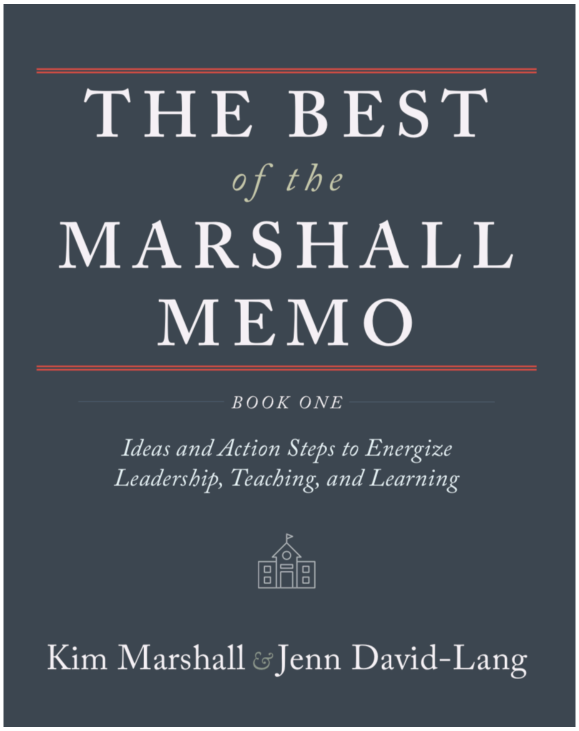
The Best of the Marshall Memo, Book Two

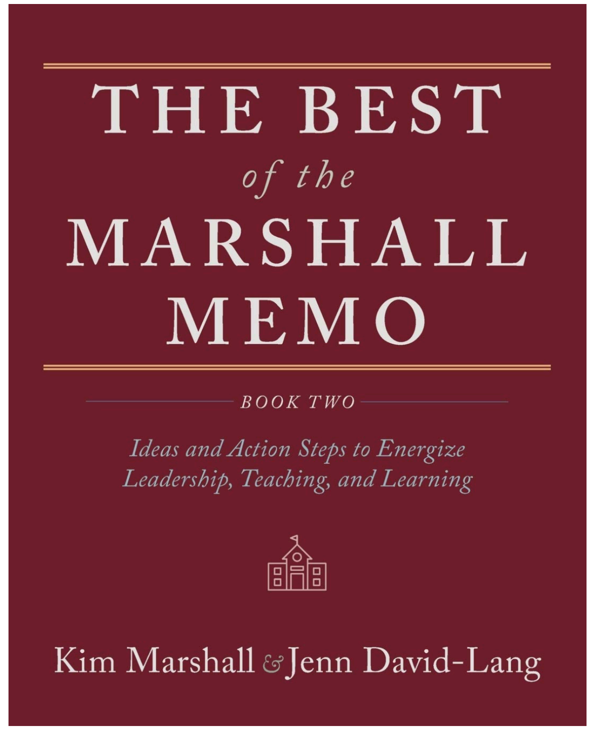
Ideas and Action Steps to Energize Leadership, Teaching, and Learning

by Kim Marshall and Jenn David-Lang

A selection of the most compelling and helpful article summaries from 17 years of the Marshall Memo, with professional learning suggestions for each chapter

Chapter Six – What Makes Learning Stick





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Chapter Six: What Makes Learning Stick

Teachers can tell and talk, but only learners can learn .... It isn't that Sally won't listen or isn't intelligent or won't try harder to memorize what she has been told; it's that she hasn't engaged in the hard work of constructing and reconstructing neural pathways to understanding.

—Alden Blodget

Most of the information that enters our brains every day is lost within a few hours. This is a source of endless frustration for teachers ("I just taught that yesterday!"), but it's a necessary adaptation that prevents cognitive overload for students and adults. The articles in this chapter fall into four buckets: brain science and working memory; the retrieval effect; study skills; and the question of what we need to memorize in the age of Google.

Brain Science and Memory – Alden Blodget describes the hard cognitive work students must do to build and maintain the neural networks that hold important information in their brains. Andrew Watson, Michael Wirtz, and Lynette Sumpter explain the limits of working memory and suggest how teachers can apply this understanding to improve students' retention and reduce classroom stress. Clare Sealy says that embedding important knowledge and skills in students' long-term memory requires skillful (not necessarily jazzy) teaching and hard work by students.

The Retrieval Effect – Pooja Agarwal, Henry Roediger, Mark McDaniel, and Kathleen McDermott describe the power of frequent, low-stakes tests to greatly improve retention. Benedict Carey explains why taking a final exam before instruction improves understanding and memory.

Kathy Ganske remembers how she got her second graders to remember what they've learned each day and week and share it with their families.

Study Skills – Susan Dynarski says research has shown that college students taking notes by hand have significantly better retention and grades than those typing notes on laptops. Benedict Carey reports that studying is most effective when students work with challenging material, study mixed content, use more than one location, space studying over time, and test themselves frequently. Daniel Willingham shares research on how students can commit facts and skills to memory, how they can avoid forgetting, and how they can avoid the trap of overconfidence.

What Should Students Memorize? – Daniel Willingham lists the four ways our brains outperform Google, and suggests the kinds of information that's best committed to memory. Amber Northern shares the Common Core's recommendations on memorizing and becoming fluent with math facts. Molly Worthen argues that having students memorize and recite poetry, which was a staple in US schools until the 1920s, has real value in today's classrooms.

Questions to Consider

- Why do students have trouble remembering our lessons?
- What makes learning stick?
- With Google in their pockets, should students memorize state capitals? Times tables? Anything?

Brain Science and Memory

1 The Neuroscience of Learning

In this *Education Week* article, Alden Blodget says that learning something new (how to solve quadratic equations, the history of the Vietnam War) involves building new "wiring," neural networks or circuits, in the brain. Unfortunately, new neural networks aren't permanent—they constantly degrade. Students seem to understand one day, and then the next day they don't. "It's as though they had never seen this stuff before," is a common complaint in faculty lounges. What seemed clear in a quiet classroom with a supportive teacher falls apart when students struggle with the homework in a noisy house with nobody around who can answer their questions.

The process of building and rebuilding neural networks "requires considerable effort from the learner," says Blodget. "The essence of learning isn't memory and recitation; meaningful learning (the sort of learning educators hope to foster) results from an active effort to understand, an effort that promotes the growth of increasingly efficient webs of neural connections among different regions of the brain …. Teachers can tell and talk, but only learners can learn …. It isn't that Sally won't listen or isn't intelligent or won't try harder to memorize what she has been told; it's that she hasn't engaged in the hard work of constructing and reconstructing neural pathways to understanding."

Every time students rebuild neural networks, skills and concepts become more stable and automatic. "The highest level of skill or understanding," says Blodget, "results from repeatedly experiencing this building-rebuilding cycle over time (years), moving through a sequence of increasingly complex levels. That movement is not linear and steady; it is dynamic and messy."

One reason many students don't make the effort to build better circuits is that they're not motivated—what they're learning doesn't matter deeply to them. Neuroscientists have found that attitudes and emotions play a major part in learning, says Blodget: "Just as you cannot separate hydrogen and oxygen and still have water, you cannot separate emotion from cognitive function and still have thinking—or learning." Emotion acts as a rudder for thought.

"Brains and Schools: A Mismatch" by Alden Blodget in *Education Week*, Sept. 11, 2013 (Vol. 33, #3, pp. 30–31), summarized in Marshall Memo 502.

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2 Not Overloading Working Memory

A little-recognized classroom skill, say Andrew Watson (Translate the Brain) and Michael Wirtz and Lynette Sumpter (St. Mark's School) in this article in *Independent School*, is managing students' working memory. This facet of our brains is distinct from declarative memory (factual information) and procedural memory (how to ride a bike). Working memory is what allows us to hold onto a few pieces of information for several seconds and reorganize them into a new system or structure. "Schools are, in effect, shrines built to honor successful working memory functioning," say Watson, Wirtz, and Sumpter. "Students simply can't think and learn without using working memory all the time."

The problem is that working memory has a surprisingly small capacity; most people can keep only five to seven items in mind at the same time. If we ask students to remember verbal instructions, that information takes up working memory capacity and reduces students' ability to think and learn. The authors confess that, as classroom teachers, "we paid little attention to a cognitive capacity that is essential for our students' learning. For this reason, we probably overwhelmed our students' working memory without ever realizing we had done so."

It's essential, they say, that educators "develop our own expertise in the field of working memory—understand what it is, how it differs from, and contributes to, long-term memory … [and] explicitly discuss and develop teaching techniques to support our students' cognition within their limited working memory capacity."

Here are some classroom and homework activities that run the risk of swamping students' working memory capacity:

- Too much new information at once;
- Verbal instructions, especially if they're long or complex;
- Too many new combinations of information at once;
- Work that combines cognitive and creative effort;
- Work early in the morning or late at night.

Here's how students often react when their working memory is overloaded:

- Difficulty remembering some information while processing other information—for example, long multiplication;
- Atypical difficulties with attention;
- "Catastrophic failure," difficulty adding just one simple step to several previous steps.

Watson, Wirtz, and Sumpter offer the following suggestions for addressing working memory overload:

• Make information visual. "Humans have much more brain real estate devoted to visual processing than to all our other senses combined," say the authors. "Visual depiction reduces working memory demands." This suggests maximizing the use of photos and videos, flowcharts and diagrams, or simply writing down complicated instructions.

• Manage note-taking. "If students are trying to understand an idea while at the same time writing notes, those two processes compete with each other in working memory," they say. "As a result, they're likely not to do either very well." One strategy is to ask students to put their pencils or pens down (or stop typing) when you're explaining new, complex, or important ideas, then have students write notes in silence with the teacher circulating to monitor what's being written.

• Redistribute working memory demands across longer periods of time. "Chunk" material—organize it into an already-familiar pattern.

• Promote attention by reinforcing conceptual frameworks. Explicitly teach strategies—for example, Treviso multiplication.

• Reduce stress, perhaps using mindfulness. Less pressure from time, grades, and peers is helpful, along with cutting down distractions in the classroom.

• Regularly emphasize that struggle is normal.

A teacher at St. Mark's School wrote the following after being exposed to the research on working memory: "I used to think that pushing the bounds of memory was helpful, much like how lifting weights makes you stronger in the long run. I learned it is quite the opposite with working memory, and that overtaxing it can cause our students to shut down. As a result, I have tried to provide more visual cues, word banks, fewer choices, etc., so that students focus on the most important task at hand, instead of trying to juggle too many pieces of information in their working memories."

Another teacher wrote, "I've learned how small and essential working memory is. When planning my lessons, I'm much more intentional about looking for areas where I risk overwhelming working memory. I know what to look for during a lesson to see if students are reaching the point of overload and how to change things up to get them back on track."

"Putting Memory to Work" by Andrew Watson, Michael Wirtz, and Lynette Sumpter in *Independent School*, Fall 2015 (Vol. 75, #1, pp. 56–60), summarized in Marshall Memo 606.

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3 Understanding Two Very Different Kinds of Memory

In this *Education Next* article, British educator Clare Sealy says it's commonly believed that to make a lesson stick in students' memories, teachers need to make it spectacular, exciting, and unusual. "Memorable events, in this view, should form the template for creating memorable lessons," says Sealy. But she believes that's a myth stemming from conflating two ways in which we remember things:

- *Episodic memory* – These are memories of events each day, and they are formed automatically, with no special effort on our part: what we had for lunch, a joke someone told this afternoon. The downside of episodic memories is that they fade quickly; we won't remember what we had for lunch a month ago unless something very unusual happened at the meal, and *that joke*—what *was* the punch line?

This means that if we as teachers put our faith in episodic memory, we'll be constantly disappointed when we ask our students what they learned the day before. They'll remember all kinds of things, says Sealy: "that you used Post-it Notes, that Mollie was late, that you spilt your coffee, that Liam made a hilarious joke." In other words, students remember the "contextual tags but not the actual learning. Episodic memory is so tied up with context it is no good for remembering things once that context is no longer present." This is especially true when students move to a different classroom, grade, or school. It's not that last year's teachers are lying when they say their students mastered fractions; it's that students' memories were largely episodic, and now the context is different.

- *Semantic memory* – This kind involves much more work—taking notes, studying, and encoding information—but the advantage is that such memories last longer. "Semantic memories have been liberated from the emotional and spatial/temporal context in which they were first acquired," says Sealy. "Once a concept has been stored in semantic memory, it is more flexible and transferable between different contexts. Semantic memory is central, therefore, to long-term learning, learning that can be put to use in novel contexts to solve unexpected problems. Semantic memory is what we use when we are problem-solving or being creative."

Episodic memories are the stuff of life in schools, especially the way students are treated and how adults treat each other. And broadening experiences outside of school (field trips to museums, theaters, historic sites, forests, mountains) are especially important for children whose families are not able to provide them. But the hum-drum semantic memories are the most important takeaways from schooling.

Cognitive psychologist Daniel Willingham says that "memory is the residue of thought." This means, says Sealy, that "teachers have to make sure that lessons give students the opportunity to think about the things we actually want them to remember, rather than some extraneous other thing. We need them to think about the message of the lesson, rather than the medium we use to teach it." And this is why "fun" lessons may be getting in the way of long-term learning; the medium may become more prominent than the message. "When teachers plan lessons," she continues, "we need to be mindful of what children will be thinking about during each part of the lesson, rather than what they will be feeling or doing. Have we planned activities that will ensure children think hard about the right things?"

British school inspectors noticed this phenomenon as they watched elementary students doing science experiments. Checking in with students, observers found that kids could explain what they were doing but not the underlying scientific concepts; there wasn't enough cognitive bandwidth for that. The logical conclusion is that students should be taught the concepts before diving into hands-on experiments. "Once the scientific concepts are secure," says Sealy, "children are much more able to really 'think like scientists,' with the added benefit that the practical activity then consolidates understanding of the previous learning."

The same is true of having students research information on their own; the cognitive work of looking for information and making judgments about its relevance prevents them from grasping and remembering content.

And this insight also applies to classroom mathematical discovery and creative problem-solving. Sealy believes these activities "are completely inappropriate for the initial stage of learning, when children are encountering a concept for the first time. If we want children to become independent problem-solvers, we need to teach them carefully and explicitly so that semantic memory can begin to form. Counterintuitive as it may seem, children do not become independent problem solvers by independently solving problems. This is because when children are trying to solve problems before they know the necessary math to do so, they will be expending considerable mental energy tracking what they are meant to be solving against what they have found out so far, so much so that even when they are successful, they will have forgotten what they actually did en route to finally finding the answer! … Frustratingly, current *performance* is a terrible guide to knowing whether or not *learning* has actually happened or not."

Explicit, step-by-step instruction is essential, she says, followed by retrieval and application at intervals after the initial lesson, with fewer cues and prompts. Only then will students begin to cement knowledge and skills in long-term memory.

It's common for people to say they don't remember anything they learned in school, but this simply means they don't have an episodic memory of specific lessons. That's not a bad thing, says Sealy, because if we remembered everything, our brains would explode. But if we were taught well, we know lots of deeper stuff, says Sealy: "triangles and oxygen, Anne Boleyn and paragraphs, square numbers and ox bow lakes, color-mixing and Lady Macbeth …. That's the beauty of semantic memory. It isn't, and doesn't need to be, tied up with episodic clutter." Those deeper memories, formed by good teaching, serve as a foundation for further learning and all sorts of creative endeavors—even if we don't remember learning them.

Well-schooled people are "knowledge-privileged," says Sealy: "You have been given opportunities to think hard about stuff you didn't know and therefore have a vast repository of semantic memory on hand, readily available whenever you want it. Yet it is all too easy to overlook this privilege and vastly underestimate how much we do in fact know and how much our schooling benefited us. Because we don't remember learning what we know, we don't remember the effort that went into teaching it."

Sealy's concern is that schools that focus on immersing students in "fun" and "involving" lessons may be short-changing this vital area, leaving kids "with an impoverished ability to think or be truly creative …. Before we decide to impose our own agendas onto children's education," she concludes, "we need to check our knowledge privilege before making decisions that will deprive children of their fair share of the rich cultural inheritance our world affords and to which they are entitled."

"The Best Way to Help Children Remember Things? Not 'Memorable Experiences'" by Clare Sealy in *Education Next*, September 26, 2019, summarized in Marshall Memo 812.

The Retrieval Effect

4 How Remembering Improves Remembering

"When we think about learning, we typically focus on getting information *into* students' heads," say Pooja Agarwal, Henry Roediger, Mark McDaniel, and Kathleen McDermott (Washington University–Saint Louis) in this Institute of Education Sciences paper. "What if, instead, we focus on getting information *out of* students' heads?" More than one hundred years of research has shown that "retrieval," calling information to mind, has the effect of strengthening retention, thus enhancing and boosting learning. "Deliberately recalling information forces us to pull our knowledge 'out' and examine what we know," say Agarwal, Roediger, McDaniel, and McDermott. "Often, we think we've learned some piece of information, but we come to realize we struggle when we try to recall the answer. It's precisely this 'struggle' or challenge that improves our memory and learning—by trying to recall information, we exercise or strengthen our memory, and we can also identify gaps in our learning …. Retrieval practice is a powerful strategy for improving academic performance, without more technology, money, or class time."

Research has shown that retrieval is much better for cementing understanding in long-term memory than commonly used strategies like rereading, highlighting, underlining, note-taking, reading review sheets, watching a video, and listening to a lecture. These strategies may produce short-term gains when cramming for a test, but memory researchers have found that they don't produce long-term retention. Counterintuitively, information that feels easy to recall is least likely to stick in our minds.

"Retrieval practice," say the authors, "makes learning effortful and challenging. Because retrieving information requires mental effort, we often think we are doing poorly if we can't remember something. We may feel like progress is slow, but that's when our best learning takes place. The more difficult the retrieval practice, the better it is for long-term learning …. Slower, effortful retrieval leads to long-term learning. In contrast, easy strategies only lead to short-term learning."

What's more, retrieval increases understanding and higher-order functions. It improves students': complex thinking and application skills, organization of knowledge, and transfer of knowledge to new concepts. The process of retrieval also clarifies for students what they *don't* know. Their improved metacognitive sense of what they've mastered and what they haven't gives students a more realistic sense of their academic status and leads to better decisions on how to spend study time.

Agarwal, Roediger, McDaniel, and McDermott pose and answer several questions about retrieval practice:

• *For which grade levels, subject areas, and students is it appropriate?* Researchers have found that it's helpful for all grades, for students at all achievement levels, and for all subject areas. Studies have been done in science, math, social studies, history, vocabulary learning, and foreign language vocabulary.

• *What are the most effective classroom strategies?* It's best to use retrieval with the whole class (using an all-class response system like clickers, Plickers, dry-erase boards, or exit tickets); to use retrieval as a learning strategy rather than a quiz or test; and to always provide feedback to students on their responses.

• *Do teachers need to stop using textbooks and traditional classroom strategies?* There's no need to change textbooks, since retrieval practice works perfectly with review or chapter questions. Nor is there a need to change one's teaching style—questions are still asked of students, but the response is more universal. And retrieval doesn't take more time—it just uses time more effectively, getting more bang for the instructional minute.

• *How is classroom retrieval practice different from "cold calling"?* Retrieval involves calling on *all* students and getting an immediate sense of how well the entire class is understanding what's being taught. "By engaging every student in retrieval practice," say the authors, "every student reaps the benefits for long-term learning."

• *How much retrieval practice is necessary?* The more the better, but spacing it out makes retrieval more challenging and effective. In terms of timing, retrieval is best a short time after a learning experience—but not too short; the more the spacing stretch, the more powerful the benefit.

• *Should retrieval questions be graded?* No, say the authors. Keeping the questions low-stakes helps students feel less pressured and more comfortable making mistakes, which students need to see as beneficial to the learning process. Rather than grades, teachers should provide immediate feedback to correct errors, misunderstandings, and misconceptions.

• *Doesn't retrieval practice increase test anxiety?* Quite the contrary, say Agarwal, Roediger, McDaniel, and McDermott; it decreases worries about high-stakes assessments by improving mastery and confidence and embedding information more deeply in students' memories.

• *What types of questions are best?* Retrieval works equally well for facts, concepts, and higher-order, complex material—ideally mixed together. And it's a good idea to shift between multiple-choice and open-response questions.

"How to Use Retrieval Practice to Improve Learning" by Pooja Agarwal, Henry Roediger, Mark McDaniel, and Kathleen McDermott in an Institute of Education Sciences paper, 2013, summarized in Marshall Memo 610.

5 Using Pretests to Improve Achievement

In this *New York Times Magazine* article, Benedict Carey asks us to imagine that on the first day of a difficult college course, before we had studied anything, we were able to see the final exam. "Would that help you study more effectively?" he asks. "Of course, it would. You would read the questions carefully. You would know exactly what to focus on in your notes. Your ears would perk up anytime the teacher mentioned something relevant to a specific question. You would search the textbook for its discussion of each question." But many people would consider that cheating.

What if you actually *took* the final exam at the beginning of the course? You would do terribly, of course, but the experience would have many of the same positive effects as the "cheating" scenario, sharply improving your overall performance.

How can doing badly on a test produce positive results? It's because of what psychologists call the pretest effect: "the attempts themselves change how we think about and store the information contained in the question," says Carey. Answering incorrectly primes our brain for what's coming later. Failing the pretest provides more learning benefits than conventional studying. In other words, "Testing might be the key to studying, rather than the other way around," he says. "As it turns out, a test is not only a measurement tool. It's a way of enriching and altering memory …. The test, that is, becomes an introduction to what students should learn, rather than a final judgment on what they did not."

It's now clear that conventional studying—reading, rereading, highlighting—is not very effective. Psychologists say that when we study in these ways, we tend to misjudge and overestimate our knowledge and skills. "We are duped by a misperception of 'fluency,'" says Carey, "believing that because facts or formulas or arguments are easy to remember *right now*, they will remain that way tomorrow or the next day. This fluency illusion is so strong that, once we feel we have some topic or assignment down, we assume that further study won't strengthen our memory of the material. We move on, forgetting that we forget." Fluency creates overconfidence and plays tricks on our judgment.

This insight about learning goes back to 1620, when Francis Bacon wrote, "If you read a piece of text through twenty times, you will not learn it by heart so easily as if you read it ten times while attempting to recite it from time to time and consulting the text when your memory fails." In 1916, Columbia University psychologist Arthur Gates conducted experiments and found that the best way to memorize a Shakespeare sonnet was to spend a third of the time trying to memorize it and two-thirds of the time trying to recite it from memory. In effect, testing was a form of studying and constant improvement.

In the 1930s, Herman Spitzer, a doctoral student at the University of Iowa, wondered: if testing is so helpful, when is the best time to do it? He had thirty-five hundred sixth-graders read an age-appropriate article and then divided them into groups, giving them quizzes at different time intervals and then measuring long-term retention. The students who were quizzed earliest had by far the best recall of the material they'd studied, even though all the students had studied for the same amount of time.

Elizabeth Ligon Bjork and Nicholas Soderstrom at UCLA explored this idea, giving some students pretests at the beginning of lectures and comparing long-term retention with students who didn't take pretests. Pretested students did poorly on the tests, but as long as they were given the right answers and explanations soon afterward, the long-term result was significantly higher retention than the control group. Bjork and others have pondered why this happens. Here are some possible explanations:

- First, students get a glimpse of what the teacher intends to teach, which helps them see where instruction is headed and how the information fits into the course narrative. Students who get the pretest preview are more confident in judging what's important and what isn't. Teachers always try to signal this as they teach, but pretested students are more attentive and hear what they're saying better. "Taking a practice test and getting wrong answers seems to improve subsequent study," says Bjork, "because the test adjusts our thinking in some way to the kind of material we need to know."
- Second, wrong guesses puncture students' overconfidence about what they know. A student might be sure he knows that Canberra is the capital of Australia, but when confronted by a multiple-choice item with Sydney, Melbourne, and Adelaide as alternative answers, he's suddenly not so sure. "If you're studying just the correct answer, you don't appreciate all the other possible answers

that could come to mind or appear on the test," says Robert Bjork. Pretesting is a kind of "fluency vaccine."

• Third, retrieving is a different mental process than straight studying. The brain is digging out information, along with a network of associations, and that alters and enriches how the network is restored. Guessing operates in similar fashion. "Even if the question is not entirely clear and its solution unknown," says Carey, "a guess will in itself begin to link the question to possible answers. And those networks light up like Christmas lights when we hear the concepts again."

This suggests a limit on the usefulness of pretesting: quizzing students in an unfamiliar language like Arabic or Chinese, in which they have no prior knowledge or associations, won't be helpful. "The research thus far," says Carey, "suggests that prefinals will be much more useful in humanities courses and social-science disciplines in which unfamiliar concepts are at least embedded in language we can parse."

"Exams Measure What We Know, But They're Also One of the Best Ways to Learn" by Benedict Carey in the *New York Times Magazine*, September 7, 2014, summarized in Marshall Memo 553. Carey's book with these and other findings is *How We Learn: The Surprising Truth About When, Where, and Why It Happens* (New York: Random House, 2014).

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6 What Did You Learn in School Today?

In this article in *The Reading Teacher*, Kathy Ganske (Vanderbilt University) recalls that when she was in elementary school, her father would ask almost every evening what she'd learned in school that day. Knowing the question was coming, she recalls, "I kept my eyes and ears open throughout the day for potential candidates for demonstrating understanding …."

When she became a teacher, Ganske began to ask her students as they waited for their afternoon buses what new ideas, concepts, facts, or processes they would share with someone at home. "At first, students were slow to generate responses," she says, "but that gradually changed. In anticipation of the talk, they sifted through our day's journey, as evidenced by the occasional announcement of 'I'm going to hang on to that one!' that punctuated our classroom learning. The end-of-day wrap-up provided a satisfying sense of closure, and the recap of learning made students aware of what they'd accomplished."

A few years later, Ganske took this a step further: her second graders began to publish a Friday parent newsletter of the week's learning dubbed *The Koko Report* (in honor of the class's bake sale support of Koko the gorilla and the Gorilla Foundation). The newsletter emerged from a meeting on the carpet in which Ganske jotted key content areas on chart paper, had students suggest other events—field trips, visitors, special projects, birthdays—and together they constructed a web of the week's learning. Initially, students had difficulty remembering what had happened during the week, but the routine improved their ability to retrieve information from several days ago. "Unless we make a conscious effort to help them solidify their learning," says Ganske, "they may lose a great deal of it."

Next, students signed up as "reporters" to write brief articles, working in groups of two or three, or occasionally solo. "The talk and recording of information jump-started and deepened students' recollections of our week," says Ganske, "and the web provided support for their beginning writing skills, as did the discussion and feedback that took place in the small groups." Students brought their reports to Ganske, who typed them on a blank newsletter template. After a group edit and the addition of a few teacher comments for parents and guardians, the Koko Report was photocopied and sent home. The whole workshop took forty-five to sixty minutes.

Convinced of the value of daily or weekly closure/remembering/consolidating, Ganske researched the topic and was surprised to find that very few studies had been done to document its impact. "We need to be sure we plan time to cycle back to the what, why, and how of students' learning to help them actively synthesize the parts into a whole," she concludes. "Lesson closure provides space for students to digest and assimilate their learning and to realize why it all matters."

"Lesson Closure: An Important Piece of the Student Learning Puzzle" by Kathy Ganske in *The Reading Teacher*, July/August 2017 (Vol. 71, #1, pp. 95–100), summarized in Marshall Memo 694.

Study Skills

7 The Difference Between Taking Notes by Hand and on a Laptop

In this Brookings article, Susan Dynarski explores research from Princeton and UCLA on note-taking in college lectures, and comes down squarely on the side of hand-written notes. "When college students use computers or tablets during lectures," she says, "they learn less and earn worse grades …. Understanding the lectures, measured by a standardized test, was substantially worse for those who used laptops."

Dynarski elaborates: "Learning researchers hypothesize that because students can type faster than they can write, a lecturer's words flow straight from the student's ears through their typing fingers, without stopping in the brain for substantive processing." It's more like a transcript than a summary. "Students writing by hand, by contrast, have to process and condense the material if their pens are to keep up with the lecture."

Taking notes serves two purposes: (a) storing the lecture's ideas for later review, which laptops do better; and (b) cognitive encoding of the information, which handwriting does better. On balance, mental processing and coding are more important, which is why handwritten notes produce superior long-term learning.

But couldn't we train students to be more thoughtful with laptop notetaking, getting them to slow down and summarize? Researchers tried this, and laptop-using students' retention and understanding didn't improve.

There's another reason for not using laptops for note-taking: the powerful temptation for students to engage in social media and online shopping during a lecture. Researchers found this kind of multitasking degraded the learning of those who engaged in it, and also lowered the performance of students sitting nearby, who could see their classmates goofing off. In fact, students looking over the shoulders of multitasking students did *worse* on post-tests (17 percent lower) than the multitaskers themselves (who scored 11 percent lower).

The experiments reported above were conducted in somewhat artificial settings, with students paid to listen to lectures that weren't part of real coursework for grades. Would the findings hold up in a real-world situation? Researchers conducted a study at the US Military Academy at West Point that met this standard. All USMA students take a semester-long introductory economics class with common multiple-choice/short-answer tests graded automatically. Researchers randomly assigned sections to one of three conditions: electronics allowed; electronics banned; and tablet computers allowed (if they were laid flat on desks where professors could observe how they were being used). Instructors teaching multiple sections were assigned more than one treatment condition.

At the end of the semester, students who used electronics in class (the first and third conditions) scored significantly worse than students who were not allowed to use computers or laptops—0.2 standard deviations lower (there was no discernible difference between the laptop and tablet sections).

Would the West Point findings hold up in a community college or four-year college? The researchers argue that disparity would be even more pronounced, since USMA classes are small, professors can more easily monitor inappropriate use of electronics, and West Point students are motivated by the high stakes attached to achievement in every course.

"There may well be particular classroom settings in which laptops improve learning," concludes Dynarski. "Perhaps a coding class, in which students collaborate on solving a programming problem. But for the typical lecture setting, the best evidence suggests students should lay down their laptops and pick up a pen."

"For Better Learning in College Lectures, Lay Down the Laptop and Pick Up a Pen" by Susan Dynarski, Brookings Institution, August 10, 2017, summarized in Marshall Memo 698.

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8 Research-Based Approaches to Studying

In this *New York Times* article, Benedict Carey reports the latest findings from cognitive science about the kinds of studying that work best for students of all ages. Interestingly, these findings are at variance with the conventional wisdom among parents and educators. For example, Carey says that all the talk about visual, auditory, left-brain/right-brain learners, etc. is unproven. A recent article in *Psychological Science in the Public Interest* found no empirical support for these theories. "The contrast between the enormous popularity of the learning-styles approach within education and the lack of credible evidence for its utility is, in our opinion, striking and disturbing," write the authors. Here's what the research says *does* work:

• *Varying study location* – Alternating between two rooms while studying significantly improves retention. A classic 1978 study found that college students who studied forty vocabulary words first in one room and then in another did far better on a post-test than students who studied the words two times in a single location. Subsequent studies have replicated this finding for a variety of subjects. "The brain makes subtle associations between what it is studying and the background sensations it has at the time," says Carey. "It colors the terms of the Versailles Treaty with the wasted fluorescent glow of the dorm study room, say; or the elements of the Marshall Plan with the jade-curtain shade of the willow tree in the back yard. Forcing the brain to make multiple associations with the same material may, in effect, give the information more neural scaffolding."

• *Mixed content* – Studying distinct but related skills or concepts in one sitting improves retention. "Musicians have known this for years," says Carey, "and their practice sessions often include a mix of scales, musical pieces and rhythmic work. Many athletes, too, routinely mix their workouts with strength, speed and skill drills." In a recent study in *Applied Cognitive Psychology*, University of South Florida researchers Doug Rohrer and Kelli Taylor reported on a study of fourth graders' retention of geometry concepts. Those who studied a mixture of problems scored 77 percent on a follow-up test, compared to 38 percent for students who focused on one kind of problem. "When students see a list of problems, all of the same kind, they know the strategy to use before they even read the problem," says Rohrer. "That's like riding a bike with training wheels." Mixed practice is far more productive. The finding has been replicated in other fields, including an experiment asking college students and older adults to distinguish the painting styles of twelve unfamiliar artists. "What seems to be happening in this case is that the brain is picking up deeper patterns when seeing assortments of paintings," says Williams College psychologist Nate Kornell, one of the authors. "It's picking up what's similar and what's different about them."

• *Spaced studying* – "An hour of study tonight, an hour on the weekend, another session a week from now," says Carey, is a highly effective study strategy. Dozens of studies have shown that spacing improves later recall for the same amount of time. One theory is that when the brain comes back to material after some time has passed, it has to relearn some that's been forgotten before adding new material. "The idea is that forgetting is the friend of learning," says Nate Kornell. "When you forget something, it allows you to relearn, and do so effectively, the next time you see it." Last-minute cramming, on the other hand, may help a student pass a test the next day but is ineffective for long-term memory. "Hurriedly jam-packing a brain is akin to speed-packing a cheap suitcase," says Carey, "… it holds its new load for a while, then most everything falls out. When a neural suitcase is packed carefully and gradually, it holds its contents far, far longer."

• *Frequent assessment with feedback* – "The process of retrieving an idea is not like pulling a book from a shelf," says Carey. "It seems to fundamentally alter the way the information is subsequently stored, making it far more accessible in the future." Washington University–Saint Louis psychologist Henry Roediger has confirmed this in his research (see Article 4 summary): "Testing not only measures knowledge but changes it," he says. "Testing has such a bad connotation. People think of standardized testing or teaching to the test. Maybe we need to call it something else, but this is one of the most powerful learning tools we have."

• *Challenge* – It turns out that a difficult test is better for long-term memory than an easy one. "The harder it is to remember something, the harder it is to later forget," says Carey. "The more mental sweat it takes to dig it out, the more securely it will be subsequently anchored." Researchers call this "desirable difficulty."

"We have known these principles for some time," says UCLA psychologist Robert Bjork, "and it's intriguing that schools don't pick them up, or that people don't learn them by trial and error. Instead, we walk around with all sorts of unexamined beliefs about what works that are mistaken."

"Forget What You Know About Good Study Habits" by Benedict Carey in the *New York Times*, Sept. 7, 2010 (pp. D1, D6), summarized in Marshall Memo 351.

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9 How Can We Help Students Remember More?

In this article in *American Educator*, University of Virginia cognitive scientist Daniel Willingham sets us straight on four common misconceptions about memory: (a) subliminal learning and memorizing while asleep are ineffective; (b) hypnosis doesn't make memory any more accurate; (c) herbal supplements or pharmaceuticals, despite tantalizing claims and a small number of suggestive findings, don't improve memory; and (d) memory doesn't depend solely on the modality in which we learn new material.

Willingham then shares research on how K–12 students—and adults—really do commit information and skills to memory, how they can avoid forgetting, and how they can tell when they've studied enough.

• *Committing facts and skills to memory* – The key to remembering is *thinking about* what you want to remember, he says. Memory is the "residue of thought, meaning that the more you think about something, the more likely it is that you'll remember it." This has immediate implications for the best way for students to study. It's not enough to tell students to think about what they're studying, and just rereading notes and highlighting them isn't that effective. It can even be detrimental if it creates the illusion that you know the material because you've "studied" it.

What's helpful is giving students a specific task that will force them to think about meaning as they study, for example, asking *Why*, after every sentence or paragraph or segment they read. One study showed that students who did this remembered significantly more than students who read the same material without asking *Why*. Another strategy is for students to write down the main ideas of a chapter and identify how the author elaborates on these points, drawing a diagram of the main and subordinate ideas. A third approach is for students to write an outline for a chapter and then see if they can write a *different* outline, organizing the same material another way.

Willingham notes that SQ3R, a widely touted study method, seems to embody the think-about-it strategy: Survey what you will read, generate Questions as you survey, Read to answer your questions, Recite the important information as you read, and Review when you've finished. Unfortunately, SQ3R doesn't work that well; the reason, he says, is that it's difficult to do well (framing good questions is the hardest part). Mnemonics, on the other hand, can be quite effective because they give us something to think about—cues to our memories. These are especially helpful when memorizing material that doesn't have much intrinsic meaning.

• *Not forgetting what's been committed to memory* – The key to accessing memories is cues or hooks that help retrieve what we've stored in our brains. Without cues, memories are inaccessible, seemingly lost. With the right cues, even distant memories can be retrieved intact. So to minimize forgetting, students need to create distinctive and memorable hooks as they store material. One strategy is distinctive mnemonics to "tag" memories. Here are some examples:

- Music or rhymes – Setting the material to be remembered to a familiar tune, for example, the alphabet song, or "Thirty days has September …"
- Acrostic – Creating an easy-to-remember sentence in which the first letter of each word provides a cue to the item to be remembered—for example, "Every Good Boy Does Fine" to remember the order of notes on the treble clef.
- Mnemonic associations – For example, remembering that the word *principal* ends in *pal*

because she is your *pal*, or remembering that *grammar* ends in *ar* by remembering not to *mar* your work with bad grammar.

- Pegwords – These are useful for memorizing lists of unrelated items. For example, remembering that the number one item on the list will be associated with "bun," the number two item with "shoe," the number three item with "tree," etc., and then creating a visual image of each item with its position word.
- Method of loci – Also useful for memorizing unrelated items, you take a mental walk down a familiar route and associate each item to be remembered with a location on the route.
- Acronym – Creating an acronym using the first letter of each item to be remembered, for example, HOMES for remembering the Great Lakes: Huron, Ontario, Michigan, Erie, and Superior.
- Keyword – Useful for memorizing foreign vocabulary: finding an English word that is close in sound to the foreign vocabulary word and creating a visual image that connects the two, for example, remembering *championes*, the Spanish word for mushrooms, by creating a visual image of a boxing champion in the ring, arms aloft, wearing large mushrooms instead of boxing gloves.

Another memory-retention strategy is distributed studying—not cramming in one session, but studying at several different, spread-out times. A third strategy is over-learning; since we tend to overestimate how much we'll remember and underestimate how much we'll forget, it makes sense to study about 20 percent longer than seems necessary. Another strategy is to test yourself as you go along, replicating the conditions under which you'll actually be tested. Finally, an excellent way to remember is to explain the material to another person—ideally someone who can ask thoughtful follow-up questions.

• *Being certain one has actually committed something to memory* – Most people, children and adults, think they remember more than they actually do. This means that students don't study as much as they need to. One experiment showed that students allocated only 68 percent of the time they needed to master material. Thus, for students to study more effectively, says Willingham, they need to find ways to assess what they know more realistically, and the best way to do that is to regularly retrieve important information and practice useful skills—to make sure they're still in there.

"Ask the Cognitive Scientist: What Will Improve a Student's Memory?" by Daniel Willingham in *American Educator*, Winter 2008–09 (Vol. 32, #4, pp. 17–25, 44), summarized in Marshall Memo 268

What Should Students Memorize?

10 Why Not Just Google It?

In this *New York Times* article, Daniel Willingham (University of Virginia) pushes back on the notion that because students can find pretty much any piece of information online (the capital of Ohio; the quadratic equation), there's no point in having them memorize stuff. Google is certainly good at finding information, says Willingham, but there are four ways that the human brain is superior to the Internet's information.

First, it can quickly determine context and decide if a particular word is the right one for the situation at hand. For example, a student might Google *meticulous*, find that it means "very careful," and write, *I was meticulous about not falling off the cliff*. Context and background knowledge supply what an online search cannot.

Second, in many situations our brains are faster than Google. Retrieving a memorized piece of information—for example, four times nine—is much quicker than opening a browser and accessing the times table. In addition, when students go to the Internet for information, they can lose the thread of solving a problem. That's why the National Mathematics Advisory Panel advocates "quick and effortless recall of facts" as essential to math proficiency. Speedy recall is also vital to reading comprehension. We read best when we know at least 95 percent of the words in a text. "Pausing to find a word definition is disruptive," says Willingham. "Online, the mere presence of hyperlinks compromises reading comprehension because the decision of whether or not to click disrupts the flow of understanding."

Third, our brains are adept at functioning with partial information—for example, we have the idea of *someone who owes money* but not the word (*debtor*). We store the meaning, spelling, and sound or words in separate areas, which is why it's possible to recall one without the others. "Good readers have reliable, speedy connections among the brain representations of spelling, sound, and meaning," says Willingham. "Speed matters because it allows other important work—for example, puzzling out the meaning of phrases—to proceed."

Finally, the brain has a built-in self-improvement function. Every time we retrieve something from memory or use a skill, the connection becomes more robust and the information or skill is easier to access next time. That's why using GPS will not help you remember your way around an unfamiliar city if at a later date you have to navigate without it.

For these reasons, says Willingham, "It's a grave mistake to think Google can replace your memory. It can, however, complement it, if we keep in mind what each does best." The Internet is clearly superior when we need to quickly find arcane or not-worth-remembering information. A rule of thumb: we should commit to memory the facts that we will often need to access quickly—the sounds of letters; core vocabulary; important science, health, and history facts; times tables; the quadratic equation—while taking advantage of the Internet to find random stuff, widen our knowledge and skills, and continuously broaden our memory bank.

"You Still Need Your Brain" by Daniel Willingham in the *New York Times*, May 21, 2017, summarized in Marshall Memo 687.

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11 Should Students Memorize Times Tables?

In this Thomas B. Fordham Institute article, Amber Northern remembers her father drilling her on multiplication facts at the kitchen table—*Six times six? Twelve times eleven? Eight times nine?* Although the sessions were arduous, she took "great pride at (eventually) memorizing the entire lot, and I relished the ritual that Dad and I shared as Mom finished the dishes and my near-teen sister chatted forever on the phone."

Not everyone is a fan of memorizing times tables, and some argue that this exercise frustrates and stresses out elementary-school children and is the very opposite of developing a genuine understanding of math concepts. What do the Common Core standards have to say? Interestingly, says Northern, the standards don't ever use the word *memorize*. Instead, they say, "By the end of Grade 2, know from memory all sums of two one-digit numbers," and "By the end of Grade 3, know from memory all products of two one-digit numbers."

What is the distinction between *memorizing* and *knowing from memory*? To find the answer, Northern spoke to one of the principal authors of the Common Core math standards, Jason Zimba, and here's what he said: "Memorizing most naturally refers to a process (such as the one you and your dad engaged in), whereas knowing more clearly refers to an end—and ends, not processes, are the appropriate subjects for a standards statement." Zimba doesn't think there is any ambiguity about what the Common Core requires about multiplication facts. "I do know there are people who wish that the sentence had not been included," he says. "Perhaps their discomfort interferes with their reading comprehension."

What about *fluency* with math facts? asks Northern. Is that the same as knowing the facts? Zimba says Common Core standards separate the two, specifying that students "Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that 8 x 5 = 40, one knows 40 ÷ 5 = 8) or properties of operations." *Knowing* multiplication facts is different. Fluency "pertains to an act of calculation," he says. "In particular, to be fluent with these calculations is to be accurate and reasonably fast. However, memory is also fast, so the difference between fluency and memory isn't a matter of speed. The difference, rather, has to do with the different nature of calculating versus remembering. In an act of calculation, there is some logical sequence of steps. Retrieving a fact from memory, on the other hand, doesn't involve logic *or* steps. It's just remembering; it's just knowing .... The standards expect students to remember basic facts *and* to be fluent in calculation. Neither is a substitute for the other."

Here's an example with addition facts. Before memorizing them, a second grader might tackle the problem 8 + 7 = ? by thinking, "One more than 7 + 7, which I remember is 14, so 15." Once students have committed the facts to memory, they won't need to go through that extra step. They *just know*, which is synonymous with *knowing from memory*.

Finally, Northern asks Zimba if the Common Core authors are critical of memorization. "Not unless you think that memorizing demands that we work in inefficient ways," he says. There are one hundred different single-digit products to learn; the first nine are 1 x 1, 1 x 2, 1 x 3, 1 x 4, 1 x 5, 1 x 6, 1 x 7, 1 x 8, and 1 x 9. It's highly inefficient to teach those as separate facts, separate from their meanings. "Memorizing single-digit sums and products isn't like memorizing the alphabet," says Zimba. "The alphabet is an irrational sequence with no structure or internal logic. It can't be optimal to memorize the addition and multiplication tables, with all their patterns, the same way we memorize the alphabet sequence. By pointing that out, I'm not critiquing memorization—I'm prompting us to think about the most effective way to reach the endpoint: knowing the single-digit sums and products from memory."

"Does Common Core Math Expect Memorization? A Candid Conversation with Jason Zimba" by Amber Northern, Thomas B. Fordham Institute, July 13, 2016, summarized in Marshall Memo 648.

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12 Should Students Memorize Poetry?

In this *New York Times* article, Molly Worthen (University of North Carolina–Chapel Hill) says, that before the invention of writing, "the only way to possess a poem was to memorize it." Then, as scrolls and folios provided a way to externally encode some of the content of humans' brains, "court poets, priests, and wandering bards recited poetry in order to entertain and connect with the divine." In early US schools, poetry recitation was "an inexpensive exercise that helped even inexperienced teachers at underfunded schools impart rhetorical skills and nurture moral character."

After the Civil War, as public schools proliferated, textbooks contained anthologies of verse, and memorizing poetry became a fixture at the elementary and secondary level. A 1902 handbook for teachers said that reciting poetry stocked children's minds "with the priceless treasure of the noblest thoughts and feelings that have been uttered by the race." Poems were chosen to model Victorian virtues—piety, noble sacrifice, and valiant acceptance of mortality—as in poems like Thomas Gray's "Elegy Written in a Country Churchyard."

But in the 1920s, educators began to question the relevance of memorizing poetry to students' lives. It was gradually replaced by activities involving self-expression, and by the 1960s had almost disappeared from schools (except in some world language classes). Now, says Worthen, memorizing poetry "has become deeply unfashionable, an outmoded practice that many teachers and parents—not to mention students—consider too boring, mindless, and just plain difficult for the modern classroom. Besides, who needs to memorize when our smartphones can instantly call up nearly any published poem in the universe?"

Worthen is not persuaded. "The truth is that memorizing and reciting poetry can be a highly expressive act," she says, and it's more important than ever: "All of us struggle with shrinking attention spans and a public sphere that is becoming a literary wasteland, bereft of sophisticated language or expressions of empathy beyond one's own Facebook bubble. For students who seem to have less and less patience for long reading assignments, perhaps now is the time to bring back poetry memorization. Let's capitalize on their ear for the phony free verse of Twitter and texting and give them better words to make sense of themselves and their world."

Worthen admits that she is impatient with poetry: "I prefer straightforward prose that tells me what it means." But she's started spending ten minutes a day memorizing carefully chosen poems—a Shakespeare sonnet, some Longfellow, some Gerard Manley Hopkins. She's finding that the close reading and hard work involved in learning a poem by heart gets her in touch with the meaning and the artistry of each poem. "Every time I bumbled through a stanza, I ruminated on each word a little more," she says. "I played with tone and emphasis .... It's time for us to show we care about words again, to rebuild our connection to a human civilization so much broader than our Twitter feeds."

"Memorize That Poem!" by Molly Worthen in the *New York Times*, August 27, 2017, summarized in Marshall Memo 704.

Professional Learning Suggestions for Chapter Six: What Makes Learning Stick

Maximizing Learning

The articles in this section show how findings in cognitive science, neuroscience, and related fields can help teachers maximize learning in their classrooms. The activities below are meant to be conducted for teachers: to help them *learn* about these new findings, *experience* the benefits of these learning techniques firsthand, and *plan* lessons for students based on these ideas.

I. Understand the Science: What Can Science Teach Us About Maximizing Learning?

The activities below are for teachers to learn about the science of learning from reading several article-summaries, and apply what they've learned to their teaching.

A. Discuss the problem of students forgetting what we teach.
Before teachers read anything, project the following quotation from "How Remembering Improves Remembering" (article-summary 4) and have teachers, in pairs, discuss what they believe it means and what implications it has for teaching and learning:

> "When we think about learning, we typically focus on getting information *into* students' heads."

In a large group, ask teachers, "By a show of hands, how many of you have had the experience of teaching something or assigning a reading, and the students have no idea what they learned after days, weeks, or months have passed?" Discuss this problem along with the quotation as a large group focusing on what teachers think might lie at the root of this problem.

B. Model the power of brain science to boost learning and remembering.
Tell teachers that you are going to give them a pretest with terms you will be discussing today as a way to model the power of the pretest to boost learning. Be sure to let them know that *no one* will see how they did on this test and that, in fact, you assume most educators don't know these terms.

Tell them they will have this very same test at the end of today's session. Now have them take out paper or use their computers to define then following terms:

episodic memory, semantic memory, retrieval, fluency illusion, working memory, building and rebuilding neural networks, and *pretest effect*.

C. Jigsaw readings on brain science and brainstorm implications for teaching.
Have teachers explore some of what science says about memory and learning and think about implications for their teaching.

1. Have teachers choose to read any two of the first five articles-summaries:

   "The Neuroscience of Learning" (article-summary 1)
   "Not Overloading Working Memory" (article-summary 2)
   "Understanding Two Very Different Kinds of Memory" (article-summary 3)
   "How Remembering Improves Remembering" (article-summary 4)
   "Using Pretests to Improvement Achievement" (article-summary 5)

2. In pairs, ask teachers to jot down some insights about learning from cognitive science, neuroscience, and related fields that they've gleaned from the two article-summaries they read using the chart that follows. Tell them to be sure to define any of the terms from the pretest that they came across in the chart as well.

Term	What Does This Term Mean and What Does the *Science* Say?	Any *Implications* for Teaching and Learning?
Building and rebuilding neural networks		
Working memory		
Episodic memory		
Semantic memory		
Retrieval		
Fluency of Illusion		
Pretest effect		

3. Now bring everyone back together and have a large-group discussion. Have teachers share what they learned about the science of learning and what implications this learning might have for teaching and learning. Everyone should have their own copy of the chart above so they can take notes on all of the terms.

C. Now that teachers have thought about the science of learning, ask them to discuss the role students must play in their own learning.

As a final activity in this section, ask teachers to discuss the following quotation from "The Neuroscience of Learning" (Alden Blodget article-summary 1), and think about the implications for teaching.

> "Teachers can talk and talk, but only learners can learn …. It isn't that Sally won't listen or isn't intelligent or won't try harder to memorize what she has been told; it's that she hasn't engaged in the hard work of constructing and reconstructing neural pathways to understanding."
>
> —Alden Blodget

II. Experience Science of Learning Techniques Firsthand

One of the best ways to understand the power of these newer findings is for teachers to experience them firsthand. Below are suggestions for how teachers can experience the power of retrieval and self-testing.

A. Have teachers engage in the second half of the pretesting exercise from earlier.

Exactly as you did before, ask teachers to take out paper or use their computers to define the following terms:

> *episodic memory, semantic memory, retrieval, fluency illusion, working memory, building and rebuilding neural networks,* and *pretest effect.*

Now have a large-group discussion: *How did you do on the second test? Do you think you did as well as you would have if you* hadn't *had the pretest? How did the pretest affect the way you read the articles and listened to the discussion, knowing that you were going to have the exact same test later? How might you use pretests in your own classroom?*

B. Have teachers engage in a self-testing exercise.

Do a little experiment with your teachers. Have teachers experience self-testing firsthand by trying the following technique with a reading.

1. Distribute the following article about puffins from the *New York Times* to the teachers:

   https://www.nytimes.com/interactive/2018/08/29/climate/puffins-dwindling-iceland.html

However, give them only the first half (thirteen paragraphs). Have them read it through once and put it away. Now, on their own, have them write down everything they remember from the article.

2. Next, give teachers the second half of the article (the following thirteen paragraphs), but tell them to stop every two paragraphs to self-test. ("What did I just learn in these two paragraphs?") At the end, have them put away the article and write down everything they learned from the second half of the article.

3. As a large group, discuss how their learning differed when reading the first and the second parts of the article.

Note that you can certainly do this exercise with a more relevant article about teaching and learning, but people might have more prior knowledge about the topic.

III. Study Skills and Memorization

The activities in this section help teachers learn more effective study skills for students, consider their own role in teaching study skills, and finally debate the importance of memorization for student learning.

A. Have teachers consider the importance of teaching study skills to their students.
Teachers have varying opinions about whether it is their job to teach study skills—and if it *is* their job, which skills to teach. Exposing them to the article-summaries that follow will introduce them to more effective study skill methods.

1. To learn more about the types of study skills that help students learn, ask teachers to read two of the following five article-summaries:

"How Remembering Improves Remembering" (article-summary 4)
"Using Pretests to Improve Achievement" (article-summary 5)
"The Difference Between Taking Notes by Hand and on a Laptop" (article-summary 7)
"Research-Based Approaches to Studying" (article-summary 8)
"How Can We Help Students Remember More?" (article-summary 9)

2. Next, ask them to discuss the following in pairs: *Do you believe it is the role of the teacher to actively teach study skills? Which, if any, study skills do you already teach students? From the articles*

you've read, do any new study skills now seem important to teach, and how might you integrate them into your instruction?

B. Have teachers debate the question: Should we teach students to memorize?

There are also conflicting ideas about the role of memorization in students' lives given that they are growing up in a time when they can Google anything. Start by asking if the teachers have any idea of the answer to this question—Do the Common Core State Standards ever mention the word "memorize"? After taking some answers, let them know that one of the articles says that the word "memorize" never actually appears in the Standards.

1. First have teachers read the three article-summaries about memorization: "Why Not Just Google It?" (article-summary 10), "Should Students Memorize Times Tables?" (article-summary 11), and "Should Students Memorize Poetry?" (article-summary 12).

2. Next, ask teachers to literally take a stand to share their beliefs about requiring students to memorize. Have one wall represent, "I completely disagree with having students memorize anything," and the other wall, "I absolutely believe students should be asked to memorize some material." Now have teachers stand anywhere along the continuum. Once everyone is standing, ask a few people to share their opinions.

C. Engage in an exercise to consolidate and solidify learning.

Just like Kathy Ganske did in "What Did You Learn in School Today?" (article-summary 6), have the teachers experience what it is like to solidify their learning from today's session with a closing activity. Distribute index cards to everyone and have them write down what they believe are the most important takeaways from today's discussions and activities about making learning stick. The size of the index cards limits how much they write and keeps this activity brief.

Let teachers know that this type of brief closure activity is useful in the classroom to solidify learning (and they can use it in other professional learning sessions as well).