

ARTICLE

Teaching to Empower: Leveraging the Neuroscience of Now to Help Students Become Self-Regulated Learners

Mays Imad

Biology Department, Connecticut College. New London, CT 06320; Department of Life and Physical Science, Pima Community College. Tucson, AZ 85716.

In his book *Descartes' Error*, neurologist Antonio Damasio argues that humans do not make decisions by relying exclusively on the rational or reason-oriented parts of their brain (2008). Evidence from patients with brain damage reveal that our abilities to reason and make decisions are greatly influenced by our emotions (Damasio et al., 1990; Saver and Damasio, 1991). In fact, our emotions and how we feel act as a gateway to our thinking and learning by providing “the bridge between rational [prefrontal cortex] and nonrational processes” [brainstem and limbic structures].” (Damasio, 2005). Understanding the ways in which our brain processes sensory inputs and integrates those inputs into our ongoing emotional state is critical for helping students become self-regulated, sophisticated learners.

In the following article, I will begin by briefly summarizing

the role of emotions in learning and the impact of toxic stress on our students' ability to engage, learn, and thrive. I will then define and present a trauma-informed teaching and learning paradigm with practical strategies that empower students to continue to learn and succeed. I will address a few misconceptions about trauma-informed education. I will conclude by making a plea to you, members of the undergraduate neuroscience community, by presenting a case for the utility and moral imperative of educating our students about the basic functioning of their brains, especially as it relates to emotional regulation and learning.

Key words: toxic stress; emotional valence; trauma; trauma-informed education; amygdala hijack; limbic brake.

“We are not thinking machines that feel; Rather, we are feeling machines that think.” –Antonio Damasio

DECISION-MAKING, EMOTIONS, AND MEMORY

Our brain is continually scanning and sampling its immediate environment, gaining access to fragments of the world to make predictions related to safety or danger, reward, or punishment. In a sense, our brains act like sophisticated simulation or statistical programs that process and integrate incoming data and extrapolate what the greater world outside is like and what it's likely to become in the future (Friston, 2010; Ortega and Braun, 2010). When the brain encounters any changes in the external environment, it will ask the question, “What strategy should I select to protect my overall well-being?”

Detection of changes in the outside world occurs through sensory inputs (sight, hearing, etc.), which are first processed by deep and ancient structures (brain stem, midbrain, limbic system). During the integration of these inputs, the limbic system also adds an emotional context, providing valence or importance to specific details. Emotions are mental experiences brought on by neurophysiological changes when we encounter stimuli and react (Ekman and Davidson, 1994; Panksepp, 2014). Thus, even at their deepest, most ancient, autonomous levels, our brains are emotional. It is impossible to choose how to protect one's well-being without being able to recognize what the desired outcome is. We make decisions to get outcomes we predict we will like, and to avoid outcomes we dislike. Both “liking” and “disliking” are examples of

emotional valence. It is only after such processing that the external inputs and their emotional context are then fed into the cortex, where higher level processing occurs, including much of reasoning and decision-making, and where we become conscious of them (Damasio, 1998; Cabanac, 2002; Barrett et al., 2007; Izard, 2009).

Learning is an Emotionally Charged Process

Learning and memory are biological phenomena arising from physical changes in neural connections and in the intrinsic excitability of neurons (Takeuchi et al., 2013; Debanne et al., 2019). As teachers, we aspire for our students to learn, integrate, and retain information to help them apply it in the world. Thus, part of being effective teachers necessitates that we understand how we can optimize our classroom environment—virtual or in-person—so the neural connections and neuronal excitability can readily change for learning to happen (Owens and Tanner, 2017). Understanding how the brain works in the context of education holds the potential for improving our teaching practices and our students' learning. As neuroscientists, we are uniquely situated to understand and help our students understand this process.

Recent research suggests that certain underlying beliefs about learning are based on misconceptions, over-interpretations, and misunderstandings. We are, to quote a recent international report, subject to “neuromyths” about how learning works (Betts et al., 2019). As the report makes clear, the prevalence of online information—and misinformation—means that the need for educators “to ensure that their practice is scientifically grounded and

evidence-based" is now more critical than ever. One of those misconceptions concerns the role of emotions in our thinking. Emotions are seen as irrational and unruly, something that is connected with acting reflexively and out of control. From that position comes the idea that by making decisions without emotions, "purely rationally," we become more sophisticated thinkers and decision-makers. As a consequence, we often expect students, and ourselves, to leave emotions outside the classroom.

Yet, as discussed in the previous section, it is impossible to separate emotions from reasoning, on either the neurological or the biochemical level (Tyng et al., 2017). Several studies have reported that human cognition is affected by emotions, including attention (Vuilleumier, 2005), learning and memory (Phelps, 2004; Um et al., 2012), reasoning (Jung et al., 2014), and problem-solving (Isen et al., 1987). Mary Helen Immordino-Yang, among others, argues for the affective nature of learning, stating that it is "neurobiologically impossible to think about things deeply or to remember things about which you have had no emotion." She goes on to say: "Our emotions, our relationships, and our cultural experiences in the social world literally organize and shape the development of brain networks that allow us to learn. ...[E]motional experiences in the learning environment are influencing what we are capable of doing." (Immordino-Yang, 2016). In fact, our emotions and how we feel act as a gateway to our thinking and learning by providing "the bridge between rational [prefrontal cortex] and nonrational processes [brainstem and limbic structures]." (Damasio, 2005). Simply put, emotion, thinking, and learning go hand in hand.

To foster an optimal learning environment, we need to pay attention to emotions and how the learner is feeling, as learning cannot take place in absence of emotion. "[T]he neurobiological evidence suggests that the aspects of cognition that we recruit most heavily in schools, namely learning, attention, memory, decision making, and social functioning, are both profoundly affected by and subsumed within the processes of emotion..." (Immordino-Yang and Damasio, 2007). The brain chooses which aspects of the outside perceptions to pay attention to, and how to make decisions about them, by assigning emotional valence to them. The instructor's voice, the contents, the assignments, the assessments – all of these are external perceptions that brain has to process, and it will process them according to the emotional state they produce. Accordingly, learning can be enhanced or stifled depending on a learner's emotional state. While negative emotions, such as fear and anger, can disrupt learning, positive emotions drive learning. The brain uses emotion to harness motivation and direct action—approaching positive situations and avoiding negative ones (Fischer and Bidell, 2006).

On some level, many of us already know this. For all the talk about rationality, all of our teaching methods are designed to provoke emotional responses, which in turn promote meaningful learning. We try to make our students emotionally invested in the work they are doing; we let them feel good in the light of approval when they succeed in school. We put dry statistics about geography or history in the context of stories that allow emotional involvement.

Even in mathematics, we try to produce a situation where a student will have a flash of awe at the elegance of a particular mathematical proof.

This incorporation of emotions into teaching, of course, does not mean that we can simply "crank up" our student's emotions and thereby improve their learning. If emotions become too overwhelming, they override rational processing and thinking, thus losing the details and the point of the lesson. This is particularly true of the negative emotions (anger, disgust, fear): while they may seem useful in certain narrow conditions, they tend to be counterproductive. A student will remember being angry or afraid during a lesson, but those sensations will override the actual details of the lesson being taught. Fear inhibits learning and memory at the detail level (de Quervain et al., 1998; Kuhlmann, 2005). For this reason, studying in an emotionally supportive environment is far more effective than studying motivated by fear of failure) (Broekens et al., 2015; Blum and Kohn, 2020).

STRESS IN THE CONTEXT OF LEARNING

Psychological stress is usually defined as a feeling of strain and pressure and can be both positive and negative. In other words, some stress is useful, for example, the type of stress we experience when we feel aroused and excited but there is no accompanying threat or fear. Eustress (good stress) allows for productive problem solving as well as motivation. We recover from good stress when the stimulus is gone and resume our resting state.

Sudden large spikes in stress (extremely traumatic or dangerous situations), or long-term exposures to repeated stressful stimuli can lead to toxic stress, which is highly destructive to learning. Leading psychiatrist and trauma researcher Bessel van der Kolk states that "at the core of traumatic stress is the breakdown in the capacity to regulate internal states," such as fear, anger, and anxiety (2005). Toxic stress has extremely negative effects on various aspects of human functioning, from basic physiological measures of health and immune system function, to ability to learn and process complex information (Maté, 2003; Kagias et al., 2012; van der Kolk, 2015; Yaribeygi et al., 2017; Yehuda and Lehrner, 2018).

Toxic stress takes a heavy toll on our body and brain and can over time become self-sustaining: instead of just following from negative emotional states, it can begin to trigger them itself, and the constant barrage can reach a level where it feels inescapable and overwhelming. When the stress persists and we continue to feel uncertain about our survival and well-being, our limbic system will activate the brain's alarm system, often called "fight-or-flight response;" but which should more accurately be called "Fight-or-Flight-or-Freeze-or-Fawn." This reaction to any perceived harmful or threatening situation is physiological, automatically engaging behavioral systems of avoidance (flight), confrontation (fight), freezing in place, or placating the perceived threat source (fawn) (Schmidt et al., 2008; Walker, 2013). In trying to answer the questions, "What strategy should I select to protect my overall well-being?" this alarm system attempts to safeguard our future physical, mental, and social well-being against perceived threats—and

the behaviors it elicits are not conducive to detailed, stable, and long-term learning.

For the brain to engage and learn, one must first feel safe, hence the phrase, “Maslow before Bloom”: Our basic needs come before our ability to learn (Berger, 2020). Whereas healthy levels of stress engage emotions and help with learning, toxic stress counteracts it: there is more activity in the limbic system and slowing down of the prefrontal cortex. In order to engage our prefrontal cortex for rational learning and analysis, we need to re-establish harmony between the emotional and rational areas of the brain. To do so, we need to feel safe. The challenges of learning must occur in an environment where a student feels safe and empowered enough to rise and meet them.

RELAXING THE NERVOUS SYSTEM: A TRAUMA-INFORMED TEACHING APPROACH

The trauma-informed lens as it relates to education is about realizing that toxic stress is prevalent and pervasive and impacts students’ ability to engage with the materials, learn, and retain information. Trauma-informed teaching is not about diagnosing or treating; most of us are not therapists nor clinicians. We do, however, occupy a close proximity to our students and can, through building meaningful relationships, help the connect, engage, and learn even in the face of ongoing challenges through a trauma-informed lens, the instructor intentionally promotes safe environments that cultivate connectedness and empowerment, acting as an “amygdala whisperer” (Baylin, 2016; Seng and CAsCAid Group, 2018). A trauma-informed approach to teaching enables us to recognize that our students may have a difficult time completing basic tasks they usually could, being motivated to study or even to show up, prioritizing assignments, managing their time, or simply not quitting. Admittedly, we can’t take away students’ challenges nor resolve their burdens. But we can help build a “learning sanctuary” (Imad, 2020a) within our classes that can offer a retreat for students to connect, belong, engage, and learn. There is a misconception that trauma-informed teaching that there are no rules, and students can “get away” with anything. On the contrary, we want to give students structures they can follow because having a predictable schedule and structure can offer an antidote to uncertainty-induced stress. Similarly, trauma-informed education is not synonymous with lowered academic expectations. To the contrary, using the lens of trauma-informed education allows us to then challenge students academically to reach their full potential.

Trauma-informed teaching is about seeing the humanity and complexity of students and, at the same time, revealing our humanity to our students to show them that we are on their side, that we have their backs, that we see them and we validate their struggles and that they matter. Trauma-informed education means that we recognize that we, educators and leaders, have the ability and the positionality in higher education to create and advocate for a critical educational praxis. We build connections with our students and empower them to cultivate connections with themselves, their classmates, and the course contents. We center kindness and wellbeing and provide students with the

tools to cope, to learn, to succeed, and to thrive.

Trauma-Informed Teaching in Practice

My framework for trauma-informed education is based upon the Substance Abuse and Mental Health Services Administration (SAMHSA) guidelines for trauma-informed care (SAMHSA, 2019; Figure 1). Simply put, those guidelines encourage us to ground all of our work in cultural humility, paying attention to historical, racial, and gender issues and identities. We cultivate safe learning environments by building trusting and transparent relationships with and among our students. We empower our students by providing them choices and encouraging them to use their voices. We build a classroom community by encouraging students to collaborate and co-create knowledge and bring their rich experiences to the learning environment. I elaborated on each principle and provide practical classroom examples in an article I wrote last year for *Inside Higher Education*. In that article, I also added an additional principle: Impart to your students the importance of having a sense of meaning by identifying goals and purpose (Imad, 2020a). In the following section, I wish to elaborate on the principle of empowerment by adding another pertinent example. Namely, empowering students to self-regulate by teaching them about the neurobiology of learning and stress.

Empowering Students with Knowledge

Like many of us, a great number of our students are experiencing an incredible amount of stress, and that stress can limit agency and generate a sense of helplessness. Loss of agency combined with unconscious beliefs about how learning works can have a negative impact on a student’s overall sense of self. A student struggling to



Figure 1. Principles of Trauma-Informed Teaching. Modified from SAMHSA’s National Center for Trauma-Informed Care.

complete an assignment may readily adopt a self-deficit interpretation (e.g., “I must be stupid”) versus a more self-compassionate understanding (e.g., “My lack of motivation is not because I am lazy but because I am coping”).

Soon after the COVID-19 pandemic hit the US, many colleges and universities across the nation began to offer trauma-informed teaching and learning webinars for their faculty. Given the prevalence of trauma and stress in our students before the pandemic, these webinars were long overdue (Auerbach et al., 2018). I participated in some of these workshops as well as facilitated many. At the end of those webinars, faculty often expressed a resounding sigh of relieve about what they themselves were experiencing (e.g., mental foggiess, exhaustion, disconnect, etc.). Faculty appreciated understanding that they were experiencing a typical physiological response to an atypical situation—the pandemic. A salient question for me quickly arose: *Who is educating our students about toxic stress and its impact on learning and wellbeing?*

In STEM education, we often talk about teaching students metacognition so they can become self-regulated thinkers (Dimmitt and McCormick, 2012; Dori et al., 2018), yet metacognition itself can be hijacked when we are under the influence of strong negative emotions. Elizabeth Norman recently outlined ways in which metacognition may reduce cognitive achievement and psychological well-being (2020). In the words of one of my former students: “Stress can always go beyond the point where it creates inaction due to paralysis or the inability to think clearly creating metacognitive activities that are harmful.” (Imad, unpublished research on metacognition). Metacognition can be a luxury for students who are experiencing toxic stress—brought on by the pandemic, by witnessing or enduring racialized violence, thoughts of the climate crisis, or the effects of socioeconomic inequality. It is hard to think about thinking when you can’t think—when you are experiencing amygdala hijack. In addition to metacognition, we need to teach students about the science of stress and its effect on their limbic system and their learning, and then give them tools to regulate their reactions to stress (Imad et al., 2021).

Research on stress and its impact on learning tells us that we can learn to regulate how we deal with stress and hence mitigate its impact on our ability to engage with the materials and learn (Hopkins et al., 2017; McCoy, 2013). Critical to this endeavor is student self-awareness and their learning about the nervous system (See for example, Desautels, 2018). Through my work with students over the past year, I’ve come to realize that the first step to helping them regulate their learning is to teach them about toxic stress because doing so helped them feel validated that their struggles are real. I reasoned that if I want students to be able to regulate their response to stress, they have to first have the knowledge of how the brain processes sensory information, how the brain handles stressful, unanticipated situations, and how our brain reacts to a negative situation—*not the situation itself*—to influence our daily psychological wellbeing (Puccetti, 2021).

To empower students to self-advocate, I decided to host a college-wide series of student webinars on the topic of

stress and emotional regulation at my institution in April 2020 (Casanova, 2020). Shortly after, many students reached out to me to thank me for helping them understand that the feelings they were experiencing, such as a lack of motivation and energy, were driven by their physiology and that “binge-watching” Netflix was not indicative that they are lazy or do not care about school (Imad, 2020b). Rather, they were dealing with toxic stress and trying to cope. The following are a few representative examples of what students said after attending a workshop on the brain, learning, and stress:

- Student 1: “Your instruction helped me to feel like I am normal and okay to feel these things.”
- Student 2: “I feel so validated that others are going through the same thing.”
- Student 3: “[Y]our presentation put everything in perspective. [A]fter watch[ing] the webinar the ‘heaviness,’ the headaches, the sleepiness, the anxiety all lifted.”
- Student 4: “The webinar helped me understand the fight or flight emotional reaction, and to recognize it so I can regulate it.”
- Student 5: “I know I am not stupid but these unprecedented times makes it difficult to focus and learn.”

These are just a few of many similar sentiments. What they underscore is not only how much students are struggling during the pandemic (Goldrick-Rab et al., 2020) but also how little they understand what is going on in their brains. I wondered how much we are failing our students by not helping them understand the relationships between stress, emotions, and learning. During the webinars, I usually began my workshop by asking the question: “How are you feeling?” and students entered their answers into a Mentimeter anonymous poll. I then run an interactive workshop on the neurobiology of toxic stress and learning where I share examples of what toxic stress does to our brain and how it impacts attention and learning. I remind students that if they are feeling depleted or not motivated or anxious or mentally foggy, they are coping and that their physiology is working. I then share practical strategies for how to recognize and deal with toxic stress. I end the workshop with the same question I started with: “How are you feeling?” When I examined students’ answers before versus after the webinar I noticed a trend toward positive emotions after the webinar. I entered students’ answers into a WordCloud to verify and was surprised to see that repeatedly students expressed more positive feelings after attending the workshop (N>200, analyzed using wordsift.org). It is important to note that attending a workshop doesn’t remove the reality of the students’ experience of feeling tired, overwhelmed, or exhausted—although it shifts their focuses to more positive feelings such as hope and gratitude and feeling empowered (Figure 2). So, here I make a plea to our neuroscience community to empower students through knowledge. We are neuroscientists who invested years of training to understand the various aspects of the nervous system. We can, and

How Are You Feeling?



Figure 2. A visual representation of text data from students responding to the question “How are you feeling,” when asked before and after a webinar on recognizing and mitigating the impact of toxic stress on learning and wellbeing. Students were asked to answer using single words. The prevalence of each word is shown with font size—bigger words mean more responses.

should, readily help our students to learn about the biology of learning and how toxic stress can hijack learning and what we can do about it.

Examples to Empower Your Students

Listed below are ten concrete approaches you can use in your courses to educate about the brain and learning, normalize the fact that toxic stress impacts learning, and share coping strategies to mitigate the impact of stress.

1. Remind your students that learning involves a complex series of events that change the structure of the brain. Learning is a journey and struggle is part of that journey (Cajete, 2000). Failure to understand the materials the first time around is part of the learning. One of the most powerful ways to impart this teaching to your students is through storytelling. Toward this end, share with your students your learning journey, especially how struggles and failure were part of that journey.
2. Foster critical self-reflection in order to help your students understand the science of that journey. We know a lot about what enhances or stifles learning. Start by asking students to consider what learning means to them, how do they know when they’ve learned, and what helps them learn and retain information. Remind your students that when they come into your class, they bring with them past experiences, language, and cultural assets which can enable meaningful learning (Rendon, 1994). Again, I use storytelling to demonstrate what I mean by that. I tell my students that I learn best through analogies. When I am confronted with a new and challenging concept I need to learn, I often spend time trying to connect to the concept by asking questions such as, “why does this matter to me?” and “how does this impact my community?”
3. Invite your students to keep a simple learning diary and

- pay attention to when their learning is interrupted or challenged and what they can do about it. When possible, keep a teaching diary and share it with your students. For example, you can include your rationale for the sequence of the course or the examples you use in lecture. This activity will reinforce the notion that learning is a journey and that the teacher, in addition to their student, is part of that learning journey.
4. Share with your students an article about “limbic brake” (Shanker, 2017) or “amygdala hijack” (Goleman, 1995) and how they can distinguish that depletion of energy (which impacts their motivation and ability to engage and learn) from being “lazy.” I remind my students that we might be experiencing the influence of strong negative emotions that might be hijacking our brain and yet we can still negotiate with our brains to focus more on what we can control and engage.
5. Introduce to your students the concepts of self-regulation and help them learn how to negotiate with their brain and act as an “amygdala whisperer” (Hopkins et al., 2017). For example, create an online discussion board and ask students to share (a) how they recognize when they are stressed, and (b) healthy coping strategies that they’ve used to successfully mitigate their response to stress. Share with your students examples of how you regulate your response to stress (Desautels, 2019).
6. Encourage your students to continue to learn about the brain. Remind them that the best way to learn is by teaching others. You could say: “For the upcoming week, learn something new about the brain and share it with other students. Tweet with #HelloBrain or #BrainandHeart.” Similarly, offer an “extra credit” assignment where students can talk about emotions and emotional regulation with their family and friends. I once offered a session titled, “Imagine if we didn’t feel,” and

began by asking student to sit with that question and discuss the consequences of not having feelings. A handful of students reflected back to me after the session how much they appreciated not being expected to suppress or ignore their emotions.

7. Repeat the message that we are relational beings and that the brain is a social-emotional organ, influenced by its surroundings. For example, share with your students an article about interpersonal neurobiology (Siegel, 2015) and ask them to notice and document what in their surroundings helps their nervous system calm down. Furthermore, invite your students to reflect on how they might help those around them feel safe, connected, and supported. Discuss with your students the research on microaggression and how it impacts the overall wellbeing, especially of marginalized groups (Sue, 2010; Reid, 2017), and how we can each ensure that we don't engage, even subconsciously, in microaggressive behavior.
8. Validate your students' struggles and normalize the necessity of mental and emotional hygiene. Make your first interaction with your students inviting. Consider how you might make the tone of your syllabus inviting where students feel comfortable coming to you and asking for help regarding their mental health and wellbeing (Gurung and Galardi, 2021). For example, in my syllabus I add the following statement: "Beyond your learning, your health, safety, and wellbeing are my primary concerns. If you are struggling with the course materials, I will help you. Moreover, please feel free to reach out to me if you are experiencing difficulties securing food, housing, or struggling with your mental health. If I can't help you directly, I will help connect you with resources on campus." Share with your students resources on how they can regulate their emotions and anxiety such as: "Unlock Your Wise and Mindful Brain" (Notebaert, 2021) and "The Anxiety Coaches Podcast." (Ryan, 2021).
9. Discuss with your students the science and neuroscience of hope (Groopman, 2006). Invite your students to reflect on how we can reignite our relationship with hope when we are hope-depleted (Imad, 2021a), and why doing so is important to us individually and collectively (Imad, 2021b). In most of my courses, I have a section designated to science and society where I engage my students and reflect on how we can enact a better world using science and the scientific community. I remind them that we can each act as a ripple effect to make the future of our humanity better for all.
10. Intentionally and explicitly destigmatize mental illness. For example, consider inviting to your class a counselor to discuss what resources are offered by the school about mental health and how to access those resources. Furthermore, draft a letter with your students to advocate for more mental health awareness and resources on campus by having them bringing into play the neuroscience of stress and mental illness and explicitly make the connections between mental health and social justice (Sheppard, 2002; Proctor, 2019).

Consider making this activity a non-disposable assignment (NDS) where the assignment provides impact or value outside of the traditional student-teacher classroom relationship (Seraphin et al., 2018). When the letter is drafted, reach out to your colleagues throughout the college community to further advocate for this work.

If we are honest with ourselves in higher education, we knew that our students were struggling before the pandemic—with stress, anxiety, and loneliness (American College Health Association, 2018). But mental health wasn't as urgent a priority for higher education before the pandemic as it should have been (note that our colleagues in K-12 were already using a trauma-informed lens long before the pandemic, see for examples, Taylor et al., 2017; Venet, 2018; Venet, 2019; Desautels, 2020). We have an opportunity to forge a post-pandemic higher education that is grounded in both science and compassion. Trauma-informed education, while it may be a current buzz word, is not merely a passing trend. It provides a lens that disrupts an educational system that too often prioritizes knowing over caring, competition over collaboration, intervention over prevention, and individuals over community. Trauma-informed education compels us to resist perpetuating systems that disproportionately overlook students with identities located at the margins of society.

Using a trauma-informed lens in higher education can help restore justice, improve students' learning and wellbeing, and make our institutions places of transformation and even healing. We can begin in our classrooms by modeling and encouraging students to center their mental wellbeing. We often think of mental health as an issue only for counselors or psychologists, but wellbeing is a higher education issue. It is a societal issue. It is a human rights issue. When practiced consistently, intentionally, and purposively, trauma-informed education benefits everybody, including ourselves, as educator.

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Address correspondence to: Dr. Mays Imad, Biology Department, Connecticut College, New London, CT 06320. Email: mimad@conncoll.edu

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