Learning, the Brain, and the Teacher

LEARNING

A teacher's prime directive is to help students learn. So what is learning? There are a variety of definitions. Figure 1 contains 21 definitions of learning. Read through this list and choose two to three with which you feel most comfortable. (Note: There is no "correct" definition.)

Figure 1. Definitions of learning.

1. ***Learning is*** acquiring new knowledge and skills.
2. ***Learning is*** acquiring new information or understanding.
3. ***Learning is*** a change in behavior that occurs as a result of instruction or experience.
4. ***Learning is*** being able to use new knowledge or skills to solve problems or create products.
5. ***Learning is*** being able to use new knowledge or skills to earn rewards and avoid punishment.
6. ***Learning is*** linking new knowledge to old knowledge to construct meaning.
7. ***Learning is*** enhancement in thinking processes that result in improved performance and problem solving.
8. ***Learning is*** a change in the structure or content of knowledge stored in long term memory.
9. ***Learning is*** new behaviors or changes in behaviors that are acquired as the result of an individual's response to stimuli.
10. ***Learning is*** developing new ways of thinking.
11. ***Learning is*** expanding consciousness.
12. ***Learning is*** the acquisition, organization, and storage of new knowledge.
13. ***Learning is*** a relatively permanent change in one's skills, knowledge and/or attitude.
14. ***Learning is*** improving one's ability to solve problems in ways that nurture the s ***Learning is*** elf, others, and the environment.
15. ***Learning is*** improving one's ability to become attuned to and utilize the multiple dimensions of self.
16. ***Learning is*** being able to use new knowledge and skills.

Learning and Humans

Described here are four general observations about learning and humans. These provide a context for the information that follows.

• **Learning is something humans do from the moment of birth to their last days** (Patterson, 1973; Rogers & Freiberg, 1994). Babies learn to associate certain stimuli with pleasurable experiences and other stimuli with less pleasurable experiences. Throughout our lives we are constantly interacting with stimuli from the environment, our accumulated knowledge and experiences, and internal stimuli in the form of emotions, intuition, and our own creative and logical thinking. These many and varied stimuli help us form associations, add knowledge to the file cabinets in our heads, strengthen neural pathways, develop new insights, generate new and novel ideas, and to grow and change.

• **Humans are naturally inclined to learn** (Brown & Dryden, 2004; DeCarvalho, 1991; Holt, 1983; Rogers, 1961). We want to find out about the world around us. Our big human brains are naturally hardwired to acquire knowledge. We are curious creatures who try to make sense of the world that confronts us. Put a human in a room with a box and sooner or later that human will look into the box in order to see what is there. This natural inclination has helped our species evolve from early times.

• **All humans will learn if the learning material is interesting or presented in interesting ways** (DeCarvalho, 1991; Rogers & Freiberg, 1994). Material to be learned can be

made interesting by linking new information to learner's needs or personal interests or by presenting the learning material in a way that is compelling or amusing (like a story). Lessons that are perceived to be too abstract, irrelevant, or meaningless are much harder to learn.

• **Human learning is cyclical not linear** (Bruner, 1977). Humans learn things by revisiting them many times at successively higher levels. Humans do not learn like computers. With a computer, you input the information once and it is learned as fully and completely as your input. With humans you can not present information just once and expect them to have learned it. Humans need to revisit skills and concepts several times and in different circumstances. With each visit we learn at increasingly higher levels.

As an example, Mr. Alan Jeffries teaches second grade. When he teaches a skill such as a short-a vowel sound he does not expect that his students will master it from his initial lesson. Instead, he provides a short bit of explicit instruction, repeated exposure and review, and lots of authentic reading and writing. He knows that over time his 2nd grade students will master this vowel sound. And because 2nd grade students are also not standardized products, there will naturally be wide variation in the degree and rate of mastery of this skill.

LEARNING AND THE BRAIN

The brain is our learning organ. There are three parts of the human brain: the brain stem, the cerebellum, and the cerebrum. The *brain stem*, sometimes called the reptilian brain or the lower brain, is the oldest most primitive part of the human brain. It regulates our life support systems and things within our body that do not take conscious thought.

The *cerebellum* is a small part of the brain that plays an important role in motor control. It takes input from other parts of the brain, the spinal cord, and sensory receptors, to coordinate the movements of the muscles and skeleton.

The *cerebrum* is the largest part of the brain that is covered by a thin layer called the *cerebral cortex* (Figure 2). This is responsible for the higher cognitive functions such as thinking, reasoning, imagination, decision-making, and problem solving. The cerebral cortex is divided into four sections called lobes. Each lobe is associated with certain types of thinking:

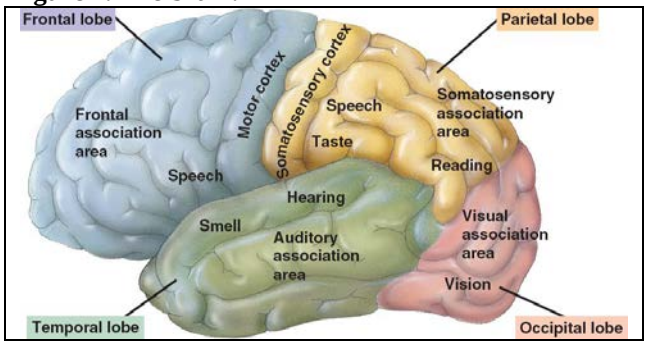
• The frontal lobe – reasoning, decision making, emotions, problem solving, and parts of speech.

• Parietal lobe – movement, perception of stimuli, taste, recognition, and orientation.

• Occipital lobe – visual processing.

• Temporal lobe – memory, speech, and perception and recognition of auditory stimuli.

Figure 2. The brain.



An Integrated Whole

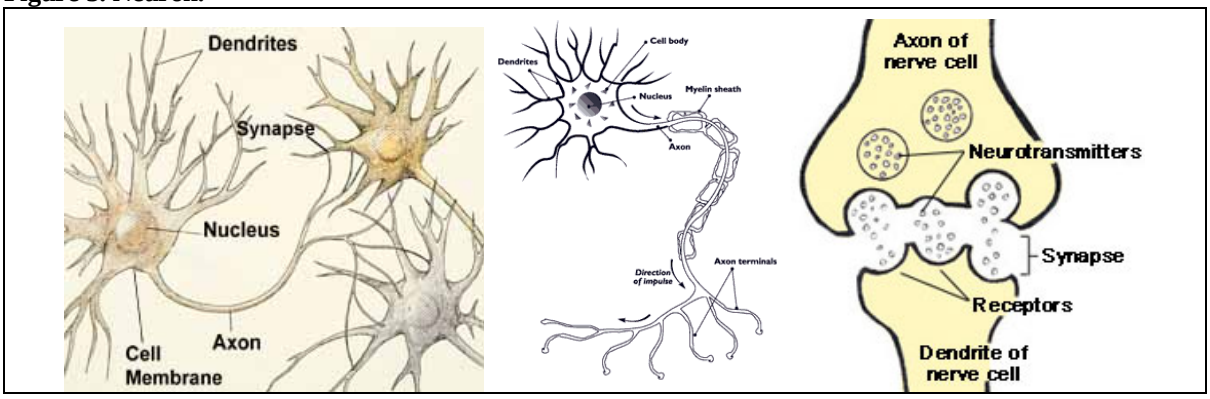
There are two halves or hemispheres to the brain that are connected by the *corpus callosum*. Each side of the brain has some specialization; however, the brain works holistically. That is, the two sides work as an integrated whole communicating back and forth. Thus, while people may be better able to process certain types of data, there are no such things as left-brained or right-brained people. In the same way, while there are certain areas of the brain that seem to specialize in certain types of tasks, there are not specific parts that are totally responsible for any one function. Instead, thinking is distributed across many areas of the brain.

Creating Neural Networks

Most of what we call thinking and learning occurs in the cerebrum, specifically the cerebral cortex where there are billions of brain cells called *neurons*. Each neuron is like a mini-computer that transmits and receives electrochemical signals in the form of nerve impulses. Each neuron can send up to 50,000 messages per minute. Multiply this by the 100 to 200 billion neurons in our brains and you begin to understand the power of this human-brain-computing-device.

From a purely neurological perspective, learning of any kind is a matter creating neural networks and strengthening neural pathways. When stimuli in the external world are perceived, relevant sense organs send signals to various part of our brain were neurons are stimulated. (Neurons can also be stimulated by other neurons as well. For example, the very act of thinking stimulates neurons and related neurons.) Once stimulated, a signal in the form of an electrical impulse is sent down a long fiber of the individual neuron called an *axon* (Figure 3). At the end of the axon there is a gap that separates the neurons called a *synapse*. Here the electrical impulse triggers a chemical release (*neurotransmitter*) that crosses the gap. The neurotransmitters are picked up on the other side of the gap by *neuroreceptors* found at the end of a shorter, branching fiber called a *dendrite*. The dendrite brings the signal up to the neuron. The signal then continues its journey down the axon to the next neuron and beyond.

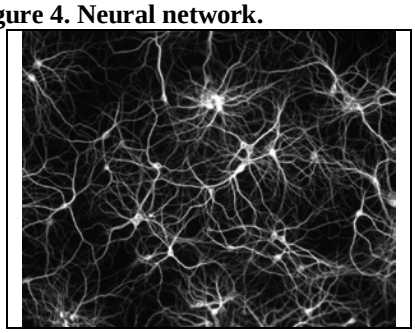
Figure 3. Neuron.



Stimulated neurons automatically send and receive messages to and from all the surrounding or related neurons. As new neurons become linked up, *neural pathways* are created, existing pathways are strengthened, and more sophistical webs or *neural networks* are formed (Figure 4). These neural networks facilitate the processing of new and related information. In other words, new learning and experiences create new and more expansive neural networks, making it easier to make connections with other new and related information and experiences. These neural networks represent the information in the head that is used to make sense of the information on the page during the process of reading. Thus, learning begets more learning. The

more we learn, the easier it becomes to learn more.

Figure 4. Neural network.



We Create our Own Reality

At birth billions of neurons exist in our brain like a gigantic dot-to-dot picture; but for the most part the dots are not connected and there are no preconceived pictures. As we begin receiving various stimuli from the physical environment, neurons fire and become connected with other neurons to form intercommunicating neural networks. The dots begin to connect and form our ever-evolving picture of reality. As stated above, these neural networks help us to perceive and process new information from the world around us. Thus, how we interpret and perceive reality is determined by our past experiences. Since each person's neural networks are unique to that person and his or her experiences, each person has a slightly different picture of reality. This means that there can be no such thing as a totally objective view of reality since even the most objective accounts of data are still subjected to a very subjective interpretation.

As we act upon the world, the world in turn acts upon us in the form of new neural pathways and neural networks. And as you can see, learning actually changes the physical structure of the brain as new neural networks are formed. The term for this is *neural plasticity*. It refers to the brain's ability to organize and reorganize itself by forming new neural connections throughout one's life.

Right now you are reading about the human brain. You most likely have had some exposure to information related to this. These related neural networks are sending mild electrochemical impulses back and forth. As you pick up new bits of information from this chapter, these networks connect with other neurons and expand. The dot-to-dot picture grows with more lines connecting to more dots. And as you see how one thing is associated with another, connections between other neural networks are formed. And as you continue to visit this network with new and related bits of information, the pathways between neurons become wider as more neurons are connected. As you are striving to make sense of this chapter and connecting new information to known information and your own experiences, your brain is changing. This change will make comprehending a little bit easier the next time you read something about learning and the brain.

Two-Way Flow

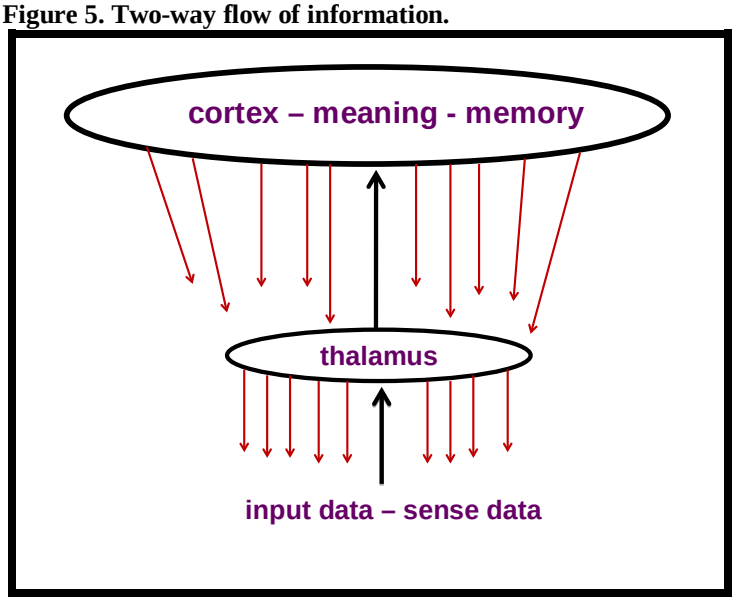
As data is taken in from the eyes and ears, it moves to the relay station in the brain called the thalamus. The thalamus receives and initially processes sense data before they moves to the cortex. The cortex is the part of the brain responsible for higher thinking and memory.

But wait, information does not flow just one way from the page up to the cortex (bottom-up). Brain imaging research shows that as we process data taken in by the various senses, information flows from the cortex down to the thalamus as well as from the thalamus up to the cortex (Hawkins, 2004). As a matter of fact, there is almost 10 times more information flowing

down from that cortex to the thalamus than up from the thalamus to the cortex (Figure 5). But what does this means?

In essence we perceive all of reality in terms of stored information, images, and patterns stored in our cortex. Our brain is essentially a memory machine. These various forms of data are used to reach out and make predictions about what we are about to perceive, experience, or encounter. Sense data is then used to confirm, revise, or deconstruct these predictions and construct our current reality. For example, if you are about to enter a restaurant your brain has already made predictions as to what this restaurant will look like based on the all restaurants you have experienced in your life. This restaurant data is called a *schema* (plural is schemata). Schemata are the file folders in your head related to specific concepts and experiences. You use schemata to help you understand what you are experiencing, but also to predict what you are about to experience.

Figure 5. Two-way flow of information.



THE TEACHER

What do you suppose is the most significant variable in determining how much learning goes on in a school or classroom? What do you think has the greatest effect on the quality of education students receive? It is the teacher. Teachers are the most significant variable in determining the quality of education (Darling-Hammond, 1999; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Darling-Hammond & Youngs, 2002; Marzano, Pickering, & Pollock, 2001). So it stands to reason then that one of the most effective ways to improve education is to attract intelligent, creative, innovative, caring, dedicated, hardworking people into the field and to give them the knowledge and skills necessary to succeed. And this is where you come in.

Dispositions

Besides knowledge and skills, effective teachers are also said to have a certain set of dispositions (Chicoine, 2004). A *disposition* is a state of mind that creates an inclination to think or act in certain ways. While we can not observe a disposition, we can observe actions that seem to reflect certain dispositions. So which dispositions are the one's that teachers should have? The dispositions in Figure 6 are those that some teachers might be considered to important;

however, a quick Internet search will show that there is a lot of different thinking on this issue. Just like your definition of learning, the teacher dispositions you select as being important are highly influenced by your personal teaching philosophy. And even though there may be people who insist that you adopt their teaching philosophy or who tell you exactly what teaching dispositions you must have, to be of any value you must ultimately develop, define, and internalize your own.

Figure 6. Dispositions for teachers.

dispositions	definition
compassion	To empathize and seek to understand. To display unconditional positive regard for students and faculty; and to try to understand the motivations and environmental circumstances of students, parents, and faculty.
kindness	To interact with students and faculty in a positive, benevolent manner; to be friendly; to seek the highest good of others; and to nurture self, others, and the environment.
courage	To stand up for the rights of students, self, faculty, schools, and the academic integrity of programs.
right effort	To fully engage and apply oneself in the act of knowing, planning, teaching, and reflection.
reflection	To think about one's actions as a teacher and a person for the intention of personal and professional growth. To define a philosophy and act based on that philosophy.
positive attitude	To think and speak in a manner that affirms, edifies, and nurtures self, students, faculty and the environment.
honesty and integrity	To speak the truth and to seek to act in the best interests of students, parents, faculty, and the school or environment.
professional respect	To celebrate differences of opinion and philosophies, to communicate and compromise to find common goals, and to seek the common good.

Other Traits of Effective Teachers

So to be an effective teacher you need a certain body of knowledge, set of skills (pedagogy), and set of dispositions (Morris, 1978). What are some other traits of effective teachers? Grant and Gillette (2006) identify the following:

- Understanding and accepting one's self.
- Being able to acceptance criticism and willingness to change.
- Open-mindedness or freedom from prejudice.
- The desire to learn new things.
- A well-construction philosophy of education that is used as the basis of their teaching.
- A multicultural view of learning and human development.
- Knowledge of and connect with the community in which one is teaching.

This list is by no means meant to be exhaustive or exclusive; rather, it is used here to simply start the conversation. As you do an Internet search using the words "effective- teacher-dispositions", you will notice that there is quite a wide variety of traits that various research studies have found to be important. See if you notice some common themes.

Becoming an Expert Teacher

Besides the traits and dispositions described above, what separates the expert teacher

from one with "growth potential" is the possession of four types of knowledge (Bruer, 1999; Darling-Hammond, 1999; Eggen & Kauchak, 2007):

• **Knowledge of content.** The expert teacher has a body of knowledge related to the content or subject matter that is to be taught. The math teacher knows a lot about math, the social studies teacher knows a lot about social studies, etc. This body of knowledge guides the expert teacher in deciding what is taught and in what order. What about the elementary teacher or the special education teacher?

• **Pedagogical knowledge**. *Pedagogy* is the art and science of teaching. Expert teachers know a variety of skills, strategies, techniques, and methods to impart knowledge or enhance learning. Effective teachers have a toolbox filled with a variety of pedagogical skills they can use with a variety of students in a variety of situations. *Educational Psychology for Teachers Book II: Advanced Pedagogy and Classroom Practices* contains a wealth of specific pedagogical skills and strategies.

• **Pedagogical content knowledge**. Pedagogical content knowledge is an understand of how to teach specific content or skills. For example, you know the best strategies for teaching reading, science, math, or writing. Also, you understand how to convert your knowledge into information that students can understand. You can break things into manageable parts, use kid language to make things clear and simple, and design activities that help students understand.

• **Knowledge of learners and learning**. You understand the learning process, you know how students best learn, and you recognize link between what you do and student learning. Here you understand human development, theories of learning. That is, how human beings learn. This text is designed to help increase your understanding of this type of knowledge.

RELATED MINI-LECTURES

Human Learning
https://www.youtube.com/watch?v=rzXoBLVIaWg

Human Learning
https://www.youtube.com/watch?v=QaYvpkKBC70

Human Learning: Creating Individual Realities
https://www.youtube.com/watch?v=yVC7HekZnic

How Humans Learn: Brain and Mind
https://www.youtube.com/watch?v=Nz5ZG_R8i_c

Schema Theory, Learning, and Comprehension
https://www.youtube.com/watch?v=V4_Kio9pPwE

Master Teachers: 4 Types of Knowledge
https://www.youtube.com/watch?v=qIah3CyY1F0

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