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The Power, Promise, and Pitfalls of Executive Function

Right Behind Your Forehead

Right behind your forehead is the part of the brain known as the prefrontal cortex. Though intriguing scientists for decades, it wasn't able to be mapped out until the 1970s. Now we know—this part of the brain is rocket fuel for human achievement. The size and makeup of this part of the brain is what separates us from all other mammals.

Executive function can be described as:

> The use of self-directed actions so as to choose goals and to select, enact, and sustain actions across time toward those goals usually in the context of others often relying on social and cultural means for the maximization of one's long-term welfare as the person defines that to be.
>
> (Barkley, 2012, p. 171)

That is a good summation of the power of all of the executive function skills presented in this book.

If you're looking to accelerate student achievement, strengthen students' social interactions, and support mental and emotional well-being, look no further. This is the area of the brain that handles most of the 40 common executive function skills (see Table 1.1).

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Table 1.1 Executive Function Skills by Brain Science Categories

• Attending to a person or activity • Focusing • Concentrating • Thinking before acting • Initiating a task • Persisting in a task • Maintaining social appropriateness • Storing and manipulating visual and verbal information • Identifying same and different • Remembering details • Following multiple steps • Holding on to information while considering other information • Identifying cause-and-effect relationships • Categorizing information • Shifting focus from one event to another • Changing perspective • Seeing multiple sides to a situation • Being open to others' points of view • Being creative	• Catching and correcting errors • Thinking about multiple concepts simultaneously • Setting goals • Managing time • Working toward a goal • Organizing actions and thoughts • Considering future consequences in light of current action • Making hypotheses, deductions, and inferences • Applying former approaches to new situations • Defining a problem • Analyzing • Creating mental images • Generating possible solutions • Anticipating • Predicting outcomes • Evaluating • Self-assessing • Overcoming temptation • Monitoring performance • Reflecting on goals • Managing conflicting thoughts

STOP! Turn to Your *Efficacy Notebook* (See the Introduction).

Title this "Taking Stock". Table 1.1 (another version is shown in Appendix A) offers a list of 40 key executive function skills. Reflect on and answer the following questions:

1. Which are you unusually good at?
2. Which could you improve upon?
3. Think about your students. Selecting a specific grade level and curriculum, which would be your priorities for your students at this point?
4. Which, if any, do you deliberately focus on in your curriculum?

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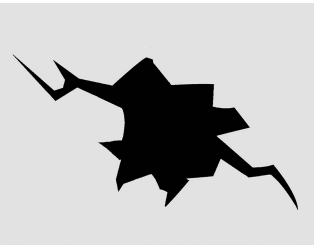
The Problem with Great Instructional Lessons

Consider the following:

> *You arrive home with your hands full of grocery bags. You manage to unlock the door and then kick it open, applying a little too much pressure. It slams into the wall behind it, punching a hole in the drywall. You think, "I know I can call someone but I bet I can learn how to fix this on my own."*



Where will you find out how to accomplish this task? With a quick Web search, you find a how-to sheet of directions with text and pictures; you also find videos of people demonstrating and explaining the process. Easy! Well, not so fast. Review the list of executive function skills in Table 1.1 and check off the ones you will need in order to process this information you found, that is, in order to successfully follow the video or Direction Sheet and patch the hole.

Personally, I checked off about two dozen skills, without which, the hole will not be patched. You can have a Direction Sheet on how to spackle a wall, but if you can't s*hift focus from one event* (reading the directions) *to another* (spackling the wall), those directions will be useless. If you can't *follow multiple steps*, you'll not be able to make use of the directions. If you can't *persist in a task*, you'll soon find a jar of spackle and a spackling knife sitting on the floor while you're off engaging in some other activity, and the hole in the wall remains.

Consider that today, with increased access to the Internet and more people uploading professional and amateur "How To" videos and Direction Sheets, you can locate information on nearly any topic you wish to pursue. If you search for "subtraction with regrouping," you'll find a wealth of resources. If you search for "light and shade in oil painting," "basketball jump shot," "how to use a glue stick," or "balancing chemical equations," you'll likewise have no lack of resources. Add to that the advances in artificial intelligence (AI) and you have a wealth of information and explanations at your fingertips. Essentially, most of the content, skills and concepts students need to learn are readily available through a variety of sources on the Internet. This is far different

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from the accessibility to content that was available just a decade ago. What *is* important, however, is that you can identify a *reliable* source, and that requires executive function. Likewise, being able to take in the content information and translate that into learning requires executive function. So with all of the "physical access" students may have to the Internet in school and at home, only the possession of strong executive function skills will provide them with the "cognitive access" to the content that will lead to learning. Physical access to content through lessons does not equal cognitive access that leads to learning. Without the skills of executive function, you cannot access the information needed to transform thinking and produce powerful learning. While the pandemic narrowed the digital divide, providing students with greater access to technology than ever before, the real issue just might be the executive function divide. Executive function is, therefore, the coveted missing link to student achievement.

Schools seeking to improve student achievement tend to invest in textbooks, computer programs, curricular programs, and related professional development on teaching lesson-level content. While an effective lesson and great materials may be useful to learning, they are not sufficient to ensure learning. They will be to little or no avail with a student who lacks the power of executive function. The key to unlocking content and ensuring a pathway to long-term memory is through executive function.

AI is Taking Over!

It is difficult to write about AI with any sense of confidence, given that by the time you read this, the following information and chatbots may be out of date. I ask for your forgiveness on this section; please read this with that in mind to capture the essence of what I'm saying. Thank you.

If all the content you need to learn is on the Internet, most of what you need to do with it is available through AI. AI can synthesize information, apply content to new situations in order to develop solutions to problems, and, for students, complete most of the assignments teachers give them. What AI apps cannot do is fully mirror the functions of the prefrontal cortex and, thus, executive function. Let's hear from a few experts.

As you read these chatbot responses, consider what teachers do in classrooms to build skills that cannot currently, and maybe ever, be mirrored

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with AI. Here is the question I posed to three chatbots, which you might want to ask now as you read the book:

> I maintain that everything you need to learn content-wise is on the Internet, and everything you need to do with it is available through AI. How well does AI mirror the brain's executive functioning skills?

I'm omitting the list of what AI can mirror and focusing on what it can't do that your students should be supported in learning to do.

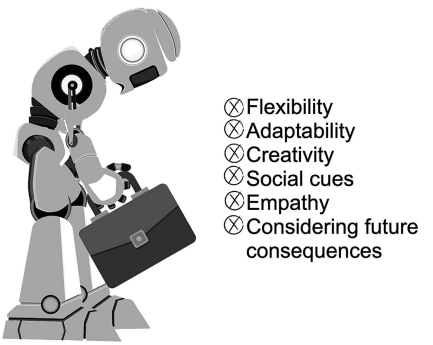
According to chatbot *ChatGPT*,

> Human executive function allows for flexible adjustment of strategies and goals in response to new information or changing circumstances in ways that AI currently cannot match. AI typically lacks the ability to reconsider and redefine goals independently as humans do.

Additionally, "The creative problem-solving humans exhibit, which often involves synthesizing disparate pieces of information in novel ways, remains largely beyond AI's capability." (OpenAI ChatGPT, personal communication, April 20, 2024).

Chatsonic agrees: "AI can generate novel solutions based on existing data, but it may struggle to exhibit the same level of creativity and innovation as the human brain." It adds, "While AI can adapt within predefined parameters, it may struggle with the same level of flexible, adaptive decision-making as the human brain in unpredictable situations." And, "AI may have difficulty understanding complex social or contextual cues, which are essential for human executive functioning in social interactions" (Chatsonic, April 2024).

Google's *Gemini* offers: "AI struggles with considering future consequences and adapting plans accordingly. Their decision-making is based on the data they've been trained on, and they may not be able to account for unforeseen circumstances or novel situations." And, "AI lacks the ability to understand and respond to emotions in a nuanced way. They can't take emotions into account when making decisions or interacting with humans" (Gemini, April 2024).



Let me recap just some of the executive function characteristics the chatbots referred to in terms of what humans can do that AI can't: flexibility, adaptability, creativity, social cues, empathy, and considering future consequences.

Read on!

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Preparing Students for Their Future

The world is in what is known as the Fourth Industrial Revolution (Schwab, 2015). The first industrial revolution was ushered in by the invention of the steam engine; the second was characterized by the use of electricity for mass production and the rise of the factory; and the third had as its hallmark computer technology and automation. Computers can automate many jobs for greater speed, accuracy, and efficiency. This caused a shift in the workforce toward humans moving off the production line and, instead, handling jobs that require design, personalization, and service. With the Fourth Industrial Revolution and the rise of artificial intelligence, the computer no longer has to depend on its programmer to offer it new capabilities. Systems of computers interacting with one another, the environment, and humans are poised to design their own future systems, making them less dependent upon programmers. They have the ability to be adaptive, robust, predictive, and anticipatory. The Fourth Industrial Revolution is taking the digital world, physical world, and biological world and fusing them together for greater innovation, efficiency, and productivity.

"The Future of Jobs Report" presents the top skills that employers around the world are prioritizing:

- Analytical thinking
- Creative thinking
- AI and big data
- Leadership and social influence
- Resilience, flexibility and agility
- Curiosity and lifelong learning
- Technological literacy design and user experience
- Motivation and self-awareness
- Empathy and active listening

(World Economic Forum, 2023, p. 42)

Are you seeing a correlation between this list and the list of what AI can't do? Clearly, employers realize that many jobs can be accomplished through computer technology and AI, reducing the need for human beings in those positions. Just think about self-checkout at the grocery store?. You arrive at checkout and have to scan and bag your purchases on a computer; no more checkout clerks. What could go wrong? This level of automation does not take into account human emotion, particularly in response to computer error. Usually, the store has one employee to oversee this process and support customers. What they perhaps missed was that the employee has to have a high level of empathy, emotional intelligence, and problem-solving skills to make

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the customers feel supported in this shift to humanless checkout. When stores began installing self-checkouts, the rage among customers was palpable and cost stores money in lost customers. Many stores shifted back to checkout lines with human beings. While that automation trend will resurface, the employees who oversee it will have to possess the kind of skills listed by the "Future of Jobs Report".

The report goes on to identify skills that will be priorities by 2028:

- Creative thinking
- Analytical thinking
- Leadership and social influence
- Marketing and media
- Resource management and operations
- Service orientation and customer service
- Empathy and active listening
- Environmental stewardship
- Multilingualism
- Quality control

(World Economic Forum, 2023, p. 86)

Notice that creative thinking (and creativity is an executive function skill) is rising to the top of core job skill priorities. How are you teaching creative thinking in your classroom or school?

Clearly, while technical skills will continue to be important, they must be coupled with strong social skills and the ability to collaborate and lead others. Such higher-order skills are the realm of the prefrontal cortex and executive function. All of these insights point to the need to help students maximize their executive function abilities in order to learn at levels beyond simple content acquisition.

Back to the prefrontal cortex!

Redefining "The Basics" of Curricular Content

Have you ever attempted to teach a student new content, presented what you felt was a very good lesson, demonstration, or explanation, only to find yourself frustrated that the student wasn't able to follow along and understand

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the content? Teachers learn to begin lessons by activating prior knowledge. A lesson on adjectives, for example, typically begins with a recall of nouns and their purpose, and then moves to brainstorming words that describe nouns. Schools tend to define "the basics" of a subject area in terms of skills and concepts within that subject area, but it may be that the path to achievement runs deeper than that. Perhaps the basics of understanding adjectives, for example, aren't simply understanding nouns and the concept of description. *Thinking about multiple concepts simultaneously*, *categorizing information*, *identifying same and different*, *storing and manipulating visual and verbal information*, *persisting in a task*, and other skills should be considered the true foundations for understanding adjectives. Without those skills, no matter what a teacher presents, students will fall short of achieving an understanding of adjectives. I'm not suggesting teachers eliminate content instruction; I'm suggesting teachers create a foundation of executive function such that students can cognitively access that content (see Table 1.2).

The foundational skills for learning to recite the alphabet include *attending to a task*, *focusing*, *storing verbal information*, and *persisting in a task*. The foundational skills for understanding the causes and outcomes of World War II include *identifying cause-and-effect relationships*, *seeing multiple sides of a situation*, *considering future consequences in light of future action*, and *analyzing*, to name a few. The foundational skills for performing a piece of music includes *concentrating*, *working toward a goal*, *monitoring performance*, *evaluating*, *catching and correcting errors*, and *persisting in a task*. The foundational skills for writing a fictional story include *creating mental images*; *being creative*; *organizing thoughts*; *making hypotheses, deductions, and inferences;* and *remembering details*. Discussing an experiment includes the foundational skills of *attending to a person or activity*, *concentration*, *shifting focus from one event to another*, *maintaining social*

Table 1.2 To Master the Concept of an Adjective

You Need To:	Which Means You Can:	Which Means You Can:
• Think about multiple concepts simultaneously • Categorize information • Identify same and different • Store and manipulate verbal and visual information • Persist in a task	• Understand and use words • Understand and use nouns • Understand the concept of description • Describe people, places, and things	• Understand and use adjectives

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appropriateness, *seeing multiple sides to a situation*, *managing conflicting thoughts*, and *overcoming temptation*. The foundational skills of sketching a still life of apples might be *shifting focus from one event to another*, *analyzing*, *changing perspective*, *organizing actions and thoughts*, *monitoring performance*, and *applying former approaches to new situations*.

Cognitive Access

Given that more traditional "lessons" that were once the monopoly of teachers are now readily available through other venues, such as the Internet, the role of the teacher and the focus of school instruction must shift. Students who possess strong executive function skills can cognitively access a lesson and learn from it; those who do not possess strong executive function, cannot.

The same is true for a classroom teacher's lesson. Those students who possess strong executive function can pay attention, follow along, and construct meaning from the information. Those who do not possess strong executive function will learn little, regardless of how accomplished and talented the teacher is. The achievement gaps that exist in schools today, therefore, may be more a matter of the brain's (cognitive) accessibility to content, that is, through executive function skills, than access to instruction.

While the spotlight on executive function first appeared in the world of special education, the reality is that all students need growth in executive function skills is needed by all students. Many students in regular education classrooms who are not identified for services related to special education struggle with academic achievement. The part of the brain that controls executive function does not fully develop naturally until the age of 25, thus anyone under that age who is challenged in the area of achievement may benefit from a focus on executive function. If you've ever heard anyone, including yourself, address a teenager or young adult with the question, "What were you thinking?" you can be sure that a lack of executive function was at the core of that frustration.

The value of teachers, therefore, goes far beyond the content presentation. If schools can help enhance and advance brain development related to executive function, they can provide their students with much greater cognitive accessibility to learning and higher-order reasoning, and protect them from the many unhealthy decisions that they might otherwise make. With executive function as the missing link to student achievement, schools cannot afford to let it be a topic of conversation only in special education circles; executive function must dominate the conversation of educational pedagogy.

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What's in a Brain?

In order to understand executive function, it is helpful to become familiar with the physiology and development of the human brain. The brain is composed of specialized cells called neurons, referred to informally as "grey matter" (Figure 1.1).

You may have studied cells in science class that looked more like rounded-edge rectangles. Neurons are highly specialized in their components. While the main cell is made up of the soma (cell body) with a nucleus (control center), look at the other components that make it a neuron. Neurons have all these little projections off of them called dendrites. The dendrites are the message receivers. Neurons each have one long axon that projects out from the soma and ends with another cluster of axon terminals. The neuron sends out signals in the form of chemicals that travel down the axon to the axon terminals, which are positioned close to the dendrites of another neuron. The tiny space between the axon terminal of one neuron and the dendrite of another is known as a synapse. The chemical is fired from the axon of one neuron, across the synapse, to the dendrite of another neuron. The more signals that are fired between two neurons, the stronger the connection, thus building brainpower, if you will. To put these neurons in perspective, the average human adult brain has approximately 100 billion neurons, each of which is connected to up to 10,000 other neurons. That's one quadrillion connections being managed by the brain!

As educators, we often refer to a student's prior knowledge or schema. This means that an existing, strong neural network is holding information for the student to retrieve and use. As young children enter school, their

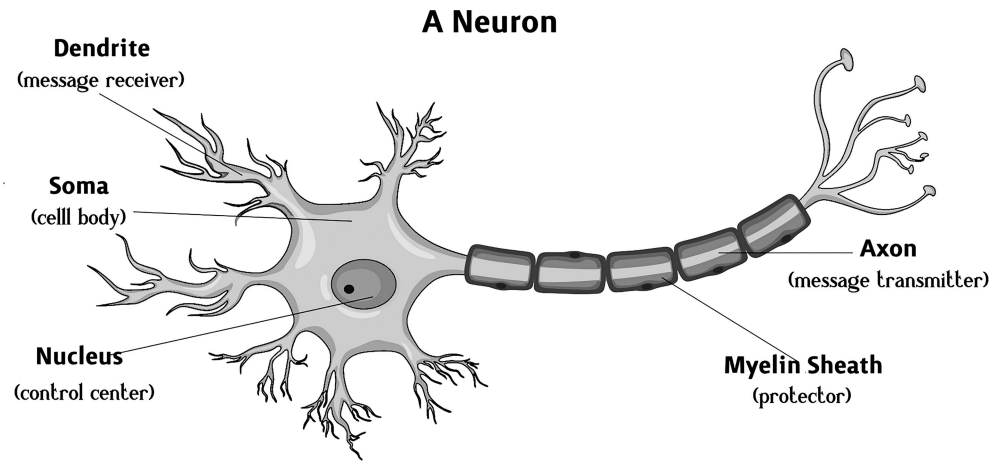

Figure 1.1 The anatomy of a neuron

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brains, and particularly the prefrontal cortex, are undergoing what is known as a synaptic proliferation: many new synapses are becoming strengthened, representing learning. The more experiences, the more practice, the more engagement with content, the more synapses will become strengthened, and therefore, the more grey matter is being created. This is why it is so important that our younger learners' days are filled with varied experiences and hands-on exploration.

As the brain matures, the axons become covered with a myelin sheath to protect them, a process known as myelination. This increases the speed of the signals flowing down the axon, thus improving the brain's memory and processing speed.

Typical Brain Development for Executive Function

The brain is typically described as various regions, each of which handles different functions, from breathing to movement to emotions to complex thought. As stated earlier, the front of the brain, just behind the forehead, is the prefrontal cortex, which handles most executive function skills. From birth, the prefrontal cortex continues to develop steadily, with inhibitory control and working memory being the first executive functions to solidify. The dendrites and connections in the prefrontal cortex grow by use. The more students hear language, the greater their ability; the more they see objects and hear objects' names, the more able they are to learn names of objects. Thus, the more executive function skills students encounter, the more the prefrontal cortex grows. The more you ask a young child to identify same and different, follow multiple steps, categorize, and be creative, the more the prefrontal cortex that handles these executive function skills grows.

From Terrible Twos to Fearless Fives

You've probably heard the term "terrible twos" when referring to toddlers. The way I see it, these toddlers have the ability to walk, grab, and move around the home; however, they lack significant executive function to determine right from wrong, consider consequences, and keep themselves out of trouble. They require constant oversight; someone else has to provide the executive function for them!

The brain then undergoes significant growth between the ages of four and five, which you'll note if you work with or have been around four-and five-year olds. For four-year olds, the reality that they can't do or have what they want feels like the end of the world. Temper tantrums can ensue. Then, within a year, five-year olds with typical brain development seem to have

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a much more reasonable view of reality. They are able to delay gratification, understand simple cause-and-effect relationships, consider future consequences in light of current action, and so forth. They have gained substantial executive function skills for social engagement; however, they still lack the skills they need to accurately assess dangerous situations; thus my term, the "fearless fives."

Stanford's Marshmallow Test

You may have heard of Stanford University's "Marshmallow Test," which is described in more detail in Walter Mischel's book, *The Marshmallow Test: Mastering Self-Control* (2014). Mischel, a researcher at Stanford, conducted an experiment in the 1960s and 1970s with over 600 children between the ages of four and six to study the ability of a child to delay gratification. The child was placed in a room, seated at a table. The test administrator placed one large marshmallow in front of the child and said that the child could eat the marshmallow now or wait for the test administrator's return with a second marshmallow, at which time the child could eat both. The test administrator then waited approximately 15 minutes before returning with the second marshmallow. A minority of the children ate the first marshmallow immediately. Most attempted to wait, using self-talk and distracting themselves from the marshmallow. Approximately a third actually waited the full time and received the reward. Age was a major determinant in the child's ability to delay gratification, further supporting the belief that executive function skills increase with the growth of the prefrontal cortex between the years of four and five. Experience in the skills listed in Appendix A will be key to prefrontal cortex growth in primary and elementary students.

Saving Our Teenagers from Themselves

During adolescence, the prefrontal cortex undergoes a second substantial growth phase, known as synaptic proliferation, and a pruning phase. Those synapses that are not regularly used are pruned and no longer available for use by the neuron. This relates to the "use it or lose it" phrase: if a youngster is learning piano and practicing regularly, most likely the brain's neurons will be firing and solidifying the connections and, thus, the capability. If a youngster has a few piano lessons and then stops playing, those unused synapses will eventually atrophy and the learning will most likely be lost.

Meanwhile, the brain is strengthening the nerve cells by wrapping a myelin sheath, made up of fat cells, around the main transmission stem (axon) of the nerve cell. The combination of the pruning process and myelination actually make the brain more effective and the prefrontal cortex stronger. However, during the pruning process, which typically occurs at puberty,

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the brain loses grey matter. Additionally, the brain matures from back to front, meaning that the prefrontal cortex is the last to mature, around the age of 25. Meanwhile, the part of the brain that reacts to pleasure and rewards is located at the back of the brain and therefore matures during adolescence, while the prefrontal cortex that handles reasoning and judgment is still developing. Adolescents are particularly prone to whatever stimulates the pleasure sensors of the brain, yet they have little ability to effectively evaluate those and make healthy judgments. Add hormones to that mix and you have the typical teenager! Teenagers need cues and protocols for navigating those teenage years. Once the growth spurt of pruning and myelination processes starts slowing down, a teenager has one powerful brain!

The Effect of Stress on the Prefrontal Cortex

Stress is not good for anyone's overall health, but it is particularly harmful on the developing prefrontal cortex. Children who live under chronic stress, which could include poverty, domestic violence, emotionally or physically abusive parents, protracted divorce, etc., tend to demonstrate lower levels of executive function. It is important to understand the impact of stress on the body.

Built into the human body, from the beginning of our days on Earth, is a "flight or fight" response to danger. If you are being attacked by a wild animal, for example, you have two choices: attempt to fight it or run as fast as you can. Deep inside the brain is an almond-shaped area known as the hypothalamus; it exists in all vertebrate animals. Its job is to make a connection between your central nervous system (brain, spinal cord) and the endocrine system, whose job it is to send hormones to targeted organs based on the body's need. At the first sign of a stressful situation, your hypothalamus sends a signal to the pituitary gland (a pea-sized gland just below the hypothalamus) which sends a signal to the adrenal glands that sit atop the kidneys. One of the functions of the adrenal glands is to secrete adrenaline and cortisol in the face of stress. Adrenaline immediately focuses your attention on the problem and provides you with that rush of energy. You've most likely experienced it when you were in a near accident: having an animal run out in front of you while driving and having to steer clear of an accident, jumping out of the way of a falling object, etc. You feel that rush, your heart starts pounding faster, you seem to visualize in slow motion so you can focus, and you may sweat. That's adrenaline, the first responder to

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stress, which puts your body in motion. It dissipates as quickly as it is created, so your body does not build up adrenaline during stress.

Immediately following adrenaline is cortisol, which pumps glucose into your large muscles that are in your legs and arms, thus the ability to fight or flee. The body draws energy away from the less important functions when you're fighting or fleeing in a stressful situation. Those include digestion and the development of the prefrontal cortex. Consider that when you're dealing with an animal attack, you really don't need to digest that meal, nor do you need to focus on higher-order reasoning. The body cannot distinguish between the stress of a charging animal and seeing your mom break down because she can't pay the bills, or being told you have to pack your things and leave your home, or being the victim or viewer of abuse. In these situations, you don't need to fight or flee, so all of that glucose entering your system goes unused, building up in the body.

Young children who live in significantly stressful situations experience chronically high levels of cortisol in their system. Chronic levels of cortisol lead to dendritic atrophy—big words that mean those dendrites that are receiving signals across synapses to build brain capacity are shriveling up. The brains of "stressed-out" children are literally less physiologically capable of learning than they would be without stress.

Hope for Advancing the Growth of the Prefrontal Cortex

Phineas Gage was a railroad construction foreman in 1848. In blasting through rock, the workers would pack dynamite into blasting holes, using a long tamping iron, and then ignite it. Somehow, Gage was distracted in the process and the dynamite ignited while the tamping iron was still in the hole. It shot out of the hole, thrust upward through the explosion, pierced Gage's jaw, destroyed a molar, took out his eye, and exited at the middle front of his skull, just below his hairline. After the accident, Gage was conscious and sat upright while transported by horse and carriage back to his house. He spoke with Dr. John Harlowe throughout the immediate treatment. The rod had sliced through Gage's prefrontal cortex, but it did not seemingly affect any life-supporting areas of the brain. Gage was 25 years old at the time. Three key events paved the way for what we know today about executive function and the prefrontal cortex.

First, his doctor and friends found that, after the accident, his personality had changed considerably, to the point where his friends referred to him as "no longer Gage." His doctor's notes indicated that Gage had outbursts of profanities, could not stick to plans, cared little for others, and was impulsive.

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Gage had survived the accident with no damage to his motor skills or basic brain functions; the rod had only destroyed a section of his prefrontal cortex, not closely related to human survival. However, his doctor was intrigued by the effects of the destruction of that part of the brain. His executive function skills, as we define them today (see Appendix A), were greatly impaired.

The second event came years later when Dr. Harlowe tracked down the family after Gage's death only to find that he had resumed a fairly normal life, even holding a job as a stagecoach driver in Chile before returning to San Francisco where he died of a seizure, believed to be related to the accident, at age 37. At the doctor's request, Gage's body was exhumed and the skull and tamping iron were given to the doctor. They reside today at a museum at Harvard Medical School.

Thirdly, in the 1970s, a psychologist and historian by the name of Malcolm Macmillan took an interest in the story of Phineas Gage. For more than 40 years he has studied the accounts of the accident. One day, Macmillan was watching Queen Elizabeth's husband, Prince Philip, racing horse coaches and realized it was similar to those that Gage would have ridden in Chile. As he watched the intricate movements that Prince Philip made to the reins, he realized that Gage could not possibly have performed those functions without executive function, and thus, an intact prefrontal cortex. Macmillan concluded that Gage's prefrontal cortex must have, in fact, regenerated. This led to the possibility of what we now know is the plasticity and ability of the prefrontal cortex to recover and grow. Gage's life is one of the well-known topics of neurology students. The recovery of his prefrontal cortex should be considered by teachers to be hope for students who lack or are delayed in developing executive function skills.

Making a Difference in the Classroom

The term "executive function" emerged in the 1980s, relatively recently in education history. Executive function encompasses a collection of skills related to working memory, inhibitory control, planning, organization, and higher-order reasoning. While once the focus of research into mental illness, it has come to also be associated with autism, ADD, and ADHD. Now, it is becoming more obvious that the skills that comprise executive function are the keys to academic achievement for all.

While scientific knowledge of the workings of the prefrontal cortex is relatively new, we now know that executive function skills are necessary for making sense of classroom instruction, and that, through targeted experiences, teachers can contribute to the growth of the prefrontal cortex and

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executive function skills. Therefore, teachers can have a positive impact on student achievement by incorporating deliberate activities, structures, and facilitation strategies in the learning environment. For younger students, building foundational executive function skills will better position them to learn academic content. For older students who seem to have a strong foundation, continuing to focus on building executive function skills may save them from making some very detrimental decisions in their lives.

Never Say, "Try Harder!"

If a principal escorted a new student with a broken arm into class, the teacher would make adjustments to accommodate the learner, given the physiological deficit. No teacher would say, "Try harder," encouraging a student to reach out for an object with that broken arm. Likewise, the phrase "try harder" should not be applied to students with an underdeveloped prefrontal cortex. Executive function is a physiological ability. Telling a child who has memory problems to "try harder" is not only ineffective, but can be harmful to a student's sense of self. Addressing deficits through deliberate activities and structures will yield far greater results in a relatively short period of time.

STOP! Turn to Your *Efficacy Notebook* (See the Introduction).

Title this "Chapter 1 Reflection." Now that you've read about the meaning of and reasons for pursuing executive function as a classroom practice, reflect on and answer the following questions:

1. What is your biggest takeaway from this chapter thus far?
2. What is your most compelling reason for attending to executive function throughout the day?
3. What else do you want to know? (Return to this when you finish reading the book to see if your questions are answered in the book or if you have to do some more digging).

Where to Start

Appendix A offers you a look at executive function skills categorized according to brain science, such as "working memory," "cognitive flexibility," and so forth. To make the pursuit of strong executive function more accessible

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in a classroom environment, I map these skills to six areas of important life skills (see Appendix B). Rather than focusing on executive function skills as another content area to be mastered for its own sake, approach executive function skills from the perspective of their importance in building important life skills. While individual executive function skills are not exclusively used in one area of life, the categorizations that follow are intended to offer a roadmap, if you will, for where to start when considering how to support executive function in students (see Figure 1.2.).

Figure 1.2 Executive function by life skill

- **Conscious Control**—One's success in life and human interaction depends upon one's ability to consciously control actions rather than being merely reactive. Being able to *focus*, *concentrate*, and *manage conflicting thoughts* are a few of the executive function skills related to conscious control.
- **Engagement**—Student compliance in the classroom may produce short-term results and the appreciation of teachers but not

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necessarily produce long-term learning. Students must grapple with content in order to make sense and meaning of it, a requirement of long-term retention of knowledge (Sousa, 2022). *Thinking about multiple concepts simultaneously*, *identifying cause-and-effect relationships*, and *persisting in a task* are a few of the executive function skills related to engagement.

- **Collaboration**—Personal and professional advancement relies upon one's ability to work well with others, including working together to solve problems. Learning is social; it involves engaging with others and others' ideas; it is a process of give-and-take, and, as one collective mind, moving beyond one's self to take ideas and innovations to the next level. *Seeing multiple sides to a situation*, *being open to others' points of views*, and *thinking before acting* are a few of the executive function skills related to collaboration.
- **Empowerment**—With learning comes independence, a level of autonomy and self-determination that allows one to advocate for one's needs, desires, and ideas responsibly. As teachers give students greater responsibility, choice, and voice in the classroom, students need to be able to rise to the challenge. *Setting goals*, *managing time*, and *self-assessing* are a few of the executive function skills related to empowerment.
- **Efficacy**—Learning eventually outfits one to carry out a plan of action, achieve goals, and make a difference. While empowerment comes from others, efficacy comes from a personal sense of one's ability to make a difference: an important quality of a world citizen. *Organizing actions and thoughts*, *creating mental images*, and *predicting outcomes* are a few of the executive function skills related to efficacy.
- **Leadership**—Ultimately, the learned lead others to achieve personal and collective goals. Leadership does not mean one leads in every situation but can lead in some. It does not necessarily mean one must take a formal leadership role but rather be able to informally lead others. Our world depends upon the development of effective, empathetic leaders. Realizing one's leadership ability is dependent upon all of the executive function skills presented in this book and in combining them in ways to reap the greatest benefits.

Appendix B offers you a look at executive function skills categorized by these life skills. As you ponder this collection of executive function skills, please know that it is impossible to pin any executive function skill to just one of the life skills above. Most of the executive function skills are critical to several of the life skills. This categorization is intended to shift focus from attempting to

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teach these skills as an end goal and, rather, address executive function skills from a "big picture" lens by linking them to more formidable life skills.

Chapter 1 Summary

- Executive function skills are required in order to make sense of content presented in lessons, text, videos, conversations, and other venues. Without it, the best lesson will fall short of its goal.
- Executive function skills are powerful partners in the teaching and learning relationship; therefore, teachers should pay as much attention to building executive function as they do to designing great content lessons.
- Artificial intelligence (AI) is increasingly available and, while it can help students synthesize and apply learning, it lacks many of the executive functions needed in life and in the workplace.
- Employers list executive function skills such as creative thinking, analytical thinking, flexibility, adaptability, leadership, empathy, active listening, and more as their priorities in hiring and upskilling employees.
- Executive function skills are controlled in great part by the prefrontal cortex, an area of the brain that undergoes significant change throughout the first 25 years of life; therefore, teachers should consider growth states of the prefrontal cortex and address students' needs accordingly.
- Chronic stress has a negative effect on the development of the prefrontal cortex and, thus, executive function skills; therefore, teachers should take steps to recognize when stress is a factor in physiological brain development and not assume students have control over their executive function skills.
- The prefrontal cortex has the ability to grow and heal based on use; therefore, teachers should provide students with deliberate activities and structures to build executive function skills, which will, in turn, build the prefrontal cortex.

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