DISPOSITIONS Reframing Teaching and Learning

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DISPOSITIONS: HARD-WIRED OR LEARNED? Chapter 5

Nine Dispositions and the Neurosciences

Nine dispositions are presented here because there is neuroscientific research to support them. For other dispositions, while they may be critical for success in school, work and life, there is little neuro-scientific research to justify the connection at this time. The purpose is to demonstrate that these dispositions were not only crucial for human survival over the centuries and they are also crucial for students' success in school, in later life and careers, but in their survival throughout the 21st and for some, into the 22nd centuries.

Metacognition

> "I've reached the moment where the movement of my thought interests me more than the thought itself. "
>
> Pablo Picasso

Occurring in the neocortex, metacognition is our ability to know what we know and what we don't know. It is the ability of the mind to monitor and redirect the activities of the brain; to plan a strategy for producing what information is needed, to be conscious of our own steps and strategies during the act of problem solving, and to reflect on and evaluate the productiveness of our own thinking.

The major components of metacognition are developing a plan of action, maintaining that plan in mind over a period of time, then reflecting back on and evaluating the plan upon

its completion. Planning a strategy before embarking on a course of action assists us in keeping track of the steps in the sequence of planned behavior at the conscious awareness level for the duration of the activity. It facilitates making temporal and comparative judgments, assessing the readiness for more or different activities, and monitoring our interpretations, perceptions, decisions and behaviors. An example of this would be how teachers: develop a teaching strategy for a lesson, keeping that strategy in mind throughout the instruction, then reflecting back upon the strategy to evaluate its effectiveness in producing the desired student outcomes.

Intelligent people plan for, reflect on, and evaluate the quality of their own thinking skills and strategies. Metacognition means becoming increasingly aware of one's mental processes and strategies and the effects they produce in others and on the environment; forming internal questions as one searches for information and meaning, developing mental maps or plans of action, mentally rehearsing prior to performance, monitoring those plans as they are employed--being conscious of the need for midcourse correction if the plan is not meeting expectations, reflecting on the plan upon completion of the implementation for the purpose of self-evaluation, and editing mental pictures for improved performance.

Metacognition and the brain

Housed in the pre-frontal cortex in front of the brain is where such capacities as use of reason, making sense of ideas and behaviors, planning and futuristic thinking, critical and creative thinking, reflection evaluation and thinking about our own thinking. These are the brain's "executive functions ".

One of the most amazing characteristics of the brain is that it is the only organ in the body that sculpts itself based on its experiences. This characteristic is called neuroplasticity. For example, while a baby is born with the capacity to speak any of over six thousand languages, the language it hears repeatedly will strengthen certain connections between brain cells, while the connections for the sounds that are not heard or reinforced will eventually fade away. While neuroplasticity has been considered to be most active when a child is young, new research has shown that the brains of older children, as well as those of adults, retain the capacity for rewiring.

Studies show that willful, intentional, mindful effort can alter brain function. Think about it and you will probably be able to think of a time when you changed one of your own habits. If you are like most, this required a great deal of effort and practice using the new set of behaviors before they became automatic. Changing your "clutch behavior" when you move from driving a car with a manual transmission to one with an automatic transmission is an example. The truly amazing thing is that this change in behaviors produced an actual change in the neural connections that control the muscles involved in shifting gears. It probably took quite a while before the new shifting behavior became as automatic as the previous one.

The same is true when we decide to develop or change a disposition. It takes instruction and practice to learn to control impulsivity, to think interdependently or to listen with understanding and empathy. When an old behavior–such as reacting impulsively–has become an automatic habit, it's not easy to change. The old habit has been reinforced many

times and is "hard wired" so to speak. It resists being changed. To replace this behavior to a new one you literally have to change the wiring of the brain, and this takes time and effort.

Persisting

> "Most of the important things in the world have been accomplished by people who have kept on trying when there seemed to be no hope at all."
>
> Dale Carnegie

In a most fundamental way, persistence has been essential to human beings since the dawn of our species. Early man endured perilous climates, uncertain food sources, tribal rivalries and hungry predators. If they were not persistent in their quest for nourishment and shelter, they died. Anthropologists now believe that persistence played an even more vital role in human development. Without it, we may never have evolved into humans in the first place nor would we have migrated to all parts of the globe.

According to Daniel Lieberman, a professor of human evolutionary biology at Harvard University, humans are one of the few mammals capable of running long distances (marathons) and the only ones who attempt such feats in the heat of the day. Endurance running became a favorite evolutionary trait two million years ago when early man engaged in "persistence hunting."

This technique was used before the invention of tools like bows and arrows or stone-tipped spears and relied on the fact that most animals were only capable of short bursts of speed. Early hunters would jog after large animals for hours until their prey overheated collapsed and could be killed with little risk of getting injured. Our ancestors were hunting big, prime-age animals with no projectile technology. They would have had to get very close

to those animals to kill them, which would have been really dangerous without persistence hunting.

Persistence and the Brain

Persistence hunters, therefore, provided nearly all the meat for early humans and of course it was this regular supply of protein-rich meat that allowed our bodies and brains to grow and evolve to the point that we could create tools and develop language—those traits that make us human. Thus this early persistence laid the groundwork for our most advanced intellectual pursuits. A persistence hunt requires one to make hypotheses, to have a theory of mind about one's prey, to make predictions, to find causal relationships and, using all the senses, to collect and interpret lots of data about the natural world. Persistence is important because it reflects the pursuit of valued outcomes (Mercer, 2012).

Managing Impulsivity

"The sign of intelligent people is their ability to control emotions

by the application of reason."

Marya Mannes

Effective problem solvers have a sense of deliberativeness: They think before they act. They intentionally form a vision of a product, plan of action, goal or a destination before they begin. They strive to clarify and understand directions, develop a strategy for approaching a problem and withhold immediate value judgments before fully understanding an idea. Reflective individuals consider alternatives and consequences of several possible directions prior to taking action. They decrease their need for trial and error by gathering information,

taking time to reflect on an answer before giving it, making sure they understand directions, and listening to alternative points of view.

Managing Impulsivity and the Brain

The degree to which people are able to manage their impulsivity is dependent on two factors, one biological and one environmental. To understand these factors, we need to look at the emotional characteristics of the human brain. The main purpose of a brain is survival and many of the structures in the brain are involved in making certain the individual (and the species) do just that. Originally these structures were designed to give the person the means to survive attacks from wild beasts or enemies. In contemporary society, the dangers are often not physical but social. However, the brain doesn't differentiate between the two; the same mechanisms are at play no matter what the source of real or perceived threat.

When a person perceives a situation to be threatening, a number of changes occur in the brain. Chemicals are released that increase heart rate and lung capacity, increase visual alertness, provide glucose for extra strength, and decrease all unnecessary functions such as digestion and immune function. (This biological response is commonly called the "fight, flight or freeze" response.) All these changes put individuals on alert and increase their chances of survival. However, there is a downside to this system and it occurs in the cortex of the brain. The cortex is where rational thinking and problem solving take place. It is also where one manages impulsivity. During a time of perceived threat, the cortex becomes less efficient. (Think about a time when you were insulted and could not think of a good retort until the next day!)

The upside of the fight or flight response is that after the initial reaction, we have a choice of ways to respond. For example, if while I'm hiking I see a curved shape on the path that looks somewhat like a snake, I may jump and scream. A few seconds later I realize that it is a stick not a snake. At this point I send a message to my brain saying, "Calm down, it's just a stick." The same thing occurs in social situations. Suppose my boss says something I don't like. My immediate internal reaction is to become angry and the fight or flight response is activated. But seconds later I send a message to my brain saying, "I don't think either fight or flight is an appropriate response here." In this case I have the ability to manage my initial impulsive reaction.

Not everyone manages his or her impulsivity well. Examples are all around us from "road rage" in adults to children starting fights on the playground. What makes the difference between those who manage their impulsivity well and those that don't?

Biological considerations: There are neural pathways in the brain that lead from the rational cortex to the emotional center of the brain and give us some control over our reactions allowing us in most instances to respond appropriately to situations. However, these pathways are not in place at birth which is evident to every parent of a young child. In most cases as the child matures these pathways become more efficient and the child's responses become more appropriate. Full biological maturation of these pathways does not often occur until persons are in their mid 20s.

The environment steps in to play a role as well. The effectiveness of neural pathways is determined to a large degree by experience. If the only response to anger a child ever experiences is lashing out, then it is likely that the child's brain will become "wired" to lash

out. If delaying gratification is not modeled or expected of children, they are unlikely to develop this very important characteristic.

An understanding of the neurological basis of emotional responses helps us better understand why some children do not manage impulsivity well. The age of the child is an important factor, however, neuroscientists tell us that the brain has amazing plasticity and this is good news. It implies that children can–and–should be taught ways to manage their impulsive behaviors.

Gathering Data through All Senses

> "Nothing reaches the intellect before making its appearance in the senses."
>
> Latin proverb

All external information gets into the brain through the sensory pathways: gustatory, olfactory, tactile, kinesthetic, auditory, visual, Most linguistic, cultural, and physical learning is derived from the environment by observing or taking in through the senses. To know a wine it must be drunk; to know a role it must be acted; to know a game it must be played; to know a dance it must be moved; to know a goal it must be envisioned. Those sensory pathways are open, alert, and acute absorb more information from the environment than those pathways are withered, immune, and oblivious to sensory stimuli do.

We gather data from internal sources as well. If we are in touch with our own emotions, we have to be in touch with the physical sensations in our body. For example, I know that I am fearful because my heart rate begins to speed up, my stomach clenches, and my hair stands on end. We sense what other people are experiencing or feeling by sensations that arise in our own bodies. All of us are like walking antennas, receiving and registering the felt experience of those around us. Some of

us are better at this than others. To accurately register this kind of information requires being in touch with our own emotional responses.

Forming mental images is important in mathematics and engineering; listening to classical music seems to improve spatial reasoning. Social scientists solve problems through scenarios and role-playing; scientists build models; engineers use cad-cam; mechanics learn through hands-on experimentation; artists experiment with colors and textures. Musicians experiment by producing combinations of instrumental and vocal music.

Gathering Data Through All the Senses and the Brain

The brain is the ultimate reductionist. It reduces the world to its elementary parts: photons of light, molecules of smell, sound waves, vibrations of touch--which send electrochemical signals to individual brain cells that store information about lines, movements, colors, smells and other sensory inputs.

The neural basis for a disposition may be a blend of automatic responses to stimuli and actions guided by knowledge and expectation. The habit of gathering data through all the senses is one that clearly fits this paradigm. First, as long as the sensory receptors (the eyes, the ears, the skin, etc.) are in good working order, they will automatically, unconsciously and simultaneously take in all the stimuli bombarding them at any given moment in time. However, this does not mean that the individual is consciously aware of all this information; much of it is determined to be irrelevant and is discarded. On the other hand, some of the stimuli (such as the temperature in the environment or other peripheral data) are encoded without the person giving them conscious attention.

You have probably experienced this phenomena many times. You walk from one room into another room for some purpose and then can't remember why you came in there. If you go back to the original room, you remember. The peripheral information from the first room was recorded unconsciously and provided the memory cue.

Another aspect of brain function that helps us understand why multiple sensory input is important is that the brain does not store a memory in a specific location, rather it is stored all over the cortex in a sort of neural circuit; the sound in the auditory cortex, images in the visual cortex, etc. When you recall the memory, the brain reactivates or reconstructs the circuit in which it was stored. The more sensory modalities that were activated, the more triggers the brain has for reactivating the circuit. This suggests that concrete experiences in the classroom that activate several of the senses can enhance the recall of the information at a later time.

Disposition are enhanced with knowledge and expectation. Providing educators with information about the way that the brain stores habits should result in their making more informed decisions as they plan their curriculum and instruction. Students also need to be informed so they can be made aware of the importance of attending to the multiple sensory aspects of their environment and how they can take advantage of these to increase their understanding and retention of information.

Thinking Interdependently

"To keep your resolve, surround yourself with those who want you to succeed.
The brain cannot do its job of protecting the body without contact with other people."
Robert Ornstein and David Sobel in *The Healing Brain*

Human beings are social beings. We congregate in groups, find it therapeutic to be listened to, draw energy from one another, and seek reciprocity. In groups we contribute our time and energy to tasks that we would quickly tire of when working alone. In fact, we have learned that one of the cruelest forms of punishment that can be inflicted on an individual is solitary confinement.

Cooperative humans realize that all of us together are more powerful, intellectually and/or physically, than any one individual. Probably the foremost disposition in the post-industrial society is the heightened ability to think in concert with others; to find ourselves increasingly more interdependent and sensitive to the needs of others. Problem solving has become so complex that no one person can go it alone. No one has access to all the data needed to make critical decisions; no one person can consider as many alternatives as several people can. (Costa and O'Leary, 2013)

Working in groups requires the ability to justify ideas and to test the feasibility of solution strategies on others. It also requires the development of a willingness and openness to accept the feedback from a critical friend. Through this interaction the group and the individual continue to grow. Listening, consensus seeking, giving up an idea to work with someone else's, empathy, compassion, group leadership, knowing how to support group efforts, altruism--all are behaviors indicative of cooperative human beings.

Thinking Interdependently and the Brain

Go back in time to when our ancestors lived in caves or on savannahs. Physical survival was a daily reality. Do you think people had a much better chance of surviving if

they lived in a group or went it alone? The answer is obvious. Those people who learned to live and work together had a much higher survival rate, and survival is the main purpose of the human brain. So, as with many brain functions, this interdependence and sociability became "hard wired." (See also, Willis, 2013, Wolfe, 2013, McGowan, 2013).

Neurological evidence for humans' dependence on one another is now beginning to be uncovered. Consider for example, the role of endorphins and dopamine in the brain. Endorphins and dopamine are chemicals (neurotransmitters) produced by the brain that are active in the brain's reward system. In other words, the brain makes "feel good" chemicals that are released when certain behaviors increase the probability of survival. Endorphins are released during sustained, prolonged exercise, increasing the individual's chances of moving quickly out of danger. Your endorphin level also goes up during childbirth, decreasing pain and increasing the possibility of having a second child. Interestingly, endorphins and dopamine levels also rise during any pleasant social interaction. You get a pleasurable feeling when someone smiles at you or compliments you. This increases the probability of continued interaction with this person.

An important component of interdependent thinking—collaboration--is contingent communication. This is the mind's ability to deal with human differences—conflicting ideas, alternative perspectives, divergent points of view and collective problem solving. Located in the prefrontal cortex, response flexibility enables the mind to attend and assess subtle verbal and non-verbal cues, and then to modify internal external reactions accordingly.

Applying Past Knowledge to New Situations

> Making mental connections is our most crucial learning tool, the essence of human intelligence; to forge links; to go beyond the given; to see patterns, relationships,
>
> Marilyn Ferguson

Human beings learn from experience. When confronted with a new and perplexing problem they will often draw forth experience from their past. They can often be heard to say, "This reminds me of...." or "This is just like the time when I..." They explain what they are doing now in terms of analogies with or references to previous experiences. They call upon their store of knowledge and experience as sources of data to support theories to explain, or processes to solve each new challenge. Furthermore, they are able to abstract meaning from one experience, carry it forth, and apply it in a new and novel situation.

Applying Past Knowledge to New Situations and the Brain

At any one fraction of a second in time, the human brain is being bombarded simultaneously with an enormous amount of sensory stimuli. Paying conscious attention to all this information is literally impossible. Fortunately, the brain has a system to unconsciously filter this mass of information and keep only that which it considers relevant. The primary purpose of this filtering system is survival, therefore our brains pay attention to novelty, loud noises, unusual movements and social cues that signal danger. For survival, our brains must continually scan the environment to determine what is meaningful. Our species has not survived by taking in meaningless information. Unfortunately, however, much of what we ask students' brains to attend to is not considered by their brains to be meaningful or relevant.

Before we throw up our hands and say all is lost, we need to consider another aspect of brain functioning--how information is stored. It appears that the brain is the ultimate organizer and to keep track of everything it has stored, it uses a sort of filing system. Think of a semantic map or web and you have a metaphor for the way our brains store information in networks or maps of neural connections. When new information arrives, the brain attempts to find the appropriate network in which it will fit.

Here's where teachers' understanding of the brain comes into play. Because the new information (such as when to use a comma or determining the causes of a conflict) must make sense to the students, the teacher needs to help the students' see where it fits, what they already have stored that can assist them in the understanding and storage of the concept. What the students already know is probably the prime determiner of whether or not the new information will make sense and therefore stored.

Finding Humor

> "This I conceive to be the chemical function of humor: to change the character of our thought".
>
> Lin Yutang

Another unique attribute of being human is our sense of humor. The positive effects of laughter on psychological functions include a drop in the pulse rate, the secretion of endorphins, and increased oxygen in the blood. It has been found to liberate creativity and provoke such higher level thinking skills as anticipation, finding novel relationships, visual imagery, and making analogies. People who engage in the mystery of humor have the ability to perceive situations from an original and often interesting vantage point. They tend to

initiate humor more often, to place greater value on having a sense of humor, to appreciate and understand others' humor and to be verbally playful when interacting with others. Having a whimsical frame of mind, they thrive on finding incongruity and perceiving absurdities, ironies and satire; finding discontinuities and being able to laugh at both situations and themselves.

Finding Humor and the Brain

The scientific study of humor is a relatively new field of research with most of the studies having been conducted in the past two decades. These studies have provided new insights into the role of humor in human development and what happens in the brain and in the body when you find something funny.

Humans In all cultures around the world are capable of finding humor. Babies will naturally find joy, smile and giggle. The typical behavioral response to humor is laughter, but why do we laugh? What is its purpose? As we pointed out earlier, as a species, humans have had a better chance of survival if they are a member of a group than if they go it alone. Scientists believe that humor is one important way to promote social bonding. Laughter helps us to establish and maintain our relationships and make our groups more cohesive. Given its value, it is not surprising to find that our brain has built-in mechanisms to reward us for laughing.

Three major brain components are involved in laughter and humor. First, the frontal lobes help us "get" the joke or perceive the humor in a situation. Second, the motor pathways in the brain move the muscles of the face that allow us to smile and laugh. The

third component, the emotional pathway, is the most complex and requires a bit of background.

Deep within the brain is a group of structures commonly known as the *reward pathway* or the *pleasure center*. Composed of the *nucleus accumbens* and the *ventral tegmental area*, this pathway releases "feel good" brain chemicals (dopamine and endorphins) when we engage in activities that increase our chances of survival such as eating or sex. Along with the emotional center of the brain, especially the *amygdala*, these structures serve the purpose of making us feel good and encouraging us to repeat whatever activity brought us such pleasure. Using brain-imaging techniques, scientists have discovered that these structures are explicitly involved in the perception of humor and that is why it gives us pleasure.

Not only does humor give us feelings of pleasure and happiness, it also has significant ramifications for our psychological and physical health. Humor appears to be a universal coping mechanism we use when faced with stress. Cortisol, a rather caustic brain and body chemical released during highly stressful situations, is reduced when you laugh. The endorphins released during laughter have been shown to reduce feelings of pain. In addition, some early studies suggest that humor may boost the immune system. While much more research needs to be done in this area, (called psychoneuroimmunlogy) if laughter could actually help us fight off infections, we'd have one more reason to help our students find humor in their lives.

Responding with Wonderment and Awe

"Wonder is what sets us apart from other life forms. No other species wonders about the meaning of existence or the complexity of the universe or themselves."

Herbert W. Boyer

Humans share the capacity for personal intensity. Nobody is born without it. But many of us never learn to tap into the source of our intensity because we fail to discover what inspires it. Passion refers to the force for intensity in all of us. One's passions might be writing, gardening, acting, sports, and working with children business, competition, and personal improvement.

Young children are naturally curious. They commune with the world around them; they reflect on the changing formations of a cloud; feel charmed by the opening of a bud; sense the logical simplicity of mathematical order. They find beauty in a sunset, intrigue in the geometrics of a spider web, and exhilaration at the iridescence of a hummingbird's wings. They see the congruity and intricacies in the derivation of a mathematical formula, recognize the orderliness and adroitness of a chemical change, and commune with the serenity of a distant constellation.

Efficacious people have not only an "I CAN" attitude, but also an "I ENJOY" feeling. They seek problems to solve for themselves and to submit to others. They delight in making up problems to solve on their own and request enigmas from others. They enjoy figuring things out by themselves, and continue to learn throughout their lifetimes.

RESPONDING WITH WONDERMENT AND AWE AND THE BRAIN

Every thought and action is accompanied by emotions. The center for emotions in the brain is the amygdala. It is deeply involved with threat, fear, and emotions of any kind. It engages many areas of the brain with chemicals and other physical interactions. Emotions have a huge impact on learning as the chemical secretions pass the information from cell to cell in the circuit. Where the secretions are positive, like serotonin, self-esteem rises and learning flourishes. These positive secretions tend to be short lived in their emotional impact. On the other hand, where the secretions are negative, like cortisol, self-esteem dives and learning withers. Moreover, the negatives like cortisol linger sometimes for a long time--days rather than minutes. Those feel-good neurotransmitters (serotonin, endorphin, dopamine) are released whenever we feel good about ourselves.

Wonderment, awe, inquisitiveness, intrigue and mystery have their origin s in the brain, and have become curious about the question of what is the connection between survival and the human sense of wonderment. Most all brain functions can be explained by the human organism's need and drive for basic survival needs, this disposition however, eludes this rationale and remains a mystery to us.

Listening to and Empathizing with Others

"Listening is the beginning of understanding…..

Wisdom is the reward for a lifetime of listening.

Let the wise listen and add to their learning and let the discerning get guidance

Proverbs 1:5

Highly effective people spend an inordinate amount of time and energy listening. Some psychologists believe that the ability to listen to another person, to empathize with, and to understand their point of view is one of the highest forms of intelligent behavior. Being able to paraphrase another person's ideas, detecting indicators (cues) of their feelings or emotional states in their oral and body language (empathy), accurately expressing another person's concepts, emotions and problems—all are indications of listening behavior (Piaget called it "overcoming ego-centrism"). They are able to see through the diverse perspectives of others. They gently attend to another person demonstrating their understanding of and empathy for an idea or feeling by paraphrasing it accurately, building upon it, clarifying it, or giving an example of it.

To listen fully means to pay close attention to what is being said beneath the words. You listen not only to the "music", but also to the essence of the person speaking. You listen not only for what someone knows, but also for what he or she is trying to represent. Ears operate at the speed of sound, which is far slower than the speed of light the eyes take in. Generative listening is the art of developing deeper silences in yourself, so you can slow your mind's hearing to your ears' natural speed, and hear beneath the words to their meaning.

Listening, Empathizing and the Brain

Cells in your brain allow you to read another person's mind. Humans not only have the ability to judge the intentions and feelings of others, they often know what another person is thinking. This ability is called empathy. Empathy is both a cognitive process (the ability to understand another's emotional state) and an affective capacity (the ability to share another's emotional state). These abilities do not appear to be a learned trait; rather they

appear to be "hard-wired" in the brain. Why would this be? What would be its purpose? According to some neuroscientists, empathy serves two evolutionary functions: to create attachment and bonding between mother and child and later in life to create attachments between mates. Empathy could be considered to be part of the glue that holds relationships and societies together.

Psychologists and neuroscientists have been baffled by our ability to anticipate other's behaviors and empathize with their feelings. A team of researchers in Italy discovered what might be a key to solve this mystery. They identified a new type of neuron that fires when you perform a manual action AND also fires when you watch someone else perform these actions. They have labeled "mirror neurons." Mirror neurons are what allow us to understand another's intentions and feelings. Mirror neurons, according to Feuerstein, are also fired in a child's brain upon hearing language as if the child were using these structures him or herself. Children thus learn to imitate the language they hear as well as the actions they see. (Feuerstein, Feuerstein and Falik, 2001).

Studies suggest that the degree of toddlers' empathy depends in part on how sensitive their parents are to others. This would make sense given the theory on mirror neurons. Children learn a great deal by imitating what they see others do.

IN SUMMARY

The intent of this chapter has been to provide neuroscientific support for dispositional teaching. While we have described each of nine dispositions separately, it should be cautioned that the brain does not draw them forth separately. Even for simple learning tasks, more than one area of the brain will be activated and the more areas that are activated and

engaged, the more learning takes place. For example, the use of all the senses can mean that there are several triggers to activate prior learning, and the more often these triggers are activated, the stronger the link becomes. Since the brain is pattern detector and past knowledge, if connected to the new learning, makes for much stronger knowledge generation. Therefore, one of the most worthwhile dispositions for students to acquire is that before starting on a new unit or study, some form of metacognitive reflection on what is already known promotes the new learning about to be undertaken.

Also of great importance is to keep in mind the brain's natural learning systems:

- tactile/physical movement--active total-body participation
- social collaboration --thinking and learning interdependently
- emotion--passion for what is being done and learned. The "feel good" neurotransmitters--serotonin, endorphin, and dopamine--are released whenever we feel good about ourselves.
- cognition:--mental engagement with relevant content
- metacognitive reflection--consideration and evaluation on one's own learning.

We've learned more about the brain in the past few years than in all of recorded history. This research has provided revelations about the structure and function of the human brain and how the brain learns. While this research does not tell us how to teach, the better we understand neuroscientific research we have a more solid foundation on which to base our educational decisions. As we explore dispositional teaching and learning, this research will help us understand how dispositions become established in the brain, and how to give our students the lasting gift of these productive behaviors.

Thus, the types of dispositions mentioned here may well serve as the most essential, enduring, powerful and desirable attributes for the graduates of our educational system. They will need dispositions and learning skills far beyond current society requirements. Most of the jobs our students will be working at have, in fact, not been created yet. Indeed, our survival may depend on it.

References

Birchfield, J. 03/13/2013 Empathy: A Gateway to Objectivity in Leadership The Blog. *Huffington Post Business.* http://www.huffingtonpost.com/jan-birchfield-phd/

Costa, A and O'Leary, P. (Eds.) *The Power of the Social Brain: Teaching, learning, and using interdependent thinking* New York: Teachers College Press

Feuerstein, R., Feuerstein, R., & Falik, L. (2010). *Beyond smarter: Mediated learning and the brain's capacity for change.* New York: Teachers College Press.

McGowan, P. (2013) Cooperation is What Makes us Human, Psychology: Where we part ways with our ape cousins. http//nautil.us/Issue/1/what-makes-you-so-special/cooperation-is-what-makes-us-human

Mercer, J. (2012). The Power of Persistence. *The Intelligent Optimist.* November/ December 2012. Pp 40 – 48.

Mohan, G. (2013) No Kidding: At 5 months babies start to figure it out. *The Sacramento Bee.* Sunday, April 21. Health and Science p. A9

U. S. Department of Education, Office of Educational Technology (2013) *Promoting grit, tenacity, and perseverance: Critical factors for success in the 21st century.* Washington D. C. Center for Technology in Learning, Sri International

Willis, J. (2013) Cooperative Learning: Accessing our Highest Human Potential in Costa,A. and O'Leary, P. (Eds.) *The Power of the Social Brain: Teaching, learning, and using interdependent thinking* New York: Teachers College Press

Wolfe, P. (2013) Thinking Interdependently— A Human Survival Mechanism in Costa, A and O'Leary, P. (Eds.) *The Power of the Social Brain: Teaching, Learning, and Using Interdependent Thinking* New York: Teachers College Press