# 1

# The Recipe for an Engaged Brain

Every weekday morning without fail, we climb out of bed, after striking the snooze button on the alarm clock the maximum allowable number of times, and prepare ourselves for an often unpredictable, but ultimately rewarding, day as an elite group of professionals dedicated to the development and achievement of all students. We are teachers. Our important and carefully scripted morning routine serves as a necessary process to ready ourselves for the action-packed day of "reading, writing, and arithmetic." Reading teachers are revving up for a day of context clues, inferences, and reading comprehension. For writing teachers, distinguishing between active and passive voice may be on the agenda. Physical education teachers, music teachers, and art teachers prepare to construct classroom experiences that promote wellness and creative expression. As mathematics and science teachers, we passionately prepare to pass along the great ideas of algebra, geometry, earth science, physics, and biology just as the intellectual giants of our disciplines, like Euclid, Pythagoras, Newton, and Einstein, did many years ago. Math teachers may battle the challenge of improper fractions, solving equations, or completing the square, all while spearheading the

fight against dependence on a calculator. Orchestrating an enriched laboratory activity that promotes and models the true nature of science and the knowledge derived from it is paramount just down the hall in the science wing.

Although the specifics of the day differ across grade levels, classrooms, and content areas, each teacher gambles on the willingness of students to "play along" and engage in his or her carefully crafted vision for the day. On the very best of days, students are eager, interested, and compliant from the beginning of the day until the final dismissal bell. They willingly complete all tasks and assignments handed to them, including those tasks and assignments reserved for "after hours." The students do their homework! The other end of the spectrum would be an apathetic, disinterested, and defiant student who notices each tick of the clock and agonizes over every second. Obviously, this student has no interest in completing any tasks or assignments, and we don't even think about collecting homework from him or her. Although individual levels of engagement fluctuate from day to day, class to class, and even minute to minute, most of you can visualize a number of students who fall on various locations along the engagement spectrum (see Figures 1.1 and 1.2). What does engagement look like and sound like?

**Figure 1.1** Engaged Students

**Figure 1.2** Disengaged Students

**Stop-n-Think Box 1.1**

If you were to look out over your classroom, how would you recognize a student who was engaged in your science or mathematics lesson? How would you recognize a student who was not engaged in your lesson?

- Make a list of behaviors and observable characteristics associated with a student engaged in your classroom.
- Make a second list of behaviors and observable characteristics associated with a student *not* engaged in your classroom.

## The Recipe for Student Engagement

The recipe for student engagement contains six "must-have" ingredients and just as many steps. Grab your lab coat and protractor, gather a group of young science and math brains, and get ready.


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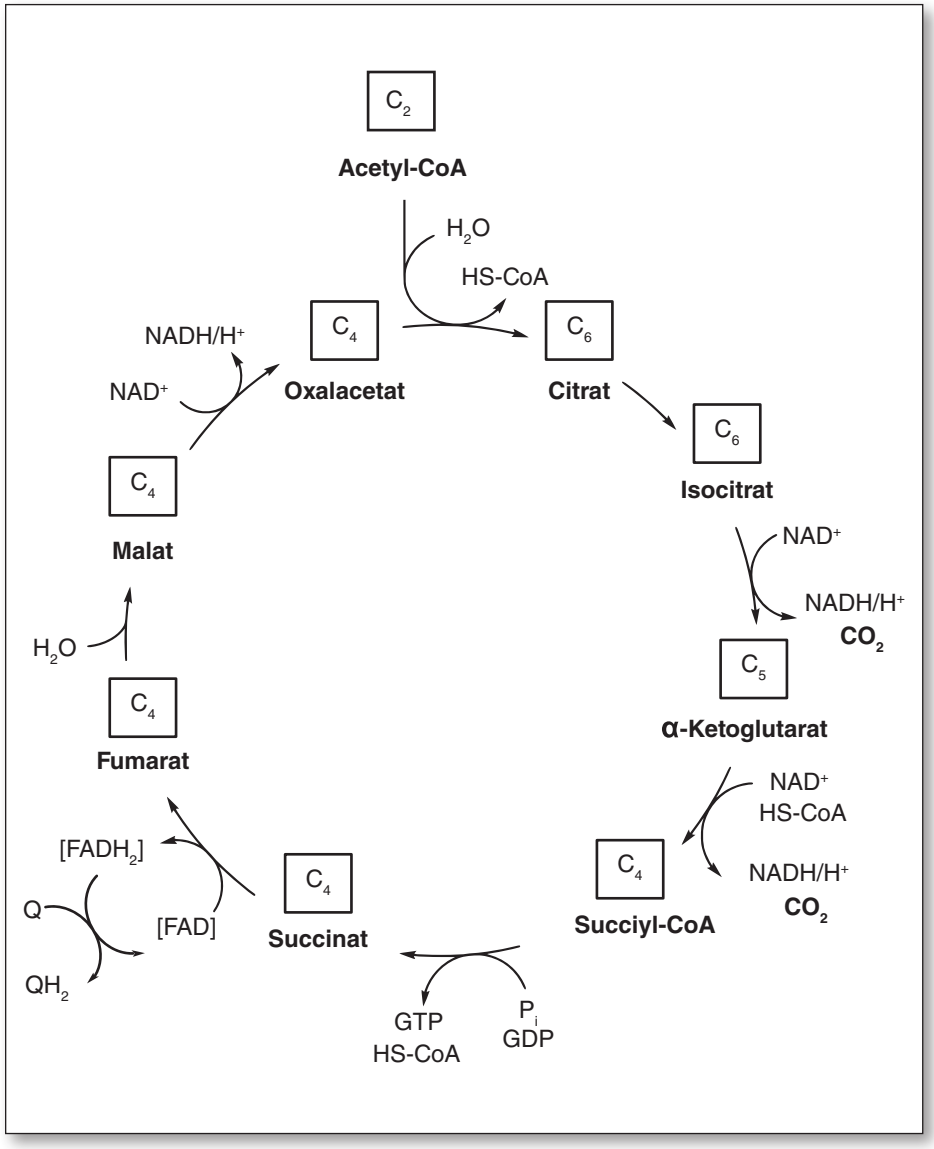
1. **Prime** the brain. Stir.
2. Sprinkle in the right amount of **novelty**. Continue to stir.
3. Insert a good portion of **relevance**. Blend together with the content often.
4. Pour into the **big picture** and mix together some more.
5. **Marinate** for approximately 15 minutes; then stir once more.
6. Allow to cook for two to three days, **checking** often for degree of doneness. Stir as needed.

This recipe provides a framework for structuring your next lesson on the Krebs cycle (see Figure 1.3), Newton's Third Law of Motion (see Figure 1.4), salinity of the world's oceans (see Figure 1.5), the Pythagorean Theorem (see Figure 1.6), or solving systems of equations (see Figure 1.7).

This recipe also provides a framework for structuring your next unit on circuits, stoichiometry, quadratic equations, or linear inequalities. Taken individually, the ingredients likely will not result in the desired outcome: student engagement. After all, simply making learning novel without "checking for degree of doneness" does not do the student brain any favors, just like a teaspoon of salt is never as delectable by itself as it is in freshly baked chocolate chip cookies. The power of the end result happens when the ingredients are blended together. Together the ingredients create a classroom environment that will not only increase student engagement in the

learning experience, but ultimately will also increase the level of student achievement in your classroom. In the chapters that follow, we will present each ingredient of the recipe, the brain science behind it, and ready-to-use strategies and examples that make each ingredient classroom ready.

**Figure 1.3** Krebs Cycle

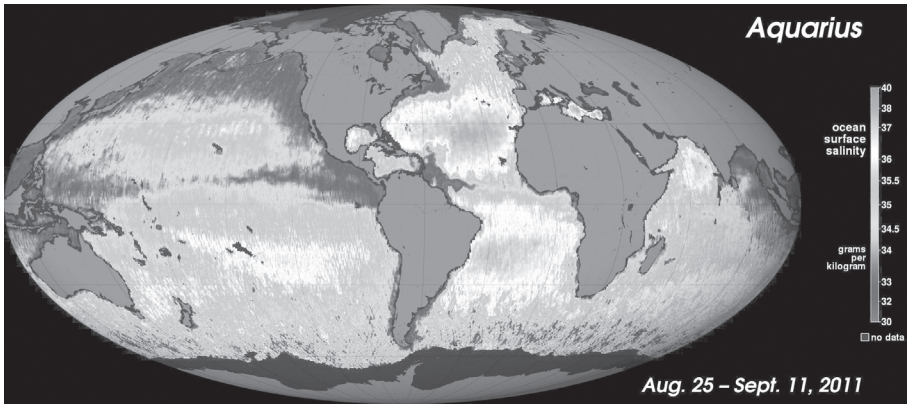



*Source:* Wikipedia/Yikrazuul.

**Figure 1.4** Newton's Third Law of Motion

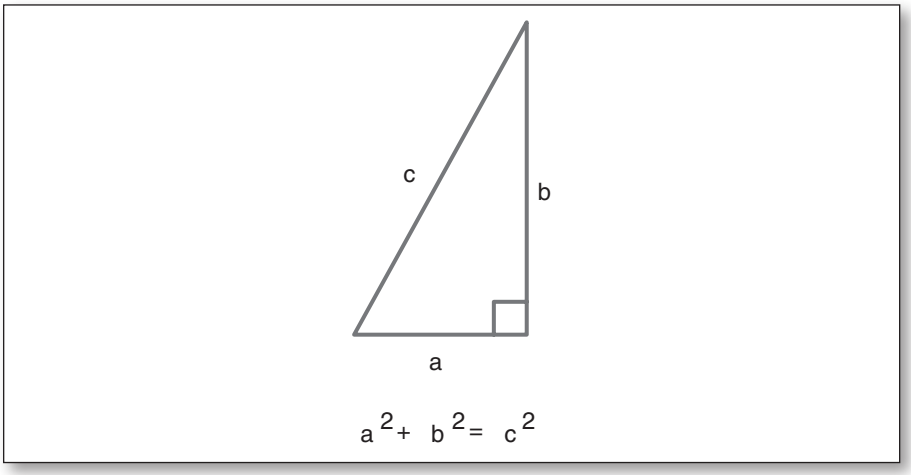

Photo from Thinkstock.com.

**Figure 1.5** Salinity of the World's Oceans



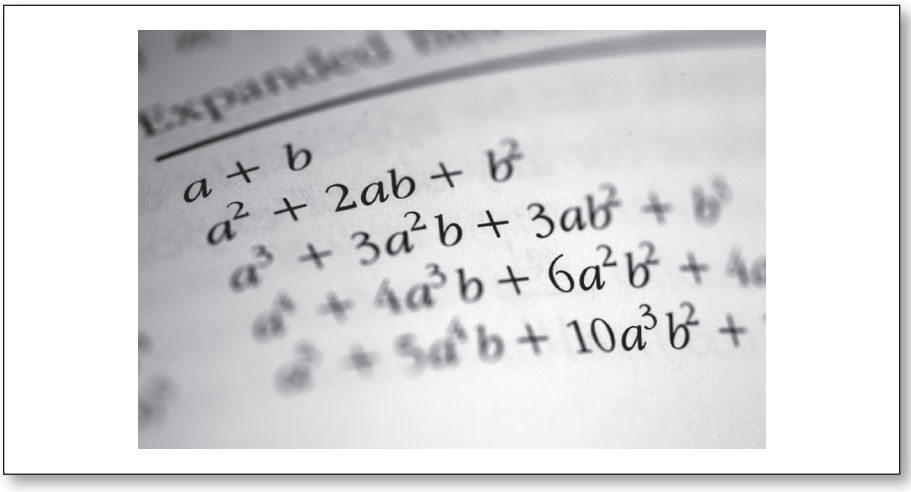

*Source:* NASA/GSFC/JPL-Caltech.

**Figure 1.6** Pythagorean Theorem




*Source:* Wikimedia.org.

**Figure 1.7** Solving Systems of Equations

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## Recipes as Frameworks

Granny's kitchen was a simple but magical place. The head chef was a five-foot-tall woman of God who took unimaginable pride in her family, her housework, and her cooking. Until the day she died, her memory retrieval about the proper way to make butter, homemade

bread, chicken and dumplings, and pie with a from-scratch piecrust was 100% accurate. Yet, if you were to ask her about the day's visitors to the nursing home, her recall was more like that of a 16-year-old taking a test in trigonometry the day before the homecoming dance: mediocre at best. However, the real point of this story has to do with my grandmother's use of recipes. She had a lot of them. They were organized by courses and then by main ingredients. But the keen observer would notice that she never used a recipe while in action. With more than 80 years of practice, she had mastered each dish and prepared it by relying only on her memory.

As her health began to decline, it was obvious to many of us in the family that Granny's kitchen traditions were at risk of being lost forever. In the interest of preserving such delectable heirlooms, I bravely asked for her recipes and gave them a try. To my amazement, they tasted nothing like Granny's. I followed them step by step, not deviating even a whisk, teaspoon, or degree from her original recipe. What could possibly have gone wrong? Not a single bite was as good as Granny's. Then it hit me: My grandmother used recipes as the framework. She then adjusted each step, depending on the other dishes or the hungry people who would slide their feet under her dinner table the moment these dishes were ready. A little more of this, a little less of that, and she managed, each time, to find perfection. It was then that I discovered she was an expert at the skill of monitoring and adjusting. These two skills also serve as the foundation for successful teachers.

The recipe for student engagement we present in this book is analagous to my grandmother's recipe for chicken and dumplings: The six "key ingredients" (prime, novelty, relevance, big picture, marinate, and checking) provide a framework for cooking up a highly engaged classroom and serving intrigued and successful students. However, the way you ration the ingredients in your classroom may be completely different from the way Mrs. Smith, two doors down, does it. Mrs. Smith's students may need more priming and less novelty, simply because the learning of the day is novel enough by itself (e.g., combustion reactions in chemistry, fractals in geometry, or tornados in earth science). You, on the other hand, may find that an extra pinch of relevance is exactly what your recipe needs that day. Not only will this differ from classroom to classroom, but the recipe may need adjusting from topic to topic and day to day.

Each student in your science or mathematics classroom has a grocery list of experiences, both positive and negative, that have had a profound influence on his or her brain. In addition, these

experiences strongly influence student attitudes and dispositions toward science and mathematics. Given that no two individuals have the same experiences in life or in the classroom, differences among teenage brains are the norm, not the exception (Blakemore, 2012; Casey & Jones, 2010; Choudhury, 2010; Crawford, 2007; Feinstein, 2009; Powell, 2006; Schenck, 2011; Wolfe, 2010). Simply put, no two brains are alike. The factors that contribute to this diversity among brains include, and certainly are not limited to, genetics, relationships, socioeconomic status, and the environment (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Baydar, Brooks-Gunn, & Furstenberg, 1994; Blakemore, 2008; Chow & Stewart, 1972; Driemeyer, Boyke, Gaser, Buchel, & May, 2008; Gottfried, Gottfried, Bathurst, Guerin, & Parramore, 2003; Greenough, Black, & Wallace, 1987; Grossman, Churchill, Bates, Kleim, & Greenough, 2002; Huttenlocher, 1979; Maguire et al., 2000; McGivern, Andersen, Byrd, Mutter, & Reilly, 2002; Rutter & O'Conner, 2004; Sameroff, 1998; Weisel & Hubel, 1965; Yakovlev & Lecours, 1967). In fact, some researchers argue that genetics contributes approximately 30% of who we are as individuals; the rest is environment (Devlin, Daniels, & Roeder, 1997; Saudino, 2005). Therefore, a cookie-cutter approach to engagement is both unrealistic and inappropriate. Just as you would adjust the recipe for a home-cooked meal to taste, the recipe for engagement can be adjusted.

Addressing the individual needs of the wide range of learners who populate your science or mathematics class would take volumes, not chapters. However, modifying the recipe in this book can meet the needs of diverse learners in science and mathematics.

It is our belief that, over time, you will master the use of the recipe and simply adjust it according to the needs of the faces staring back at you as you assume your position at the front of the room. How will you know when to adjust the recipe?

## Using Your Engagement Monitor

**Stop-n-Think Box 1.2**

No one knows your classroom better than you. Make a list of the big ideas or major concepts that you teach in a given month, semester, or year. Based on your past experiences, which of these ideas or concepts need more priming? More or less novelty? More or less relevance? Which ideas or concepts require more checking for degree of doneness?

Did you know that the average teacher typically makes about 1,500 decisions every day (A. Fredericks, 2005)? Many of these decisions concern the development and presentation of a well-cooked lesson. The monitoring and adjusting process starts with your content and relies on your experience in the classroom. As you monitor and observe the students' behaviors, you should be watching for those observable characteristics you previously identified in Stop-n-Think Box 1.1. Then ask yourself, are those behaviors telling you that little Johnny's brain is highly engaged, or are they simply telling you that his brain has "left the building"?

How often do you create 100% active participation—the continuous, ongoing, simultaneous engagement of all students in relevant learning—in your classroom? Wouldn't it be great if every time you asked a question or presented a task you generated 100% participation? It is possible!

## Engagement: An Overt and Covert Operation

There are three types of engagement: behavioral engagement, emotional engagement, and cognitive engagement (Appleton, Christenson, & Furlong, 2008; J. Fredricks, Blumenfeld, & Paris, 2004; Reschly, Huebner, Appleton, & Antaramian, 2008; Skinner, Kinderman, & Furrer, 2009). In the classroom, on any given day the odometer readings for each individual student fluctuate across these three types of engagement (see Table 1.1).

**Table 1.1** Three Types of Engagement

| *Type of Engagement* | *Description* |
|---|---|
| Behavioral Engagement | The student is compliant with all rules, regulations, and instructions. Put differently, the student does exactly what he or she is supposed to do.<br>This is the most easily observable type of engagement. |
| Emotional Engagement | The student is vested in the classroom, lesson, and/or activity. He or she has bought into what is happening in the classroom and thus feels connected to his or her learning.<br>This is the most overlooked type of engagement. |

| *Type of Engagement* | *Description* |
|---|---|
| Cognitive Engagement | The student is thinking about what he or she is engaged in at this particular moment.<br>Hands-on and minds-on.<br>The occurrence of this type of engagement depends on the specific strategy, task, or activity provide by the teacher. |

For example, students may shuffle in at 8:00 a.m. on time with all of their supplies (high behavioral engagement), but they may have no interest in being at school (low emotional engagement). Or, a student in the third row, second seat back has her book, notebook, pencil, and calculator out on her desk; she is sitting quietly while the teacher presents an example of how to graph a linear inequality in algebra or set up a free-body diagram in physics (high behavioral engagement). However, the student is daydreaming about this Friday's high school football game (low cognitive engagement).

**Stop-n-Think Box 1.3**

List specific examples of strategies that promote behavioral engagement, emotional engagement, and cognitive engagement.

The task for us as teachers is to cook up a plan that encourages all three types of engagement. A teacher who stresses behavioral engagement (e.g., lots of rules, procedures, and a superb classroom discipline system) will only be successful if he or she includes specific strategies to promote emotional and cognitive engagement. Otherwise, he or she will have a room full of well-behaved students who are miserable and thinking about all of the other places they would rather be. Similarly, if you have cognitively complex and engaging activities, but your classroom is a three-ringed circus, student achievement will suffer. The recipe for engagement is designed to provide a guide to finding the ideal balance of behavioral, emotional, and cognitive engagement by pairing research on the student brain with specific classroom strategies. These strategies come in two distinct forms: overt and covert.

You can increase the level of student engagement by making a conscious decision to use these two different strategies simultaneously.

Whenever your students' behavior can be observed, monitored, or measured, they are exhibiting an overt response (Corno, 1993; Finn, 1989, 1993; Finn & Voelkl, 1993; Pintrich, 2004; Schunk & Zimmerman, 2003; Vrugt & Oort, 2008). Quite often teachers successfully engage their students in many overt activities throughout the day, such as creating a nonlinguistic representation, engaging in a peer conversation, drafting an advanced organizer, or performing a demonstration. All of these activities can be observed, measured, or monitored by the teacher and by other students. There are also activities that cannot be seen, measured, or monitored: Whenever you ask your students to think, imagine, visualize, or go over something in their minds, you are asking them to perform a covert behavior (Appleton, Christenson, Kim, & Reschly, 2006; Corno, 1993; Finn, 1989, 1993; Finn & Voelkl, 1993; Furlong & Christenson, 2008; Pintrich, 2004; Schunk & Zimmerman, 2003; Vrugt & Oort, 2008). Even though you cannot observe, hear, measure, or monitor the activity, if the students are performing the requested task, it is active participation.

Much of the thinking done in formal education has focused on skills of analysis. As students perform many of the 21st-century learning skills, they will be engaging in a covert activity. This includes mentally estimating answers, identifying and eliminating incorrect responses, and critically thinking about logical solutions. When we request these tasks, we are creating covert learning experiences for our students. Developing the thinking skills of your students is becoming a vital part of education. When they go out in the working world, potential employers will be seeking employees who are proficient at exploring ideas, generating possibilities, and seeking multiple answers to challenges. This is only one reason why it is essential that teachers make conscious decisions to embed both overt and covert active participation in their lessons.

The real bang for your planning buck will come when you combine these two strategies. When the strategies are used separately, the students you intentionally involve in an overt activity (e.g., putting a problem on the board, explaining a particular concept, or answering a question) are highly engaged; however, too often this leaves the rest of the students in the class disinterested and unengaged. Consequently, teachers are often occupied with the students who are engaged and don't even realize that a large percentage of the students are waiting or tuning out. Put yourself in their shoes. If a teacher calls on a student to describe the difference between abiotic and biotic factors in an ecosystem, in most cases, his or her classmates are either relieved because they were not called on or are disappointed that they

were not allowed to show off their knowledge of ecosystems. In both cases, the odds of them checking out for this time are probably quite high. So the next time you ask a student, or several students, to go up to the interactive whiteboard to complete an equation or solve a problem, simultaneously assign a covert thinking activity to the other students in the room. If a student is sharing his or her solution of a physics or chemistry problem, ask the other students to check their solutions, step by step, looking for alternative routes or areas where they would have done something different. What a great opportunity to stimulate higher-level thinking, embed creative thought, or develop problem-solving skills. It can be as simple as asking the other students to reflect on the process the student used to derive the solution or to develop a different method for finding the solution and then explain their thoughts.

**Stop-n-Think Box 1.4**

What are other strategies for fostering overt engagement in your science or math classroom? What are some ideas you have for simultaneously combining overt and covert strategies?

## You Can Lead Students to Class, but Can You Make Them Think?

Many teachers will argue that you cannot make students think. They are exactly right! If we create a climate in which one or two students volunteer to participate, the others may disengage or feel no accountability for participating. Instead, create an engaging climate by inviting your students to think, and then follow up by giving them the opportunity to show and tell you what, in fact, they thought about. For example, two very important words can make a huge difference: *all* and *everybody* (see Table 1.2).

It is amazing how those two simple words, *all* and *everyone* can increase the level of active participation. Try it; you'll like it! Set the expectation that all your students will think, instead of unintentionally sending the message that whoever wants to participate is welcome to share his or her thoughts. When you expect students to think and participate, you are requiring that students put forth effort. Once you have made the conscious decisions necessary to result in a certain percentage of your students engaging in an overt activity and the

**Table 1.2** Volunteering Versus Engaging

| *Volunteering Climate* | *Engaging Climate* |
|---|---|
| Who would like to . . .? | Everybody, be ready to . . . |
| Would someone please read . . .? | All of you think about a method that will . . . |
| Can anyone tell me why . . .? | Everyone write down . . . and raise your hand when you are ready to share. |

remainder of your students engaging in some type of covert thought process, you have created the expectation that all of your students are engaged. Congratulations, you are on your way to 100% active participation!

As a note for emphasis, this usually does not *just happen.* During the planning process, as you develop your lessons you will need to make conscious decisions to embed the different types of engagement within the recipe. Active participation has been known to increase students' rate and degree of learning, create motivation, and help students develop those relevant meaningful connections that are so important for the brain (Connell, Spencer, & Aber, 1994; Marks, 2000; Pashler, 1999; Skinner, Wellborn, & Connell, 1990; Styles, 1997).

## CHAPTER 1: 3-2-1 EXIT TICKET

List at least **three** ideas or concepts you want to remember from this chapter.


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Describe at least **two** strategies you will take away from this chapter and try out in your classroom.

What is **one** challenge you will face as you implement the ideas from this chapter?

## Engaging Professional Development Tasks

1. This professional development task involves a video critique of your teaching. Video record yourself teaching a lesson or activity. Set up the flip camera or digital video recorder so that when you review the digital recording, you can see the behavior of the students in your classroom and your behaviors as a teacher. Wait a day or two and watch your teaching video by yourself to ensure an honest evaluation and critique. Make notes of what you observe during this teaching episode. Use the following questions to guide your reflection about your teaching video:
   - Are your students engaged? How many are and how many are not?
   - What are you using as evidence to decide whether they are or are not engaged?

- Can you identify the use of covert and overt engagement strategies?
- Is your climate a volunteering climate or an engaging climate?
- What are your students doing while you are teaching?
- Does the level of student engagement change during the lesson or activity? Is this change associated with a particular part of the lesson or activity?
- How has this video review and reflection changed your perspective on your teaching and student engagement?

2. This professional development task focuses on the use of the recipe to increase engagement in a diverse classroom. No two students are alike. In your classroom, students come from diverse socioeconomic, ethnic, racial, and cultural backgrounds. Similarly, students vary across a range of cognitive ability, learner readiness, and interest levels. As a result, the recipe for engagement must be seasoned to taste. That is, the amount of time spent on any one part of the recipe should be directly related to the characteristics of the students in the class. How might the recipe be modified for the following students?

   - A student with attention-deficit/hyperactivity disorder, dyslexia, or another learning disability.
   - A student who comes from a low socioeconomic status.
   - A student whose primary language is not English.
   - A student who is highly gifted in science and mathematics or has parents in science- and mathematics-related disciplines.

What parts of the recipe may need more emphasis or less emphasis? Why do you believe that to be the case?

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