Leveraging Neuroscience in Lesson Design

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Acknowledging key facts from neuroscience research can help teachers plan instruction that aligns with how the brain learns.

There has been strong anticipation in the education field that neuroscience research might reveal some new strategies or resources that will deepen learning for every student in every classroom. I, too, hope for some kind of "magical toolbox" that will help us engage and motivate all students. However, in more than a decade of work to bridge the conversation between neuroscience research and education practices, I have found that the most powerful tool neuroscience can offer our classrooms is a shift in mindset about how we design our lessons.

The good news is that this shift won't cost a penny. The challenging news is that change is difficult. Educators often fall back on old ways of designing our lessons or setting up our classroom spaces—ways that don't align with the foundational understanding of how the brain learns. But we can change our habits.

Two Critical Facts

Advances in neuroscience have revealed two facts about the brain that every educator, parent, and student should know: that emotion is essential to learning, and that each brain is unique. While these two facts are likely familiar to educators, we may not have realized that each has the potential to transform our teaching practices and empower student autonomy for learning.

I would argue that educators knew these facts to be true even before neuroscience heightened our understanding of the mechanisms behind them. However, evidence from neuroscience may offer educators additional inspiration—and a sense of urgency about changing teaching practices that don't align with what we know about the brain.

Take a moment to really reflect on your current teaching practice. Do you still have students asking, "Why do we need to know this"? Do you still typically have all students complete assignments in the same way and at about the same time? If you answered yes to either of these questions, then there's more you can do to change your lessons and classroom design to ensure that learning experiences in your classroom align with what we know about the learning brain.

Critical Fact #1: Emotions Are Essential for Cognition

Emotions are never separate from cognition (Immordino-Yang & Damasio, 2007). Brain science shows that vast, interconnected neural networks are involved with emotion and intricately link with strategic networks that are involved in decision making and executive functions, including skills like goal setting, self-regulation, and progress monitoring. Emotion networks are also intertwined with perceptual networks in the brain, which process what we see and hear from the environment.

These emotion neural networks have such a powerful an influence on perception that they can sway how we view seemingly objective facts. For example, people perceive a balcony as being higher and an incline steeper if they are in a negative emotional state (Riener et al., 2011). Similarly, students' emotions are likely to influence how they perceive the resources available and the demands of learning tasks in our classrooms. While there may be multiple resources available to support learning, a student may not perceive those supports as helpful or as realistic options due to a range of factors, such as previous negative experiences or their current physiological or emotional state (say, being hungry or tired or experiencing a conflict with a friend).

Emotion networks also activate our physiology, directing attention and driving heart rate and blood sugar to meet the perceived demands of a situation. Too much activation, such as stress or anxiety, or too little activation, such as depression or apathy, can both impact cognition. When we perceive there to be a threat (such as, for some students, having to read aloud in class) or a distraction (such as being made to work in a group), the resulting cascade of emotions influences even the most basic activation of our physiology.

Given this central role of emotion in cognitive processes, teachers need a way to ensure that they design lessons that tap into emotions and engage students in meaningful opportunities to drive learning. Here is one suggestion for doing so. Take any upcoming lesson or activity and make sure you can answer the "why do we need to know this?" question. How could students make a personal connection with this content, or how might it be relevant in some way for the school or community? Whether you're connecting graphing a parabola to the shape of satellite dishes or relating an ecology unit to the ecosystem on the playground, focus first on engaging students in why the topic *matters*.

We must also recognize that what fires up some students will not interest others. Having some flexibility in how students can build their background understanding, collaborate with peers, and share what they know can support the activation of emotion for a range of students.

This mindset of planning a lesson to try to maximize student interest and engagement isn't an "extra" that you might include in some lessons or save for the "after standardized testing" units. Activating emotions and engaging students in real-world experiences is the critical first step to supporting learning in our classrooms.

Critical Fact #2: Each Brain Is Unique

Brain science shows that each brain is one-of-a-kind. Even identical twins have differently active brain patterns and neural networks. We don't actually have areas of thinking isolated in the right or left hemispheres of our brain, and people don't have set learning styles based on their brain configurations (Pashler et al., 2008). Instead, the brain is incredibly dynamic and interconnected. Neurons grow and strengthen with use, and in a matter of days, neural pathways can be activated or deactivated based on the interactions an individual has with their environment.

Considering this neuroplasticity, we cannot simply label a student as being a fixed kind of learner and then give them a particular kind of learning "treatment." Learning is much more complicated, as every brain continues to develop and to be sculpted based on the unique combination of nature (from genetics) and nurture (from interactions in the environment).

For a teacher who works with dozens or even hundreds of students each term, this variability can seem overwhelming. Consider research findings on working memory, the ability to hold information in mind and manipulate or use it. Working memory is important, for instance, when we verbally give students multiple-step directions. It's critical for reading and problem solving in math. However, as research by Ulmann and colleagues (2014) shows, in a single classroom of 12-year olds, working memory capacity scores can range from 12 to 40, indicating the incredible range we can anticipate in any of our classrooms.

We can anticipate similar variability across many other dimensions of learning, such as attention, vocabulary, perception, and background skills. Simply providing a certain strategy for a particular kind of learner (such as a "visual option" for a mythological "visual learner") is not adequate. Given the tremendous variability of each of the subcomponent skills involved in student learning, our approach to teaching needs to be more flexible.

To align our teaching practices with the wide variability of our students, teachers can shift the way they provide resources and scaffolds. Instead of giving the whole class a "one-size-fits-all" lesson or giving only a specific group of students particular modifications, we can provide a "learning buffet" of options students can use to achieve an intended learning goal. To do this, first make sure you have clarified the intended learning objective for the activity or lesson. Then, provide several options of activities or resources that support the lesson goal and allow students to choose any of those options as they work.

For example, when learning a math concept, some students may want to build a stronger background related to the topic, while others may prefer additional problem sets to push them further. Some will need to have the key ideas and vocabulary highlighted for them; others may prefer to work independently. When we provide a "buffet" so students can select their own pathway to achieve the goals of a lesson, we're aligning instruction more to what we know about the variability of the learning brain (Meyer, Rose, & Gordon, 2014).

As another example of variability, consider the fact that executive function skills are largely supported by the frontal lobe, which continues to develop uniquely for each individual throughout their 20s. For decades, teachers have provided options like a graphic organizer, checklist or rubric, or model examples to support students' organizational skills. However, when we realize that we need to offer students such options *because* we know there will be a range of executive function skills in our class, then we're more intentionally aligning how we deliver instruction with what we know about the brain and learning.

Another way to address brain variability and support learning is to transform classroom spaces to provide predictable options for students. For example, you might set up a quiet area where students can wear headphones and work independently, a collaborative area where students can work together (or with the teacher), and flexible seating options that let kids sit, stand, or move about more. Such flexible design encourages each student to have some autonomy and independence to optimize their learning. This approach is a tremendous shift from the traditional role of the teacher as the one who adapts a lesson for individual students.

Toward Empowerment and Diversity

When we empower students to make their own learning choices and set their own goals to reach learning targets, we support both the emotional component of learning and the variability of our students' brains. In addition, students will begin to better understand what they need to do their best learning; they'll learn how to maximize their strengths and support their challenges. Teachers can become facilitators of learning who talk with students about their learning progress and their needs—such as when a student may need to take more risks and push herself or when she may need to slow down and build more background.

This shift in mindset and design that better aligns our teaching with what we know about the brain will be worth it. It may take time to integrate some of these flexible, goal-driven approaches. Start with small steps and work with a colleague or team to try out new ideas. Know that your intentional design will benefit your students. Tapping into students' emotions and providing all students flexible options to use in lessons will let you better leverage the incredible diversity and experiences of your students and the variability that enriches a classroom culture.

References

Immordino-Yang, M. H., & Damasio, A. (2007). We feel, therefore we learn: The relevance of affective and social neuroscience to education. *Mind, Brain, and Education, 1*(1), 3–10.

Meyer, A., Rose, D. H., & Gordon, D. T. (2014). *Universal design for learning: Theory and practice*. Wakefield, MA: CAST Professional Publishing.

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest, 9*(3), 105–119.

Riener, C. R., Stefanucci, J. K., Proffitt, D. R., & Clore, G. (2011). An effect of mood on the perception of geographical slant. *Cognition and Emotion, 25*(1), 174–182.

Ullman, H., Almeida, R., & Klingberg, T. (2014). Structural maturation and brain activity predict future working memory capacity during childhood development. *Journal of Neuroscience, 34*(5), 1592–1598.

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