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Why Don't Students Like School?

Question: Most of the teachers I know entered the profession because they loved school as children. They want to help their students feel the same excitement and passion for learning that they felt.

They are understandably dejected when they find that some of their pupils don't like school much, and that they, the teachers, have trouble inspiring them. Why is it difficult to make school enjoyable for students?

Answer: Contrary to popular belief, the brain is not designed for thinking. It's designed to save you from having to think, because the brain is actually not very good at thinking. Thinking is slow and unreliable. Nevertheless, people enjoy mental work if it is successful. People like to solve problems but not to work on unsolvable problems. If schoolwork is always just a bit too difficult (or too easy) for a student, it should be no surprise that she doesn't like school much. The cognitive principle that guides this chapter is:

> People are naturally curious, but we are not naturally good thinkers; unless the cognitive conditions are right, we will avoid thinking.

The implication of this principle is that teachers should reconsider how they encourage their students to think, in order to maximize the likelihood that students will get the pleasurable rush that comes from successful thought.

The Mind Is Not Designed for Thinking

What is the essence of being human? What sets us apart from other species? Many people would answer that it is our ability to reason – birds fly, fish swim, and humans think. (By thinking I mean solving problems, reasoning, reading something complex, or doing any mental work that requires some effort.) Shakespeare extolled our cognitive ability in Hamlet: "What a piece of work is man! How noble in reason!" Some three hundred years later Henry Ford more cynically observed, "Thinking is the hardest work there is, which is the probable reason why so few people engage in it"* (Figure 1.1).

Both Shakespeare and Ford had a point. Humans are good at certain types of reasoning, particularly in comparison to other animals, but we exercise those abilities infrequently. A cognitive scientist would add another observation: Humans don't think very often because our brains are designed not for thought but for the avoidance of thought.

FIGURE 1.1: Kanye West is one the most successful and respected songwriters and performers, as well as a highly successful businessman. But he has said, "I actually don't like thinking. I think people think I like to think a lot. And I don't. I do not like to think at all."[1] Source: © Getty Images/ Brad Barket.

Your brain has many capabilities, and thinking is not the one it does best. Your brain also supports the ability to see and to move, for example, and these functions operate much more efficiently and reliably than your ability to think. It's no accident that most of your brain's real estate is devoted to these activities. The extra brain power is needed because seeing is actually more difficult than playing chess or solving calculus problems.

You can appreciate the power of your visual system by comparing human abilities to those of computers. When it comes to math, science, and other traditional "thinking" tasks, machines beat people, no contest. Calculators that can perform simple calculations faster and more accurately than any human have been cheaply available for 40 years. With $50 you can buy chess software that can defeat more than 99% of the world's population. But we're still struggling to get a computer to drive a truck as well as a human. That's because computers can't see, especially not in complex, ever-changing environments like the one you face every time you drive. And in fact, the self-driving vehicles in development typically use radar, lasers, and other sensors to supplement information from visible light.

Robots are similarly limited in how they move. Humans are excellent at configuring our bodies for tasks, even if the configuration is unusual, such as when you twist your torso and contort your arm in an effort to dust behind books on a shelf. Robots are not very good at figuring out novel ways to move and are most useful in repetitive work such as spray painting automotive parts or moving pallets or boxes at an Amazon fulfillment center – jobs in which the objects to be grasped and the locations to move them are predictable. Tasks that you take for granted – for example, walking on a rocky shore where the footing is uncertain – are much more difficult than playing top-level chess (Figure 1.2).

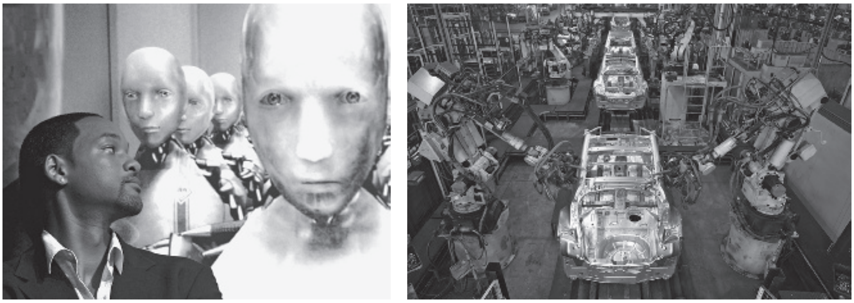

FIGURE 1.2: Hollywood robots (left), like humans, can move in complex environments, but that's true only in the movies. Most real-life robots (right) move in predictable environments. Our ability to see and move is a remarkable cognitive feat. Source: Hollywood robots © Getty Images/Koichi Kamoshida; factory robots © Getty Images/Christopher Furlong.

Compared to your ability to see and move, thinking is slow, effortful, and uncertain. To get a feel for why I say this, try solving this problem:

> In an empty room are a candle, some matches, and a box of tacks. The goal is to have the lit candle about 5 ft off the ground. You've tried melting some of the wax on the bottom of the candle and sticking it to the wall, but that wasn't effective. How can you get the lit candle 5 ft off the ground without having to hold it there?[2]

Twenty minutes is the usual maximum time allowed, and few people are able to solve it by then, although once you hear the answer you will realize it's not especially tricky. You dump the tacks out of the box, tack the box to the wall, and use it as a platform for the candle.

This problem illustrates three properties of thinking. First, thinking is slow. Your visual system instantly takes in a complex scene. When you enter a friend's backyard you don't think to yourself, "Hmmm, there's some green stuff. Probably grass, but it could be some other ground cover – and what's that rough brown object sticking up there? A fence, perhaps?" You take in the whole scene – lawn, fence, flowerbeds, gazebo – at a glance. Your thinking system does not instantly calculate the answer to a problem the way your visual system immediately takes in a visual scene. Second, thinking is effortful; you don't have to try to see, but thinking takes concentration. You can perform other tasks while you are seeing, but you can't think about something else while you are working on a problem. Finally, thinking is uncertain. Your visual system seldom makes mistakes, and when it does you usually think you see something similar to what is actually out there – you're close, if not exactly right. Your thinking system might not even get you close. In fact, your thinking system may not produce an answer at all, which is what happens to most people when they try to solve the candle problem.

If we're all so bad at thinking, how does anyone get through the day? How do we find our way to work or spot a bargain at the grocery store? How does a teacher make the hundreds of decisions necessary to get through her day? The answer is that when we can get away with it, we don't think. Instead we rely on memory. Most of the problems we face are ones we've solved before, so we just do what we've done in the past. For example, suppose that next week a friend gives you the candle problem. You would immediately say, "Oh, right. I've heard this one. You tack the box to the wall." Just as your visual system takes in a scene and, without any effort on your part, tells you what is in the environment, so too your memory system immediately and effortlessly recognizes that you've heard the problem before and provides the answer. You may think you have a terrible memory, and it's true that your memory system is not as reliable as your visual or movement system – sometimes you forget, sometimes you think you remember when you don't – but your memory system is much more reliable than your thinking system, and it provides answers quickly and with little effort.

We normally think of memory as storing personal events (memories of my wedding) and facts (the seat of the Coptic Orthodox Church is in Egypt). Our memory also stores strategies to guide what we should do: where to turn when driving home, how to handle a minor dispute when monitoring recess, what to do when a pot on the stove starts to boil over (Figure 1.3). For the vast majority of decisions we make,

FIGURE 1.3: Your memory system operates so quickly and effortlessly that you seldom notice it working. For example, your memory has stored away information about what things look like (Gandhi's face) and how to manipulate objects (turn the left faucet for hot water, the right for cold) and strategies for dealing with problems you've encountered before (such as a pot boiling over). Source: Gandhi © Getty Images/Dinodia Photos; faucet © Shutterstock/RVillalon; pot © Shutterstock/Andrey_Popov.

we don't stop to consider what we might do, reason about it, anticipate possible consequences, and so on. For example, when I decide to make spaghetti for dinner, I don't scour the Internet for recipes, weighing each for taste, nutritional value, ease of preparation, cost of ingredients, visual appeal, and so on – I just make spaghetti sauce the way I usually do. As two psychologists put it, "Most of the time what we do is what we do most of the time."[3] When you feel as though you are "on autopilot," even if you're doing something rather complex, such as driving home from school, it's because you are using memory to guide your behavior. Using memory doesn't require much of your attention, so you are free to daydream, even as you're stopping at red lights, passing cars, watching for pedestrians, and so on.

Of course you could make each decision with care and thought. When someone encourages you to "think outside the box" that's usually what he means – don't go on autopilot, don't do what you (or others) have always done. Consider what life would be like if you always strove to think outside the box. Suppose you approached every task afresh and tried to see all of its possibilities, even daily tasks like chopping an onion, entering your workplace, or sending a text message. The novelty might be fun for a while, but life would soon be exhausting (Figure 1.4).

You may have experienced something similar when traveling, especially if you've traveled where you don't speak the local language. Everything is unfamiliar and even trivial actions demand lots of thought. For example, buying a soft drink from a vendor requires figuring out the flavors from the exotic packaging, trying to communicate with the vendor, working through which coin or bill to use, and so on. That's

FIGURE 1.4: "Thinking outside the box" for a mundane task like selecting bread at the supermarket would probably not be worth the mental effort. Source: © Shutterstock/B Brown.

one reason that traveling is so tiring: all of the trivial actions that at home could be made on autopilot require your full attention.

So far I've described two ways in which your brain is set up to save you from having to think. First, some of the most important functions (for example, vision and movement) don't require thought: you don't have to reason about what you see; you just immediately know what's out in the world. Second, you are biased to use memory to guide your actions rather than to think. But your brain doesn't leave it there; it is capable of changing in order to save you from having to think. If you repeat the same thought-demanding task again and again, it will eventually become automatic; your brain will change so that you can complete the task without thinking about it. I discuss this process in more detail in Chapter 5, but a familiar example here will illustrate what I mean. You can probably recall that learning to drive a car was mentally very demanding. I remember focusing on how hard to depress the accelerator, when to apply the brake as I approached a red light, how far to turn the steering wheel to execute a turn, when to check my mirrors, and so forth. I didn't even listen to music while I drove, for fear of being distracted. With practice, however, the process of driving became automatic, and now I don't need to think about those small-scale bits of driving any more than I need to think about how to walk. I can drive while simultaneously chatting with friends, gesturing with one hand, and eating French fries – an impressive cognitive feat, if not very attractive to watch.[†] Thus a task that initially takes a great deal of thought becomes, with practice, a task that requires little thought.

The implications for education sound rather grim. If people are bad at thinking and try to avoid it, what does that say about students' attitudes toward school? Fortunately, the story doesn't end with people stubbornly refusing to think. Despite the fact that we're not that good at it, we actually like to think. We are naturally curious, and we look for opportunities to engage in certain types of thought. But because thinking is so hard, the conditions have to be right for this curiosity to thrive, or we quit thinking rather readily. The next section explains when we like to think and when we don't.

People Are Naturally Curious, But Curiosity Is Fragile

Even though the brain is not set up for very efficient thinking, people actually enjoy mental activity, at least in some circumstances. We have hobbies like solving crossword puzzles or scrutinizing maps. We watch information-packed documentaries. We pursue careers – such as teaching – that offer greater mental challenge than competing careers, even if the pay is lower. Not only are we willing to think, we intentionally seek out situations that demand thought.

Solving problems brings pleasure. When I say "problem solving" in this book, I mean any cognitive work that succeeds; it might be understanding a difficult passage of prose, planning a garden, or sizing up an investment opportunity. There is a sense of satisfaction, of fulfillment, in successful thinking. Neuroscientists have found overlap between the brain areas that are important in learning and those that are important in perception of pleasure, and many neuroscientists suspect that the two systems are related. Rats in a maze learn better when rewarded with cheese. When you solve a problem or satisfy your curiosity, your brain may reward itself with a small burst of a naturally occurring chemical in the brain's pleasure system. Even though the neurochemistry is not completely understood, it seems undeniable that people take pleasure in solving problems.

It's notable too that the pleasure is in the solving of the problem. Working on a problem with no sense that you're making progress is not pleasurable. In fact, it's frustrating. Then too, there's not great pleasure in simply knowing the answer. I told you the solution to the candle problem; did you get any fun out of it? Think how much more fun it would have been if you had solved it yourself – in fact, the problem would have seemed more clever, just as a joke that you get is funnier than a joke that has to be explained. Even if someone doesn't tell you the answer to a problem, once you've had too many hints you lose the sense that you've solved the problem, and getting the answer doesn't bring the same mental snap of satisfaction.

Mental work appeals to us because it offers the opportunity for that pleasant feeling when it succeeds. But not all types of thinking are equally attractive. People choose to work crossword puzzles but not algebra problems. A biography of Taylor Swift is more likely to sell well than a biography of Keats. What characterizes the mental activity that people enjoy (Figure 1.5)?

The answer that most people would give may seem obvious: "I think crossword puzzles are fun and Taytay is cool, but math is boring and so is Keats." In other words, it's the content that matters. We're curious about some stuff but not about other stuff. Certainly that's the way people describe our own interests – "I'm a stamp collector" or "I'm into medieval symphonic music." But I don't think content drives interest. We've all attended a lecture or watched a video (perhaps only after being prevailed upon to do so) about a subject we thought we weren't interested in, only to find ourselves fascinated. And it's easy to find yourself bored even when you usually like the topic. I'll never forget my eagerness for the day my middle school teacher was to talk about sex. As a teenage boy in a staid 1970s suburban culture, I fizzed with anticipation of any talk about sex, anytime, anywhere. But when the big day came, my friends and I were bored senseless. It's not that the teacher talked about flowers and pollination – he really did talk about human sexuality – but somehow it was still dull. I actually wish I could remember how he did it; boring a bunch of hormonal teenagers with a sex talk is quite a feat.

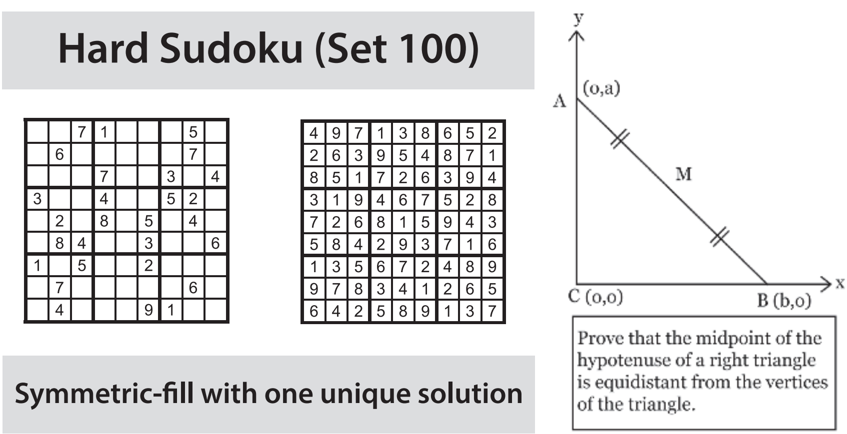

FIGURE 1.5: Why are many people fascinated by problems like the one shown on the left, but very few people willingly work on problems like the one on the right? Source: Sudoku © Shutterstock/Heather Wallace; geometry © Anne Carlyle Lindsay.

I once made this point to a group of teachers when talking about motivation and cognition. About five minutes into the talk I presented a slide depicting the model of motivation shown in Figure 1.6. I didn't prepare the audience for the slide in any way; I just displayed it and started describing it. After about 15 seconds I stopped and said to the audience, "Anyone who is still listening to me, please raise your hand." One person did. The other 59 were also attending voluntarily; it was a topic in which they were presumably interested, and the talk had only just started – but in 15 seconds their minds were somewhere else. To be clear, I'm not blaming them; the content of a problem – whether it's about sex or human motivation – may be sufficient to prompt your interest, but it won't maintain it.

So, if content is not enough to keep your attention, when does curiosity have staying power? The answer seems to lie in our judgment of how much we are likely to learn. Curiosity is maintained when we think we'll learn a lot.

That judgment – will I learn? – is closely related to our perception of the difficulty of the problem. If it's that little burst of pleasure from solving a problem that we look forward to, then there's no point in working on a problem that is too easy – there'll be no pleasure when it's solved because it didn't feel like much of a problem in the first place. Then too, when you size up a problem as very difficult, you are judging that you're unlikely to solve it, and are therefore unlikely to get the satisfaction that comes with the solution. A crossword puzzle

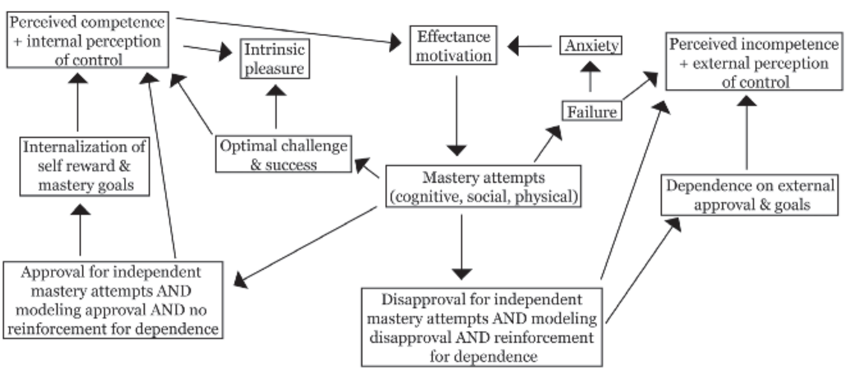

FIGURE 1.6: A difficult-to-understand figure that will bore most people unless it is adequately introduced. Source: © Anne Carlyle Lindsay.

that is too easy is just mindless work: you fill in the squares, scarcely thinking about it, and there's no gratification, even though you're getting all the answers. But you're unlikely to work long at a crossword puzzle that's too difficult. You know you'll solve very little of it, so it will just be frustrating. The slide in Figure 1.6 is too detailed to be absorbed with minimal introduction; my audience quickly concluded that it was overwhelming and mentally checked out of my talk.

To summarize, I've said that thinking is slow, effortful, and uncertain. Nevertheless, people like to think – or more properly, we like to think if we judge that the mental work will pay off with the pleasurable feeling we get when we learn something new. So there is no inconsistency in claiming that people avoid thought and in claiming that people are naturally curious – curiosity prompts people to explore new ideas and problems, but when we do, we quickly evaluate how much mental work it will take to solve the problem or understand what's described. If it's too much work or too little, we stop thinking about the problem if we can.

This analysis of the sorts of mental work that people seek out or avoid also provides one answer to why more students don't like school. Working on problems that are of the right level of difficulty is rewarding, but working on problems that are too easy or too difficult is unpleasant. Students can't opt out of these problems the way adults often can. If the student routinely gets work that is a bit too difficult, it's little wonder that he doesn't care much for school. I wouldn't want to work on the Sunday New York Times crossword puzzle for several hours each day.

So what's the solution? Give the student easier work? You could, but of course you'd have to be careful not to make it so easy that the student would be bored. And anyway, wouldn't it be better to boost the student's ability a little bit? Instead of making the work easier, is it possible to make thinking easier?

How Thinking Works

Understanding a bit about how thinking happens will help you understand what makes thinking hard. That will in turn help you understand how to make thinking easier for your students, and therefore help them enjoy school more.

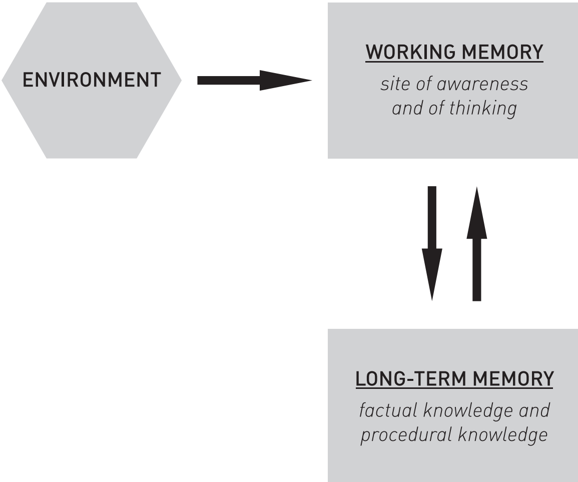

FIGURE 1.7: Just about the simplest model of the mind possible. Source: © Greg Culley.

Let's begin with a very simple model of the mind. On the left of Figure 1.7 is the environment, full of things to see and hear, problems to be solved, and so on. On the right is one component of your mind that scientists call working memory. For the moment, consider it to be synonymous with consciousness; it holds the stuff you're thinking about. The arrow from the environment to working memory shows that working memory is the part of your mind where you are aware of what is around you: the sight of a shaft of light falling onto a dusty table, the sound of a dog barking in the distance, and so forth. Of course you can also be aware of things that are not currently in the environment; for example, you can recall the sound of your mother's voice, even if she's not in the room (or indeed no longer living). Long-term memory is the vast storehouse in which you maintain your factual knowledge of the world: that leopards have spots, that your favorite flavor of ice cream is chocolate, that your three-year-old surprised you yesterday by mentioning kumquats, and so on. Factual knowledge can be abstract; for example, it would include the idea that triangles are closed figures with three sides and your knowledge of what a dog generally looks like. All of the information in long-term memory resides outside of awareness. It lies quietly until it is needed and then enters working memory and so enters consciousness. For example, if I asked you, "What color is a polar bear?" you would say, "white" almost immediately. That information was in long-term memory 30 seconds ago, but you weren't aware of it until I posed the question that made it relevant to ongoing thought, whereupon it entered working memory.

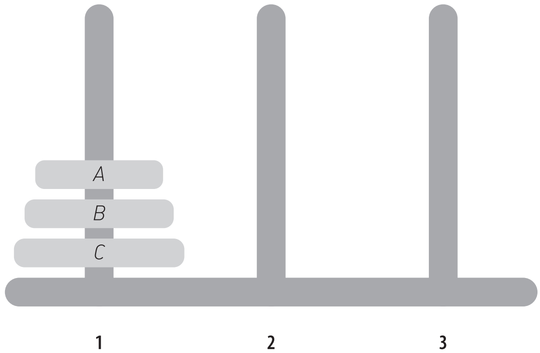

FIGURE 1.8: The figure depicts a playing board with three pegs. There are three rings of decreasing size on the leftmost peg. The goal is to move all three rings from the leftmost peg to the rightmost peg. There are just two rules about how you can move rings: you can move only one ring at a time, and you can't place a larger ring on top of a smaller ring. Source: © Greg Culley.

Thinking occurs when you combine information (from the environment and long-term memory) in new ways. That combining happens in working memory. To get a feel for this process, read the problem depicted in Figure 1.8 and try to solve it. (The point is not so much to solve it as to experience what is meant by thinking and working memory.) With some diligence you might be able to solve this problem,‡ but the real point is to feel what it's like to have working memory absorbed by the problem. You begin by taking information from the environment – the rules and the configuration of the game board – and then imagine moving the discs to try to reach the goal. Within working memory you must maintain your current state in the puzzle – where the discs are – and imagine and evaluate potential moves. At the same time you have to remember the rules regarding which moves are legal, as shown in Figure 1.9.

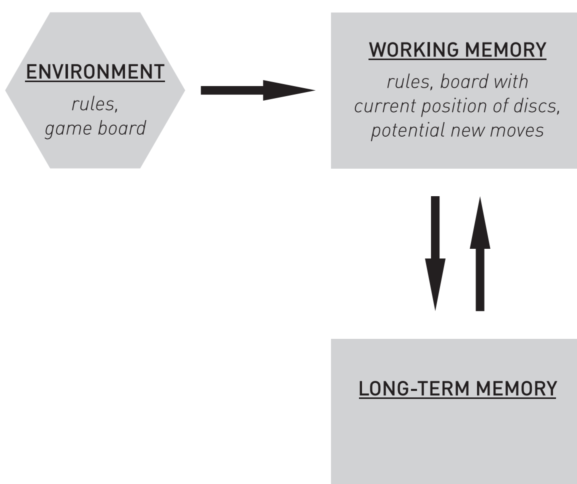

FIGURE 1.9: A depiction of your mind when you're working on the puzzle shown in Figure 1.8. Source: © Greg Culley.

The description of thinking makes it clear that knowing how to combine and rearrange ideas in working memory is essential to successful thinking. For example, in the discs and pegs problem, how do you know where to move the discs? If you hadn't seen the problem before, you probably felt like you were pretty much guessing. You didn't have any information in long-term memory to guide you, as depicted in Figure 1.9. But if you have had experience with this particular type of problem, then you likely have information in long-term memory about how to solve it, even if the information is not foolproof. For example, try to work this math problem in your head:

$$18 \times 7$$

You know just what to do for this problem. The sequence of your mental processes was likely something close to this:

1. Multiply 8 and 7.
2. Retrieve the fact that $8 \times 7 = 56$ from long-term memory.
3. Remember that the 6 is part of the solution, then carry the 5.
4. Multiply 7 and 1.
5. Retrieve the fact that $7 \times 1 = 7$ from long-term memory.
6. Add the carried 5 to the 7.
7. Retrieve the fact that $5 + 7 = 12$ from long-term memory.
8. Put the 12 down, append the 6.
9. The answer is 126.

Your long-term memory contains not only factual information, such as the color of polar bears and the value of 8×7, but it also contains what we'll call procedural knowledge, which is your knowledge of the mental procedures necessary to execute tasks. If thinking is combining information in working memory, then procedural knowledge is a list of what to combine and when – it's like a recipe to accomplish a particular type of thought. You might have stored procedures for the steps needed to calculate the area of a triangle, or to duplicate a computer file using Windows, or to drive from your home to your workplace.

It's pretty obvious that having the appropriate procedure stored in long-term memory helps a great deal when we're thinking. That's why it was easy to solve the math problem and hard to solve the discs-and-pegs problem. But how about factual knowledge? Does that help you think as well? It does, in several different ways, which are discussed in Chapter 2. For now, note that solving the math problem required the retrieval of factual information, such as the fact that $8 \times 7 = 56$. I've said that thinking entails combining information in working memory. Often the information provided in the environment is not sufficient to solve a problem, and you need to supplement it with information from long-term memory.

There's a final necessity for thinking, which is best understood through an example. Have a look at this problem:

In the inns of certain Himalayan villages is practiced a refined tea ceremony. The ceremony involves a host and exactly two guests, neither more nor less. When his guests have arrived and seated themselves at his table, the host performs three services for them. These services are listed in the order of the nobility the Himalayans attribute to them: stoking the fire, fanning the flames, and pouring the tea. During the ceremony, any of those present may ask another, "Honored Sir, may I perform this onerous task for you?" However, a person may request of another only the least noble of the tasks that the other is performing. Furthermore, if a person is performing any tasks, then he may not request a task that is nobler than the least noble task he is already performing. Custom requires that by the time the tea ceremony is over, all the tasks will have been transferred from the host to the most senior of the guests. How can this be accomplished?[4]

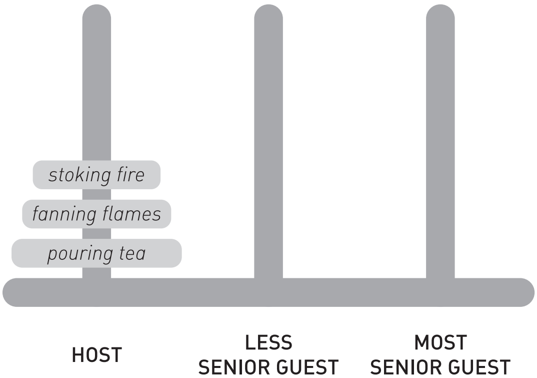

FIGURE 1.10: The tea-ceremony problem, depicted to show the analogy to the discs-and-pegs problem. Source: © Greg Culley.

Your first thought upon reading this problem was likely "Huh?" You could probably tell that you'd have to read it several times just to understand it, let alone begin working on the solution. It seemed overwhelming because you did not have sufficient space in working memory to hold all of the aspects of the problem. Working memory has limited space, so thinking becomes increasingly difficult as working memory gets crowded.

The tea-ceremony problem is actually the same as the discs-and-pegs problem presented in Figure 1.8. The host and two guests are like the three pegs, and the tasks are the three discs to be moved among them, as shown in Figure 1.10. (The fact that very few people see this analogy and its importance for education is taken up in Chapter 4.)

This version of the problem seems much harder because some parts of the problem that are laid out in Figure 1.8 must be juggled in your head in this new version. For example, Figure 1.8 provides a picture of the pegs that you can use to help maintain a mental image of the discs as you consider moves, whereas the tea ceremony version provides no such support. And in the tea version, the description of the rules that govern moves is longer and therefore occupies so much space in working memory that it's difficult to plan a solution.

Aristotle said, "The pleasures arising from thinking and learning will make us think and learn all the more."[5] You've seen that this view is too optimistic. It's *successful* learning that's pleasurable and that will keep students coming back for more. We've seen that one of the factors in successful learning is having the right information in long-term memory. In the next chapter, we examine that need more closely.

Summary

People's minds are not especially well suited to thinking; thinking is slow, effortful, and uncertain. For this reason, deliberate thinking does not guide people's behavior in most situations. Rather, we rely on our memories, following courses of action that we have taken before. Nevertheless, we find successful thinking pleasurable. We like solving problems, understanding new ideas, and so forth. Thus, we will seek out opportunities to think, but we are selective in doing so; we choose problems that pose some challenge but that seem likely to be solvable, because these are the problems that lead to feelings of pleasure and satisfaction. For problems to be solved, the thinker needs adequate information from the environment, room in working memory, and the required facts and procedures in long-term memory.

Implications for the Classroom

Let's turn now to the question that opened this chapter: Why don't students like school, or more accurately, why don't more of them like it? Any teacher knows that there are lots of reasons that a student might or might not enjoy school. (My wife loved it, but primarily for social reasons.) From a cognitive perspective, an important factor is whether or not a student consistently experiences the pleasurable rush of learning something new, of solving a problem. What can teachers do to ensure that each student gets that pleasure?

Be Sure That There Are Problems to Be Solved

By problem I don't necessarily mean a question addressed to the class by the teacher, or a mathematical puzzle. I mean cognitive work that poses moderate challenge, including such activities as understanding a poem or thinking of novel uses for recyclable materials. This sort of cognitive work is of course the main stuff of teaching – we want our students to think. But without some attention, a lesson plan can become a long string of teacher explanations, with little opportunity for students to solve problems. So scan each lesson plan with an eye toward the cognitive work that students will be doing. How often does such work occur? Is it intermixed with cognitive breaks? Is it real cognitive work that can lead to the feeling of discovery and not just retrieval from memory? (Think especially about questions posed during whole-class instruction – research shows it's easy for teachers to slip into a pattern of asking lots of fact-retrieval questions.) When you have identified the challenges, consider whether they are open to negative outcomes such as students failing to understand what they are to do, or students being unlikely to solve the problem, or students simply trying to guess what you would like them to say or do.

Respect Students' Cognitive Limits

When trying to develop effective mental challenges for your students, bear in mind the cognitive limitations discussed in this chapter. For example, suppose you began a history lesson with a question: "You've read that 35 nations united to expel Iraq from Kuwait in the First Gulf War, the largest coalition since World War II. Why do you suppose so many nations joined?" Do your students have the necessary background knowledge in memory to consider this question? What do they know about the relationship of Iraq and neighboring countries that ended up joining the coalition prior to the war? Do they know about how Iraq brought their dispute with Kuwait to the Arab League before the invasion? Do they know about the significance of oil to the world economy and the forecast economic consequences of the invasion? Could they generate reasonable alternative courses of action for those countries leading the invasion? If they lack the appropriate background knowledge, the question you pose will quickly be judged as "boring." If students lack the background knowledge to engage with a problem, save it for another time when they have that knowledge.

Equally important is the limit on working memory. Remember that people can keep only so much information in mind at once, as you experienced when you read the tea-ceremony version of the discs-and-pegs problem. Overloads of working memory are caused by such things as multistep instructions, lists of unconnected facts, chains of logic more than two or three steps long, and the application of a just-learned concept to new material (unless the concept is quite simple). The solution to working memory overloads is straightforward: slow the pace, and use memory aids such as writing on the whiteboard to save students from keeping too much information in working memory.

Clarifying the Problems to Be Solved

How can you make the problem interesting? A common strategy is to try to make the material "relevant" to students. This strategy sometimes works well, but it's hard to use for some material, and your struggle to make it relevant to students is usually obvious. Another difficulty is that a teacher's class may include two football fans, a doll collector, a NASCAR enthusiast, a horseback riding competitor – you get the idea. Mentioning a popular singer in the course of a history lesson may give the class a giggle, but it won't do much more than that. I have emphasized that our curiosity is provoked when we perceive a problem that we believe we can solve. What is the question that will engage students and make them want to know the answer?

One way to view schoolwork is as a series of answers. We want students to know Boyle's law, or three causes of World War I, or why Poe's raven kept saying, "Nevermore." Sometimes I think that we, as teachers, are so eager to get to the answers that we do not devote sufficient time to developing the question. That probably happens because the question is obvious to us. But of course it's not obvious to students, and as the information in this chapter indicates, it's the question that piques people's interest. Being told an answer doesn't do anything for you. You may have noted that I could have organized this book around principles of cognitive psychology. Instead I organized it around questions that I thought teachers would find interesting.

When you plan a lesson, you start with the information you want students to know by its end. As a next step, consider what the key question for that lesson might be and how you can frame that question so it will have the right level of difficulty to engage your students and so you will respect your students' cognitive limitations.

Reconsider When to Puzzle Students

Teachers often seek to draw students into a lesson by presenting a problem that we believe will interest the students. For example, asking, "Why is there a law that you have to go to school?" could introduce the process by which laws are passed. Another strategy is to conduct a demonstration or present a fact that we think students will find surprising. In either case, the goal is to puzzle students, to make them curious. This is a useful technique, but it's worth considering whether these strategies might be used not only at the beginning of a lesson but also after the basic concepts have been learned. For example, a classic science demonstration is to put a burning piece of paper in a milk bottle and then put a boiled egg over the bottle's opening. After the paper burns, the egg appears to be sucked into the bottle. Students will no doubt be astonished, but if they don't know the principle behind it, the demonstration is like a magic trick – it's a momentary thrill, but their curiosity to understand may not be long-lasting. Another strategy would be to conduct the demonstration after students know that warm air expands and cooling air contracts, potentially forming a vacuum. Every fact or demonstration that would puzzle students before they have the right background knowledge has the potential to be an experience that will puzzle students momentarily and then lead to the pleasure of problem solving. It is worth thinking about when to use a marvelous device like the egg-in-the-bottle trick.

Accept and Act on Variation in Student Preparation

As I describe in Chapter 8, I don't accept that some students are "just not very bright" and ought to be tracked into less demanding classes. But it's naïve to pretend that all students come to your class equally prepared to excel; they have had different preparations, as well as different levels of support at home, and they will therefore differ in their abilities, as well as their perception of themselves as students. Those factors, in turn, affect therefore their persistence and resilience to failure. If that's true, and if what I've said in this chapter is true, it is self-defeating to give all of your students the same work. The less capable students will find it too difficult and will struggle against their brain's bias to mentally walk away from schoolwork. To the extent that you can, it's smart, I think, to assign work to individuals or groups of students that is appropriate to their current level of competence. Naturally, you will want to do this in a sensitive way, minimizing the extent to which some students will perceive themselves as behind others. But the fact is that they are behind the others, and giving them work that is beyond them is unlikely to help them catch up and is likely to make them fall still further behind.

Change the Pace

We all inevitably lose the attention of our students, and as this chapter has described, it's likely to happen if they feel somewhat confused. They will mentally check out. The good news is that it's relatively easy to get them back. Change grabs attention, as you no doubt know. When there's a bang outside your classroom, every head turns to the windows. When you change topics, start a new activity, or in some other way show that you are shifting gears, virtually every student's attention will come back to you, and you will have a new chance to engage them. So plan shifts and monitor your class's attention to see whether you need to make them more often or less frequently.

Keep a Diary

The core idea presented in this chapter is that solving a problem gives people pleasure, but the problem must be easy enough to be solved yet difficult enough to take some mental effort. Finding this sweet spot of difficulty is not easy. Your experience in the classroom is your best guide – whatever works, do again; whatever doesn't, discard. But don't expect that you will really remember how well a lesson plan worked a year later. Whether a lesson goes brilliantly well or down in flames, it feels at the time that we'll never forget what happened; but the ravages of memory can surprise us, so write it down. Even if it's just a quick scratch on a sticky note, try to make a habit of recording your success in gauging the level of difficulty in the problems you pose for your students.

One of the factors that contributes to successful thought is the amount and quality of information in long-term memory. In Chapter 2 I elaborate on the importance of background knowledge to effective thinking.

Notes

*A more eloquent version comes from eighteenth-century British painter Sir Joshua Reynolds: "There is no expedient to which a man will not resort to avoid the real labor of thinking."

†And in fact people's driving is more impaired than they realize when they multitask. Don't try this at home!

‡If you couldn't solve it, here's a solution. As you can see, the rings are marked A, B, and C, and the pegs are marked 1, 2, and 3. The solution is A3, B2, A2, C3, A1, B3, A3.

Further Reading

Less Technical

Coalition for Psychology in Schools and Education. (2015). Top 20 principles from psychology for preK-12 teaching and learning. https://www.apa.org/ed/schools/teaching-learning/top-twenty-principles.pdf (accessed 13 July 2020). A brief, easy introduction to applying knowledge from psychology to classrooms, and a free download.

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York: Harper Perennial. The author describes the ultimate state of interest, when one is completely absorbed in what one is doing, to the point that time itself stops. The book does not tell you how to enter this state, but it is an interesting read in its own right.

Didau, D., & Rose, N. (2016). *What Every Teacher Needs to Know About Psychology*. Melton, UK: John Catt. Brief chapters on a broad sweep of topics, including evolution, creativity, motivation, and more, very much from a teacher's perspective.

National Academies of Sciences, Engineering, and Medicine. (2018). *How People Learn II: Learners, Contexts, and Cultures*. National Academies Press. https://www.nap.edu/catalog/24783/how-people-learn-ii-learners-contexts-and-cultures (accessed 13 July 2020). Intended as an overview of cognition applied to education, this book sometimes overreaches, moving into peripheral topics, but it's worth the read, and it's a free download.

Willingham, D. T. (2019a). The high price of multitasking. *New York Times* (15 July), p. A21. https://www.nytimes.com/2019/07/14/opinion/multitasking-brain.html. A quick review of evidence that we cannot cope with working memory overload as well as we think we can.

Willingham, D. T. (2019b). Why aren't we curious about the things we want to be curious about? *New York Times* (20 October), p. SR9. https://www.nytimes.com/2019/10/18/opinion/sunday/curiosity-brain.html. This op-ed considers what triggers curiosity and how we might make ourselves curious about things that align with our long-term interests.

More Technical

Baddeley, A. (2018). *Exploring Working Memory: Selected Works of Alan Baddely*. Oxford, UK: Routledge. A retrospective of the most important articles by Alan Baddeley, commonly considered the central figure in the development of working memory theory over the last 50 years.

Berridge, K. C., & Kringelbach, M. L. (2015). Pleasure systems in the brain. *Neuron*, 86(3), 646–664. Reviews evidence that various types of pleasure we feel—from using addictive drugs, listening to music, experiencing romantic love, or eating delicious food—all have a common anatomic basis in the brain.

Kidd, C., & Hayden, B. Y. (2015). The psychology and neuroscience of curiosity. *Neuron*, 88(3), 449–460. An overview of contemporary theories of curiosity, focusing on the idea that curiosity evolved to ensure that animals, including humans, learn about their environment. We are maximally curious when we think the environment offers the greatest opportunity to learn.

Long, N. M., Kuhl, B. A., & Chun, M. M. (2018). Memory and attention. *Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience*, 1–37. Hoboken, NJ: Wiley. You probably didn't need to be convinced that paying attention is a prerequisite for learning. This chapter offers much more detail and, as you'd expect, some caveats and complications.

Willingham, D. T., & Riener, C. (2019). *Cognition: The Thinking Animal*, 4. Cambridge, UK: Cambridge University Press. This is a college-level textbook on cognitive psychology that can serve as an introduction to the field. It assumes no background, but it is a textbook, so although it is thorough, it might be a bit more detailed than you want.

Discussion Questions

1. We like to think only when we believe we'll be successful. If you want to engage in thinking more often, how then might you change your environment so that you more often encounter the right sort of mental challenge? Or what might you say to yourself to get you to try more often?
2. When are your students on autopilot? It's easy to say there's value in trying to go off autopilot and *think* more often, but what are the obstacles to doing so? Can you think of ways of picking problems that they currently solve on autopilot that actually seem promising to think about?
3. Just how much reward does a student need for the work of thinking? There's no firm answer to this question, and we'd certainly guess that it would vary by age and would vary within a classroom, probably based on students' concept of themselves as students and some inherent aspect of each student's persistence. Nevertheless it's worth considering: on average, how often would you like students to feel the pleasure of success? Equally important, how do you know when they do? If they solve a problem, are you sure they feel success? If not, is there anything you can do to prompt that feeling?
4. Think of some assignments that your students consistently enjoy, and view them through the cognitive-work-that-succeeds lens. Does that work share any common characteristics?

5. I suggested that students don't fully understand or appreciate the question that the to-be-learned content is meant to answer. How often do you think that applies to your context? How easy or difficulty might it be to get students to both understand the question at stake and to engage with it?
6. I was a little casual in the implications section when I said that it's straightforward to deal with working memory overload. I said you should slow down and break things into smaller chunks, which is true, as far as it goes. What's trickier to deal with are the differences among students in what makes them feel overloaded. What can be done about that?