harmony with the patterns of their subject matter. It also supplies specific suggestions for teachers who ask, How can I help my students use patterns to enhance their learning?

In chapter 10, "Repetition and Elaboration," I examine the memory research that shows two major factors in effective long-term recall. One is that the information must be repeated over time. The other is that recall is much easier if the information is elaborated upon. Chapter 10 discusses the work of John Medina, John Ratey, Robert Bjork, Janet Zadina, and Daniel Schacter in the effort to answer the question, How does the brain make memories and how can we teach and help our students learn to study in ways that promote long-term recall?

In chapter 11, "Is a Revolution Coming? Movement, Exercise, and Learning," I explore the research findings from evolutionary biology that strongly indicate humans were meant to move while learning, not sit at desks. In Harvard professor John Ratey's 2008 book, *Spark the Revolutionary New Science of Exercise and the Brain*, he said that exercise is the single most important thing a person can do to improve learning. Chapter 11 answers the question, Why do movement and exercise help learning and what are some creative ways we can get more movement in our classes?

Chapter 12, "Getting Others to Embrace Learner-Centered Teaching," addresses the question most frequently asked by faculty members: How do I justify my use of a learner-centered practice when my department chair or colleagues don't support it? Chapter 12 outlines specific arguments that give strong support to LCT and offers a set of actions to defend and advocate for a learner-centered practice. I have found that many people who oppose LCT actually know very little about it. The chapter is designed to educate them and support this research-based, authentic approach to improved student learning.

Additionally, chapters 1, 4, 8, 9, and 10 have related videos. The videos can be viewed on video enabled e-readers or accessed on-line at tinyurl.com/learnercenterdvideo.

Learner-centered teaching is the first teaching approach based on hard science. It represents a new paradigm in how we look at the teaching process. As a relentless explorer of the best ways to help students learn, I have seen research prove again and again that LCT is the most powerful enhancement for student learning. By reading this book and trying the suggestions you find here, you are demonstrating that you, too, desire to cultivate the potential of your students by serving them in a way supported by modern scientific research. With the skill set and knowledge necessary for moving forward, you'll be a practicing advocate of the learner-centered teaching approach.

1

FOLLOW THE RESEARCH

Whole swaths of the brain not only turn on, but also get functionally connected when you're actively exploring the world.

(as cited in Nauert 2010)

The question everyone asks, and rightly so, is, Why should teachers change to a learner-centered approach to instruction? The answer is actually very simple. Fifteen years of neuroscience, biology, and cognitive psychology research findings on how humans learn offer this powerful and singular conclusion: "It is the one who does the work who does the learning" (Doyle, 2008). This conclusion strongly suggests that the traditional model of teacher-centered instruction, where teachers do a lot of the work, is less effective and can be detrimental to students' learning. Therefore, a new approach is needed that gets the students to do most of the learning work, and that approach is learner-centered teaching.

The One Who Does the Work Does the Learning

Learner-centered teaching (LCT) is about optimizing the opportunities for our students to learn. This means figuring out the best possible ways to get them to do the work. The widely accepted definition of learning is that it is a change in neuron-networks of the brain (Goldberg, 2009; Ratey, 2001). For this change to happen, students must be paying attention and actively engaging their brains to process new sensory input. There is no such thing as passive learning. Cognitive neuroscientist Janet Zadina explained in her presentations that, if students' brains are engaged in new learning, their brains' neurons (specifically the dendrites) begin to grow new cellular material. This new material is the start of new neural connections that will represent the new information. She also pointed out that if the new information

To view chapter-related videos please go to tinyurl.com/learnercenteredvideo.

does not get used or practiced, the brain will reabsorb the new cellular material. Zadina made it clear that the brain is good at conserving its resources. Therefore, the only way for our students to increase their learning is to actively engage in learning the content and skills we teach, and then use and practice the content and skills for significant periods of time. This practice causes the new neural connections to grow into permanent representations of the learned material. This means that most of the time, our students need to be doing more than just listening to a lecture. Our students need to be doing the work.

In their new book, *Academically Adrift: Limited Learning on College Campuses,* Arum and Roksa (2011) used the Collegiate Learning Assessment (CLA) test to show that after two years of college, students haven't learned very much. Forty-five percent of the 3,000 students in the study showed no significant gains in learning after 2 years, and 36% showed little change after 4 years. The CLA does not measure content gains, just core outcomes, including critical thinking, analytical reasoning, problem solving, and writing. The reasons for these poor results are tied directly to the amount of time spent in learning and the amount of work students were asked to do. Students reported that they spent on average only 7% of their time each week studying compared to 51% socializing. Thirty-five percent of students said that they spend five or fewer hours each week studying on their own, and those who spent additional study time in groups tended to have lower gains in learning. Fifty percent of the students said that, in a typical semester-long course, they wrote less than 20 pages, and 32% said that they had to read no more than 40 pages per week (Arum & Roksa, 2011). Although this is only one study, and some professionals in higher education are questioning some aspects of the study, these findings speak loudly to the need for getting our students to do more of the work, which is a goal of learner-centered teaching.

A Clarification About the Use of Lecture

Before moving on, an important clarification about learner-centered practice and the use of lecture must be made. Lecture has an important place in a learner-centered practice. Students will always need teachers to explain complex and complicated information and to give great examples to help connect new information to students' backgrounds. This remains a vital role for faculty members. However, the use of lecture in a learner-centered practice

needs to follow a simple definition; lecture is talking to students about things they can't learn on their own. When seeking to optimize students' learning, teachers must make careful decisions in determining when students need to listen and when they need to try to figure things out on their own. Chapter 8 discusses ways to make lecture a more effective teaching tool by making it a multisensory experience for the students.

The Goal of LCT

The goal of a learner-centered practice is to create learning environments that optimize students' opportunities to pay attention and actively engage in authentic, meaningful, and useful learning. This kind of learning activates the reward pathway in the brain that is responsible for driving our feelings of motivation, reward, and behavior. The reward pathway releases the chemical dopamine, which gives us a little jolt of pleasure, enticing us to repeat the behavior (Genetics Science Learning Center, 2010). Activating this pathway is a major key to successful learning (Zadina, 2010). It is a bit ironic that the more "helpful" a teacher is in terms of giving students answers or solving their problems, the less the students actually learn. I say "ironic" because the very thing many students want their teachers to do and that many teachers *like* to do is provide solutions to educational exercises. This may be why teacher-centered instruction has persisted for centuries and continues to be a regular practice within higher education today. It makes everyone happy. But just because everyone is "happy" doesn't make it an effective pedagogy.

An Obligation to Follow Where the Brain Research Leads—A Personal Experience

In 1995, I read *A Celebration of Neurons* by University of Oregon education professor Robert Sylwester. This was the first book I had ever read about the human brain and learning. One of the first points Dr. Sylwester made in this book was that the information on which we base our teaching decisions is much closer to folklore than science. This bit of wisdom confronted me in the most powerful way when, in 2009, French neuroscientist Stanislas Dehaene wrote a book titled *Reading in the Brain.* As a reading teacher by training, I was eager to find out what neuroscience had discovered about the reading process. What I discovered caused me not only to rethink my approach to teaching reading, but to cringe at the advice I had given over the years to many of my students who suffered from dyslexia.

For over a century, it had been assumed that dyslexia was a problem in the visual-processing area of the human brain. This assumption was plausible because a common symptom that someone suffering from dyslexia has is difficulty in recognizing words in the correct pattern. For example, a person with dyslexia would see *was* as *saw*. For a hundred years, The Orton Society has dedicated itself to helping people with dyslexia based on the belief that dyslexia is a visual-processing problem. However, Dehaene made it very clear that brain research *indicates* dyslexia is in fact an auditory-processing problem (Dehaene, 2009). Specifically, dyslexia appears to be a reading deficit that can be reduced to a problem with single word decoding, which is itself due to impairment in grapheme-phoneme conversion. Put another way, it is a problem in speech processing (Dehaene, 2009, p. 239). How could so many well-meaning teachers and reading experts get it so wrong? Brain-imaging tools that show what is really happening in the brains of people suffering from dyslexia had not yet been available. The best guesses were just that: guesses. And those guesses were wrong. The exciting part about these wrong guesses is that because of them, we now know the brain is so malleable and has so many redundant systems, especially in children, it may be possible to design training programs that teach children to use other brain systems to overcome some of the problems dyslexia presents (Dehaene, 2009, p. 258)!

Dehaene also taught me a second powerful lesson. I have always been a firm believer in a whole language approach to teaching reading, ever since I read Indiana University professor Frank Smith's book *Reading Without Nonsense* in 1985. Smith emphasized that learners need to focus on meaning and strategy instruction, and that language is treated as a complete meaning-making system, with the parts functioning in relational ways. The goal was to immerse students in the reading process with the belief that they would, through repeated exposure, acquire the reading skills they needed to be successful. Phonics was seen as slowing readers down. However, as Dr. Dehaene pointed out, brain research does not support a whole language approach. Research findings show phonics is necessary because of how it changes the way the brain processes speech sounds. This finding means that the crucial process by which written words are turned into strings of phonemes must be explicitly taught. How the brain processes speech sounds doesn't happen just from immersion into language. Such findings from neuroscience research required me to reconsider my approach with students who were seriously limited in their reading abilities. I now include instruction in phonics activities. If I am to optimize my students' learning, I need to follow the research.

Another example of the power of moving from folklore to science comes from the work of Dr. Aditi Shankardass. Dr. Shankardass is a neuroscientist trained across three disciplines of the field: neurophysiology, neuroanatomy, and neuropsychology. Currently, she leads the Neurophysiology Lab of the Communicative Disorders Department at California State University. Dr. Shankardass's work has been devoted to the use of an advanced form of digital quantitative electroencephalography (EEG) technology that records the brain's activity in real time and then analyzes it using complex display schematics and statistical comparisons to norms, thus enabling far more accurate diagnoses of children with developmental disorders. Dr. Shankardass reported that as many as 50% of the people diagnosed with autism and other developmental disorders have been misdiagnosed. Some children diagnosed with autism are actually suffering from micro brain seizures that produce the same symptoms as autism but can be treated with medication (Shankardass, 2009). Dr. Shankardass's work provides a powerful example of how many of our current assumptions about the best ways to help students learn may actually restrict their potential. We who teach in higher education, especially because we have been trained to be researchers, have an obligation to follow where the research leads us.

What Can Brain Research Tell Us About Students' Learning?

First, Be Cautious About the Information

Essential information about the brain comes from biologists who study brain tissue, experimental psychologists who study behavior, and cognitive neuroscientists who study how the first relates to the second (Medina, 2008). The relationship between brain systems and complex cognition and behavior can only be explained satisfactorily by a comprehensive blend of theories and facts related to all the levels of organization of the nervous system, from molecules and cells and circuits, to large-scale systems and physical and social environments. We must beware of explanations that rely on data from one single level, whatever the level may be (Damasio, 2001).

Neuroscientist Peter Snyder of Brown University cautioned in a 2010 *Newsweek* article that lots of quick and dirty studies of cognitive enhancement make the news, but the number of rigorous, well-designed studies that stand the test of time is much smaller. Further, he wrote, "It's kind of the wild, wild west right now" (as cited in Begley, 2011). Almost daily, we see reports on something new that can make us smarter or keep our brains younger or healthier. The facts are often quite different. For example, in the 2010 evaluation of purported ways to maintain or improve cognitive function, conducted for the National Institutes of Health, vitamins B6, B12, E, beta-carotene, folic acid, and the trendy antioxidants called flavenoids were all found to be busts when it comes to enhancing cognition. Findings that alcohol and omega-3 fatty acids (the fatty acids in fish) and having a large social network enhance cognition were found to be weak. Research on the value of statins found they do not enhance cognition, and neither does estrogen or nonsteroidal anti-inflammatory drugs (NSAIDs; aspirin, ibuprofen). Snyder also suggested in the *Newsweek* article that we be skeptical of practices that promise to make us smarter by increasing blood flow to the brain: There is no evidence that more than normal blood flow would be of value to the brain.

What Do We Know? We Can Get Smarter!

Neuroscientist James Bibb of the University of Texas was an organizer of a symposium on "Cognitive Enhancement Strategies" at the 2010 meeting of the Society for Neuroscience. He said, "Neuroscientists have accumulated enough knowledge about the mechanisms and molecular underpinnings of cognition at the synaptic and circuit levels to say something about which processes contribute to cognitive enhancement" (as cited in Begley, 2011). What are cognitive enhancements? They are behaviors, drugs, nutrients, or other stimuli that help the brain produce more neurons or synapses and create higher levels of neurogenesis (the growth of new neurons), especially in the memory-forming hippocampus. They also increase production of brain derived neurotrophic factor (BDNF), which stimulates the production of neurons and synapses. Neurogenesis and synapse formation boost learning, memory, reasoning, and creativity. For example, people that excel at a particular task have more synapses, thus causing their brain circuits to be more efficient (using less energy even as cognitive demand increases), with higher capacity, and to be more flexible (Begley, 2011).

Neuroplasticity

One of the most important research findings for educators about the human brain is the neuroplasticity of the brain. Neuroplasticity refers to the ability of the human brain to change by adding new neural connections and to grow new neurons as a result of one's experience. This is the proof that the one who does the work does the learning. These increases in neural connections and new neurons are what neuroscientists say make us smarter.

The information that the brain actively pays attention to is the key to new neural growth. For example, skills we've already mastered don't make us much smarter because we barely pay attention to them. However, new, cognitively demanding activity such as learning a foreign language or taking an economics course for the first time is more likely to boost processing speed, strengthen synapses, and expand or create functional networks (Begley, 2011). We have always known that we have to have our students' attention to teach them; this finding reinforces that working knowledge.

Another area of interest to educators is cognitive training. A significant number of new businesses have been developed on the belief that engaging the brain in cognitive training boosts mental prowess, and studies show this is true. However, memory training, reasoning, or speed of processing improves only the particular skill on which it is focused and does not generalize to other tasks (Stern, 2009). In other words, doing crossword puzzles just makes you better at doing crossword puzzles. Scientists are most interested in activities or drugs that actually boost overall memory, reasoning ability, or speed of processing.

What Else Do We Know?

Daydreaming and Attention

I still remember how upset the nuns I had in grade school would get with students who daydreamed. They saw daydreaming as a sign of being a "slacker." I can't help but wonder what they would think of the following studies. Studies on mind wandering show that all people find it difficult to stay focused for more than a few minutes on even the easiest tasks, despite the fact that we make mistakes whenever we drift away (Smallwood & Schooler, 2006). Recent research shows that mind wandering can be positive because it allows us to work through some important thinking. Our brains process information to reach goals, but some of those goals are immediate and others are distant. Somehow, we have evolved a way to switch between handling the here and now and contemplating long-term objectives (Smallwood & Schooler, 2006). It may be no coincidence that most of the thoughts that people have during mind wandering have to do with the future. Even more telling is the discovery that "zoning out" may be the most fruitful type of mind wandering. Studies using functional magnetic resonance imaging (fMRI) found that the default network and executive control systems are even more active during zoning out than they are during the less extreme mind wandering with awareness. When we are no longer even aware that our minds are wandering, we may be able to think most deeply about the big picture (Smallwood & Schooler, 2006).

Multitasking and Learning

It is almost like a badge of honor to say that you are a multitasker in today's world. It's kind of like being the superman of brain power. The only problem is that multitasking is not possible when it comes to activities that require the brain's attention (Foerde, Knowlton, & Poldrack, 2006). Given that attention is the key to learning, this is a very important finding. Multitasking violates everything scientists know about how memory works. Imaging studies indicate that the memory tasks and the distraction stimuli engage different parts of the brain and that these regions probably compete with each other (Foerde, Knowlton, & Poldrack, 2006). Our brain works hard to fool us into thinking it can do more than one thing at a time. But it can't. When trying to do two things at once, the brain temporarily shuts down one task while trying to do the other (Dux, Ivanoff, Asplund, & Marois, 2006).

Shifting Tasks

If instead we define multitasking as successfully dealing with situations that require performing multiple tasks, appropriately shifting attention, and prioritizing the tasks, then it would be accurate to say that many people have developed this skill. In fact many jobs demand successful multitaskers who can focus their attention on the task where attention is most needed at the moment, and then adapt to changes in task priority as they occur. It is this latter feature of multitasking that suggests a natural relationship with adaptive performance; the capability to adapt to changing task priorities is essential for effective complex task performance (Oberlander, Oswald, Hambrick, & Jones, 2007). Clearly the ability to switch tasks quickly is an important skill, and many of our students are good at it; however, even this form of multitasking has its drawbacks. Studies by University of Michigan neuroscientist Marc Berman show that processing a barrage of information leaves people mentally fatigued. Even though people feel entertained, even relaxed, when they are multitasking, they're actually fatiguing themselves (Berman & Kaplan, 2010). The drawback to brain fatigue is that our brains need to engage in direct attention to be in a learning mode. When the brain is fatigued, learning becomes much more difficult to accomplish. One solution is a walk in nature, which replenishes our capacity to attend and thus has a restorative effect on our mental abilities (Berman, Jonides, & Kaplan, 2008). Berman and Kaplan's work also found that irritability in people is often caused by brain fatigue. On days when our students are upset, perhaps it is just that their brains are tired.

Downtime and Learning

University of California at San Francisco neuroscientist Loren Frank found in a 2009 study that the brains of rats that were given downtime following new learning could solidify the new learning experiences and turn them into permanent, long-term memories while still awake. It had been the assumption that long-term memory formation happens only during sleep. Frank reported that when the brain is not given downtime, memory solidification and formation processes don't take place. He indicated in his study that he suspects the findings also apply to the process of human learning (Karlsson & Frank, 2009). A study in 2010 by neuroscientist Lila Davachi of New York University found that during rest following new learning, the areas of the brain that are active during learning remain just as active, especially if the task is particularly memorable. She indicated that the greater the correlation between rest and learning, the greater the chance of remembering the task in later tests. Davachi suggested in her study that taking a (coffee) break after class can actually help students retain the information they just learned. "Your brain is working for you when you're resting, so rest is important for memory and cognitive function" (as cited in Hamilton, 2010).

Drugs and Learning

When I present to faculty members that nicotine has been found to enhance attention, which is the key driver of neuroplasticity and cognitive performance in both smokers and nonsmokers, I have often received concerned responses ranging from, "Are you certain this is true?" to "I don't think this should be shared with our students." Despite the concerns, the National Institute on Drug Abuse (NIDA) reported in a 2010 analysis of 41 double-blind, placebo-controlled studies that nicotine has significant positive effects on fine motor skills, the accuracy of short-term memory, some forms of attention, and working memory, among other basic cognitive skills. The NIDA concluded that the improvements likely represent true performance enhancement and beneficial cognitive effects. The reason is that nicotine binds to the brain receptors for the neurotransmitter acetylcholine, which is a central player in cortical circuits (Begley, 2011). The findings also included a warning that smoking has been linked to dementia, among dozens of other health risks. Studies using nicotine in gum or patch form were not complete at the time of this writing.

Adderall and Ritalin

Stimulants such as Adderall and Ritalin have some cognitive benefits, at least in some people for some tasks. Studies show that both drugs enhance the recall of memorized words as well as working memory, which plays a key role in fluid intelligence (Begley, 2011). A survey done by McCabe, Knight, Teter, and Wechsler in 2005 estimated that almost 7% of students in U.S. universities had used prescription stimulants to aid learning and studying, and that on some campuses, up to 25% of students had used them in the past year. These two drugs, usually prescribed for people with attention deficit hyperactivity disorder (ADHD), increase executive functions both in people with ADHD and in most healthy people who do not have ADHD, improving their abilities to focus their attention, manipulate information in working memory, and flexibly control their responses (Sahakian & Morein-Zamir, 2007). It is important to note that use of prescribed medications by persons other than the patient is never recommended, and selling prescription drugs such as Adderall or Ritalin by a patient to others is a punishable violation of the law. I remind my students who do not have attention deficit disorder (ADD) or ADHD that 30 minutes of aerobic exercise (see chapter 11) will give them better attention and focus than these drugs, enhance their learning and memory, costs nothing, and won't cause them to break the law.

Three Cognitive Enhancements That Work

The three enhancements that have been very well tested and do show that they enhance cognitive function are exercise, especially aerobic exercise; meditation; and some computer games. I will discuss the important role that exercise can play in enhancing learning in chapter 11. The use of exercise to enhance learning is a very exciting finding and can have a significant impact on how we help students to learn and even how we conduct our classrooms.

Meditation can increase the thickness of brain regions that control attention and process sensory signals from the outside world (Jha, 2011). Meditation has shown success in enhancing mental agility and attention by

changing brain structure and function so that brain processes are more efficient, a quality that is associated with higher intelligence (Jha, 2011). This finding is important to pass on to our students. Studies regarding the positive influence of meditation on the brain don't come only from neuroscience research. In fact, studies from other areas in health science have demonstrated positive health benefits from meditation such as lowered stress levels (Nidich et al., 2009).

Yaakov Stern, neuroscientist at Columbia University, found that some video games might improve general mental agility (as cited in Begley, 2011). Games that require motor control; visual search; working memory; long-term memory; decision making; and attention, specifically the ability to control and switch attention among different tasks, can enhance cognition. Only a limited number of games have been studied, but this research shows that people who play these types of video games are more successful on tests of memory, motor speed, visual-spatial skills, and cognitive flexibility.

Brain-Based Learning Has Arrived

Certainly one significant sign that higher education has begun to embrace the integration of neuroscience findings into teaching and learning is the establishment of a master's degree in Mind, Brain, and Education at Harvard University. Harvard's mission is to build a movement in which cognitive science and neuroscience are integrated into education so that educators will learn how to incorporate them both in research and practice.

Evolution and Learning

One of the most important things to recognize about the human brain comes from the study of human evolution. Natural selection favored a brain that could solve problems related to survival in an unstable outdoor environment, and to do so in nearly constant motion (Medina, 2008). The significance of this for educators is that it appears we have gotten the classroom model completely wrong. Students' brains evolved to work best when moving, not sitting. This finding brings new meaning to the idea of "active" learning. As discussed in further detail in chapter 11, a great deal of movement (aerobic exercise) is one of the best things our students can do to improve their learning.

Is it possible to teach students who are moving? Is this a better way for our students to do their work? At least in certain circumstances, the answer might be yes. Bob Nellis of the Mayo Clinic in Rochester, Minnesota, conducted a study on the benefits of "chairless classrooms" and found students to be more energetic and more engaged in this active learning environment. Students who needed movement were able to move, but they did so in ways that did not disturb others (Pytel, 2007). Across the United States, dozens of studies are underway in which desks have been replaced with tables and exercise or stability balls as chairs. When students sit on the balls, they have the freedom to move about in small but important ways. Research clearly indicates that movement, even in small amounts, is good for learning (Ratey, 2008). John Kilbourne, a professor in the Department of Movement Science at Grand Valley State University in Allendale, Michigan, switched to stability balls in his college courses in 2009. His survey of the 52 students in his class on the change from chairs to balls found that 98% of students preferred sitting on the balls. Students mentioned improvement in their ability to pay attention, focus, take notes, engage in classroom discussions, and take exams. "They said the balls improved their focus and their attention, that everything was just better" (Kilbourne, 2009).

In visiting campuses across the country, I regularly ask faculty how they might integrate more movement into their students' learning processes. I have received ideas ranging from holding moving discussion groups in which students are allowed to walk while discussing readings, to moving assessments in which students move about the room evaluating their peers' findings that have been posted on whiteboards or newsprint. If we are to optimize our students' opportunities to learn, then we need to put some creative thought into how movement may be integrated into courses, since this is where the research is leading us.

When Doing the Work, Two Heads Are Better Than One

The study of human evolution also provides strong evidence that human survival depends on humans working together. If humans didn't help each other adapt to new environments or solve new problems, they wouldn't have survived. Collaborating with others made survival possible. It was always better to have more than one person keeping an eye out for a hungry tiger or to have four people attack a mammoth rather than one. In keeping with the survival instinct, having students do their work in groups, teams, triads, or pairs has its origins in human evolution. The use of groups as a learner-centered learning tool is discussed in more detail in chapter 7. It is very helpful to share with students that collaborating is a natural part of who they are and that it continues to be important for their survival, in this case, their academic survival.

Try This Example

The following is a simple example to use with your students to illustrate the value of working and learning from others. Ask your students to add 17 and 55 together in their heads. Once they have done this task, survey the students for how they solved this simple cognitive problem. Ask how many added the numbers in columns, carrying the 1 to the 10's column, just like they would do on paper. Then ask how many added 10 to 55 to get 65 and then 7 to 65 to get 72. Finally, ask how many added 20 to 55 and subtracted 3 to get 72. You can also ask if anyone did the adding in a different way than the ones that are mentioned here. You'll find that sometimes you'll get some interesting answers. This exercise demonstrates that even with the simplest cognitive process, people don't think alike and don't use the same tools to get their answers. This means that there is often something to be learned by working with others. In this particular case, those who used columns could learn a more efficient system of computing the answer from the students who added 10 or added 20 and subtracted. In most cases, multiple brains outperform single brains (Medina, 2008).

Doing the Work Is the Way Our Students Make Long-Term Memories

As I mentioned earlier in the chapter, if our students' brains are going to develop new neural networks, they must use the new information and skills we teach for extended periods of time. This is necessary for the new networks to become well established and eventually permanent (Ratey, 2001). Without use and practice, the brain reabsorbs the new cellular material and no neural networks exist (Zadina, 2010). The application of this brain research finding to our teaching is clear. We must find ways to get our students to use and practice over time the new course material that we ask them to learn. Traditional methods of letting students listen passively to lectures and then use a short burst of intensive study to cram for a test three or four times a semester does not result in students forming new neural networks. Cramming does not result in the formation of long-lasting neural networks because the amount of time and number of practices needed for this process is completely inadequate (Medina, 2008, p. 125). UCLA psychologist and memory researcher Robert Bjork defined learning as "the ability to use information after significant periods of disuse and it is the ability to use the information to solve problems that arise in a context different (if only slightly) from the context in which the information was originally taught" (Bjork, 1994). By definition, a teaching approach that allows for cramming fails to meet the definition of learning. Cramming results in a hollow victory for students. They often earn a passing grade but they are unable to recall or use most of the information even a week later (Bjork, 1994; Ebbinghaus, 1913).

Each time our students use new information, their brains create stronger and faster connections for the neurons that represent that information (Ratey, 2008, p. 39). This is why it is so important to have students do a lot of the work in our courses. An equally important finding about long-term memory formation comes from the work of Harvard psychologist Daniel Schacter, in his book *The Seven Sins of Memory*. Dr. Schacter reported, "For better or worse, our recollections are largely at the mercy of our elaborations." If students are to form long-term memories, they need to use new information in a variety of ways (read, recode, write, summarize, annotate, speak, listen, map, reflect, etc.) to make the information available to them for recall through many different neural networks. In other words, they need to do a lot of work with the information to be able to recall it. In chapter 10, I take an in-depth look into the research of memory formation and recall and suggest applications of the research findings to instruction practices in ways that promote long-term recall.

Be Professionals by Following the Research

At a workshop in Oregon in 2010, I was asked what I thought about faculty members being evaluated on their teaching. I believe the question was posed because the person asking had a colleague who believed the administration was out to get rid of bad teachers by using evaluation practices. I answered that, "As professionals, we should be evaluated just like any other professional." I went on to say that we should welcome it as a way to improve our teaching and our students' learning. My message was that, as professional educators, we have the responsibility to maintain standards of practice and that this includes changing our teaching when the research offers evidence that new practices are warranted. We have an obligation to follow where the research leads us. As illustrated in this chapter, there is an extensive amount of research supporting the move to a learner-centered practice.

GETTING STU
TO DO THE

Do not confuse motion and progress. A rocking horse keeps moving but does not make any progress.

(Alfred A. Montapert)

Last winter, I had a small run-in with a student, call
of my study strategies courses. At the time, I had
visiting my classroom, so the brief confrontation h
drama to it. The conflict spurred from my request that
headphones and listen to instructions. He first removed onl
I asked him again. He then removed the other earbud bu
hat down over his eyes, apparently in protest. I politely as
his hat and he replied in a highly disrespectful manner, "
away from me!" Soon after the incident, I invited KM to m
what had transpired. His first words to me were that I had
I had no business asking him to remove his earphones or ra
explained to him that one of the most important jobs I ha
to maintain the learning environment of the classroom so
can be fully prepared to engage in learning. I continued th
earphones was an indication of a lack of readiness to learn,
message to other students that they could do the same. I exp
unprepared to learn was unacceptable and went against th
of being in a college class. What happened next brings us to
story. KM told me that he had never heard that a teac
maintain the learning environment or that teachers were s
students at least "appear" ready to learn. I told him that I
was my job and, in fact, I travel the country teaching othe