Brain-based classroom learning techniques: From understanding to practice

Jeff Mehring
Ohkagakuen University

Jennifer Edwards
Ohkagakuen University

Thinking. We all understand the importance of getting students to think and use what they have learned to form new ideas, or build on old ones, but how do you motivate students or teach them to pay attention? When a teacher tells a student to "pay attention", do students really understand what the teacher means? What happens in the brain as teachers lecture, hoping the students will remember what is being taught? Motivation, novelty, and memory are all tied together with how the brain functions. Many of the techniques mentioned in this paper to increase motivation, novelty, and memory are already used by teachers. However, understanding the connection between these techniques, how they affect the brain, and what the potential outcomes are, is an exciting result of brain-based research in education. Understanding how to use these techniques while keeping the potential of the brain in mind in a classroom setting will help create a more learner-centered environment. This is where building an understanding of how the brain works and incorporating brain-based techniques such as time, music, visuals, and group work can ignite a renewed curiosity in learning for students.

　私たちは全員「学習者が学んだことをいかしながら、新しい考え方を身につけていくこと」が重要であると理解している。しかしながら、どのようにすれば、学習者が進んで学ぶ姿勢を持つことが出来るのであろうか？また、どのようにすれば、授業に集中するだろうか？教師が「こちらの方を注目するように」と言った際に、学習者は本当にその言葉の意味が分かっているのだろうか？　学習者が教わったことは覚えているだろう、と思いながら講義をする際に、学習者の脳の中では実際にどのようなことが起こっているのだろうか？実際には「動機・新鮮さ・記憶」の３者が脳を機能させる要素として同時に影響していると考えられる。本論文において言及している「動機・新鮮さ・記憶」を促すための教授方法は、すでに教師たちによって実践されているものではある。しかしながら、テクニックの使用法／実践面に加えて、それらがどのように脳の認知側面と関連を持ってくるのか？という研究結果については、大変興味深い結論につながってくるのである。効果的な教授方法を脳の認知側面を意識しながら、特定の教室環境の中でどのように使用していくか？ということを考えることは、真の意味で学習者中心の授業展開につながっていくものであると期待している。このような研究によって、たとえば音楽使用や視聴覚教材使用、グループワークといった教授テクニックが実際の脳機能とどのような相乗効果をもたらすのか？という疑問を明らかにしていくものであると考えている。

THE HUMAN brain is an amazing organism. About the size of a grapefruit and made up of 78% water, 10% fat, and 8% protein (Jensen, 2005), it is what makes us human. As humans we have a built-in process by which we can think/reason and make choices about our lives. The brain has neuroplasticity which makes it malleable and changeable, and with proper input and action, new connections can be made in the brain (Doidge, 2007). The ability to change, link ideas, and build upon those ideas is the source of innovation and the

expansion of learning experiences. When teachers use brain-based research to guide classroom teaching, they can provide their students with the potential to expand the learning experience infinitely. Using brain-based research in the classroom is not a quick fix but a theory, based on empirical evidence, which when incorporated as a philosophy of teaching can become the foundation of all methods and techniques used in the classroom. Therefore, in this paper we will first introduce the importance of understanding how memory works, and then we will provide techniques such as novelty, music, predicting, time on task, and chunking to help teachers create successful lifelong learners.

How memory works

It is helpful for teachers to gain a better understanding of how the brain functions to assist them in better understanding why students do what they do in the classroom setting. Input can pass through the brain at 120 meters per second (Jensen, 2008) so it is important that teachers help students to transfer the new learning to long-term memory properly so the new input does not leave the brain as fast as it enters the brain. For this transfer to take place it is necessary to understand the process new input goes through as it passes through short-term and working memory with each area playing an important role, individually and working together.

New input enters the brain through the senses--sight, hearing, smell, taste, and touch--and first passes through the reticular activating system (RAS) which is responsible for filtering the incoming input. The RAS, as described by Willis (2008), filters all incoming sensory input and determines what input is important enough to be examined in more detail and which input can be discarded. To demonstrate this point, count the number of times the letter *p* appears in the following sentence: *Peter, Paul and Mary went up the hill to pick purple plums and dump them in Egypt.* You most likely counted six because your RAS most likely did

not count the *p* in "up", "dump" and "Egypt". This is how your RAS works: it edits which sensory input will get through to your conscious brain, or the thinking brain, and the sensory information that does not attract your attention is discarded. This process takes between 5 and 20 seconds during which the RAS will filter the input on a survival needs basis. If the RAS determines that the new input is important for survival, it will pass through to the higher brain where cognition can take place. If the brain feels that the outside input is not prevalent to its survival, the brain will discard the new input as irrelevant (Willis, 2008). In essence, the brain is very strict on what it allows into working memory, but as we shall see later, there are ways to help ease the transition into working memory.

Subsequently, new input, once it has passed the "survival" test, will move into working memory where two new challenges are presented. The first transitional challenge is that working memory will try to connect new input to a person's schemata by asking two simple questions. The first question is whether or not the new input makes sense. According to Sousa (2006), *making sense* refers to how well the learner can understand the new input based on experience. Does the new input "fit" into what the learner already knows about the world, subject, or topic? The second question is whether the new input has meaning. Put another way, is it relevant to the learner (Sousa, 2006) and why is it important for the learner to know? This is the "what's in it for me" mentality that students may verbally or mentally express when learning new material. To each learner meaning will be different; it is personal and it is based on their own unique experiences. For example, if I tell a student in my English class that the passing grade is 80% but that in another teacher's English class it is 85%, the information for both classes will make sense to her, but the passing percentage for my class will be more relevant and have more meaning, since she is enrolled in this class. There is a better chance she will remember her own class's passing percentage but not the other class's since it lacks

personal meaning for her. Jensen (2005) stated that we never really cognitively understand something until we can create a model or metaphor that is derived from our unique personal world. Unfortunately, new input will not become part of our personal world if it does not have sense and meaning.

The second transitional challenge is time on task. Students need time to process and make the learning their own. When new input is in working memory, it is at a very critical juncture in the learning process. Information can only be held in working memory for 20 minutes (Willis, 2006; Sousa, 2006) and, if working memory information is not moved into long-term memory within this 20 minute time period, it is lost. Like turning off your computer without saving the data, it is gone and has to be relearned. An illustration of this is when someone gives you directions to their house: As you begin you are sure of where you need to go, but soon become confused or lost and give up, only to ask again. The information was never placed in long-term memory so the information, although understood, was lost due to its not being transferred in time.

To better understand the relationship between time and working memory one needs to be aware of the *primacy-recency effect*. The primacy-recency effect, according to Sousa (2006), is described this way: We remember best what comes first and we remember second best what comes last. In Figure 1, prime-time 1, primacy mode, is input which the teacher feels is most important for students to learn (Sousa, 2006). During prime-time 1, which in Figure 1 takes place at the beginning of class, students' brains are most ready to learn and remember what they are being taught. Unfortunately, many teachers may use this time instead to take attendance, go over announcements, or hand back homework, etc. So it is understandable that students remember those events but cannot recall what they learned in class. Prime-time 2, recency mode, is input which comes last. In Figure 1 this would be near the end of class. Examples of what

may take place during this time could be teachers explaining the homework or clerical work such as checking to make sure students bring their ID cards for a campus event the following day. Wedged in between prime-time 1 and prime-time 2, downtime is the period when learning is lowest. In Figure 1, during an 80-minute lesson, 38 percent (30 minutes) of the lesson is downtime when students' brains are not in the learning mode, as compared with 10 percent in a 20-minute lesson. In Figure 1 this takes place right in the middle of the lesson. Although a teacher may feel this is the most important time in the lesson, explaining and practicing with students on assignments from the day's content, in actuality, at this point in the lesson students' brains are not receiving the incoming information. To counter this extended downtime and make learning more brain-friendly, teachers need to adapt to how the brain learns. When teachers shorten the content learning time to 20 minute segments as seen in Figure 2, we now see that an 80-minute lesson only has 8 minutes of downtime (10 percent of the lesson) when students' brains are not learning. There is also much more time spent in prime-time 1, the time when the brain is most ready to learn. In order to move new input from working memory into long-term memory, a teacher needs to take a break from presenting new material and give students' brains time to make the transition from working memory to long-term memory. With this in mind, let's examine a few techniques to ease the transition through the RAS and into working and long-term memory.
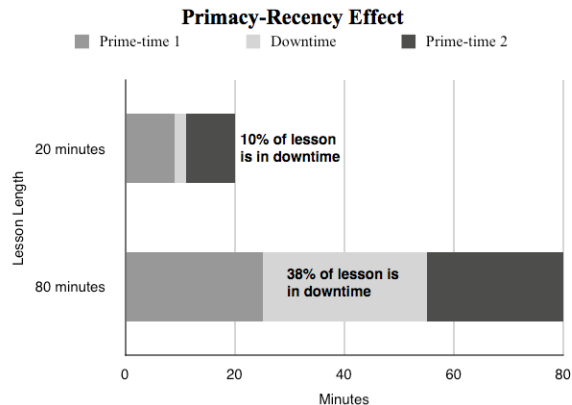
Primacy-Recency Effect

Figure 1. The breakdown of down-time and prime-time for 20- and 80-minute lessons before division (adapted from Sousa, 2006).
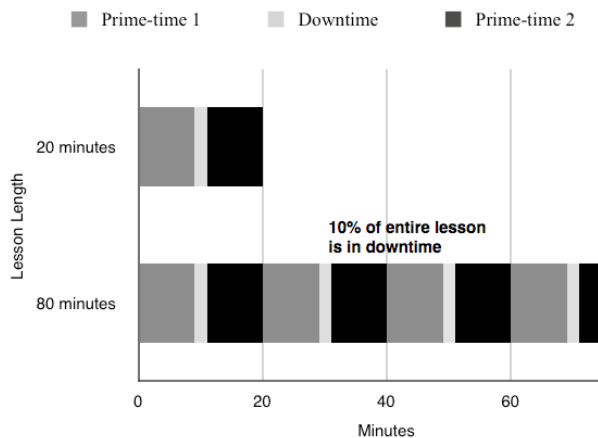
Figure 2. The breakdown of down-time and prime-time for 20- and 80-minute lessons after division (adapted from Sousa, 2006).

Techniques

Novelty

Novelty is one method which will attract the attention of the RAS, enabling new input to pass through the RAS and into working memory. Novelty influences the brain and gets it to pay attention. Wolfe (2010) stated, "Novelty is an innate attention-getter" (p. 115). Our ancestors needed to be aware of anything new or different in their environment in order to survive. Novelty tells the RAS to "look at me! I'm something different." Think of how advertisers try to sell their products. They use many images, catchy phrases, and music to attract our attention and make us want to watch or listen for a while, but after seeing the advertisement a few times we stop paying attention. It has lost its novelty. Since classroom "novelties", like turning on and off the lights to get students' attention, may only work once or twice before they become routine, a teacher needs to have many different attention-grabbing strategies. A few ideas are: dressing up in a costume that represents what will be studied, speaking in a different tone of voice, or using various colors when writing on the whiteboard or giving handouts. When used properly, novelty can be a very effective tool for creating curiosity in the classroom.

Music

Music has many effects. It can make us jump around, sing to the lyrics, and feel happy or sad. Music also helps us relax which in turn relaxes our brains. When used in the classroom, music can set the mood for different parts of a lesson. Before beginning the lesson, a teacher could play a high-energy song to energize the students for learning. Using music can be a great technique to move from one activity to another or when students are doing pair work. Baroque music helps to stimulate alpha waves in the brain, which can heighten memory and link facts more easily

(Sprenger, 2010). So during pair/group work baroque music would make a nice addition which would, unbeknownst to students, help them with memory enhancement without distracting them from the task at hand. Playing baroque music during a testing period has also been shown to increase test scores by an average of 10% (Rose & Nicholl, 1997). There are many benefits to playing music but like all novelty items students' brains will become accustomed to it, so teachers need to continually vary the music to keep students' interest.

Predicting

Students are naturally curious. Unfortunately, when you mention school, studying, or learning, curiosity dies quickly. By building curiosity and predicting, a teacher can increase the students' motivation to learn. Think of all the video games students play today. They can spend hours in front of a video game, going over the same sections as they try to improve, without any physical rewards given. The understanding that they are successful at the game is all the reward they need, being better than their friends or siblings. Students are always predicting when playing these video games to find the correct move to reach the goal or next level. When teachers utilize the same method in the classroom, they can increase student motivation because students are motivated by the need to know if they are correct (Willis, 2008). Reading teachers often incorporate prediction into lessons by discussing what the book is about before reading it by examining the cover and pictures inside. When a teacher asks students to predict, and the student is correct, a surge of dopamine is released into the prefrontal cortex of the brain. If the student is wrong, there is a steep drop in the dopamine released, but if the teacher follows up the incorrect prediction with constructive feedback, the brain will learn not to make the same mistake again (Willis, 2008). In addition, teachers need to make sure students write down their predictions to increase the students' investment in the activity. It is not necessary for students to show anyone else their predictions because just the simple act of writing it down increases the students' investment. Having students write their predictions down on a small white board or piece of paper and holding them up so the teacher can see them is one example. Also, teachers can play games incorporating the unit's learning objectives, either in small groups/pairs or as a class, encouraging students to make predictions and learn from the answers. Another possibility is to begin each unit with a prediction question: "What does this picture have to do with this week's unit"? A teacher can use a sentence, pictures, or music to elicit a prediction.

Another example is to begin by telling students a story about the person they are going to study when the person was the same age as the students are now. When a teacher researches something interesting from the person's life when he/she was the same age as the students, the teacher is helping students to better relate to the story. Then as the students become more interested in the story through this ability to relate with the person on some level, their curiosity will grow and motivation increase as will their interest to learn more about the person in class. Many teachers already incorporate prediction activities into their lessons. They just need to look at it from a different angle, and as they do so they will see more and more benefits of its usage in the classroom.

Time on task

As previously mentioned, in order to increase the chance of new input moving from working memory to long-term memory, a teacher needs to break up lessons into short 20-minute segments to improve the primacy-recency effect. Teachers need to intersperse more implicit learning strategies amongst the 20-minute lesson segments, some of which are simulations, role-playing, complex games and connecting new input to real life experi-

ences. There are numerous activities teachers can incorporate in their classes to enhance the primacy-recency effect. A few of them are using mind maps, creating storyboards, using paintings, or making models of what is being learned. Other activities which will help students put new learning into their long-term memory are graphic organizers such as Venn diagrams, small group discussions using reflective or critically based questions, or opportunities to get up and move around the room as they discuss questions posed by the teacher. These types of strategies give students time to elaborate on the input they are receiving, and elaboration in turn gives the brain a chance to sort, sift, analyze, test and deepen learning (Jensen, 2008). As well as timely implicit learning strategies, teachers should remember also that if the topic is difficult for students to understand, it could take longer for students to process, and react to, the information. Rochester (1973) along with Saville-Troike (1985) stated that reaction time is tied to topic difficulty or students' sensitivity to a topic. When students are asked a question, they first retrieve additional information from their long-term memory, check to see if it will answer the question asked, formulate an answer, and finally tell the teacher. This all takes time, and if their long-term memory does not have any additional information, students may not be able to formulate an answer; hence they will most likely remain silent. Material that recalls students' prior learning, and gives students time to process the new material, will enable students to place the new information into their long-term memory. It is also important to understand the amount of new input working memory is capable of holding at any one period in order not to overwhelm the brain and lose valuable new input. Dividing a lesson up into shorter segments, giving students activities which encourage new input to transfer from working memory into long-term memory, is just one element when it comes to teaching with the brain in mind.

Chunking

Equally important as the amount of time on task, and how material is presented, is the importance of how much material can be grasped at a time. This is referred to as chunking. Therefore, the amount of new input working memory is able to hold needs to be considered by any teacher who wishes to maximize student learning. As explained by Zull (2002), working memory can only hold 3 to 4 pieces of information and then students need to be given time to place that information into their long-term memory. Sousa (2006) used the idea of 7 plus or minus 2, so between 5 and 9 pieces of new input are all working memory can handle. Even if a teacher would like the students to learn the 13 American Colonies in one lesson, students will most likely only remember between five and nine colonies without the use of chunking. It is important that teachers chunk new input to enable working memory to handle more input. Think of telephone numbers: they are not seven or eight separate numbers but two chunks of numbers. Putting items into easy-to-remember chunks will not only allow working memory to handle more input, it will also allow teachers to teach all the items originally planned with the maximum benefit for the students.

Conclusion

Learning involves many different processes taking place in the brain as new input becomes memory. A teacher cannot just stand at the front of the room and speak to the students for long periods of time and expect students to understand and remember. Developing various paths and strategies to presenting new material, which incorporates prior learning, is a very important first step and will help students make stronger connections for recalling new information over longer periods of time. When prior learning is activated, the brain is much more likely to make connections to the new material, therefore increasing com-

prehension and meaning. Students also need time to process new input and make it their own through various activities, and teachers need to create an environment of critical thought so that the learning not only makes sense but also has meaning for the students. New information cannot be learned through osmosis; it needs to be given in small chunks. Creating memories is a slow process and will take place over weeks and months, not hours or days. But over this time students will begin to become better learners and thinkers. The brain is malleable and capable of learning new things; teachers just need to give it the proper stimuli, time, and student interaction with the content for the brain to develop the connections it needs to create long-term memories and life-long learners.

Bio data

Jeff Mehring is an Associate Professor in the Department of English at Ohkagakuen University. His research interests include brain-based learning, edugaming, and educational technology. He can be reached at <mehring@ohkagakuen-u.ac.jp>

Jennifer Edwards is the director of the English Language Program in the Department of English at Ohkagakuen University. Her research interests include teaching English to children and writing. She can be reached at <edwards@ohkagakuen-u.ac.jp>

References

Doidge, N. (2007). *The brain that changes itself*. New York: Penguin.

Jensen, E. (2005). *Teaching with the brain in mind*. Alexandria: ASCD Publications.

Jensen, E. (2008). *Brain-based learning: The new paradigm of teaching*. London: Sage.

Rochester, S. R. (1973). The significance of pauses in spontaneous speech. *Journal of Psycholinguistic Research, 2*(1), 51-81.

Rose, C., & Nicholl, M. (1997). *Accelerated learning for the 21st century*. New York: Dell Publishing.

Saville-Troike, M. (1985). The place of silence in an integrated theory of communication. In D. Tannen (Ed.), *Perspectives on silence* (pp. 3-18). Norwood: Ablex.

Sousa, D. (2006). *How the brain learns* (3rd edition). London: Sage.

Sprenger, M. (2010). *Brain-based teaching in the digital age*. Alexandria: ASCD Publications.

Willis, J. A. (2006). *Research-based strategies to ignite student learning*. Alexandria: ASCD Publications.

Willis, J. A. (2008, Spring). Information into knowledge: Teacher and neuroscientist shares her RAD teaching strategies for bypassing the brain filters to increase student engagement, motivation, and memory as they turn information into knowledge. *CAIS Faculty Newsletter*, 4-7.

Wolfe, P. (2010). *Brain matters: Translating research into classroom practice*. Alexandria: ASCD Publications.

Zull, J. (2002). *The art of changing the brain*. Sterling: Stylus.