What is the Neuroscience Behind Student Engagement?

First of all, what exactly is student engagement? It could mean many things but here I'm referring to the relationship between the student and the amount of interest, curiosity, degree of attention and passion the student has towards what is being taught in the lesson. It's the degree to which the student is motivated, understands the material and internalizes it into their personal life. The lesson must be meaningful and relevant with emotional involvement and commitment from the learner.

So what is actually happening inside the brain when learning takes place?
Student engagement is much more than just a student paying attention. It is the behavioral, cognitive and emotional participation in the learning environment. When learning takes place, neural networks, or neural maps are created and it greatly depends on what the individual already knows… it's prior knowledge. Sylvia Vorhauser-Smith, Senior Vice President of Global Research at PageUp People, mentions that there are three dimensions to learning, as well as three potential barriers, that can interfere with the learning process (Vorhauser-Smith, 2011):

The Three Dimensions of Learning (Vorhauser-Smith, 2011)**:**

1. **Content**

In order for prefrontal cognition to occur, lessons must be engaging so the student's attention is clearly focused on the material. If there is insufficient concentration on the subject, the neural networks are weak and/or incomplete and fail to form adequately. Very little retention will take place if the neural networks are inadequate.

2. **Incentive**

There must be some type of motivation behind wanting to learn anything. If the student does not see the value in what he/she is learning, or there isn't any real interest in the subject, then this becomes a barrier to his/her learning. The individual may be overwhelmed or afraid of change, which also creates a barrier. If there is no intrinsic incentive to learn, "…the dopamine reward mechanisms, necessary to stimulate and reinforce learning, fail to be activated" (Vorhauser-Smith, 2011. Pg. 10).

3. **Social**

Our social brain reacts to who else is involved in our learning process. The interaction and support we receive, as well as the quantity and quality of the communication, has a direct correlation to how and what we learn. As a teenager, I learned so much from Coach Cohen because he inspired me and he was exhilarating … sharing his passion for learning. Good teachers, coaches and mentors do this all the time. "Conversely, when we have been in unsupportive environments, or (worked with) unproductive teams, learning outcomes are compromised" (Vorhauser-Smith, 2011. Pg. 10).

The Importance of the Hippocampus
When someone wants to recall what they have learned, the hippocampus comes into play. This is the region of the brain where encoding takes place and memory activation

begins. (Davachi, 2002). As neuroscientists studied the biology that is involved in the actual learning process, they could see that there were activities that actually activated (or did not activate) the hippocampus (e.g Davachi & Wagner, 2002; Lepage, Hibib & Tulving, 1998). This has a tremendous impact on the teacher's lesson and how to encode information into long-term memory.

Massing vs. Spacing

Research studies made us realize that perhaps repetition wasn't as important as the spacing of the learning activity. Back in 1976, Crowder's studies show us that spacing the learning over a period of time had a much higher retrieval rate that cramming blocks of learning into short periods (Crower, 1976). However, massing (large amounts of information studied over a short period of time) was good for short-term performance…such as cramming for a big exam (Baddeley & Longman, 1978; Kornell & Bjork, 2008; Simon & Bjork, 2001). Massing, however, did not help with long-term memory retrieval, which is the ultimate goal of all educators.

Spacing seems to build stronger long-term memory and produces a higher retrieval rate of new information (Litman, 2008). Time is needed to allow neurons to make and wire new connections, even when the learner is resting (Tambini, 2010). So spacing is essential for enhanced memory performance, giving time for the hippocampus to activate consolidation (Litman, 2008).

Now we know that the hippocampus must be paying attention for memory to be encoded. However, that's easier said than done. There are so many distractions and dividing attention between two tasks decreases the quality of attention. If the attention is divided, the hippocampus is not engaged (Kesinger, 2003). Because the brain can only pay attention to one item at a time (Watch for my article on "*The Cocktail Party Effect*."), multi-tasking decreases the neurons from firing, and, hence, "learning decreases significantly" (Arnsten, 1998/2003). Therefore, it's critical to have "undivided attention" during the lesson.

Neurochemicals needed for paying attention

When we are actively paying attention, two very important neurochemicals, called catecholamines, are released. Dopamine and norepinephrine are found within the synapses allowing the brain to focus on the items being taught.

First of all, if the lesson has novelty associated with it, it will grab the learners attention as dopamine is released in the brain, making the individual feel good. Dopamine is a catecholamine that gives them a "natural high," such as when walker completes their workout. When a person is curious, goal-focused, or accomplishing a task, dopamine is also present.

Norepinephrine is a neurochemical that is also released during stress (refer to my article on *Stress: It Neurological Implication on Learning*). It's designed to help us pay attention and needed for survival. It's the chemical that is released with the "Fight or Flight Response." It causes our senses to be on high alert. It's what is released before

we give a speech, or what a gymnast sets into motion right before a performance. In order for one to pay attention to a particular lesson, norepinephrine will help the brain stay focused.

So how can a teacher increase this natural chemical of the brain? One way is by making the lesson meaningful and relevant to the learner. The student must see the value, or the potential reward they will receive when the material is mastered. It must be meaningful to them as a learner.

Making learning meaningful

In Dr. Pat Wolfe's workshop, *The Neuroscience to Teaching and Learning* (Wolfe, Feb. 2018), she talks about the importance of making lessons relevant to the students' lives. In the one exercise she showed the participants a picture of a bunch of ink spots and asked if anyone could see an object. Within a few seconds, someone said, "I see a Dalmatian." The brain is quickly searching for what it knows about dogs, about Dalmatians, and links it's prior knowledge to that information.

Then Dr. Wolfe goes on to explain that if the participants were all from Mars and there were no dogs on Mars, the viewers would never, ever, see the Dalmatian because the brain has no prior knowledge and there is nothing to hook the new information to it. So she then asks, "If I were a teacher on Mars, and I want you to see this Dalmatian, what would I have to do?"

First, the teacher could link it to something they do have knowledge about. There are cats on Mars so the teacher could say, "It's like a cat, but has longer legs, and a much longer nose." So the new information is being linked to the previous knowledge about cats.

Or the teacher could create the experience with them by bringing in a Dalmatian to the classroom, or showing them the movie, *101 Dalmatians*. This experience is now much more meaningful to the student.

Conclusion:

As mentioned earlier, for effective student engagement to occur, the lesson must catch the student's attention first (Refer to my article, *How do we Learn and How is Information Stored in Long-term Memory?*). Teachers should remember, "the hippocampus will not fire sufficiently for memory encoding to occur if the optimum attention level is not reached (Davachi L. K., 2010)." Paying close attention to something that is meaningful to the individual and relevant in their lives, must also be challenging enough to keep their focus. "In short, making learning easy to digest, through chunking, visuals and stories, and making it interesting and engaging are critical for optimizing retrieval of information" (Davachi L. K., 2010).

Learning is a very complex process. Teachers need to adjust their teaching strategies to enhance their students' learning opportunities. So how can teachers create deep circuits in the hippocampus for easy retrieval? Refer to my upcoming article, *" Looking*

at Student Engagement, and Based on Neurological Research, How Should Lessons be Designed?"

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