8 Information Processing to Build Intellective Capacity

Growing Brain Power Through Elaboration

Our brains are magnificent organs for the discovery and creation of meaning. Awake or asleep our brains constantly seek to make sense of inner and outer experience.

—Arthur W. Combs, Educator and Psychologist

I don't divide the world into the weak and the strong, or the successes and the failures, those who make it or those who don't. I divide the world into learners and non-learners.

—Benjamin R. Barber, Political Theorist

Our ultimate goal as culturally responsive teachers is to help dependent learners learn how to learn. We want them to have the ability to size up any task, map out a strategy for completing it, and then execute the plan. That's what independent learners do. Up until this point, we have talked about the necessary conditions that need to be in place in order to focus on building dependent students' cognitive horsepower so that they can easily reach the higher levels of Bloom's taxonomy. On

behalf of culturally and linguistically diverse dependent learners, that means paying attention to ways to minimize the impact of school environments that are less than welcoming. All that work to build learning partnerships, become an ally and a warm demander is so that culturally and linguistically diverse students have the space to grow their intelligence. In this chapter, we move from Practice Area II: Learning Partnerships to Practice Area III: Information Processing in the Ready for Rigor framework. We want to look closely at the dimensions of culturally responsive teaching that focus on building intellective capacity through information processing—the student's ability to take inert facts and concepts and turn them into useable knowledge.

Often educators mistake the idea of "using the cultural knowledge, prior experiences and performance style of diverse students" as the need to dress up or disguise a lesson with cultural references to food, holidays, or prominent cultural figures while delivering the lesson in traditional ways—lecture, reading, and testing. We have all seen the math lesson that tries to superficially link math concepts to Egyptians in Africa or Aztecs in Mexico. It doesn't take much to find some straight-laced teacher on YouTube trying to rap about some historical event as a way to make her social studies lesson "culturally responsive" while her students sit and giggle as passive spectators rather than participate as active learners. As important as including multicultural content is to making learning relevant, it alone doesn't increase brainpower.

Processing information for understanding is very different from simply remembering dates, people, and events. Yet, when I was an instructor at a community college in Washington State, I saw many students who believed that's what learning was. I taught freshman composition and my students were always shocked at the amount of close reading of complex texts they were expected to do. (That's before we called it "close reading of complex texts.") I'd always hear moaning and groaning when we reviewed the syllabus. There was always some bold soul who'd challenge me on this. "I don't get it. What does all this reading have to do with writing?" "If we didn't read, then what would we write about?" I'd ask. They would go along with the program until we began our reading. It was clear some students didn't understand how to process the text or how to extract the author's points and arguments. They didn't have tools or strategies. Most had been allowed to write about their opinions as if they were facts and pass it off as argumentation. When it came to responding to those ideas in writing, there were always tears. At first I couldn't understand why there was so much crying and so many meltdowns. It was just a composition class, but I soon realized many of my community college students, mostly poor working class students and students of color, had not been asked to

do this type of work in high school. They didn't have the cognitive tools to complete the task, and they learned I wasn't going to spoon feed it to them. Instead, I set out to help them increase their brainpower by helping them learn to process texts using cognitive strategies and information processing techniques that stretched them into their zone of proximal development.

THE POWER OF ACTIVE PROCESSING

The power of culturally responsive teaching to build underserved students' intellective capacity rests in its focus on information processing. Processing is the act of taking in information with the intent to understand it, relate it to what you already know, and store it in a way so that you can easily retrieve it. For example, imagine you've just been introduced to a new concept in science such as displacement (when the volume or weight of a fluid such as water is displaced by an object of equal weight). Just because you have heard the teacher's lecture or lesson on displacement doesn't mean you've processed it. To process it, you stop, pay attention to the idea, and begin a set of mental operations to understand the concept. You try to relate it to something you've experienced so you think about when you got in the bathtub and the water overflowed. Your brain continues to process the concept until you have an "aha" moment, the proverbial light bulb goes on, and you get it. You understand the concept of displacement both as a concrete event and an abstract idea. This new understanding is now permanently connected to your old knowledge and stored in your memory ready to be used when you need it.

Our ability to process, store, and use information dictates whether we are able to do more complex and complicated thinking in the future because they are the very things that stimulate brain growth. It is precisely explicit information processing that is too often left off the equity agenda for low performing students of color, preventing them from becoming truly independent learners. According to Robert Marzano (2004) in *Building Background Knowledge for Academic Achievement*, the ability to process information effectively can offset other disadvantages such as lack of access to enrichment activities, trips to museums, and other academically oriented experiences that build background knowledge.

Daniel Rigney (2010), author of *The Matthew Effect: How Advantage Begets Further Advantage* points out the negative effects of not having the opportunity to develop key cognitive skills. The cognitively rich will only get academically richer while the cognitively poor will get academically

poorer, as small differences in learning abilities such as information process are allowed to grow into large gaps. *The Matthew Effect*, named after the Bible verse found in the Gospel of Matthew, underscores why we won't be able to close the achievement gap and other opportunity gaps if a disproportionate number of children of color are dependent learners. Without greater intellective capacity, dependent learners will never improve their achievement on standardized tests or meet the Common Core standards because they cannot perform the necessary processing on their own.

THE NEUROSCIENCE OF INFORMATION PROCESSING

Culturally responsive teaching offers a way to reintegrate information processing into everyday instruction because many of the learning strategies parents of culturally and linguistically diverse students use at home resemble the cognitive routines taught in advance classes. We will look at those routines later in the chapter. First we need to understand how the brain actually processes information. Think of the brain like a power plant that takes raw material and moves it through a series of filters, blenders, and applications in order to turn that raw material into something useable. Cognitive scientists recognize three stages in the process: *input*, *elaboration*, and *application*. Here is a brief description of what goes on in each stage.

Stage 1: Input. During the first stage, the brain decides what information it should pay attention to. The brain is bombarded with over a billion bits of information per second from the environment. In the classroom, this includes sounds of chairs moving, fellow students whispering behind you, the teacher giving directions, announcements over the PA system, and a host of other things happening. In the middle of a lesson, while taking notes, the student has to decide what to write down, what information to pay attention to. Thanks to the reticular activating system (RAS), the brain is able to filter out a lot of this extraneous input and zero in on what it recognizes as important—something relevant, something that stimulates curiosity, or something that elicits a strong emotional response. Pictures, puzzles, sound, and other attention getters signal to the brain that a particular piece of information is important. If the brain decides to process this information, it routes it through the hippocampus in the limbic brain into the memory system. The first stop is short-term memory where the new information sits while the brain decides if it wants to continue processing it. Think of the short-term memory as a clipboard where you place temporary information. It can only hold a few bits of information, up to seven

numbers such as in a phone number. The information can stay there 5–20 seconds before it begins to fade to make room for new information coming in. The hippocampus sends the information along to the elaboration stage if it wants to process it.

Stage 2: Elaboration. If the brain decides it wants to let in this information and seek to understand what it means, it sends the info on to the next phase, elaboration. Elaboration makes material memorable and meaningful. The elaboration stage is where learning for understanding takes place. Cabrera and Colosi (2012) say that elaboration marks the difference between students becoming knowledgeable or "information-filled." The brain moves the information from the clipboard of the short-term memory on to the working memory.

Think of the working memory as a workbench or tabletop. The brain has 5–20 minutes to begin processing the input once it is placed on the tabletop. It is during this stage that the brain is working hard to organize the material into recognizable patterns and to remember it for the future. It is during this stage we introduce culturally responsive processing tools: movement, repetition, story, metaphor, or music to help the brain process. It then begins going through a set of cognitive routines that activate the "firing" of neurons and triggers a cascade of chemical and electrical impulses. If music or some other element is used to help process the information, the neurons connected to that element begin to fire in sync with neurons coded with the new information. As they fire together, they "wire" together, making a permanent association in the brain. This is the main activity of culturally responsive teaching. This mental kneading, massaging, and braiding together of material in an effort to make sense of it and connect it to what the brain already knows stimulates dendrites, those treelike extensions on a neuron that help increase the surface area of the cell body, to grow.

As the brain works to couple the old and new material, it has to periodically stop and cycle down, going into a brief consolidation mode where it stops processing information for a few minutes to let things settle. Our brains can do active processing for 12–20 minutes based on age. For example, in a 40-minute middle school lesson, the brain processes for 12–15 minutes before it cycles down for about 10 minutes. Regardless if the teacher is still talking or not. it will stop paying attention. Then it returns to processing for another 12–15 minutes (Sousa, 2001). It cycles between elaboration and down time to consolidate the information it just processed.

Stage 3: Application. After elaboration, the brain moves to application. The application stage focuses on giving the brain opportunities to apply this new knowledge through deliberate practice and real life application.

Opportunities to apply what we have learned come through place-based learning, project-based learning, or problem-based learning and help solidify learning. The old adage "use it or lose it" applies to this stage of information processing. The brain is working hard to turn those neurons' new dendrites into a permanent neural pathway. We have 24–48 hours to revisit, review, and apply what we have learned in order to make it permanent and move it to long-term memory where it becomes part of our skill set, background knowledge, or conceptual understanding. Every time we think about or use our new knowledge through deliberate practice the new sparse neural pathway that is no more than a footpath soon becomes a well-worn path that allows us to quickly go into long-term memory and retrieve it. As new neural pathways are created, working memory's capacity expands. In addition to strengthening the neural pathways, active, focused practice stimulates the process of myelination. Myelin, that fatty coating on the outside of the neuron, acts as an electrical conduit that allows neurons to "fire" faster and stronger, expanding the capacity of working memory. As memory capacity expands so does intellective capacity and the student's ability to do higher order tasks.

The Cultural Connection

Now that we have covered the brain's steps for processing, let's turn our attention to understanding how to use culture to help students move through each stage. Culturally responsive information processing techniques grow out of the learning traditions of oral cultures where knowledge is taught and processed through story, song, movement, repetitious chants, rituals, and dialogic talk. They are all forms of elaboration and rely heavily on the brain's memory system.

In response, children's brains create neural pathways in the working memory that are primed for processing information orally and actively. Today, these methods are deeply ingrained in the way learning happens at home for many students of color from community-oriented cultures. If you were to ask their parents to explicitly explain these methods, they'd probably say "That's just the way we did it when I was a kid."

You might think that these traditional cultural learning methods have faded in today's print-heavy and tech-savvy society. Culturally and linguistically diverse families still use them to teach children life skills and to pass along important cultural knowledge from generation to generation. At home and in their communities, traditional learning methods still work. Consequently, culturally and linguistically diverse students come to school with well-developed neural pathways for actively processing information under the right conditions.

Building Intellective Capacity

As a culturally responsive teacher, you should be planning instruction so that students move through the brain's three stages of information processing—input, elaboration, and application. Here I offer four macro level instructional strategies that help move students through each stage. These four strategies should become a staple of your lesson planning and instruction. Within each strategy are a variety of culturally responsive techniques to use. The four macro level instructional strategies are as follows:

- Ignite—Getting the brain's attention
- Chunk—Making information digestible
- Chew—Actively processing new information
- Review—Having a chance to apply new learning

Ignite: Cue the Brain to Pay Attention

Attention is the first step in learning. During the input stage of learning, the brain has to let in the new content. First we have to pay attention. We cannot learn, remember, or understand what we don't first give our attention to. Note that beginning a lesson by simply announcing that you are going to start the lesson will not activate the brain's learning apparatus. Culturally oriented attention-getting strategies focus on waking up students' RAS because that is what happens at home or in the community. This is why in oral cultural traditions, learning or storytelling is started with some attention-getting activity—drumming, chanting, music, hand clapping.

For example, in most African Caribbean, Latin Caribbean, and southern African American cultural circles such as the Gullah Islands off the coast of South Carolina, storytelling traditions have a performance element to them. The "Crick Crack" storytelling chant is an example of this. It looks a little different in various Caribbean countries but has common elements. It is a group performance in which the "audience" participates and there is a close connection between the storyteller and audience to the extent that the two almost become one.

It has the African format of a leader and chorus (in which the participants are both chorus and audience). The "leader" announces that a story is about to be told by calling out "Crick!" The audience responds by shouting back "Crack!" completing the signal that storytelling is about to begin. Then, playfully, the leader tests the audience with riddles to which they may shout out the answers at random (like Hollie's *Jump In* strategy). After this back and forth, the story is told. Through this simple storytelling feature,

the RAS is guaranteed to be activated. Use novelty (put on a costume, recite a poem), curiosity (offer a puzzle that can only be put together based on information in the lesson or a mystery to be solved CSI style), or relevance (an emotionally charged headline that turns conventional thinking on its head) to generate excitement and attention.

Other culturally oriented techniques include the following:

Call and Response. Develop a simple back and forth chant that cues the brain that something in particular is going to happen. The brain's neurons start to get excited. The "call" from the teacher that begins the process alerts the student's brain that something is about to happen. The brain becomes curious and begins to pay attention in a different way. The call part of call and response triggers the student's RAS. This is why call and response is done in a lively, energetic way. It activates our RAS and helps us generate mental energy and focus. The takeaway here is to ritualize how you activate students' RAS to turn on their attention.

Music. I remember every Saturday when growing up after breakfast, my mother would put on an upbeat Aretha Franklin record and crank up the volume a bit. That was our cue that it was chore time. Music is a common multicultural attention-getting cue. Find a short upbeat clip and use it to signal the start of some specific type of learning. Maybe it's The Jackson 5's "ABC" to signal time for literacy block. Select a grade appropriate clip.

Provocations. Select an eye-opening quote with strong emotion, a challenging puzzle, or an outrageous statement; create a slideshow with powerful images related to the lesson; or show a video clip that arouses emotions. Challenge dominant culture's worldview or speak to relevant community issues. These types of openings provoke us and create a gentle disequilibrium. These cues not only signal the brain to pay attention but also provide some type of priming that makes the RAS scan the lesson, reading, or discussion for the answer. Wake up the RAS by reading a quote or offering the puzzle from the back of the room. Catch them off guard to increase the impact.

Talk. Create a short, intense, and semistructured talk activity that allows students to engage in culturally congruent ways—overlapping speaking, all at once, or pair share. Give each student a slip of paper with a quote or word. For example, have students share their quote or word and the connection they make to it with another student. Then they swap quotes and find another person to share it as they move around the room.

Remember, the goal of the cueing isn't simple engagement but engagement so that the brain pays attention, recognizes what's coming is

important, and lets in the new content being offered. Music, rhythm, and orality are often used as "calls to action" that signal a shift in attention. Find a variety of methods that work for your teaching style and personality. Don't do call and response if it feels uncomfortable to you. If you do, students will sense it and see it as a gimmick, not an authentic way to begin the learning process.

Design the day's lesson to begin by actively activating students' attention. Think about how you will trigger the RAS at the beginning of learning. This type of brain activation doesn't have to be time consuming and should last only 5–10 minutes. If these strategies seem a bit dramatic, they are intended to be. In oral cultures, there is a reliance on oral expression to carry meaning and feelings through its emotional vitality. The goal is to express aliveness and animation to stimulate the senses, just what the RAS likes.

Chunk: Feed the Brain Right-Sized Pieces of Information

Oral cultures rely heavily on the memory system for learning, especially the working memory. But the brain can only hold a certain amount of information for processing at a time. To make the first part of information processing manageable, feed students "right-sized" bits of information. We commonly call this chunking, presenting new information in small, digestible bites. The rule of thumb is 7 + 1. (That's why phone numbers are seven digits.) It is still important that they get the big picture when introducing new concepts or processing, but when teaching for understanding they need smaller chunks of information so that they can easily begin connecting to their current funds of knowledge.

Chew: Help the Brain Process the Content

Next, you will want to help dependent learners "chew on" or process the chunk of content they just received. There are two parts to the chew strategy: unstructured think time and cognitive routines. Begin with unstructured think time as the simplest way to get students to begin processing the content. Why? The brain naturally pushes its mental pause button once it's reached capacity in working memory. Think of a self-operated coin counting machine. It has you feed your bag of loose coins into the slot. At a certain point, the screen flashes a message: Stop and Wait While Processing. It is trying to process the coins it already has and doesn't want to take in more until it has made room.

Our brains work in a similar way. When our working memory's functional capacity is full, the brain cycles down. Remember, in a 40-minute

class, the brain takes in information for 12–20 minutes before it cycles down for about 5–10 minutes in order to process what it just took in (Sousa, 2001). The culturally responsive teacher understands both the advantages and limits of the working memory and chunks information so that it fits into the brain's natural processing capacity and uses the down time to allow students to "chew on" what they have just taken in to start the processing cycle. Too often, we continue lecturing without providing time and space for students to do active processing. Dependent learners need the cognitive space to process.

Ramit Mureta, a tenth grade social studies teacher at a large urban high school was openly skeptical when I introduced this strategy at a seminar on culturally responsive information processing. I asked him and his colleagues to go back into their classrooms and simply insert some "chew time" after 15–20 minutes of instruction in the form of a 5–7 minute break. During that break time students processed what they heard, either with a drawing, in writing with the prompt, *"What was the muddiest point you are trying to make sense of?"*, or they could do the Three on a Pencil protocol where students could talk through what they heard. Teachers had to do some front-loading in the beginning to explain the process to students and share the different ways to process.

We came back together three weeks later in a follow-up professional development session to debrief how it went. Ramit's hand was the first to go up. He said he was amazed at how much more his students not only retained from the lesson but how much deeper their understanding was of the content, although he did admit it felt a bit chaotic when he first started using the strategy. That soon passed as students saw the benefit of extra processing time.

Cognitive Routines Aid Elaboration

In addition to giving students unstructured think time, introduce them to cognitive routines for deeper processing. Giving students the chance to actively process information is at the heart of culturally responsive teaching because all new content that makes it to our working memory must be mixed with our existing background knowledge. You become the mediator that helps students make the connection between what they know and how this new information connects to it.

The ultimate goal of culturally responsive instruction is to help students build inside their heads a "cognitive power plant" that allows them to do more complex and challenging work by building on their cultural ways of learning through the explicit focus on *cognitive routines*. These routines are the engines of information processing. When students couple

Figure 8.1 What Are Cognitive Routines?

To do effective information processing, students have to have a way to turn inert information into useable knowledge. Cognitive routines are the basic mental maneuvers the learner uses for information processing, especially when doing higher order thinking and creative problem solving.

Cognitive routines involve the following:

- A sequence of internal learning moves during the elaboration phase of information processing
- The specific structures and protocols a student uses in his sequence of learning moves
- A set of steps students use collectively in the classroom during discussion, brainstorming, group problem solving, Socratic seminar, or other academic conversations

These routines become the cognitive tools the learner uses every time he takes on a learning task.

metacognitive or self-regulation strategies with structured cognitive routines, they are able to monitor and evaluate their comprehension. The ability to identify and utilize cognitive routines is a necessary skill for an independent learner.

As part of the cognitive routine, have students ask these four questions:

- How is this new material connected to what I already know?
- What are the natural relationships and patterns in the material?
- How does it fit together? What larger system is it part of?
- Whose point of view does it represent?

These questions represent the fundamental ways that we process information as the brain goes through the elaboration stage. Cognitive routines as part of a chew strategy give dependent learners a set of explicit learning moves when confronted with new content. There are four key cognitive routines the brain gravitates to when we place new information on working memory's tabletop. Some also call them "thinking dispositions" or "thinking routines" (Cabrera & Colosi, 2012; Ritchhart, 2002). They are:

- *Similarities and Differences.* The brain looks for distinctions between this new information and other similar types of objects, concepts, or events. The brain tries to understand what features make them the same or different.
- *Whole-to-Part.* The brain tries to understand how things are organizing into a system. Is the object, concept, or event part of a larger

system or pattern? Is it a smaller part of the whole or is the whole made up of smaller parts?

- *Relationships.* The brain tries to see the relationship of the object, concept, or event to other things. It wants to understand how it is connected and the role it plays as it interacts with other events, objects, or concepts.
- *Perspectives.* The brain tries to figure out the point of view or perspective being presented. It tries to determine who is telling the story or controlling the narrative.

In the process of carrying out these routines, the brain responds by growing dendrites, creating new neural pathways, and expanding intellective capacity. Remember that cognitive routines aren't really strategies but more like habits of mind. We want to make the routine part of a cognitive habit loop that, over time and with repeated use, becomes automatic for the student. This automaticity is the advantage independent learners have over dependent learners.

Two things are necessary for thinking routines to take hold as cognitive habits:

1. There has to be a strong cue that prompts the thinker into starting the routine.
2. The routine has to be internalized, meaning the learner has to remember the steps in the routine on his own eventually.

That means first you have to scaffold dependent learners into the habit of using them with explicit scaffolding then removing the scaffolds piece by piece, creating some opportunity for productive struggle as the student learns to prompt himself. We call this process *internalization.* It is at this point that culturally responsive teachers need to remember the social-emotional aspects of learning. Struggling of any kind can trigger an amygdala hijack. Students might react with resistance or withdrawal. In your role as their ally, you can help them stay calm and focused as they develop these new habits.

In addition to cognitive routines, here are other techniques to help students "chew on" content for active processing.

Talk to Learn. Learning theorist, Leo Vygotsky (1978) said language is the medium by which children acquire their information. Through informal and formal conversations with other community members, students also acquire the "mental tools" for processing information. Bandura (2001) points out that learning is a sociocultural act governed

by language. We learn best when we are able to talk through our cognitive routine. Talking to learn, also called *dialogic talk*, is deeply rooted in oral cultural tradition. This kind of talk gives us the opportunity to organize our thinking into coherent utterances, hear how our thinking sounds out loud, listen to how others respond, and, often, hear others add to or expand on our thinking. Tharp and Gallimore (1991) call this **instructional conversation**, the kind of talk that acts like a mental blender, mixing together new material with existing knowledge in a student's schema.

Using discussion protocols like World Café, Four on a Pencil, and Give One Get One help create variety in the ways students talk to each other in the classroom, offering a chance to both work collaboratively and have their individual voices heard.

Rhythmic Mnemonics in Song or Spoken Word Poetry. Have students write their own songs, raps, or spoken word pieces in the style of the alphabet song or the Schoolhouse Rock! episodes. Music is an important element in oral traditions. When we process new content with music and rhyme, the brain creates multiple neural pathways in different parts of the brain that become permanently connected. This connection across modalities helps strengthen memory. The neurons wire and fire together. Once this wiring happens, the music becomes a cue for remembering key concepts or rules. It's the reason we remember the alphabet song after all these years.

Spoken word is a broad term often applied to performance-style poetry that mixes social awareness, music, and language. Storytelling, spoken word, and poetry slams all fit under this category. Spoken word topics can cover large sociopolitical themes that lend themselves to the cognitive routines such as perspective taking: Love, Racism, Hometown Pride, Politics, and Self-Realization in the context of the curriculum. The world of spoken word is vibrant, compelling, and highly academic in approach. Poetry Slam is essentially a form of competitive performance poetry. Individuals or teams prepare work on a given theme that they perform before judges and an audience. The process of writing, drafting, editing, and rehearsal is vital to the end product, and Slams tend to be very powerful expressions of ideas and feelings through the medium of very skilled writing and performance.

"Story-ify" the Content. Verbal expressiveness is a central cultural theme in oral cultural traditions (Cazden, 2001; Ladson-Billings, 2009). Stories are a mainstay in African American and Latino cultures. Middle Eastern and Southeast Asian communities also have long oral traditions

with rich stories. It turns out the brain is wired for stories. Why? When we are being told a story or are telling it, the brain's neurons light up not only in the language processing parts of the brain but in other regions just as if we were performing the action ourselves. For example, if someone in the story is running or jumping, the motor regions of our brain light up. The narrative format lets the brain take big ideas, abstract concepts, and dry facts and transforms them into something we can more easily remember.

As a way to process new content in any subject area, let students weave it together in story form. The Heath Brothers in *Made to Stick* (2007) remind us that the story format makes ideas and concepts "sticky," meaning our brains remember it long after we have heard the story. You can scaffold students into the process by providing the key ideas, words, or concepts from a unit and asking them to weave them together in a coherent, cogent narrative. "Story-ifying" will help students work through the four cognitive routines: *identifying similarities and differences, finding relationships, noticing how things fit together whole-to-part in a system,* and *recognizing point of view.*

Recursive Graphic Organizers, Infographics, and Other Nonlinguistic Representations. Marzano (2004) says that creating pictures, visuals, or other nonlinguistic representations is one of the most powerful ways to process information. According to research, knowledge is stored in two forms: linguistic and visual. Recently, neuroscience has confirmed that the use of nonlinguistic representations increases brain activity and aids information processing. Drawing pictures, flowcharts, or any type of visual is consistent with culturally responsive ways to process information. Incorporate words and images using symbols to represent relationships. Use physical models to represent information.

A common tool that can be used in a culturally responsive way is the graphic organizer. Most teachers use them mainly to activate prior knowledge but students rarely go back to revise them. Use the graphic organizer throughout the lesson. Have students fill it in before the lesson, conduct the lesson, and then ask them to go back and update their graphic organizer with new information they just learned using a different colored pencil or marker. The interaction with the visual representation of information helps speed processing. Have students swap papers with a neighbor or get together in helping trios and compare what is different or the same on their organizers.

Infographics have become a very popular way to graphically display information. Have students create an infographic as a way to process conceptual information or represent their understanding of similarities and differences, relationships between events, concepts, or objects.

Metaphors and Analogies. Information processing through the creation of metaphors and analogies helps by making meaningful connections more obvious. Students use the tools of metaphor building and analogy creation (Wormeli, 2009) to make implicit relationships explicit. The explicit comparisons in a metaphor help students move beyond memorization to deeper comprehension. Resist giving students "plug and play" templates to complete like this: _____ is to _____ as _____ is to _____. This type of frame doesn't build dendrites because students don't really have to grapple with the potential relationships. Instead, have students mine their own funds of knowledge for possible comparisons.

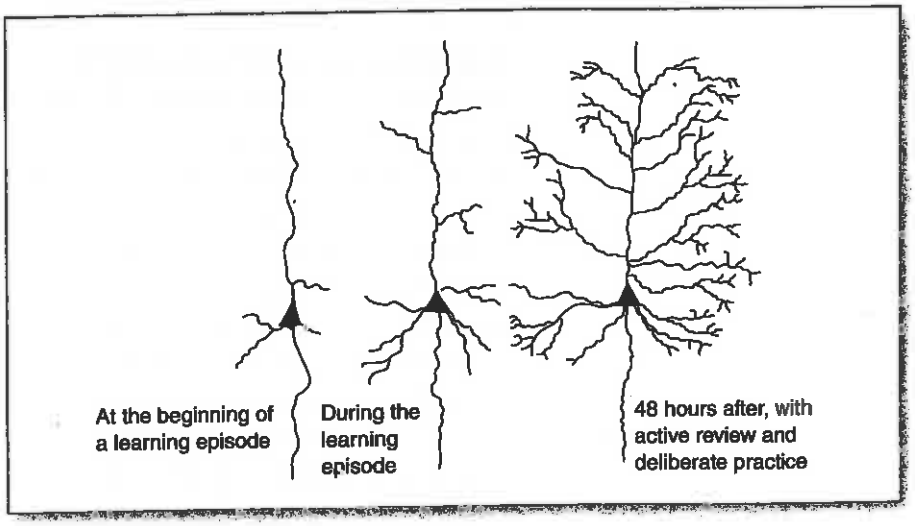
Word Play and Humor. Capitalize on youth culture's rich word play. Word play is deeply rooted in African American culture and has found its way into the mainstream youth culture in the form of urban slang and hip hop. Provide students with opportunities to use word play to process information. Consider setting up "verbal battles" similar to the DJ battles common in hip hop that grew out of the tradition of "playing the dozens." Playing the Dozens is an African American custom of verbal sparring in which two competitors go head to head in a competition of comedic "trash talk" while the audience watches and cheers them on. The Dozens evolved from an oral tradition rooted in West African cultures. It is a contest of personal power—of wit, verbal ability, and mental agility. A skilled contender, win or lose, may gain the respect of the audience. What makes the Dozens a powerful, albeit unique, elaboration tool is that it forces the participants to recognize implicit relationships. Rather than using it to trash talk each other, select elements from the social studies, language arts, or science lesson and have students write their funny "insults" that use the key concepts, facts, or events from the lesson. Instruct students to keep the "insults" friendly and funny, not hurtful or negative.

Review: To Strengthen New Neural Pathways

For new neural pathways to consolidate, the learner has to apply their new understanding within 24 hours. Application can take the form of authentic practice that lets the learner rehearse using his new understanding and correct any misconceptions or weakness in understanding. In *Brain Rules*, Medina (2008) reminds us that rehearsal (using the new knowledge or skill) and repetition (revisiting it) in timed intervals is the mental glue that cements learning. This is where the saying "use it or lose it" comes from. If you learn something new and do it only once or twice, the dendrite connection is very fragile and can begin to fade. Within

20 minutes, you remember only 60% of what you just learned and within 24 hours, you remember only 30%. But if you practice within 24 hours and then practice again later, you remember 80%. Practice at regular intervals, with intensity and deliberateness, is essential for long-term retention and building understanding. The very process of reviewing newly learned content, practicing new skills, or applying new knowledge stimulates dendrite growth, leading to greater intellective capacity.

Figure 8.2 Dendrite Growth



Here are some possible ways to help students apply what they have learned.

Play a Game to Review. Games provide a unique opportunity to review and rehearse new knowledge. The very act of playing the game encourages the brain to strengthen the new neural pathways by making the learner continuously search his memory for information. Even the brains of those students only watching the game are firing and wiring thanks to mirror neurons.

Try to set up games like Jeopardy, Family Feud, Pyramid, or Pictionary that can be played with teams. Be sure to set up teams so that dependent learners can actively participate and be successful. You might give students some preparation time to review core concepts. These games are particularly helpful because they are set up uniquely. For example, Jeopardy provides the answer. The player has to come up with the question, forcing him

to think in terms of relationships, whole-to-part systems, and point of view. These are the basic thinking dispositions that you are trying to cultivate. The game Pyramid has one player read off a list of items. The other player must understand the implicit relationship between them. All these activities help strengthen the fragile neural pathway made up of new dendrite growth. These games help students create well-rehearsed mental routines.

Solve the Mystery or Real-Life Problem. At the start of a unit or lesson, set up a problem or mystery to be solved. Once students have worked through the elaboration stage, have them return to the problem and apply their new knowledge to solve the problem or mystery.

Work on Long-Term Projects. Anchor a unit with a place-based learning activity connected to a real life community issue. Once instruction has been delivered. use the project as an opportunity to apply new skills and knowledge. Select a project that addresses a real life task. For example, planning a community garden can be a project to anchor a science unit on soil. Collaborate with local organic farmers or local community gardens in the vicinity of the school.

CULTURALLY RESPONSIVE INFORMATION PROCESSING IN MATH AND SCIENCE

A teacher recently said to me he wasn't convinced about using culturally responsive teaching in math. "Teaching equations is pretty straightforward," he said. "How do you do that without making up some gimmick?"

His comment is pretty typical among math and science teachers I run into, so I thought it was important to address it. Culturally responsive teaching has usually been presented to them as an engagement strategy designed to motivate students. Most often the examples used to demonstrate it are focused on language arts and social studies. We have not made it clear to math and science teachers how they would interject culture into the teaching of math when teaching formulas and procedures seems straightforward and culturally neutral.

The power of culturally responsive teaching is in its ability to help students deepen their understanding of core concepts as well as build automaticity and fluency with core facts. The Common Core State Standards in math actually call for helping all students develop greater conceptual understanding and mathematical thinking, not just on trying to get

students faster with procedural skills such as steps for solving an equation. Helping students understand math concepts means helping them not just with procedural knowledge such as how to solve for x but also understanding how this concept is relevant to everyday life.

Using information processing strategies consistent with culturally and linguistically diverse students from oral and collectivist cultures to scaffold deeper conceptual understanding is culturally responsive teaching, without ever having to mention race or culture. Yet, recognizing that problem-based learning that looks at sociopolitical issues relevant to culturally and linguistically diverse students' lives grounds the context of mathematics and science. For example, former classroom teacher Jana Dean (2006) wrote about using issues of rising gas prices in urban areas as an entry point for conceptual understanding of algebra and its application in real life.

Helping students build an academic vocabulary in math and science will lay a strong foundation for doing more rigorous conceptual thinking in those subject areas. This is where culturally responsive information processing techniques are most effective. For example, sixth grade science teacher Janelle Reed admitted she was pretty traditional when it came to vocabulary instruction in science. She knew the academic vocabulary associated with science was important but didn't devote a lot of class time to it. At the beginning of every week, students in her class got a list of science terms and concept words. There would be a test at the end of the week. Once she gave them the list, they were on their own to learn the words. She encouraged them to use the dictionary and write out sentences using the vocabulary. She did a few word study activities, but by the end of the week few students had learned the vocabulary.

She started to rethink her approach after studying culturally oriented information processing methods to build independent learning. She says she'd always thought being culturally responsive meant explicitly tying everything to students' culture or race. Instead, she redesigned her science vocabulary instruction to focus on culturally grounded information processing. Rather than a weekly take-home vocabulary list, she tried using sorting and games in class to help students with learning vocabulary for the week's unit and committing it to their long-term memory. The vocabulary games had students working and processing in new ways. The games she picked emphasized collaboration and teamwork. She says engagement went through the roof. One student said in passing, "Oh, we are learning. You are just hiding it in the fun." All she could do was smile. At the end of the unit, she noticed their conceptual understanding of the lesson was deeper and their class discussions were richer as they used the vocabulary more frequently.

IMPLICATIONS FOR SUPPORTING DEPENDENT LEARNERS AND BUILDING INTELLECTIVE CAPACITY

Helping dependent learners process information more effectively is an important step toward closing the achievement gap. Our goal is to help culturally and linguistically diverse students build in their heads a "cognitive power plant" that will get them ready to take on the rigorous Common Core State Standards at every grade level. Ultimately, we want to empower them by helping them become independent learners who are capable of taking on any academic challenge.

Keep in mind that culturally responsive information processing doesn't have to be race-specific. It does have to be grounded in the context of students' lives. Our task is to find ways to access their funds of knowledge and understand their home-based ways of learning as starting points for designing more authentic learning experiences.

CHAPTER SUMMARY

- Simply adding surface-level cultural details to low-level decontextualized activities doesn't offer any cognitive challenge and won't build intellective capacity.
- Culturally responsive teaching for information processing follows the brain's natural input, elaboration, and application cycle.
- Students need to learn and internalize cognitive routines in order to move toward more independent learning.
- Engagement is a means to an end, not the end goal of culturally responsive teaching.

INVITATION TO INQUIRY

- How do you incorporate information processing into your lessons currently?
- How often do students have a chance to actively work through the elaboration stage of processing?
- How explicitly have you taught students about using a set of cognitive routines to process content? Do you check to ensure they have internalized the routines?
- Where do you see opportunity for incorporating more information processing activities in your instruction?

GOING DEEPER

- *Student Success with Thinking Maps: School-Based Research, Results, and Models for Achievement Using Visual Tools* (2011) by David Hyerle and Larry Alper
- *Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners* (2011) by Ron Ritchhart, Mark Church, and Karin Morrison
- *Metaphors and Analogies: Power Tools for Teaching Any Subject* (2009) by Rick Wormeli
- *Reading for Their Life: (Re) Building the Textual Lineages of African American Adolescent Males* (2009) by Alfred Tatum
- *Thinking at Every Desk: Four Simple Skills to Transform Your Classroom* (2012) by Derek Cabrera and Laura Colosi