The Relationship between the Information Processing Theory and Learning Disabilities

Educational Psychology
As future educators, understanding how students learn and the disabilities that accompany learning is critical in implementing classroom instruction. Having this insight on how one learns, acquires new information and retains previous information shapes a teacher’s method of effective instruction to meet the needs of all students including those with learning disabilities. There are various theories that look at the connection between teaching and learning which also take into consideration various learning disabilities and their occurrences based on learning processes.

One of the main approaches to learning is the cognitive approach. Unlike behavioral based theories, cognitive theories look beyond behavior to explain brain-based learning. The two main assumptions in the cognitive approach to learning are: (1) the memory system is an active organized processor of information and (2) prior knowledge plays an important role in learning (Huitt, 2003). The information processing theory is a leading cognitive theory today which emphasizes memory and the brain as the main components in promoting students learning and looking at the amount and the way in which the brain processes and stores information.

**The Information Processing Theory**

Eliasmith (2001) defines memory as the “general ability, or faculty, that enables us to interpret the perceptual world to help organize responses to changes that take place in the world.” It is implied by this definition that there must be a concrete structure or model in which new stimuli is incorporated into memory. Although there have been several information processing models created overtime, they all share a few key assumptions or considerations. First being there is a limited capacity to how much the brain can encode, store and retrieve (Huitt, 2003). Depending on the theory, these limitations occur at different points in the information
processing. The second assumption is that there is some type of control system in dealing with the stimuli. Another key assumption is that there is a relation between new information and already stored information. The last assumption shared among the different models is that all humans have specific genetic traits that influence the way in which they process information (Huitt, 2003). Learning disabilities create exceptions and implications to these assumptions which are discussed later in later sections of this paper.

The most widely used information processing model today is the stage model created by Atkinson and Shriffin in 1968 (Mayer, 1996). The basis of this model is it views memory and learning as sporadic and multi-staged and as new information is taken in, it is manipulated before being stored. The stage theory model distinguishes three stages of memory: sensory memory, short-term or working memory, and long-term memory.

*Sensory Memory*

Sensory Memory is the first channel in the memory store which all the new information and environmental stimuli end up passing through. In a normal functioning information processing system, the sensory memory gathers all the raw data from the different senses such as sight, hearing, taste, tough and smell for 1-4 seconds (Eliasmith, 2001). Learning begins in this stage of the information processing theory. During this stage, once the incoming information is attended to or acknowledged as significant enough, students will develop their initial perception of the stimulus. A student’s perception of a stimulus is the most imperative step as it directly affects how the student consciously understands the information later on in the working memory (Eliasmith, 2001). Over time, in average developing children, their senses become more acute because they are better able to discriminate between the sensory stimuli they experience and see.
Short-term/Working Memory

Once the information has reached the sensory memory and has been attended to, the information goes into short-term or working memory. Working memory has limited capacity of approximately seven chunks of information and functions most efficiently when perceived information is immediately acted upon (Suthers, 1996). Information comes into the working memory from two directions, the sensory memory and the long-term memory. Once the information is in the working memory, it needs to be processed and practiced within 5 to 20 seconds for it to be transferred to the long-term memory (Eliasmith, 2001). This information will only be transferred to the long term memory if it is encoded in some way. Encoding and recoding allows individuals to recall the information from their memory and use it. Some ways information is effectively encoded is when material is meaningful and when prior knowledge activation occurs. Strategies for encoding include rehearsal, chunking, schema activation and mnemonics. Rehearsal can simply be repeating the information over and over or can be more elaborate when new information is linked to already known information (Suthers, 1996). Chunking is breaking up the information into manageable chunks so it is easier to remember. Schema activation is a strategy to use with encoding complex information, relating and fitting new information into existing schemes (Eliasmith, 2001). Schemes are structures which help organize our knowledge and assumptions about something and are used for interpreting and processing new information. Lastly are mnemonics which are memory strategies that help people remember information by using something such as a rhyme or song or pairing the already known information to the new information. As average children develop, the working memory becomes larger, more capable of holding different types of information and is able to automate certain tasks with the increase in speed during information processing (Suthers, 1996).
Long term memory

The transfer from short-term to long-term memory has been compared to the processes of a computer because it first encodes and then later stores information. Long-term memory is the part of memory which has an unlimited capacity and holds information indefinitely (Eliasmith, 2001). It provides the framework to which we attach new knowledge. There four types of information that can be processed: verbal knowledge, intellectual skills such as knowing how to perform a task like paraphrasing, visual images and episodes (Mayer, 1996). In long-term memory storage, information either becomes declarative knowledge which deals with factual knowledge or procedural knowledge which is knowing how to perform a task. Long-term memory storage is subject to fading or forgetting so several retrievals of memory may be needed for long-term memories to last. Creating lasting, long-term memories is dependent upon the depth and efficiency of the information processing system.

Implications for Learning Disabilities

When there is a deficiency in the brain of its processing and understanding of information, learning disabilities result. Learning disabilities are not related to a physical disorder such as hearing loss or impaired vision and are not related to one’s intelligence (Swanson, 1987). It may take several years to determine that a student has a learning disability, because during childhood the behavior may simply be equated to common childhood issues. Since the functions in information processing cannot be directly observed, it is difficult to diagnose specific learning disabilities. Students who have average or above-average intelligence can be diagnosed with learning disabilities when there is a significant inconsistency between their academic achievement and their intellectual ability (McDevitt & Ormrod, 2004). Learning
disabilities can fall under several categories whether it be spoken language-listening and speaking; written language-reading, writing and spelling; arithmetic-calculation and mathematical concepts or reasoning-organization and integration of ideas and thoughts (Mayer, 1996). Other conditions such as ADD/ADHD, psychiatric, or mobility impairments can accompany learning disabilities by further hindering normal information processing (Özel, 2009).

Specific processing problems may occur in different stages of information processing. For learning to occur the material and information must be input through one or more of the senses, it must be attended to, perceived and made sense of through organization, stored and later retrieved with memory, and then pushed back out during output.

*Input*

According to the information processing theory, information is first received through input of one or more of the senses. Input is the main component in information processing impairments due to visual or auditory issues because the eyes and ears are the primary means of delivering information to the brain (McDevitt & Ormrod, 2004). Some of the early signs of visual learning disabilities are children who are often distracted easily and who find visual stimulation to be difficult. They confuse or misunderstand simple symbols like x + & / . While doing math problems, students with learning disabilities may misalign equations, or have a problem staying within the lines or margins while writing in English class (McDevitt & Ormrod, 2004). The student may have difficulty distinguishing differences in shape, skip words when reading or bump into things while moving about as they have a hard time judging depth or distance. The student may have difficulty processing the information that is presented with
overhead projection, graphs and charts, videos or websites. For most individuals, especially those with learning disabilities, the more methods of learning that are used the better the chance the input will be remembered. Students with auditory processing disorders are those that have trouble processing information that is given verbally such as lectures or class discussions. In this case, the ears hear what information is said but is not processed correctly. Another sign is that these students may have problems discerning between background noise and the meaningful sound to which they are supposed to hear and attend (Özel, 2009). Because of this it may be difficult to stay focused on a person’s voice or remember a song. Those with auditory processing disorders may also mix up sounds that sound alike or have trouble speaking in a normal tone. Students having either of these auditory and visual processing impairments have an overall slower information processing speed than average developing students due to their trouble with the information input to their sensory memory.

Attention

Attention is the learner’s ability to focus on the information at hand. Once the information is presented to one or more of the senses, it must be attended to. Information that is not attended to, does not enter into the information processing system and without a student’s attention to the task at hand, learning cannot occur (Suthers, 1996). In most cases, the learner can only pay attention to a select amount of information sometimes paying attention to the information that may not be important in helping him or her learn. Students with ADD and ADHD have trouble with the attention component of information processing because information is missed due to being distracted all the time. It can be hard for them to maintain focus, racing from task to task instead of attending to the information. When the students are paying attention to the information presented but they fail to pay attention to the critical
attributes of the lesson this can also present problems to learners. It is essential for the learners to indentify clearly what they should be paying attention to and to check throughout the lesson that they are meeting the objectives. In the novel, *The Curious Incident of the Dog in the Night-time*, written in the first-person perspective of an individual with multiple disabilities, Christopher talks about the hardship of his disability when it comes to information processing in that it can be hard to attend to and take in several sensory items at once. This makes it hard for him to interpret the world around him and to understand things as it always seems like a sensory overload. He states “…there was too much interference in my head and this had made me confused” (Haddon, 2003, p. 96). The passage below illustrates that he first sees everything clearly as its coming in and then he says “after a few seconds it looked like this because there were too many and my brain wasn’t working properly and this frightened me so I closed my eyes again and I counted slowly to 50” (Haddon, 2003, p.96). It is an example of him not being able to properly attend to the information entering the sensory register.

*Figure 1. An example of all the information that is entering Christopher’s sensory memory when he steps off the train and enters the city.*
Perception, Integration, Sequencing & Abstraction

Once the information is brought into the brain through input and attended to, there are certain tasks that must be carried out in order to make sense of the information. How the information is perceived can affect one’s understanding of it. Depending on the individual’s specific learning disability, they may have difficulty interpreting and organizing the information from the different sensory channels (Suthers, 1996). In order to be able to organize the information the individual needs to be able to sequence the information. With learning disabilities, individuals may sometimes have a hard time learning information in the proper sequence such as the alphabet, months of the year, or a times table. Students may also have difficulty with abstraction, with things such as inferences and finding the meaning of words or concepts, making idioms and puns or jokes hard for them to understand (McDevitt & Ormrod, 2004). It is difficult for those with abstraction issues to understand words that have different meanings depending on their context and how they are used. Those with auditory and visual...
perceptional disabilities may have difficulty with perception due to the reasons linked to those noted under input.

**Memory**

From the previous sections, we know that memory is a key component to the information processing theory. Once the information is perceived, it enters the short-term memory and individuals with learning disabilities may have trouble with either their short-term or their long-term memory processing. Working memory can become overloaded when too much information is presented. If the learner fails to perform some type of processing with the new information through self-questioning or thinking about how the information fits with what he or she already knows or looking for patterns, there is a disconnect and the information does not get learned (McDevitt & Ormrod, 2004). Successful learners actively and appropriately engage in taking what they already know and connecting the new information to that, naturally building on their long-term memory networks (Eliasmith, 2001). Those with learning disabilities do not automatically do this and need help connecting new information with what they already know.

**Output**

Once the information is learned it then needs to be retrieved and communicated. Information can be communicated in terms of words through language output or through motor activities such as writing, drawing or gesturing. Individuals may have either language or motor disabilities making it hard for information to be communicated (Swanson, 1987). With language disabilities, it is not easy for the individuals to organize the thoughts, find the right words and speak them all at the same time making it hard for them to speak in demanding situations where they may be asked for an answer or explanation (Swanson, 1987). Learning disabilities with
writing involve both the physical act of writing and forming words and letters and the mental act of comprehending information or organizing thoughts on paper. Individuals with motor disabilities have trouble with fine motor skills or tasks that require hand-eye coordination and might have problems coloring, writing, cutting, etc. making it difficult to communicate information to others what they have learned (Mayer, 1996).

Each of these steps is significant and students may have weaknesses in one or more of the areas causing a learning difficulty. Perception, Integration, Sequencing and Abstraction are important processes to numerous educational skills and abilities. Children with learning disabilities process information more slowly than normal students and because of this their storage and ultimately their retrieval of this information suffer. If any of the information processing steps are not carried out properly, it will create an obstruction to the learning process and as a consequence their learning is subsequently negatively affected.

Using Instruction that incorporates the information processing theory

With the increased numbers of those with information processing disorders and learning disabilities it is important for us as teachers to make accommodations to fit the needs of our students. I believe that there are a number of things that a teacher can do while planning a lesson to make it more accessible to all students.

Educators must create a set of techniques to attract and hold a student’s attention such as moving around the room, using gestures and eliminating any unnecessary distractions caused by lighting, noise, temperature, seating, etc. Also, it is important to make sure we have the student’s full attention prior to presenting information. During the lesson, we must focus student’s attention on the important concepts by highlighting the main ideas and be selective about what
information is given to be careful not to cause an information overload (Özel, 2009). Because the working memory can only hold approximately seven items, it is important to reduce the cognitive load for students through “chunking” information.

As a strong believer in the constructivist theory, I believe that meaningfulness is a key component to information processing. I believe that when students are able to associate new information with past knowledge or experiences it will be more meaningful and therefore remembered much easier. When teaching a lesson, a teacher should state objectives and review previous lessons to help students attach information to what they already know. Closely related to meaningfulness is organization because the information that is presented in a more organized manner is more meaningful as students will be able to make better sense of it. A teacher can do this by using outlines or diagrams to organize the information into categories and give examples. Using mnemonics, concept maps, visual images, and graphics can be constructive tools for enabling individuals with learning disabilities to remember the information that is being taught (McDevitt & Ormrod, 2004). These devices help the learner see how the information is organized which aids in long-term memory storage. Another key part to helping students successfully learn is giving students practice in using the new information; after defining, highlighting, and elaborating on a concept, ask the students to do something with it, like solve a short problem, write a sentence or draw a picture. Students will find the learning more meaningful when they are provided opportunities for overlapping fundamental concepts and skills.

When teaching students with visual perception and processing disorders I believe it is important that the teacher uses many forms of teaching such as sounds, images and written and spoken words so the student can see the new information and process it using several of the senses instead of just visual (McDevitt & Ormrod, 2004). While being spoken or read to,
additional time may be needed for the individual to decode and then comprehend the written material. Taking into account individual differences, as teachers we must provide printed materials upfront to allow students enough time to read and comprehend the material. It is beneficial for students with learning disabilities to use software or different type of technology which can read book or textbooks to them (Özel, 2009). By adapting the lessons to the needs of the students and allowing them to use different methods and materials it can help them to more easily reach their learning goals by bridging the gap between information processing and their learning disability.

Information Processing is how one’s body collects various pieces of information and creates knowledge. During this process, the brain is supposed to pull together the information that is being brought to them through stimuli, recognize the information and then give a response. When information is stored during this process, next time similar stimuli are presented the brain will know how to respond more quickly. Aside from the school setting, information processing is the process that makes it possible for individuals to do everyday tasks. Learning disabilities can interfere with any of the stages of information processing, affecting the way that people carry out these tasks. Overall, I believe that examining the basic processes that govern learning and understanding the strengths and weaknesses of the learner’s information processing can guide a teacher in structuring instruction to build upon those strengths and help the learner compensate for their areas of needs in order for them to effectively learn when new information is being presented.
References


