Captivate, Activate, and Invigorate the Student Brain in Science and Math

Grades 6–12

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Foreword

The past three decades have seen an explosion of information from the fields of cognitive science, neuroscience, and educational research. We've learned more in these few years than in all of history. Although everyone seems to be fascinated with these new findings, educators are perhaps more captivated than most. The reason is not difficult to understand: The brain is the organ of learning, but we have had little information about how it works! Our students' brains have been black boxes, with their secrets locked inside. Why is it that some children learn to read easily and others suffer great difficulty with the task? How is it a teacher can explain something one day and the next day students act as if they've never heard it? What role does emotion play in learning? How can teachers motivate reluctant learners?

Teaching involves making thousands of decisions each day; however, the knowledge base from which they've generated their decisions has been limited. Educational practice has been largely based on what the behavioral sciences could provide, which is sometimes helpful but not sufficient. There's more to teaching and learning than reinforcement theory. Of necessity we've operated intuitively. Intuition has worked well in many instances but has left us without the ability to articulate our craft to others. Because of this, we've become, as educator and expert on the brain Bob Sylwester puts it, a "folklore profession." This lack of scientific knowledge has left us at a disadvantage in designing pedagogy and implementing curriculum in our schools.

While neuroscientists seldom give educators specific suggestions on how to implement their findings in classrooms, the research is giving the field a new understanding of how the brain encodes, manipulates, and stores information, in other words, how it learns.

Preface

> *The primary finding is this, student time spent engaged in relevant content appears to be an essential variable for which there is no substitute . . . Teachers who make a difference in students' achievement are those who put students in contact with curriculum materials and find ways to keep them in contact.* (Rosenshine & Berliner, 1978, p. 12)

With the recent media attention focused on American students' performance in science and mathematics relative to the rest of the world, science and mathematics achievement in the United States has become a hot topic in education circles and public conversation (National Academy of Science, 2005, 2010; National Center for Educational Statistics, 2011a, 2011b; National Research Council, 2011; National Science Board 2007, 2008, 2010). After listening to the reports about America's science and mathematics students, the message that most of the public walks away with is that our students are falling behind. For every person involved in this discussion, there is an opinion on how to address the concern. Some argue that we need higher standards, while some argue for more funding, teacher preparation, or even the restructuring of public schools. As a response to yet another approach, Diane Ravitch (2011) stated, "We can't fire our way to excellence," which counters the desire of some stakeholders to simply fire teachers in low-performing classrooms.

The framework presented in this book takes a significantly different approach—an approach that is a ground-up framework. The best way to tackle a problem is to start with the things that are within your control. Sitting around dissecting the American Education

System leads to a time-consuming conversation that, in the end, solves nothing. Speaking in generalities such as America's students cannot do fractions, think critically, or avoid science and mathematics is purely venting and concludes without a solution. However, this is not the case in your classroom. Your classroom is where daily change can and does happen. The recipe for engagement takes the most recent understanding of how the student brain works and interfaces it with an approach for teaching science and mathematics. The end result is an engaging science and mathematics classroom for a wide range of diverse learners. As students file into our classrooms, it would be very difficult to anticipate or hypothesize about their expectations for the semester or the year. Students take classes for a variety of reasons. Whether students take our classes because biology and geometry are the next courses in the sequence, chemistry and trigonometry are requirements to graduate or they have room for an elective and picked physics and calculus to fill up their schedule influences what they expect from you and your class. However, our expectation should be that each and every student walks through the door at the beginning of class and out of the door at the end of class better off because he or she spent some time with us. This starts by designing each individual activity, lesson, conceptual unit, and science and mathematics course with the sole purpose of engaging the student brain.

So what would this look like? My guess is that every teacher would be interested in having every student fully engaged in learning from the start of class until the end of class. Would you be interested in picking up strategies that increased the levels of student engagement in your science or mathematics classroom? Would you be interested in a list of "must-haves" for increasing student engagement? That is exactly what this book sets out to provide a framework for captivating, activating, and invigorating your students, keeping them engaged in your science and mathematics classroom. This book presents a list of six essential ingredients for cooking up an engaging science and mathematics classroom. In the form of a recipe, these six ingredients are based on the latest research brought to you by neuroscientists, cognitive scientists, and educational psychologists, synthesized and summarized for classroom application. If you stir and blend these ingredients with the strategies that you are currently using in your classroom, you will take your students' learning to a new level. This book highlights the relevant application of the research findings to your instructional lessons.

Important Features of the Book

This book not only provides a recipe for engaging the student brain in science and mathematics; it also strives to model the very ideas presented in each chapter. To reinforce each ingredient and promote the transfer of ideas from this book to your classroom, several in-text features are included:

- Stop-n-Thinks to break the information up into chunks and provide opportunities to review, revise, and process the information
- Exit Tickets to consolidate information and bring closure to the big ideas or concepts presented in each chapter
- Engaging Professional Development Tasks that promote the application of the big ideas or concepts to your classroom while at the same time encouraging collaboration between you and your colleagues
- Metaphors and Analogies provide references to concrete objects, events, or topics that promote clarity and understanding of abstract ideas or concepts presented in the chapter (e.g., the hippocampus acts as a surge protector for the brain)

The important features of the book reinforce each ingredient and promote the transfer of ideas by modeling them. Although the Stopn-Thinks, Exit Tickets, Engaging Professional Development Tasks, and the metaphors and analogies are targeted at you, each of these features can be modified and used in your science and mathematics classroom.

This brings up the final and most important feature of the book: strategies. Each chapter is stuffed full of strategies that highlight the ingredients of the engagement recipe. These strategies are examples and can be applied to your classroom as is or be tweaked to better fit your unique environment. Furthermore, many of the strategies apply across several ingredients. We have worked hard to provide a range of strategies across the variety of science and mathematics classes found in a typical middle or high school. Our hope is that this book will engage your brain to take the strategies presented in this book and adjust them to work in your classroom.

Breakdown of Chapters

In the chapters that follow, we present each ingredient of the recipe, the brain science behind it, and ready-to-use strategies and examples

that make each ingredient classroom ready. Before we dive into the recipe, we have to get familiar with the elements of engagement. What we are talking about here is the student brain! If we are going make a deliberate effort to engage the brains of our students, it is helpful to understand how the student brain works, at least in terms of how it engages in learning. Chapter 2 builds background knowledge and familiarize you with the parts of the brain that are implicated in attention, engagement, and learning.

Chapter 3 presents the importance of priming the brain and the role of prior knowledge in new learning. Chapter 4 presents amazing research on the use of novelty to grab students' attention and enable them to remember what they are paying attention to.

Pause for a moment and call up those feelings that surface when a student has just asked, "Why do we have to know this?" or "Is this going to be on the test?" These questions are sure signs that your students are seeking relevance. That is the topic of Chapter 5. Chapters 6 and 7 look at the input and attentional limitations of the brain and how information moves from short-term to long-term memory. Finally, Chapter 8 pulls it all together by helping you develop an action plan for implementing the ideas you came up with throughout the book.

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