and adults feel safe enough in this environment, they will not learn. What does it mean to feel safe?

   - You aren't afraid to share your ideas or concerns.
   - Someone listens to you and talks directly to you, not at you.
   - You can ask a question, and no one says or shows nonverbally that it isn't important.
   - People smile often, laugh out loud, and show they enjoy your company.
   - People show that they like you and say you have good ideas.
   - You aren't afraid to show that you do not know something.
   - You have time to think.
   - You aren't picked on, embarrassed, humiliated, or bullied.
   - You aren't afraid to show what you know or don't know.
   - You feel secure and wanted.
   - People show that they have respect for you and others in the class.
   - Everybody gets along with each other most of the time.
   - You feel like you belong.
   - People take care of each other.

   A safe environment has a profound effect on how students feel about themselves and the learning process. When children (and adults) feel successful and good about themselves, they are motivated to learn and continue to be motivated throughout the learning process.

2. *Set reasonable expectations for both behavior and academic skills.* In a safe environment children's self-esteem flourishes when teachers and parents set reasonable expectations for learning and behavior and hold children accountable. For example, consider the following exchange between a teacher and a first-grade child after the child had fallen off his chair "accidentally" for the third time in one day: "Michael, you have been in first grade for three days and first graders do not fall off their chairs." To which the child replied, "I can behave like a first grader from this day forth!" The teacher replied, "I knew you would be a responsible first grader, I could tell the first day we met." This teacher let Michael (and other children in the classroom) know in a firm and appropriate way her expectations for classroom behavior.

   The teacher must also establish reasonable expectations for children's learning goals. In order to set these expectations, teachers must know what the child knows and can do, as well as what the child will need to learn *next* to advance his thinking and skills. There should be enough challenge, and the teacher should also be reasonably certain that the child can meet the challenge with minimal teacher support. Using something the child knows is the best way to assure that this will happen.

3. *Praise children for* real *achievements.* Too often well-intentioned parents and teachers praise children for minor things or everything they do. It does not take children long to know that no matter what they do they will hear "Excellent." When such a phrase is used often, it means nothing. False compliments can actually undermine or call into question children's self-worth.

   One child told her mother angrily, "Getting 10 wrong on that paper is not excellent, you always say that and it isn't excellent." This mother accepted everything the child did as wonderful. In this case, the child reprimanded her mother for the behavior. Some children, however, have a distorted view of their capabilities because the teacher or parent has provided too much praise too often. Parents and teachers who overpraise or give unearned praise are oftentimes hindering rather than helping children's motivation and self-esteem. Praise that is earned and specific, on the other hand, motivates and bolsters children's self-esteem and self-concept.

   Real self-esteem can grow only from the mastery of genuine challenges, which in turn will greatly improve self-concept (Greenspan, 1997). If teachers and parents have responsive and positive interactions with children, the child's self-concept will follow a positive course; with criticism and ridicule, the opposite will occur. It is also important for parents and educators to realize that as children grow older, it becomes more and more difficult to change their self-concepts.

4. *Set high expectations.* Teachers who have high expectations and the necessary knowledge about the emotional, social, and cognitive dimensions of learning, along with skills in teaching reading and writing processes, can help every child learn how to read and write. One of the most positive things parents and teachers can do is to encourage

children. Positive reinforcement boosts morale and motivates children to continue to try. And when they have completed and accomplished a hard-earned task, parents, teachers, and children greatly appreciate congratulations for a job well done.

One of the most destructive things parents and teachers can do is react impatiently or harshly when children make mistakes. Comments such as, "You're just lazy," or "Can't you do anything right?" undermine positive teacher-student and parent-child relationships and destroy self-esteem and motivation.

Teachers and parents need to set high expectations and learn how to support children's fragile self-concepts and increase their self-esteem. A strong link exists between children's self-esteem and accomplishments. Consequently, parents and teachers should try to build children's self-esteem with praise and reassuring comments. Positive feedback from others continually influences the children's developing images of themselves.

## Conclusion

Brain-based research provides solid evidence that virtually every child is capable of learning how to read and write. Under the right circumstances, all but those who have severe neurological problems (no more than 1–2% of the population) can learn to read and write in the primary grades; this foundation will serve as a basis for success in the later grades. Recognition of this fact is essential to the education of students who are considered at risk of school failure after 3 years of formal schooling. Allowing large numbers of children to leave the primary grades with minimal skills ensures them a life of school failure, as well as poverty and long-term dependence on society—the consequences of which are disastrous to the well-being of the nations of the world.

Every educational system should pay attention to research on how the mind works and the brain develops and functions. When this happens, society will be compelled to recognize the social, emotional, and cognitive dimensions of learning and address individual differences among learners. Moreover, teachers will be encouraged to create bridges between the very different experiences of individual learners and use a variety of instructional approaches to build on their culture, knowledge, and interests. Teachers must also understand how their students think and learn as well as what they know and can do independently. Unless this is done, many children will not be able to realize their full potential.

Our schools' failure to educate masses of children fully capable of learning is not the result of overemphasis on unearned self-esteem or touchy-feely frills, but from reliance on a model (of education) that ignores the emotional and social nature of the learning process. What teachers, parents, and caregivers do and say impacts children's learning and belief in themselves and their abilities for a lifetime. For those of you who are feeling that you have made mistakes teaching children over the last several years, remember that you cannot change what is over, but only where you go from here.

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