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Francis would like to express his gratitude for financial support from the University of Kentucky and the interest and enthusiasm for the book’s subject matter among classroom teachers he has had the good fortune to work with and his many graduate students.

Ken would like to thank his long-time colleague and friend, Deb Zacarian, for encouraging him to pursue his interests, and Cecelia Buckley at the Collaborative for Educational Services in Northampton for her support. He also wants to acknowledge the long list of teachers who opened their classrooms to him and collaborated with him around supporting their struggling learners.
Ken writes:

In the early 1990s, I was several years into being an English as a Second Language teacher at an elementary school in a small, relatively affluent western Massachusetts town. While I was pretty successful teaching students from families associated with the five colleges in the area and students who were from professional families, I was increasingly dissatisfied with my work with the children of Cambodian refugee families who were being settled in the area in large numbers. The school had creatively organized around supporting the students and their families, and while the students were making academic gains, they were not achieving like other populations of English learners, let alone other students at the school. As the population in the town grew more economically and culturally diverse, other pockets of underachievement began to develop. I had been trained in cutting-edge ESL techniques and was well-versed in the progressive pedagogy of the school, but felt I was still missing something important. I knew I needed to think outside the box—but I didn’t know the nature of the box I was in.

Francis writes:

I bumped into Ken at a party in the early 1990s. He was an acquaintance from our days as graduate students at The School for International Training, and I was now a
doctoral candidate in education at the University of Massachusetts. Ken told me of the academic struggles of some of his Cambodian American students. I told Ken about sociocultural theory, and we discussed the connections among language, learning, and culture. In particular, we spoke about my interest in Vygotsky and the sociolinguist James Gee, and his conception of thinking and doing as a part of the communities in which we live and work. While Ken and I had both lived and taught abroad, and thinking about culture is part of the air an ESL teacher breathes, thinking about learning itself as fundamentally a cultural (as opposed to mainly intellectual) process struck a chord with Ken. He invited me to observe his classes, and a collaboration was born.

Over the next two decades, we worked together to try to better understand the many ways struggling learners can be mismatched with the U.S. school system and the cultural assumptions that underlie schooling in the United States. We conducted classroom research and wrote articles, and Ken wrote a book on working with culturally and linguistically diverse learners who struggle academically, based in large part on the journey we had taken together. Ken has since become a coach and trainer focusing on helping teachers better meet the needs of struggling learners, and Francis’s career as a teacher educator has ever since been grounded in the realities of children struggling to make sense of language, culture, and schooling.

But how did we, with our passionate interest in culture and language learning, end up writing a book about memory and cognition? We realized that a better understanding of the brain was the next step for us to take in order to understand and respond to the needs of struggling students. Ken had already been trained in a cognitive education program, which was quite successful with his struggling students, and it opened up new horizons for us to explore together. We have come to realize that language/culture and cognition are two wings of the same bird. When both are intentionally accounted for in teaching, learning has a chance to soar.

Our explorations have led to the conclusion that understanding the role that memory plays in learning is something that would benefit every teacher. We try to explain memory systems in straightforward terms and connect them to learning principles, instructional strategies, and teaching techniques. We use classroom scenarios to ground the discussion of memory, learning, and classroom practices in the realities of academically struggling students. We review relevant classroom research and also draw our own inferences for applications to classrooms. Our choice of what to address out of the myriad possibilities
in this fascinating field is guided by one principle: it must have a clear and direct link to academic learning, and a discernible payoff for classroom practice.

This is a book about the brain and learning, but we focus on memory systems. These connect us directly to the neurology and physiology of the brain, such as neurons, neurotransmitters, and white and gray matter. However, that level of knowledge can rarely be used to help us make decisions in our classrooms or plan lessons, so we try to focus on what is most practical for classroom teachers. For example, while the brain’s production of dopamine is integral to the process of learning, we do not describe how that system works, but instead focus on what at the cognitive level stimulates the brain to produce it. Although the various brain regions are quite specialized in their role in learning, we do not identify which brain regions are responsible for what learning, but rather describe ways to structure activities to get those areas of the brain to engage.

One of the challenges of exploring cognitive research is that while much has been learned about human cognition in the last few decades, it is still an area of active research. It’s a complex and messy field with multiple models and interpretations. But there are nuggets to glean. The research and theories that resonated most with us were developed by cognitive psychologists who propose that humans create internal representations of experience as we learn. We draw on these representations to process future experiences and to direct behavior. Most of this literature is written by psychologists who are eager to share their insights with educators but know little about classroom learning. So they provide general, mainly theoretical guidance that does not translate easily to classroom practices. And they often use complex, technical language that is challenging to wade through unless you yourself are a cognitive psychologist. One thing we have tried very hard to do is write a book that communicates directly to you, our teaching colleagues, in the context of classroom practice.

Finally, humans are social beings, and we learn in context. The problem is that education tends to be a rather compartmentalized field. There are the brain specialists, and there are experts in the social and cultural influences on learning. But the mind is the nexus that connects our inside to the outside context. So while the main focus of the book is the learner’s “inside,” we cannot ignore its connection to the context of learning. The social and cultural contexts of learning are the most relevant environments for us as teachers, and for our students as learners. Because so many struggling learners are from diverse cultural communities, we realize that any attempt to understand learning that focuses mainly on
culture or the brain, but not both together, is missing a vital connection. We want to tie the insights from these two powerful fields together into a coherent whole. Our goal is to write the book that we wish we’d had when we were struggling to make sense of things long ago. We believe that our intentional coupling of these two fields makes this a more valuable book for the realities of practicing teachers.

We are very excited to share a perspective on teaching and learning that infuses important cognitive science research on memory systems with issues of culture and language, one that is practical and can directly support the achievement of struggling learners. We hope you find it as enjoyable and helpful to read as we found it enjoyable and educational to research and write!

1. The Feuerstein Instrumental Enrichment program.
2. The models and theories of cognition that we draw on are grounded in research in the cognitive sciences, and our understanding of memory and learning is informed by this work.
3. We often use “we” as a pronoun throughout the book to mean “us and you, our teacher colleagues.” One other pronoun note: we alternate “he” and “she,” as the third-person singular pronoun when referring to an unnamed student.
The primary goal of this book is to help classroom teachers figure out how to support learners—especially struggling learners—through a focus on human memory. By developing a deeper understanding of learning and learners, we can teach more effectively. We also have to understand classroom learning as a process that plays out in a social and cultural context. Each chapter is a balance between science’s new insights into human memory, filtered through the lens of how learning is also a cultural process, and how this informs classroom learning and instruction. We can harness this knowledge to gain fresh insights into the challenges faced by students who struggle academically. Each chapter provides a set of practical classroom strategies that address pressing issues in the education of our school-age children.

By exploring the different dimensions of memory and their implications for the social and individual dimensions of teaching and learning, this book can serve as a primer for all of us who would like to better understand why our struggling students continue to underperform academically, and how we can enrich our classroom teaching to better address their educational needs.
What You Will Learn in This Book

Through the study of research on learning and memory, we encourage teachers to take on the role of “learning specialist” with a particular focus on students who are academically underperforming. The book provides classroom teachers with the opportunity to deepen their understanding of both the central role that memory plays in academic learning and the (sometimes surprising) role that culture plays in memory formation and use. We present a framework for looking at learning as a social and cultural process, as a way to connect the reality of learners as neurobiological individuals to their equally important reality as social and cultural beings.

Using real-life teaching examples, the book highlights a set of specific classroom learning challenges that students (and teachers) face. We analyze these challenges from the perspective of the memory systems that play the central role in classroom learning. At each major point about memory systems, practical classroom applications accompany new insights into memory and learning. When appropriate, these are described as to how they apply to more than one grade level, and there are examples from both elementary and secondary levels throughout the book. The final chapter argues for the importance of teachers advocating for and teaching in ways that are consistent with the needs of academically challenged learners.

Chapter 1: Why Learn About Memory?
Teachers are overwhelmed as it is, so why add one more thing to our load? This chapter explores the importance of teachers becoming learning specialists, attuned to the leaning needs of our most vulnerable learners. We connect the dots as to why it is so important to take the time to understand memory systems in relation to learning, in spite of all we have to do, to better reach and teach our struggling learners.

Chapter 2: Five Core Memory and Learning Concepts
As classroom teachers, we are well trained in terms of curriculum and teaching methods, but often don’t know enough about the process of learning itself. However, if we understand the functional and neurological characteristics of memory and learning, it will help
us better understand the nature of classroom learning and avoid misunderstanding the source of many challenges that students face. The five core concepts introduced in this chapter sketch out the parameters of the physical nature of our memory systems and guide our understanding of the cognitive realities of classroom learning.

Chapter 3: Why Do the Cultural Roots of Learning Matter So Much?
Many culturally and linguistically diverse learners struggle in our classrooms, in spite of best practices and new training and programs. Low-income students struggle even if they are from the “mainstream culture.” This chapter explores diverse communities of learners and highlights the social roots of human memory and learning. A sociocultural framework is introduced to help understand and respond effectively to the struggles that many academically underachieving students face.

Chapters 4: Working Memory: The Doorway to Learning
Ever wonder why students seem to forget so much of what we thought they’d learned? The key is working memory. Working memory is central to learning, as it is where we initially process new information about what we’re learning, focus attention, and manipulate information. It is closely connected to the conscious mind. It’s the gateway for all learning. It is in working memory, for example, that reading comprehension takes place and mental math is processed. Chapter 4 shows how working memory plays a decisive role in all learning—if the classroom environment is not attuned to working memory, then learning will be impaired.

Chapter 5: Executive Functions
Academic learning depends on the ability to independently interpret, strategize, and problem solve—what are called executive function skills. The problem for many struggling students is weak executive function skills, so their learning is built on a house of sand, no matter how we teach our lessons. Executive functions work closely with working memory in the regulation of attention and decision making to support academic learning. In this chapter, we explore some key executive function skills needed for successful academic learning.
Chapters 6 and 7: Semantic Memory

Semantic memory is our storehouse of facts about the world: world capitals, the year we were born, the molecular formula for water, our child’s face, the texture of oatmeal. It is stuffed full of all the accumulated knowledge of our own years on the planet, not to mention whatever we take from the store of human knowledge formed over millennia, and stored (semipermanently) in our semantic memory. It is semantic memory that stores our knowledge of words—their meanings, pronunciations, and spellings—and how they are related to other words and concepts. Much of schooling is directed at enriching the knowledge stored in semantic memory. Chapter 6 examines important features of semantic memory that impact classroom learning. In this chapter, we also discuss another long-term memory system, procedural memory, and its role in issues of literacy development and second language learning. Chapter 7 explores the cultural roots of semantic memory organization, as well as a set of important cognitive skills closely connected to semantic memory organization.

Chapter 8: Episodic Memory

Think of an important event that you experienced in your life. Perhaps you remember the birth of a child, or the day you graduated from college or were married. Vivid personal memories of both daily events and important events in our lives, complete with images, sounds, and feelings, are stored in episodic memory. It records our everyday lives—where we were, when the event happened, what we did and said, what we were wearing, who we talked with. While semantic memory stores facts, episodic memory records our sensory impressions of our lives. We explore the role that this form of long-term memory plays in classroom learning in Chapter 8.

Chapter 9: Autobiographical Memory

Over time, students develop a sense of themselves as students: good at math, bad at spelling, interested in art or science, and especially good or not at reading. This self-image strongly impacts academic performance and is formed in autobiographical memory. When students are independent, confident, and motivated, there’s a much stronger likelihood of academic success than if students are always dependent on us, lack confidence, and feel that any efforts they make will go for naught. An understanding of autobiographical memory provides an opportunity for us to develop a new awareness of
our role as classroom teachers in creating positive learner identities, a key indicator of our effectiveness as teachers.

Chapter 10: Practice
It is essential that students take initial classroom learning and transform it into stable, productive, long-term development. They do that through practice. In this chapter, we explore a number of issues related to maximizing student practice, including the importance of helping struggling learners figure out effective ways to practice.

Conclusion
The sad reality is that despite an endless parade of new teaching methods, curriculum reform, and educational policies, the academic gap of middle-class/affluent and lower socioeconomic students continues to grow. Many of our struggling students come from diverse communities, with non-literacy-oriented and culturally disrupted learners. We advocate for teachers as learning specialists to focus on understanding the source of struggling students’ academic challenges and ways to help students become better learners especially in light of the Common Core. This includes advocating for classroom practices that are aligned with the functioning of human memory and the ways children learn.

Wouldn’t it be great to walk into a classroom full of students and feel like you really knew how they learned? To feel confident that the lessons you designed worked in sync with the way the brain works? To pinpoint problems in the learning process to help struggling students learn better?

We all want to do the best we can for our students. We spend hours and hours planning wonderful lessons, but we know that not all students benefit equally from our hard work. We agonize over students who struggle in our classrooms. We receive professional training in program after program—both what our districts make us do and what we do ourselves—to try to make the learning process work well for all students. But it still doesn’t. So what are we missing?

The central idea of this book is that if we knew more about how the brain actually works in the process of learning, we would become more flexible, skillful, and successful teachers—and our students would be more successful learners. One of the challenges of teaching is that classroom teachers cannot focus on only one dimension of a learner: We must teach to the whole student—their cognitive, emotional, and social selves. We must balance their complex needs and unique characteristics with our curricular goals. This book
Why Learn About Memory? 7

shows the importance of memory in learning and how social learning affects memory and the complex learners we work with.

In spite of the many serious challenges of being public educators in this day and age, we are fortunate because we now know so much more about the human brain. Until recently, that was a door that was closed to us. But now that door is at least partly open, and we can begin to explore and use what we find on the other side. Cognitive science is transforming the way we understand our brains and offers many insights into how the memory system is integrally connected to the process of learning. With decades of research to draw upon and many new research tools to use, cognitive researchers have much to offer us in our work with students.¹

Much of cognitive research has been done in controlled research settings, and reading about it can often feel like wading through a swamp. But we educators must find practical ways to use the information emerging in cognitive science. This book is written by educators for educators to harness this emerging knowledge of the human brain and memory systems in the service of our students and our profession. In particular, this perspective will enable us to work more successfully with populations who struggle in our classrooms for whatever reason, including many low-income students, English language learners, special education students, and others.

For all too long, our field has operated like the enchanting logic employed by a character in this Iranian story:²

A neighbor of Mullah Nasruddin’s woke up early one morning and went outside to stretch in the early light. He noticed the Mullah at his doorstep, throwing rice all around.

“Good morning, Mullah. And may I ask, what on earth are you doing throwing rice around like that?”

“Keeping away the lions,” said the Mullah.

“Don’t be silly,” said the man. “There are no lions around here!”

“Aha!” said the Mullah, wagging a finger and smiling. “It works!”

Many things do work in the classroom—but not always for the reasons we think. We are barraged with “best practices,” new programs, new movements in education, all claiming to have the answer to how to overcome inequalities. But the fundamental questions we address throughout this book are, How can a clearer understanding of memory and the brain help us understand teaching and learning? And how can this knowledge help us reach and teach struggling students?
Memory at Work in the Classroom

Memory: Central to Learning

Knowledge and memory are inseparable—if you are in the knowledge business, then you are also in the memory business. An efficient memory system is a requirement for all learning, in or out of the classroom. At times, children do not seem to be learning what we want them to learn—and their memory systems are at the heart of that, too. We believe that it is crucial for teachers to understand why effective practices are effective for many students, and also why they may not be so effective for others. The key to understanding teaching and learning processes, including the breakdowns that sometimes happen, can be found by better understanding memory.

Consider the following scenarios. Do they resonate with your experiences as a teacher or remind you of other situations where you wondered, “What is going on?!”

Scenario #1: A teacher in 2nd grade is leading a discussion in a science unit on mammals. The teacher is focusing students on the physical traits that all mammals have in common. In the classroom discussion, one child begins to talk about her pet dog and why she likes to play with it. The teacher notes that this child usually approaches school subjects from her own personal experience and is slow to keep up with the flow of classroom learning. The teacher thinks, “Why can't this child stick to the topic?”

Scenario #2: A 5th grade student from Southeast Asia is being referred for a possible learning disability. His academic progress has been slow, although it doesn’t seem to be an issue of language, as the student has pretty strong oral communication skills in English. In the testing, nothing specific shows up. The child is given an exercise to choose one object from a set of three or four objects that does not belong with the others. The very first item has pictures of a knife, fork, and cake. The student looks confused. When gently pressed for an answer, the student says, “I don’t get it.” The tester explains the directions again. The student says, “But they all belong together!”

Scenario #3: A 9th grade algebra class has a number of students who constantly get overwhelmed and confused. They seem to forget how to solve the kinds of problems they once seemed to know, they mix up terms and concepts, they skip steps, and they get low scores on tests after they seemed to know the material. No matter what the teacher does, these students almost always have the same kinds of issues, unit by unit by unit.
This book examines situations like these from the perspective of memory to help us understand why these situations occur, how to understand them, and how to work with them.

We all know teaching consists of many roles: lesson designer, curriculum specialist, instructor, assessor, psychologist, counselor, and even surrogate parent at times. One role that we urge teachers to take on through this book is that of “learning specialist.” We find it ironic that while there can be no learning without the learner, out of all the factors we have to juggle in our various teaching roles, we may know least about the mechanics of learning! Many of us have been trained in schools of education and our school districts in teaching methodologies, curriculum mapping, assessment, using test data . . . but how learning is a function of the memory system? Not so much! Yet memory is a key system we need to troubleshoot when problems in learning arise.

So What Is Memory, Anyway?

In which of the following activities do you think memory plays a role?

- Driving a car and talking with a friend in the passenger seat
- Reading and understanding a news story
- Hearing a new word and being able recognize it and use it later
- Retracing one’s steps to find a lost item
- Describing specific details about an important personal event from the distant past
- Adding the numbers 12, 3, and 5 together
- Recognizing the face of a loved one
- Describing what you did yesterday
- Knowing that the capital of Massachusetts is Boston

Memory plays a role in all of these activities. For many of us, memory is synonymous primarily with just “remembering” a past personal experience or “memorizing” some new information. So it may come as a surprise that human memory plays such a central role in learning. Memory is the label we use for cognitive processes that are central to our lives and sense of who we are, and they cross the boundaries of all types of activity in our lives. We draw on various elements of our memory systems for all thinking, and all learning.
Memory is fundamental to our humanity and identity. Who would we be without our memories of past events and people in our lives? How would we survive without the ability to remember where we have gone and what we did in the past? How would we learn without the ability to store information away and retrieve it when needed? As humans evolved, we developed memory systems that allowed us to store and retrieve information necessary to take care of basic survival needs, such as gathering food, reproducing, and responding to danger by fleeing or fighting.

We also developed memory systems that are central to human cultural evolution. Our ability to learn and manipulate cultural symbol systems and their meanings has provided the social knowledge and organization that underlie modern life. With the development of language, which is also intimately connected to the memory system, humans gained the ability to work skillfully in the abstract realm of thought, a skill that is highly prized in schools.

Every day in classrooms, students struggle to learn the vast ocean of knowledge that sweeps over them. New concepts, images, names, dates, and formulas roll in. Some students float to the top and swim around happily, others flounder and struggle, while yet others sink like stones. If we reflect on this honestly, we notice that who swims, who flounders, and who sinks is pretty predictable, all things being equal. But don’t we all want to know how to help all students float and swim, not only the students who are most likely to do so anyway? After all, we should measure our effectiveness as teachers not by the achievement of the strongest swimmers (who are likely to achieve, with or without us), but by the achievement of those who need us most. When we work with the most academically challenged students in our schools, such as English language learners or students with individual educational plans, we have the most to gain from understanding how the memory system impacts learning, and how to adapt our instruction to reflect those realities. **Understanding how memory works can help us get all students to swim!**

1. Medina (2008); Dehn (2008); Sousa (2011); Ambrose et al. (2010).
3. It is well established that poverty, race, cultural background, and linguistic diversity are all predictors of academic underachievement of U.S. public school students (Hochschild, 2003; Kozol, 1992; Spring, 2011).
This chapter establishes five core realities about memory and the hardwiring of the brain that define learning at the physical level. It’s important to ground our understanding of human learning in the realities of neurological and physiological processes. This understanding pulls back the curtain on educational philosophy and methodology and allows us to shine a light on learning “the way it is,” based on how our brain works, at least to the degree that early 21st century science allows. We refer to these five elements throughout this book.

1. **Learning Means the Efficient Functioning of the Memory System**

Without memory, learning would be impossible. The very act of thinking cannot happen without engaging our brain’s memory system. To a large degree, the process of learning means

1. Creating a representation of some type of information;
2. Storing that representation in long-term memory;
3. Being able to retrieve that representation to interpret reality and solve new problems.

In order to make meaning of the world around us and problem solve (e.g., apply math to a story problem, interpret a poem or graph, write an essay), all the components of our memory systems need to be working in sync. So, one of our primary roles as teachers must be helping students shape their memory systems to the demands of the school curriculum. We must also shape the focus and flow of the school curriculum to our students’ memory systems. The memory systems explored in this book are represented in Figure 2.1.

Figure 2.1 | Human Memory Systems

2. Memory Is a Physical Process

The brain is continually being shaped through experience. When we learn, a physical change takes place in our brain. Our ability to be lifelong learners, to continue to update our memory systems, is termed “neuroplasticity.” Anyone can learn at any time. Understanding the physical side of the learning process can help us become better learning specialists in the classroom.

Our brains have a system of neurons—billions upon billions upon billions of them—linked together through a web of connections through axons (the armlike parts that send information to other neurons by electrochemical means) and dendrites (the fingerlike...
part of the neuron that receives information from other neurons). Data signals pass from neuron to neuron—the axon of one neuron meets the dendrite of another. There are actually tiny gaps between neurons, and signals jump these gaps aided by complex chemical processes. (See Figure 2.2.)

When we learn, our neurons are bombarded with all kinds of input, clamoring for their attention, sort of like being on the floor of the New York Stock Exchange at peak trading hours—it is lively and cacophonous! Sometimes the loudest shouts are “Yes, yes, go for it!” and we choose it, at other times, “No, no, not that!” and we let that go. So, neurons can either send data along the neural web or inhibit the data. In fact, one of the main processes of learning is inhibiting unwanted information and selecting desired information. The things we exclude do not make it into our neural network and cannot be stored for future use. Successful learners are successful in part because they can select the right information to pass along and store. Conversely, this is a key obstacle for many struggling learners.

What to focus on, what to let pass? It seems easy enough, but when that curricular tidal wave is rolling over our struggling learners, their instinct is to grab onto the closest, most obvious, easiest thing—the problem is, that’s not always the best one to grab onto.
As neurons get activated during learning, their axons get coated with goopy white brain matter, called a myelin sheath. The more a neuron gets activated about a particular piece of learning, the more goopy coating its axons get, which facilitates faster information transfer and protects that particular connection. The more we use a connection, the faster it gets triggered as well. While our parents always told us that practice makes perfect, it actually happens that practice makes goop (while it also makes permanent).

One other relevant thing to note about myelination is that it prevents the brain from “pruning” unused or rarely used connections. Our brain does periodic “desktop cleanups” with neural networks. It does a lot of dendrite pruning when children are very young, and as we get older, it prunes away some neural connections. Myelin is a signal to the brain to “leave this connection alone.” (See Figure 2.3.)

**Figure 2.3 | Neuron and Myelination**

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**Firing and Wiring**

We retain information learned through stimuli and responses. This concept is famously expressed by Canadian psychologist Donald Hebb (1949) as “neurons that fire together, wire together.” When we notice something in our environment, we automatically link that
object or event to a network of internally stored information. When a child encounters a dog and hears the word “dog,” she begins to build an association between the word and the animal. Over time, the network of neurons that constitute the child’s representation of a specific animal will become densely connected to the verbal label “d-o-g.”

The physical nature of learning and the brain’s plasticity has profound implications for us as educators. It makes us question commonly held perspectives of early childhood and human development that view children as permanently limited if they have not attained the requisite developmental, behavioral, cognitive, and academic milestones by certain ages. For example, we may view a child who cannot read well at age 13 as not having the capacity to learn to read well. Research in cognitive science and education is now showing us that this view actually limits us; it limits our view of children and what they can do. As we understand our memory system, we gain new tools to make a deeper and more long-lasting impact in our work with students who struggle, helping them to become more flexible and considered learners in their future.

We should note that sleep loss, poor diet, and lack of exercise impair the generation of neurons in the brain. Many of us have students who, unfortunately, experience these conditions, so it is important to acknowledge the special challenge these students face in learning. Armed with this information, we can advocate for the pace of our instruction to be decided by our students’ learning needs. But we must also advocate for the importance of helping accommodate these needs in school programs—such as having food available for students, resisting the reduction of recess time in favor of more on-task content learning time, or building more physical movement into the school day. These things may not be what politicians, bureaucrats, and district administrators think learning entails, but our kids’ brains know better.

3. Our Brain Learns Best Through Multiple Pathways

Throughout most of human history, we learned through direct experience, when almost all our senses were engaged. Our brains evolved to prefer multisensory experiences for learning. Now, with schooling and literacy having taken on an increasingly important role in our cultural learning practices, we have forgotten how our brain is built, and we create learning experiences that do not build on the brain’s preferred ways to learn. But we have all experienced how hands-on learning usually sticks best, and how students typically enjoy it more.
Each part of the brain is dedicated to a specific set of tasks: sensory processing, motor activity, and verbal and mathematical processing centers. For example, the brain’s web of neural interconnections allows us to take visual information and integrate it with our language system so that we can talk about what we see, and so that we can reach into our long-term memory to recall a vacation we took to the mountains in Idaho in July and tell our family and friends about it when we get back to New England in August—or write in response to the prompt “What did you do during your summer break? Be sure to be as descriptive as you can.”

Networks of Representations

The way our brains prefer to learn explains how information is stored once it gets into our memory system. Information is stored in diffuse networks linked to multiple regions of the brain, as language, nonverbal images, feelings, sounds, sensations, and smells. For example, here’s a common tool:

This image activates neuron clusters in both your visual processing system and in the motor system that would activate in order to use the hammer. This allows you to both
re-create an image of the tool in your brain as well as know how to use it. This neural network is also linked to the word “hammer,” which in turn is also linked to the concept and word “tool.” The flip side of saying that a student has “learned something” in our classroom is saying that a new neuron network has been forged across a range of regions of the brain, all connected up in semantic memory. So, for example, as we read, images and other mental sensations are created along with our processing of word meanings.8

Teaching with a Multisensory Perspective

As Judy Willis, a neurologist and classroom teacher, notes, “By stimulating several senses with the information, more brain connections are available when students need to recall that memory later on. This means that the memory can be retrieved by more than one type of cue” (2006, p. 10). For example, having students listen to a video of a scientist talking about a concept, and then having them read about the same topic along with visual representations (such as pictures, graphic organizers, or charts), provides three pathways to learning the new concept and helps to build networks that facilitate long-term storage and retrieval. Then if we engage students in actively manipulating that information (sorting and categorizing the information, problem solving, experiments, projects), we add new possibilities of sense connections. Visuals, role-plays, manipulatives, and realia not only are more fun for students to engage with than verbal lessons but also allow them to grab onto learning in many different ways. All our lessons should involve at least two learning channels.

4. We Do Not Experience Reality Directly

Knowledge is a representation stored in long-term memory and is often termed “schema.” A schema is essentially a network of neurons that gets activated based on what we experience in our environment or something we think about. To say you “know” or “know how to do” something means that you are able to access the relevant representation and activate it. Once you have activated the precise schema, you are able to use it to carry out daily plans, solve a problem, or learn something new.

An astonishing insight regarding learning comes from a deeper understanding of the connections between raw input from our environment—a thunderclap, an utterance from a teacher, a sentence from a book—and the “knowledge representations” we store
in memory. By the time we are conscious of experiencing something happening around us, our brain has already processed the initial sensory information, activated the relevant schema, and created a new knowledge representation of the experience. We use that knowledge representation to think with and respond appropriately. In fact, whenever we are thinking, learning, or acting, we are manipulating schemas stored in long-term memory.

The sensory world does not have a direct pipeline into our memory system. The various centers of the brain are interconnected and process information at really high speeds, so it seems like we are reacting to an external stimulus. But we relate to reality through the lens of our own mental constructs about the world, through words, concepts, images, feelings, likes and dislikes, and our interpretation of experience rather than the direct experience itself. Students are not just information-processing devices—computers—neutrally taking in and storing our instructions, but rather are making sense of, interpreting, and shaping our instruction based upon their own internal schema. Student learning is fundamentally determined more by what goes on inside the learner than on our instruction pouring in from the outside.

This highlights three elements of instruction that we should be sure to incorporate in order to teach in sync with the realities of the brain: backgrounding, uncovering misunderstandings, and monitoring learning.

**Backgrounding**

Many of us already use “background-building” activities. Students are usually asked to focus on something they learned earlier in that school year or in a previous year, or on something they learned outside school that is related to the new material in some way. Indeed, from a memory system perspective, it is important to have some kind of schema-activating activity prior to any lesson. By engaging learners in extended talk about a topic, we wake up those neuron clusters in long-term memory associated with the topic.

However, it is usually a mistake to assume that all of our students have “learned” material from a previous month or year at school to the point that it is readily retrievable now. Have they really moved the new information into long-term memory storage and integrated it into existing networks of information? It is quite likely that many students will only have a vague recollection of it. In addition, we all have students who, for any number of reasons, were not at our school when those lessons were taught.
So we also advocate putting students in touch with their real-life experiences outside the classroom. All learners have knowledge and experiences from their home and community lives, and we can almost always find something to connect to. Whenever possible, we need to help students get in touch with information that they know best: their own lives.

There are parallels between real life and almost anything we learn at school. Some examples: we could use a discussion of fights with friends on the playground to learn about the American Revolution, because conflict is conflict; we could talk about planning for a party before we turn students’ attention to the value of pre-writing. What real-life connections could you help students make to (see our suggestions at the end of the chapter)

• Inferencing?
• Multiplication?
• The scientific method?
• Manifest Destiny?

As we think in this way more and more, it becomes easier to see these connections.

Learning occurs because there is background to build on. All students can get excited talking about their lives, and that shared experience becomes the baseline of what the new learning is built on. Then students are walking into a lesson that otherwise they may have little or no interest in with more interest and desire to learn. It stimulates more of a feeling of “Hey, I know this already!” instead of “Yuck, another hard, boring thing I have to learn and will be bad at.”

By making efforts to connect “inside school” to “outside school,” we also help students to develop semantic memory systems fully integrated with the fabulous cultural resources and cognitive tools that they have inherited from their ancestors. We will be revisiting this topic of background grounding frequently throughout the book, as it is so important to the efficient functioning of the entire memory system.

Uncovering Misunderstandings

Students may have “faulty” background knowledge. We all have created misunderstandings about things, which form the (faulty) baseline for our new learning. The longer a misunderstanding persists, the harder it is hard to shake.

Once Ken was working with some students on a book about the fires that raged through Yellowstone in 1988. The book was about the controversy that ensued—should the fires be put out or not? The author stated directly on the back cover that the book was
about the controversy, not taking a position on which side was right. But after reading and processing that with the students, Ken asked as a comprehension check, “So, does the author think the fires were good or bad for Yellowstone?” All the students instantly replied, “Bad!” Why? Even though they had ostensibly “understood” the back cover statement about the book, the year before in 4th grade they had all been through a fire safety unit where the message was quite clear: Fire is dangerous and bad! That past learning would have formed the faulty baseline for the comprehension in the present text if Ken had not lucked out by asking them a follow-up question that required them to apply what they apparently had “clearly understood” just seconds before in the conversation. There can never be too many comprehension checks or attempts to pin students down about what they actually understand.

**Monitoring Learning**

We have to create opportunities for students to demonstrate their real-time learning, which can be evaluated on an ongoing, formative assessment basis. With frequent check-ins, we have a better chance to head off misperception, misinformation, and poorly processed ideas at the pass. Not only are turn-and-talk, Think-Pair-Share, learning log reflections, and other ongoing assessment techniques helpful for students to get time to take stock of and solidify their learning, but if we actively attend to what students are saying or writing during such activities, we can see how accurate their fledgling understanding is.

**5. Honoring the Limbic System**

The limbic system\(^1\) is the brain’s center of emotional control. The thing to realize about emotion is that it is a form of intelligence in its own right. Emotions like anger, fear, or joy are the result of our limbic system’s assessment of our environment. The limbic system draws on the knowledge representations we’ve stored in long-term memory to make sense of context and come to a conclusion about what our priorities for action should be, based upon how we are feeling. Without the limbic system assigning a high priority to what is being taught, or if we sense a threat in the environment or even feel generally uncomfortable, we will simply not activate our memory systems for learning.

For example, if we are forced to go to a professional development (PD) workshop by our district about a topic we do not find engaging or important, and the presenter just
reads off the slides, our limbic systems rebel, and we retain very little of the content—we might even get surly! Feelings of anxiety, fear, disconnection, confusion, and anger all make the limbic system tell the brain to hunker down in “protect” or “disengage” mode.

Similarly, if our classrooms feel to students like that PD feels to us, their learning won’t happen, either. If students think that we don’t like them, or that other students don’t like them, or that they are just bad at school, or that everything moves too fast, or for any other reason, their emotional response makes it very unlikely that they’ll engage their memory systems successfully in learning. Without positively engaging our students’ limbic systems, we are unlikely to be able to teach them successfully, however wonderful or built on “best practices” our lessons are otherwise.

Or maybe a student’s limbic system is still engaged with something that happened in the home, or on the street, or on the bus. It is so important to ensure a safe, welcoming, and open classroom environment. Otherwise, we are just slamming the door shut on even the possibility of some (or even many) of our students’ being able to learn.

Acute stress causes us to produce hormones that make us go into “hunker down mode.” Learning becomes problematic and it gets hard to think straight because our limbic system is on such high alert. At that point, neither working memory nor our long-term storage systems work as optimally. Many children, sadly, grow up in a very stressful environment and come to school fighting an uphill battle with their stress hormones. In Chapters 3 and 5, we will see that this directly impacts their ability to learn independently. Knowing this makes creating a warm, welcoming, and stress-free classroom so important, and we need to take the time to make it happen.

**Teaching Point**

The more we know about something, the better we can make use of it. That’s the spirit behind the value of becoming a learning specialist. As we learn more about the physiological and neurological realities of learning, we can teach in ways that honor these truths. In the same way, students can make use of this information: everything we need to know, they can benefit from knowing, too. We highly recommend trying it out!

For example, if they know that without tapping into background, learning won’t happen, there is at least the possibility that they will try to tap into it independently, and maybe be more proactive about asking if they don’t know much about a subject or text. If they
learn about myelination, it’s an easier sell in reply to “We did this already—why are we doing it again?” to say, “But remember, practice makes goop!” Each of the core concepts in this chapter can be fodder for lessons where students learn about how they learn. The class can physically act them out after they learn about them, sing songs about them, or draw their own pictorial representations, cartoon, or learning flow chart.

The same can be done with the different memory systems (working memory, long-term storage systems) when we get to those. By learning how their brain is working as they learn, what makes learning easier and what complicates it, students can become better learners, more able to advocate for themselves individually and as a class.

What’s Next

Before we explore each section of the memory system in greater detail, we first take up, in Chapter 3, the social and cultural context in which schooling occurs. Although it may seem counterintuitive, important elements of our memory system—which we just described as a physical and neurological process in this chapter—are profoundly affected by culture. In order to fully appreciate the workings of memory and the struggles of many learners, we need to establish learning as a social and cultural process.

OUR BACKGROUND GROUNDING IDEAS (from page 19)

• **Inferencing**
  We could ask students, “Have you wanted to ask your mom and dad for something, but when you go to ask them, something about them makes you think, ‘Whoa, now’s not the time’?” Or, “Have you ever done something your parents asked you not to do, and just by looking at them, you know just how they feel about it?” *All kids* “read” *expressions of parents, teachers, friends, etc.*

• **Multiplication**
  We could ask students how many of them eat cookies or chips, how many of their parents buy gas for the car or how basketball shots turn into points. *There are many examples of things that kids know well that come in packages or groups, or that are calculated more than one at a time.*
• The Scientific Method
We could ask students what they do if they ask their parents for something and their parents say no. Do they ask again another time, in a different way? Or, how do they figure out how to beat levels in a video game? *Kids hypothesize and make adjustments to what they do through what they've experienced throughout their lives.*

• Manifest Destiny
We could ask, “How many of you have a bigger brother or sister who comes into your room anytime they want, even takes your things, but you aren’t allowed into their room without getting permission first”; or, “If you’re the older brother/sister, is it that way for your younger brother/sister?” *There’s unfairness (at least the perception of it), and the abuse of position because one has the means to do so, in every child’s life.*

2. The brain does initially process sensory information from our eyes, ears, nose, skin, and tongue (somewhat) independent of long-term memory. However, quite early on in sensory processing, a long-term memory schema is engaged to help identify and make sense of new environmental input. Conscious thoughts such as naming an object or event, comparing two things, forming an opinion, and interpreting language require access to long-term memory (LeDoux, 2002).
3. Feuerstein et al. (2010).
12. Bibok, Carpendale, & Müller (2009); Blair et al. (2011); Buckner & Kim (2012); Fernald et al. (2011); Herbers et al. (2011); Hughes & Ensor (2009).
REFERENCES


Harvey W (1628/1941) An anatomical disquisition on the motion of the heart and blood in animals. In F. Williams & T. Keys (Eds.), Cardiac classics. St. Louis, MO: CV Mosby Co 14–79.


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Francis Bailey is the Director of the Teaching English as a Second Language (TESL) Master’s program at the University of Kentucky. Francis has a doctoral degree from the University of Massachusetts. His primary educational focus is on issues in teaching English language learners in and outside of the United States. He has conducted research on second language acquisition and the challenges faced by culturally and linguistically diverse students due to differences between home (and community) ways of learning and knowing and the academic and social demands of schools. Francis has become increasingly interested in the ways that the cognitive sciences can inform our understanding of classroom learning.

Francis has conducted qualitative research on classroom learning, both in the US and internationally. His publications include research on Feuerstein’s Instrumental Enrichment program, topics on sociocultural perspectives on learning and teaching, and research on Nigerian primary school education. Francis attempts to bring a perspective on educational issues that is informed by research and theory on both the cultural nature of learning and the diverse cognitive processes of learners.
Ken Pransky has been working in the field of multicultural education for 35 years. He has taught K–12, at the college level, and to adults. He has taught as an EFL teacher overseas and for 20 years was an ESL teacher in the Massachusetts public schools, where he became increasingly interested in understanding, researching, and writing about what causes underachievement and academic struggle. Since 2008, he has been a full time teacher trainer and instructional coach through the Collaborative for Educational Services in Northampton, MA.

In addition to his teaching and training work, Ken has presented at national and international conferences. He has authored and co-authored several articles published in leading education journals, such as Theory into Practice, Reading Teacher and Ed Leadership, about working with underachieving students, and in 2008 published Beneath the Surface: The Hidden Realities of Working with Culturally and Linguistically Diverse Young Learners, with Heinemann.