1. Primacy-Recency Effect

Research and anecdotal record prove that what is presented first in a lesson is best remembered. What is presented last in a lesson is remembered second best. What comes in the middle of the lesson is remembered least. So what do most school classrooms do in the beginning of class? Attendance, announcements, check homework, and other clerical matters. The meat of the day's lesson doesn't start until 15 minutes into the period. What do students remember? Who was absent, when clubs are meeting, how many problems they got wrong on page 242. When is the critical point of today's knowledge presented? In the middle where it will be remembered least effectively. Let's change this.

Sousa calls this the "Primacy-Recency Effect," and he says the portions of the lesson at the beginning and the end are "prime time" for brain learning. Because we know about this, we need to change what we do. This means we should present the lesson's most important points, the big truths, within the first 5 to 10 minutes. It's okay to do this without students knowing how we arrived at the big truths. We can do that part later in the lesson. The important thing is to give them the essential and enduring knowledge when it is most likely to be remembered—at the beginning. Be careful not to ask students to brainstorm what they know about a topic as you start a lesson. Inaccuracies may be presented and the brain will more than likely remember them and not your corrections of them.

Think about this one: You finish five minutes early and want to give your students a free time as a reward for paying attention and working hard. You tell them they may sit quietly, talk, and even listen to music until the end of the period. Sousa points out that this is prime time for the brain. It will be remembered more than the great truths of your lesson. In these free times at the end of classes, what do students elevate to long term memory storage? Staring out the window, doodling, the song that was playing on the radio and the latest classroom gossip. Your wonderful lesson on habitat carrying capacity was moved to the limited learning zone of the middle portion of the lesson. If you're going to give students a break, therefore, do it in the middle of your lesson, not at the end. Save the end for summarization and reflective activities so students take the learning with them. You can also teach two twenty-minute lessons, rather than one long 45-minute lesson. You increase the amount of prime time for the brain. You have two beginnings and two ends this way. With one longer lesson, you only have one beginning and one ending.

2. Appeal to the Senses and the Emotions

All information enters the brain via sight, hearing, and touch. It makes sense (pun intended) to start successful processing in the brain by appealing to one or more of these senses. Anything the teacher can do to incorporate more than one sense into the lesson will increase the likelihood of retention.

I can't say enough about the power of emotions in middle school learning. Students really respond to them and retain information as a result. It turns out that research supports this. Teachers that turn up the emotional context of the lesson, **therefore**, have students that achieve. The amygdala (on the Hippocampus) encodes emotions onto information before sending it to long term memory. The emotion acts like a beacon. The stronger it is, the more easily retrievable is the information. This is why learning experiences with a strong emotional component are retained longer and with more accurate recall than experiences that lack emotional attachment. Is it possible to go too far? Yes. Too much emotion actually paralyzes the learner with anxiety and it can slow the processing or prevent it from happening. Sousa says that threats (such as a teacher's angry retribution for undisciplined students) do the same thing. So the key, then, is to maximize the emotional component of our lessons without crossing the threshold into shutdown mode.

We need to do whatever it takes to make sure students feel safe and invited in our classrooms. If they do, they are more likely to engage in the learning. One way to do this is to teach the three modalities: visual (seeing), auditory (hearing), and kinesthetic (moving). All of us tend to learn better through one of the three ways. Though it is easiest to teach through visual or auditory media, it takes some creativity sometimes to teach an abstract concept kinesthetically.

To increase thought processing, make the lessons compelling. Use students interests or create suspense. Socrates always told us that all thinking begins with wonder. Create wonder in your lesson on polynomials. Another motivator is accountability. If it's going to be checked or graded, students pay attention to it. Providing feedback that is, "prompt, specific and corrective…they are more likely to continue processing, making corrections, and persisting. Many brief quizzes that are carefully corrected and returned promptly are much more valuable learning tools than the unit test" (Sousa, p. 25).

3. Water and Peanuts

'Significant increase in conductivity along the myelin sheath that surrounds the neuron when people drink a lot of water. The more hydrated the neuron is, the faster and stronger the electro-chemical pulse will be. Thinking is improved. When we drink too much alcohol and get a hangover, we're actually experiencing a dehydrated brain. That's what alcohol does. We feel terrible and it's a struggle to think, move, and speak. To get back in shape we rest and re-hydrate the brain with lots of water.

Dr. John Fahey in the March 2000 issue of ASCD's *Educational Leadership* talks about his use of water in the school when he was assistant principal. He said it transformed the atmosphere of the school and it improved student achievement. He mentioned the other great thing water does for the brain—it brings oxygen. Oxygenated brains learn, non-oxygenated brains don't. Let's bring some water coolers in the classroom.

Peanuts, beans, and seeds do the same thing to the myelin sheath. They increase conductivity and thinking. In the November 1998 issue of *Educational Leadership*, George Mason University professor, Barbara Given, tells us that the proteins in these foods cause the release of 21 amino acids in the brain, a portion of which get transformed into dopamine. Dopamine generates "alertness, attentiveness, quick thinking, rapid reactions, motivation, and mental energy" (p. 70). She also says that students who eat proteins and carbohydrates for breakfast instead of just carbohydrates do much better in school. They are not sluggish and do not frustrate easily. In one study, students who were poorly behaved that changed their breakfast to one that included proteins, in fact, were well behaved within two weeks.

Students who snack on healthy foods throughout the day do better in school, Given says. This justifies allowing students to bring water and healthy snacks to class. I've done it for 19 years and never regretted it. In the beginning of the year we list what's acceptable and what's not and the students abide by it. Our list includes: nuts, sandwiches, fruit, bagels, raw vegetables, beef jerky (if you can stand the smell), or trail mix with a lot of nuts in it. Of course, we have to be careful with today's growing population of students allergic to peanuts and peanut products, but it's worth considering.

4. Brain Elasticity

Research cited in the Washington Post, March 9, 2000 shows that the brain continues to grow through puberty to age 15. During these years it is "hard-wired" for tasks. It's important, therefore, to provide the most effective learning experiences and repeated exposure to those concepts and skills through early adolescence. This supports the idea of brain elasticity. The idea is that the brain changes physiologically as a result of experience. Pat Wolfe and Ron Brandt talk about this in the November 1998 issue *Educational Leadership*. Neurons grow multiple, branching dendrites over time as people learn new material. If a pathway isn't used for a while, other pathways grow through it and thereby "bleed" off the impulses that might have wanted to access what lay at the end of the original pathway.

Wolfe and Brandt also tell us that the brain is innately social. It requires interaction, therefore, in order to develop. In interaction-deprived environments, the ability to think is diminished or never develops, they say. In interaction-rich environments, thinking ability and memory increase. The researchers make it clear that IQ is not fixed at birth. The brain stretches and constricts over time, depending upon the extent of its stimulation. If we want early adolescents to learn, we have to constantly work those neural pathways and stretch those brains.

This supports one of Sousa's claims that the more the brain retains, the more it can retain (Sousa, p. 75). By increasing the learning, we create more neural pathways. There are literally more connections waiting to be made. Learning something new makes those connections, at the same time creating a need and capacity for more connections. Learning, therefore, increases our capacity to learn.

The Christopher Reeve Foundation has discovered that exercise can actually grow neurons. Prior to this, we thought we couldn't generate new neurons, only navigate through what we already had. If we want students to do well on assessments, then, we better be increasing their P.E. experiences and/or exercise. In addition, the Foundation has found that it's possible to migrate the new neurons to damaged areas of the brain and be successfully integrated and functional with the new tissue.