Monograph | Volume 1

Neuroplasticity, Optimal Learning & Regulations

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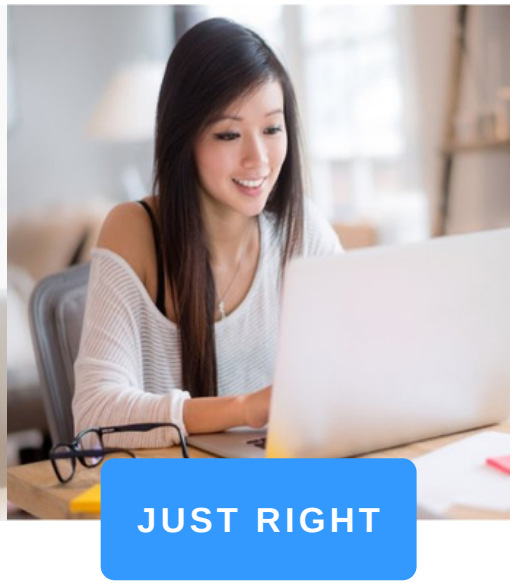
1 NEUROPLASTICITY & CHANGING BRAINS

It was once believed that the brain was fixed and could not change. However, advancements in research, technology, and neuroscience provide critical insight into the human learning process and what we know about the brain. One of the greatest areas of research is on neuroplasticity, which is the brain's ability to reorganize and rewire itself based on experience and interactions with the environment. According to Dr. Lara Boyd (2018), a Neuroscientist and Physical Therapist at the University of British Columbia, "What we have learned is that **every time you learn something new – you learn a new skill or a new fact, you have an experience – you change your brain**." Moheb Costandi (2019) shares in *Neuroplasticity* that the **brain changes continuously throughout life "in response to everything we do and every experience we have**" (p. 3).

Why is understanding neuroplasticity important for educators? **Educators are brain changers**. As shared by McTighe and Willis (2019) in *Upgrade Your Teaching: Understanding by Design Meets Neuroscience,* "**Every lesson, assignment, and interaction shapes your students' brains**" (p. 3). Furthermore, "Brain plasticity underlies the brain's extraordinary capacity to **learn, unlearn, and relearn**" (Wesson, 2020, para. 5).

Research reveals that the "human brain consists of **100 billion neurons and over 100 trillion synaptic connections**" (Colón-Ramos Lab, 2021, para. 1). Memories are based on the reactivation of groups of neurons which strengthen with practice and weaken or disappear when not used. Instructors, instructional designers, and professional development administrators are all in roles that have an incredible impact on learning. As brain changers, understanding how the brain learns can be transformational for course design, teaching, and engagement to promote neuroplasticity.

2 THE GOLDILOCKS PRINCIPLE & STUDENT WORKLOAD



The Goldilocks Principle is known globally and across industries as the “just right” concept. The origin stems from the fairy tale of *Goldilocks and the Three Bears*. During Goldilocks' visit, she tasted three bowls of porridge of which one was too hot, one was too cold, and one was “just right.” She also found in trying out three chairs and three beds, a chair and a bed that were "just right." In the literature this concept is also referred to as the “sweet spot” or “just enough.”

For educators, the Goldilocks Principle provides a strong framework for **instructional design and teaching**. It is particularly important when teaching online or pivoting across learning formats from face-to-face to hybrid or emergency remote. The challenge is knowing how much is *too much, too little or just right*.

> “If cognitive load becomes too high, it hampers learning and transfer”
>
> **-Sweller, 2019**

A course that is front loaded with **too much** content in the first few weeks can result in early attrition. Complex activities or assignments that are not scaffolded or unclear can affect cognitive load. According to Sweller et al. (2019), “If cognitive load becomes too high, it hampers learning and transfer” (p. 261). **Too little** content can lead to demotivation, boredom, disengagement, and affect academic progress. McTighe and Willis (2019) state that students are likely to persist when they are engaged at achievable levels of challenge and believe they can meet stated goals - **just right**.

The Goldilocks Principle and importance of interaction are not new to education, particularly online education. In 1989, Moore published an editorial on **Three Types of Interaction**: *Learner-Content, Learner-Instructor, and Learner-Learner*. The connection between interaction and learning is also linked historically to many other renowned thought leaders such as Dewey (1916), Vygotsky (1972), and Kolb (1984). Today, advancements in technology and neuroscience reveal the brain changes over a lifetime through our interactions and experiences, which is referred to as **neuroplasticity**.

On **July 1, 2021**, the U.S. Department of Education Distance Education and Innovation regulations went into effect, which included clarity on demonstrating **Regular and Substantive Interaction (RSI)** (NC SARA, 2020; Office of Postsecondary Education, 2020). Why is *regular and substantive interaction* important for educators? Because it is through interaction with instructors, learners, and content, both in and outside of the courses, that learning occurs. In reflecting on Moore's Editorial from 1989, his final statement is as relevant today as it was 30 years ago:

> In short, it is vitally important that distance educators in all media do more to **plan for all three kinds of interaction**, and use the expertise of educators and communication specialists in both traditional media-printed, broadcast, or recorded-and newer teleconference media. (Moore, 1989, p. 6)

As educators design and redesign courses across learning formats, it is important to reflect on the Goldilocks Principle and RSI. Educators are encouraged to stay current with research, build upon evidence-based practices, balance content and cognitive load, and align courses with regulations to support learning through regular and substantive interaction.

3 CURRICULUM OVERLOAD: CHANGING THE FUTURE OF EDUCATION

Global disruption has created many challenges in education. However, with these challenges come new opportunities. The etymology of disrupt stems from disrumpere in Latin: dis- (apart) and rumpere (to break) (Merriam-Webster, n.d.). As educators plan for the future, there are unique opportunities to "break apart" from functional fixedness and to reimagine PK-12 and higher education. According to Sahle-Work Zewde, Chair of the International Commission on the Futures of Education, UNESCO, "**It is evident that we cannot return to the world as it was before**" (p. 3). Therefore, educators must be strategic and collaborative in planning for the future.

Advancements in neuroscience, psychology, and education provide critical insight about the brain, mind, and learning. Educators have an opportunity to redesign curricula in PK-12 and higher education that build upon human learning principles and innovative pedagogical practices to enhance engagement, transfer of learning, well-being, and flourishing. Research on neuroplasticity reveals that educators are brain changers. Furthermore, experiences and the environment have a profound effect on neuroplasticity and learning over the lifespan. Recognizing that the human brain is a complex organ with over 100 billion neurons and 100 trillion synaptic connections as shared by the Colon-Ramos Lab at Yale University, educators are encouraged to integrate research related to the human learning process and neuroplasticity into PK-12 and higher education across all course formats (i.e., face-to-face, hybrid, online) to support strong neural connections and deeper learning. According to a video presentation by Urban Child Institute (2016):

> **Connections that are used more grow stronger and more permanent.** Meanwhile, connections that are used less fade away through a normal process called pruning. Well-used circuits create lightning-fast pathways for neural signals to travel across regions of the brain.
>
> **With repeated use, these circuits become more efficient and connect to other areas of the brain more rapidly**. Like building a house, everything is connected and what comes first forms a foundation for all that comes later.

The challenge within PK-12 education and higher education is **time**, which is needed to support and strengthen neural connections through deeper learning and transfer of learning across real-world contexts.

In 2020, the Organisation for Economic Co-operation & Development (OECD) published *Curriculum Overload: A Way Forward*. This report provides a detailed overview of the importance of countries being responsive to change within curricula but **being cognizant of curriculum overload and the effects it can have on students and teachers**, even serving as "an impediment to learning." OECD provides a table that examines four dimensions of curriculum overload as shared in Figure 1.

Figure 1

Four Dimensions of Curriculum Overload (OECD, 2020)

1. **Curriculum expansion** refers to the tendency to include new content items in the curriculum in response to new societal demands without appropriately considering what items need to be removed.
2. **Content overload** refers to the actual dimension of curriculum overload, rather than as it perceived or experienced (i.e., the excessive amount of content to be taught and learned in relation to the time available for instruction).
3. **Perceived overload** refers to the perceived or experienced dimension of overload, as reported by teachers and students.
4. **Curriculum imbalance** refers to disproportionate attention given to certain areas of the curriculum at the expense of others without appropriate adjustments in the low-priority areas.

One of the key issues with curriculum expansion and overload is ensuring that students still have time to engage with the content and each other to support learning and practice leading to mastery as well as unlearning and relearning. As noted in the OECD report:

> More countries and schools have increasingly become aware of the importance of focusing on **quality of learning time (rather than quantity per se)** as well as student well-being. Addressing curriculum overload is also actioned to **ensure teacher well-being and support effective teaching**. (2020, p. 9)

The reexamination of curricula and courses mitigates the risk of shallow learning as a result of insufficient time to “explore new concepts in a meaningful way” and support deeper learning.

Curriculum expansion and overload are also prevalent in higher education. Certificate and degree programs are designed to prepare graduates as lifelong learners for future careers, career transition, career advancement, and/or advance studies. Curricula must support learning outcomes as well as align with standards related to accreditation and licensure. Furthermore, curricula must prepare graduates for an increasingly competitive and ever-changing global landscape. Like PK-12 education, the challenge is time. Thus, the importance of quality vs. quantity. In the article, "More Content Doesn’t Equal More Learning," Monhan (2015) states, “**Perhaps it’s time to rethink the role of content in teaching and learning**. A fresh perspective on this problem includes thinking about our role as faculty and that of our students, as well as reconsidering the nature of curriculum design" (para. 3).

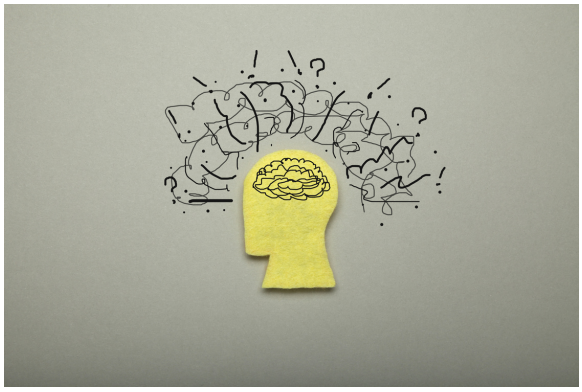
> “Students also may feel stress and pressure, while lacking the time in or out of school to complete all required assignments”
>
> **- OECD, 2020**

Curriculum overload can affect student performance and health. In the national study *Stress in America 2020*, approximately 90% of college-aged students (18-23 years old) reported education as a **significant source of stress** (APA, 2020). According to *Curriculum Overload: A Way Forward*:

> Students also may feel stress and pressure, while **lacking the time in or out of school to complete all required assignments**. This stress, in turn, can undermine students' ability to engage in deeper learning or the productivity or quality of learning time may be lower. (2020, p. 7)

Research reveals that stress can affect cognitive performance, including working memory; and cognitive impairment can lead to increased stress. In the article "Learning and Memory Under Stress: Implications for the Classroom," Vogel and Schwabe (2016) state:

> While stress around the time of learning is thought to enhance memory formation, thus leading to robust memories, stress markedly impairs memory retrieval, bearing, for instance, the risk of underachieving at exams. Recent evidence further indicates that stress may hamper the updating of memories in the light of new information and induce a shift from a flexible, 'cognitive' form of learning towards rather rigid, 'habit'-like behaviour. Together, these stress-induced changes may explain some of the difficulties of learning and remembering under stress in the classroom. (para. 1)



Curriculum overload and stress may also affect sleep as students balance multiple courses with new supplemental readings, expanded assignments, discussion boards across varying course formats – in addition to co-curricular activities, family, work, and other responsibilities. Sleep is critical to learning, memory, and performance. According to the Division of Sleep Medicine at Harvard Medical School:

> When we are sleep deprived, our focus, attention, and vigilance drift, making it more difficult to receive information. **Without adequate sleep and rest, over-worked neurons can no longer function to coordinate information properly, and we lose our ability to access previously learned information**. (2007, para. 9)

In reimagining PK-12 and higher education, it is important to examine current curricula and courses across learning formats (face-to-face, hybrid, HyFlex, online) to mitigate curriculum overload and to support deeper learning. As brain changers, educators have the opportunity to refine and redesign curricula to align with the science of learning, neuroplasticity, cognitive load theory, and flourishing. According to the UNESCO report, *Education in a post-COVID World: Nine Ideas for Public Action*, "**This is the right time for a deep reflection on curriculum**. **We must prioritize the development of the whole person not just academic skills**" (2020, p. 18).

4 STRESS: BRAIN & LEARNING

All stress is not bad. Some stress can be beneficial. However, **chronic stress can affect brain size and structure, impacting learning and memory**.

Stress becomes negative when it goes beyond our ability to manage it, turning it into **long-term or chronic stress**. Madhumita Murgia's video, "How Stress Affects the Brain," reveals that "**Cortisol can literally cause your brain to shrink in size**." Long-term stress and overexposure to cortisol and other stress hormones increase the risk of myriad of health problems as described by the Mayo Clinic (2021), including:

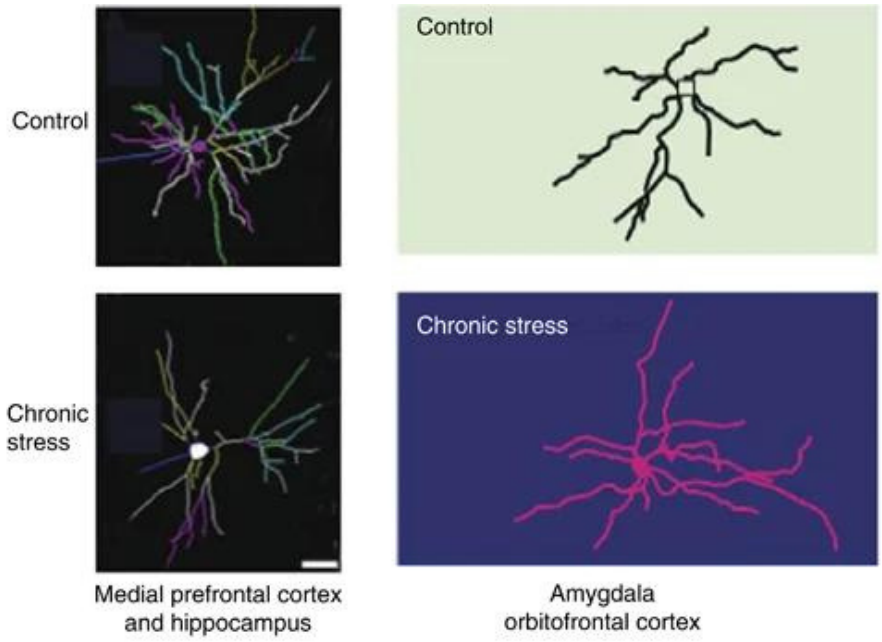
- Memory and concentration impairment
- Sleep problems
- Anxiety
- Depression
- Digestive problems
- Headaches
- Muscle tension and pain
- Weight gain
- Heart disease, heart attack, high blood pressure and stroke

Understanding how stress effects the brain is important for **all students and educators**. A 2018 report from the American College Health Association reported that "more **60 percent of college students** said they had experienced *overwhelming anxiety* in the past year" and "over 40 percent said they felt so *depressed* they had *difficulty functioning*" (Wolverton, 2019, para 7). According to the CDC, from April 2019 through October 2020, the proportion of children between the **ages of 5 and 11 visiting an emergency department** because of a **mental health crisis** climbed 24 percent compared to that same time period in 2019 while the number increased by 31 percent for 12- to 17-year-olds (Leeb et al., 2020). In a study conducted by the American Teachers Association (AFT), **educators and school staff** reported that they found their "**work *always* or *often* stressful 61 percent of the time**, **significantly higher than workers in the general population,** who report that work is *always* or *often* stressful only 30 percent of the time" (AFT, 2017, p. 2).

When a threat is detected, the amygdala sends a distress signal to the hypothalamus which sets off a cascading alarm in the body that prompts the adrenal glands, which are located on top of the kidneys, to release a surge of hormones that include both adrenaline and cortisol. While adrenaline affects heart rate and blood pressure, cortisol increases sugars in the bloodstream and enhances the brain's use of glucose (Mayo Clinic, 2021). "**Chronic stress** causes remodeling of dendrites and synaptic connections in many brain regions, including not only hippocampus but also amygdala and medial prefrontal and orbitofrontal cortex" (McEwen et al., 2016, p. 13). Figure 2 provides images of the effects of stress on neuronal structure.

Figure 2

Stress Effects on Neuronal Structure: Hippocampus, Amygdala, and Prefrontal Cortex
(McEwen et al., 2016, p. 13*)*



Research at Yale University (2012), also found that chronic stress and depression can contribute to **emotional and cognitive impairment**, as well as **loss of brain mass in the prefrontal cortex**, which is involved in executive functions such as decision-making and planning. Furthermore, stress is a "potent inhibitor of adult neurogenesis" which refers to the birth of new neurons in the adult brain (Krugers et al., 2010, p. 2). Neurogenesis has been found to occur in the hippocampus and in the amygdala (Queensland Brain Institute, 2021). There is extensive literature on the profound **effects of childhood stress and trauma on the brain** relating to the amygdala and hippocampus.

The article "Learning and Memory Under Stress: Implications for the Classroom" by Vogel and Schwabe (2016) provides excellent detail on the memory stages, the effects of stress on learning, and considerations for educators (see Figure 3).

Provided below are critical key points shared by Vogel and Schwabe (2016) in "Learning and Memory Under Stress: Implication for the Classroom."

- "The **effects of stress** on memory are, however, not limited to the **formation of memories** (i.e., memory encoding and consolidation) but extend also to **memory retrieval**. Given that exams and tests can easily cause stress in students and students are evaluated based on their performance in these tests, **it is particularly relevant to understand how stress affects memory recall**" (p. 3).

- **"Stress may lead to stronger memories for negative events** happening in the classroom, such as failed exams, embarrassing experiences or interpersonal conflicts (e.g., bullying) and these strong negative memories may induce long-lasting frustration and a negative attitude towards school and the individual's abilities" (p. 6).

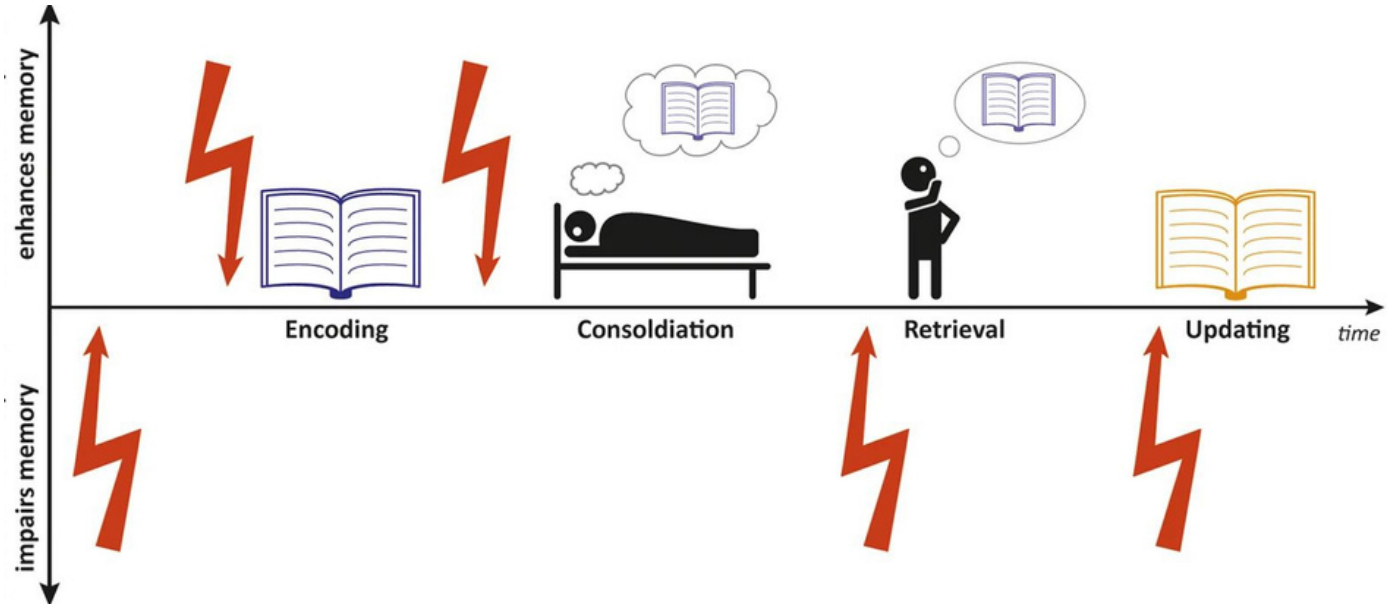
- "**Moderate or high levels of stress** before exams will most likely **hinder memory retrieval** and lead to an underestimation of the students' knowledge, putatively resulting in bad grades" (p. 6).

- "Stress may hinder the integration of new information into existing knowledge structures, which may **prevent the updating of knowledge by new facts or a deep multidisciplinary understanding** of concepts which is often required in education" (p. 6).

- "Considering that stress is ubiquitous in education and even primary school children often report stress symptoms, **understanding the effects of stress on memory is very important"** (p. 7).

Figure 3

Effects of Stress on Memory (Vogel & Schwabe, 2016, p. 3)



Educators have the unique opportunity to design classroom environments (face-to-face, hybrid, HyFlex, online) that foster positive learning environments to support learning and enhance memory. Furthermore, educators have the opportunity within curricula and courses to teach students about the effects of stress on the brain to increase awareness and to introduce strategies to assist students learning how to manage stress which can be used over a lifetime.

As educators design content, presentations, activities, and assessments, they **must consider the balance with quantity and quality** so students are able to actively engage with the content, reflect, and transfer what they are learning across real-world contexts.

5 SLEEP DEBT: MEMORY & PERFORMANCE

Memory is quintessential to learning. As part of the human learning process, memory consolidation is needed to support the storage of enduring memories. Therefore, **sleep is critical for memory and learning**. However, sleep deprivation is one of the greatest challenges for students. Sleep deprivation has been identified as a **global epidemic** with a myriad of negative consequences on cognitive function, psychological well-being, and physiological health (Lyon, 2019).

"College students rank sleep problems as the No. 2 cause of difficulties with academic performance. Stress is No. 1"

- **Emerson, 2018**

Sleep debt is defined as getting fewer than the recommended hours of sleep needed. Simply sleeping in on the weekends will not erase slept debt that accumulates over many nights. It is essential to know how much sleep you should be getting. It is also important to understand the **negative effects that sleep debt has on cognitive function, psychological well-being, and physiological health**. For students, this is particularly important since **sleep debt impacts learning, memory, and health**. Sleep debt also affects educators.

How much sleep is recommended? The Center for Disease Control (2017) provides sleep recommendations based on hours per day and age groups (see Table 1).

Table 1

Recommended Hours of Sleep Per Day (CDC, 2017)

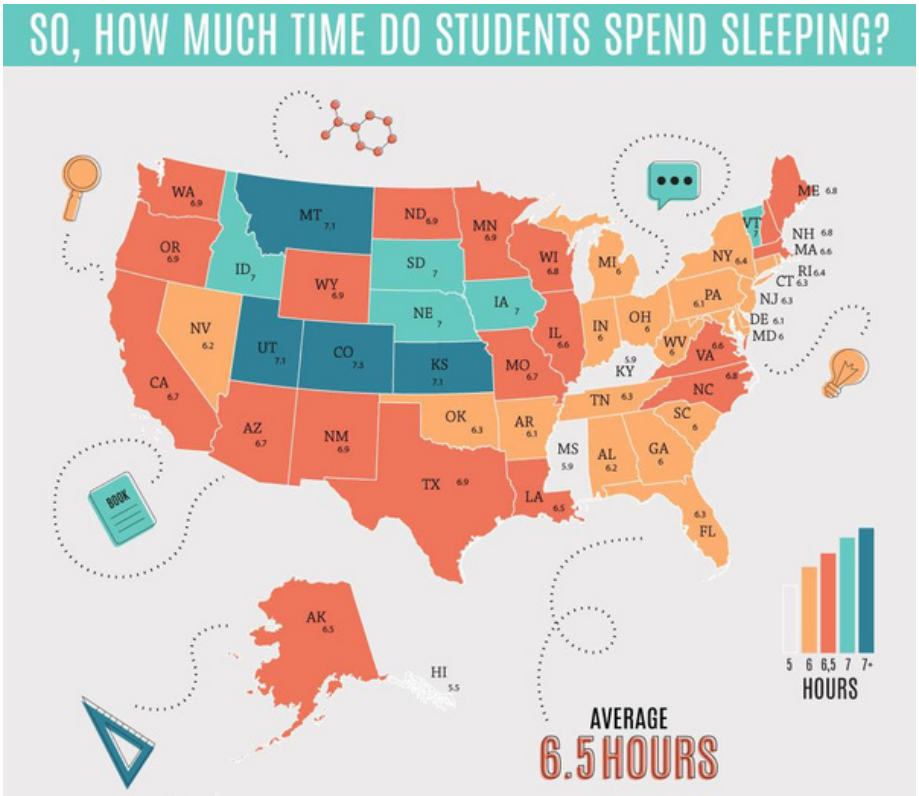
Age Group		Recommended Hours Per Day
School Age	6-12 years	9-12 hours per 24 hours
Teen	13-18 years	8-10 hours per 24 hours
Adult	18-60 years	7 or more hours per night
	61-64 years	7-9 hours
	65 years and older	7-8 hours

It is important to review what national data reveals about sleep deprivation for students and educators in the United States. The following citations provide an overview why understanding sleep debt is so important to the well-being of students and educators. Note: Data is pre-pandemic.

- "The CDC estimates that an estimated **83.6 million U.S. adults** sleep less than 7 hours" (American Academy of Sleep Medicine, 2016, para. 3).
- "**80% of college students** get less than 7 hours of sleep on average" (Breese, 2020; see Figure 4).
- "**Up to 60% of all college students** suffer from a poor sleep quality, and 7.7% meet all criteria of an insomnia disorder" (Schlarb et al., 2017, para. 1).
- "**72.7% high school students** (grades 9-12) did not get enough sleep on school nights" (CDC, 2020, para. 6).
- "Sleep deficit stats prove that **60-70% of American teens** live in **sleep debt**" (Jacimovic, 2020, para. 47).
- "College students rank **sleep problems as the No. 2** cause of difficulties with academic performance. **Stress is No. 1**" (Emerson, 2018, para. 3).
- "**Teachers and staff** slept an average of 6.6 hours per night and 48 percent slept six or fewer hours per night" (American Federation of Teachers, 2017, p. 5).

Figure 4

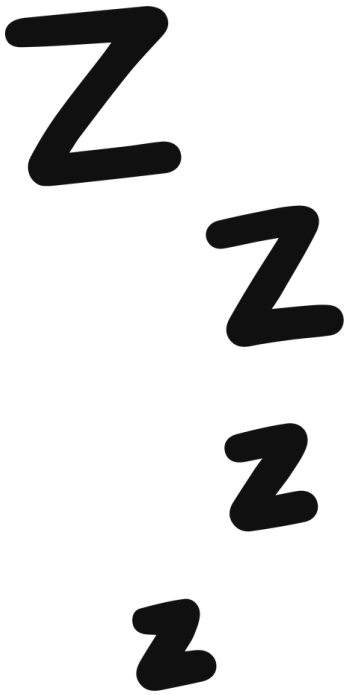
Number of Hours College Students Sleep by State (Breese, 2020)



It is important that educators and students understand the **profound negative effects of sleep deprivation on cognitive function, psychological well-being, and physiological health**. The data below provides critical insight into the effects of sleep deprivation that have short and long-term consequences on the brain and body.

Cognitive Function

- "Being sleep-deprived impacts the skills needed to do well on tests, like **memory recall and concentration**" (AASM, 2021, para. 2).
- "Getting six-and-a-half hours of sleep every night resulted in **grades that were 50 percent lower** than students who averaged just one more hour of shut-eye each night" (Kekatos, 2019, para. 2).
- "College students who pull "**all-nighters**" are **more likely to have a lower GPA**" (AASM, 2017, para. 8).
- "Students who **stay up late on school nights** and make up for it by sleeping late on weekends are more likely to **perform poorly in the classroom**" (AASM, 2017, para.8).
- "After two weeks of **sleeping six hours or less** a night, students feel as bad and **perform as poorly** as someone who has gone without sleep for 48 hours" (AASM, 2017, para. 2).
- "People with **sleep problems** were found to have an approximately **1.5 times greater risk of Alzheimer's disease** than those with normal sleep" (Lyon, 2019, para. 1).
- "**Just one night** of sleep deprivation can lead to accumulation in the brain of the beta amyloid protein, a key component in risk for Alzheimer's disease" (American Heart Association, 2020, para. 4).



Psychological Well-Being

- "**Anxiety causes sleeping problems**, and new research suggests **sleep deprivation can cause an anxiety disorder**" (Anxiety & Depression Association of America, 2020, para. 6).
- "**Sleep deprivation** can **worsen anxiety**, spurring a negative cycle involving insomnia and anxiety disorders" (Sleep Foundation, 2020, para. 1).
- "**Sleep deprivation** affects your **psychological state and mental health**" (Harvard University, 2021, para. 1).
- "**44% of students** experience symptoms of depression" (National Alliance on Mental Illness, 2021, para. 6).
- "**80% of students** feel overwhelmed by academic responsibilities, and **50%** have struggled with anxiety" (AASM, 2021, para. 3).

Physiological Health

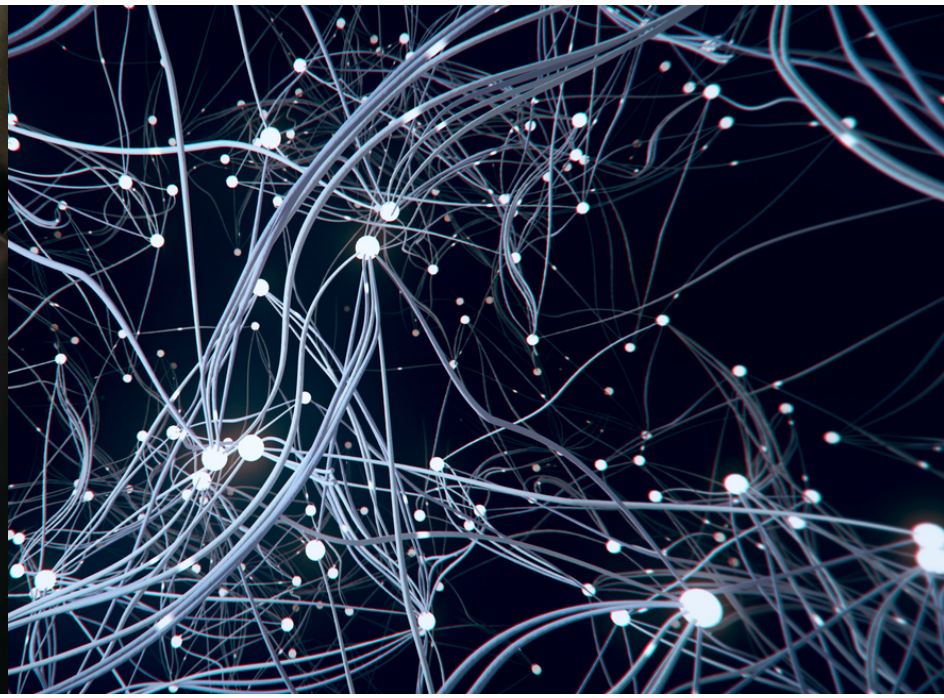
- "**Chronic poor sleep** may increase the likelihood of developing **dementia, heart disease, type 2 diabetes, obesity and even cancers** of the breast, colon, ovaries and prostate" (Johns Hopkins University, 2021, para. 2).

- "Another recent study found people who **slept fewer than six hours a night** – compared with those who slept six to nine hours – had a **20% higher risk of heart attack**" (American Heart Association, 2020, p. 7).

- "**Lack of sleep** is a major predictor of 'all cause mortality' including **cancer, Alzheimer's, heart disease, stroke, diabetes, depression, and suicide**" (Sydney Sleep Center, 2019, p. 2).

- "Children and adolescents who **do not get enough sleep** have a **higher risk of obesity, diabetes, injuries, poor mental health, and problems with attention and behavior**" (CDC, 2020, p. 1).

The reality is that sleep is underrated and undervalued.**Students and educators need to understand the important connection between sleep, academics, and health**. Research on sleep reveals consolidation is critical to the formation of memories. Born and Wilhem (2012), describe two types of memory consolidation: "**synaptic consolidation**, refers to changes of synaptic connections in localized neuronal circuits" (p. 193) and "**system consolidation** which takes place preferentially off-line during sleep, because this type of consolidation involves the reactivation of fresh memory representations to promote their redistribution to the long-term store" (p. 193). It is important to note that synaptic consolidation occurs rapidly after a learning experience, ranging from minutes to several hours, while system consolidation can take much longer to complete and may range from days to years or decades (Baars & Gage, 2010).



Educators and students need to also understand the **positive effects that sleep has on learning**. There is extensive research that highlights the connection between sleep and learning which is critical to academic performance.

- "**Sleep** has been shown to be **critical for the transfer and consolidation of memories** in the cortex" (Langille, 2019, p. 18).
- "**Sleep** is **very important for consolidating memories**. In any sort of experimental setting, study results show better performance if you learn material and then sleep on it, instead of remaining awake" (Harvard Summer School, 2021, para. 28).
- "When you **learn something new, the best way to remember it is to sleep on it**. That's because sleeping helps strengthen memories you've formed throughout the day. It also helps to link new memories to earlier ones" (NIH 2013, para. 1).
- "**Get a good night's sleep before learning**. Lack of sleep can cut learning ability by up to 40%" (NIH, 2013, para. 12).
- "We've learned that **sleep before learning helps prepare your brain for initial formation of memories**. And then, **sleep after learning is essential to help save and cement that new information** into the architecture of the brain, meaning that you're less likely to forget it" (NIH, 2013, para. 3).
- "**Sleep reduces stress**. A good night's sleep can lower blood pressure and the elevated levels of stress hormones that are a natural result of today's fast-paced lifestyle" (Cornell Health, 2021, para. 3).

Research indicates that sleep is critical to memory, learning, health, and performance. Dr. Matthew Walker, Director of the Centre for Human Sleep Science at the University of California Berkeley, shares two videos in which he speaks about the effects of sleep deprivation on the brain and body as well as the effects of sleep deprivation on learning: What Happens to Your Body When You Don't Get Sleep (4:49) and The Sleep Deprivation Epidemic (6:51).

Dr. Walker's website, Sleep Diplomat, also provides research and extensive resources on the connection between sleep, learning, and optimal performance.

6 EMOTION & EMOTIONAL CONTAGION

"What does emotion have to do with learning? Everything!"

- Schmidt, 2017

"Research has found that upbeat emotions such as enthusiasm and joy, as well as negative ones, including sadness, fear and anger, are easily passed from person to person, often without either party's realizing it"

- Colino, 2016

The influence of emotion on learning and memory is profound. "**Emotion is the rudder that steers our thinking**" and "directs our mind" as shared by affective neuroscientist and human development psychologist, Dr. Mary Helen Immordino-Yang (Education Week, 2016, para. 2). According to Immordino-Yang (2016), "It is literally **neurobiologically impossible to build memories**, **engage complex thoughts, or make meaningful decisions without emotion**" (p. 18).

Advancements in technology, neuroscience, and research provide critical insight on how emotion impacts learning and memory. Neuroimaging, including functional magnetic resonance imaging (fMRI), positron emission tomography (PET), electroencephalography (EEG), and functional near-infrared spectroscopy (fNIRS), is being used to examine cognitive-emotional interactions associated with different brain regions. Tyng et al. (2017) state that **emotion has a strong influence on attention as well as motivating action and behavior**. Furthermore, **emotion facilitates encoding and retrieval.**

Within education, emotional states such as anxiety, frustration, and boredom can affect learning and memory. According to Tyng et al. (2017):

> ...emotional influences should be carefully considered in **educational courses design** to maximize learner engagement as well as improve learning and long-term retention of the material (Shen et al., 2009). Numerous studies have reported that **human cognitive processes are 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). These factors are critical in educational domains because when students face such difficulties, it defeats the purpose of schooling and can potentially render it meaningless. (p. 2)

Students in higher education and PK-12 education are engaged much of the year with deadlines, exams, homework, and high stakes assessments which can evoke a myriad of emotions that can impact learning and memory. Research studies indicate that **positive emotions can facilitate learning and contribute to academic achievement** (Tyng et al., 2017). While stress is often perceived as negative, Vogel and Schwabe (2016) share that "emotions or light to moderate forms of stress may increase memory formation, which may have positive effects on memories for study material" (para. 20). However, Vogel and Schwabe (2016) also state that "moderate or high levels of stress before exams will most likely hinder memory retrieval and lead to an underestimation of the students' knowledge, putatively resulting in bad grades" (para. 20). Vogel and Schwabe (2016) further note that stress can also hinder the "integration of new information into existing knowledge structures which may prevent the updating of knowledge by new facts or a deep multidisciplinary understanding of concepts which is often required in education" (para. 3). Therefore, educators must be able to design and teach courses that balance emotional states to facilitate learning and memory.

"Stress is contagious"

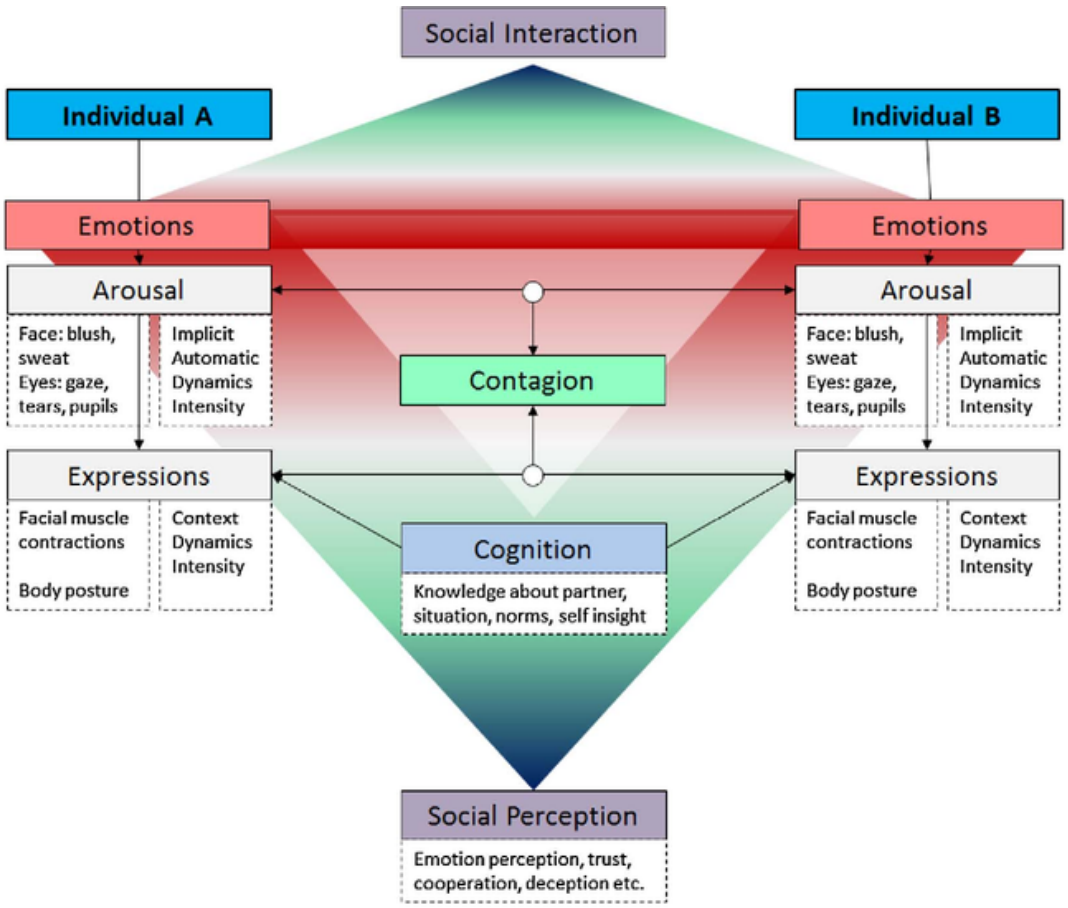
- Wilding, 2021

Classroom climate can also impact emotion. Therefore, understanding the concept of emotional contagion is important, particularly as classrooms have had to pivot across learning formats throughout the pandemic. **Emotional contagion** is defined by the Encyclopedia of Social Psychology as "the phenomenon that individuals tend to express and feel emotions that are similar to those of others" (para. 1). Emotional contagion can occur between two individuals as well as in large groups. Research by Adam et al. (2014) shows that "**emotional states can be transferred to others via emotional contagion, leading people to experience the same emotions without their awareness**" (para. 1). Hence, the importance of educators understanding how emotion may impact learning and memory as it relates to classroom climate is critical.

Emotional contagion is described to **occur within milliseconds**. According to Colino (2016), "Research has found that upbeat emotions such as enthusiasm and joy, as well as negative ones, including sadness, fear and anger, are easily passed from person to person, often without either party's realizing it" (para. 2). Emotion is also expressed through tone of voice and word choice in which individuals may "match the emotional valence of their word choices" particularly with words that may have negative connotation such as "hate, anger, sadness" (Colino, 2016). Motor mimicry, as described by Prochazkova and Kret (2017) includes mimicry of facial expressions, body postures, vocal characteristics, yawning, speech gestures, and laughter. Figure 5 provides a detailed schematic representation of emotion processing and emotional contagion (Prochazkova & Kret, 2017).

Figure 5

*Emotion Processing and Emotional Contagion (*Prochazkova & Kret, 2017)



According to Prochazkova and Kret (2017), Figure 5 shows:

> ...how *emotions* that are expressed during a social interaction by Person A, through *emotional contagion*, influence the emotions and expressions of Person B. Person A and B not only mimic each other's facial expression, they also link on the physiological level and without being aware of it, synchronize on the level of arousal. (p. 771)

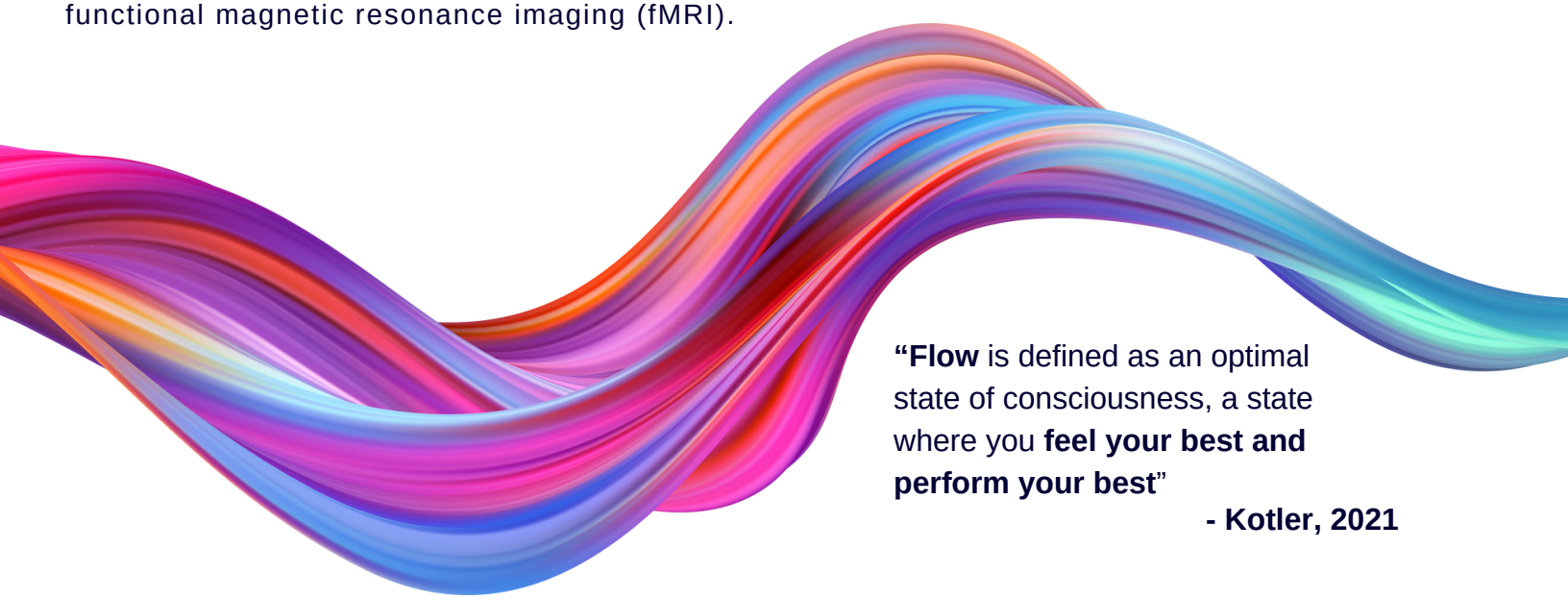
Research reveals that **stress is contagious** (Wilding, 2021). Therefore, as students and educators look at re-entry to classrooms worldwide, it is critical to consider emotions associated with **re-acclimation** and **re-entry anxiety**. Wilding (2021) shares that protecting against re-entry emotional contagion is something to be mindful of since the emotions of others in your environment can impact your well-being. **Stress has been found to be contagious within educational classroom**. A report published in *Social Science & Medicine* by Sifferlin (2016), found that **when "teachers are stressed, so are their students"** (para. 1); in fact, "**researchers found that students had higher levels of cortisol if their teachers reported higher burnout levels**" (para. 3).

The role of faculty, teachers, and instructional designers goes beyond simply developing content that aligns with stated outcomes. Understanding the human learning process and the impact emotion has on learning and memory must be central to scaffolding content to build upon prior learning, being cognizant of cognitive load when presenting content, and providing students with strategies to support resilience and self-regulation to proactively address anxiety and stress. More than ever, educators must learn how to pivot across learning formats to actively engage students in classroom climates and to support transfer of learning across real-world context in preparation for a dynamic and shifting employment landscape.

7 FLOW, MOTIVATION & LEARNING

The concept of flow has garnered increasing attention through research in psychology, neuroscience, and education. **Flow** is often described as being "**in the zone**," when one becomes **completely immersed** in an activity. Mihaly Csikszentmihalyi, pronounced *Me-High Chick-Sent-Me-High*, spent much of his career researching and writing about the concept of flow. According to Csikszentmihalyi (1991), the theory of the **optimal experience** is based on "the concept of flow—the state in which people are **so involved in an activity that nothing else seems to matter**; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it" (p. 4). There are three interconnected areas that Csikszentmihalyi brought global attention to through his research: **attention, flow, and positive psychology**. Terms often associated with the state of flow include, but are not limited to clarity, timelessness, task absorption, serenity, and transcendental.

Research has traditionally explored the flow experience through collecting qualitative data from interviews and quantitative data from self-reported surveys. Factors associated with flow in research with athletes and musicians have typically included motivation, performance preparation, attentional focus, awareness of skills, and confidence among other factors (Bartl & Füller, 2020; Phillipe et al. 2021). Advancements in technology provide new insight on the study of flow states through electrocardiography (ECG), electromyography (EMG), electroencephalography (EEG), and functional magnetic resonance imaging (fMRI).



"Flow is defined as an optimal state of consciousness, a state where you **feel your best and perform your best**"

- Kotler, 2021

Research on flow in the workplace provides important insight on engagement and finding ways to foster optimal performance with employees. According to Lee (2020), research reveals that workers spend "**typically less than 10% of their workday in a focused flow-like state**" (p. 1). Lee (2020) further shares that employers are often "not aware of when workers are in or out of a focused flow-like state and lack an understanding of the contexts in which workers are able to be most productive" (p. 2). Therefore, there is an **incredible opportunity** to "unlock this untapped productivity while increasing satisfaction and well-being" (p. 1) as indicated by Lee (2020) by making changes in the workplace, to job tasks, and the employees' skills to facilitate flow states.

In education, **understanding factors that facilitate flow states are just as important in and outside of the classroom** as it is in the workplace, athletics centers, and artistic venues. There is much that educators can apply from Csikszentmihalyi's research on flow. *In Flow and Optimal Experience*, Biasutti (2011) highlights several points that are key to understanding flow based on Csikszentmihalyi's research:

- It was surprising to discover that enjoyment did not result from relaxing or living without stress, but during these intense activities, in which their attention was fully absorbed. This state was called by Csikszentmihalyi flow, because during the research, people illustrated their intense experiences using the metaphor of being carried by a current like a river flows. (p. 1)

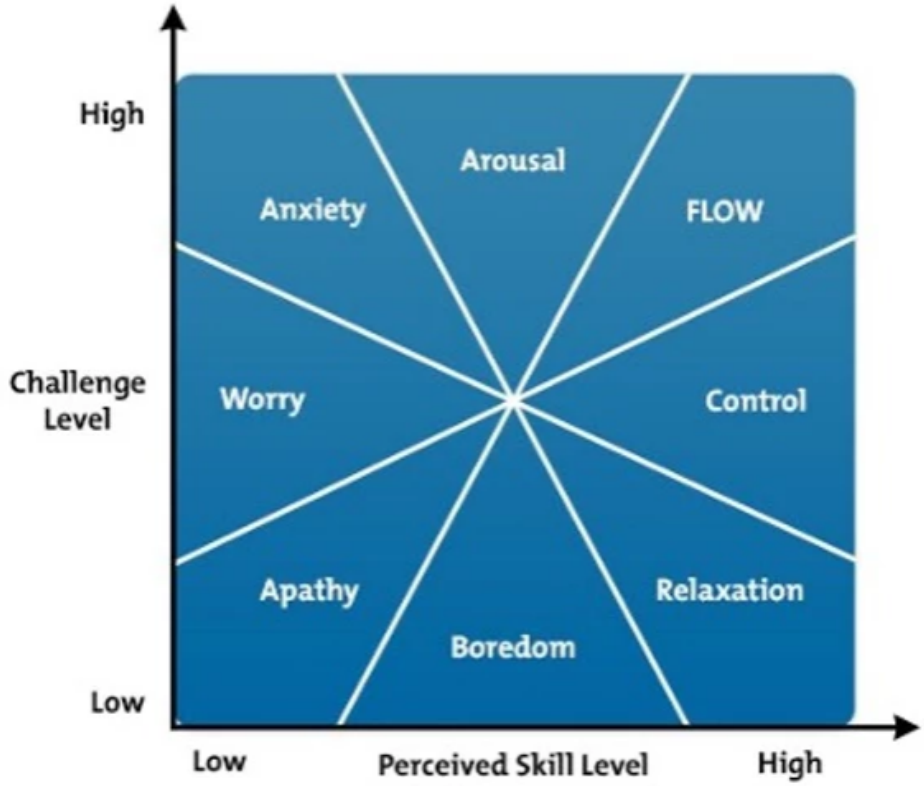
- The flow experience came when the activity was difficult and involved risk. It usually stretched the person's capacity and provided a challenge to his/her skills. (p. 1)

- Csikszentmihalyi reported that flow occurred more often during work than free time. It was easier to achieve the flow state in activities such as performing music, dance and writing since they had rules and required the learning of skills. (p. 1)

Educators can reflect on research conducted by Csikszentmihalyi to find ways to design educational experiences to engage students through activities that facilitate flow (see Figure 6).

Figure 6

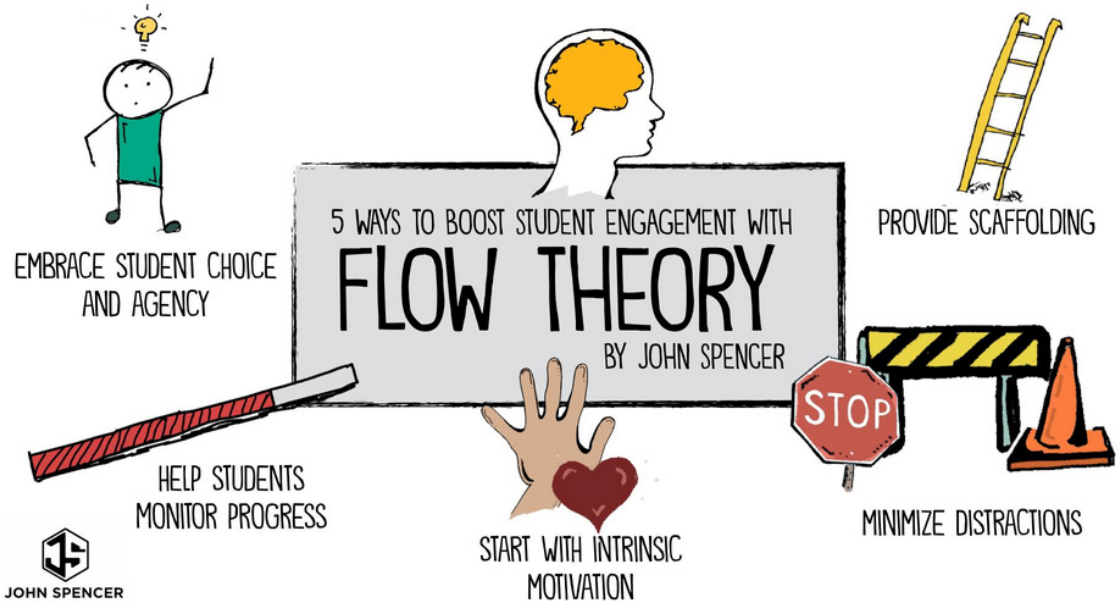
Finding Flow by Mihaly Csikszentmihalyi (© 1997, 1998, 2007)



Within education, John Spencer has explored strategies to boost student engagement through flow theory as shared in Figure 7. According to Spencer (2021), "flow theory explains what happens when we hit that place of *optimal experience*, where you are fully engaged, present, and focused" (para. 1).

Figure 7

Five Ways to Boost Engagement through Flow Theory (Spencer, 2017)



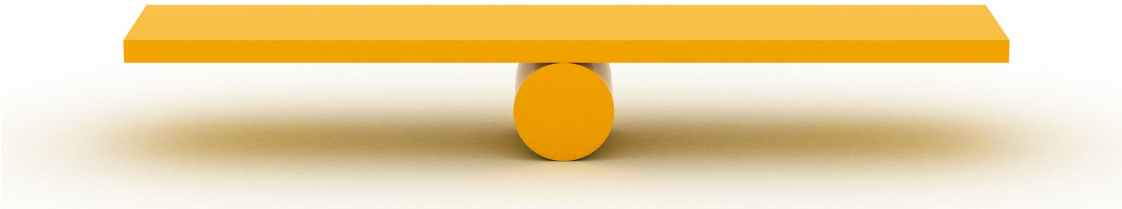
Researchers, like Steven Kotler, bring a dynamic and innovative approach to flow. Kotler discusses how educators can benefit from research in athletics, the arts, and other fields through understanding flow states and the neurochemistry of flow. Kolter shares two videos that provide an overview of flow: Flow and Ultimate Human Performance, The Rise of Superman (2:58) and The Neurochemistry of Flow States, Big Think (4:20).

According to Kotler (2021):

> Flow is defined as an optimal state of consciousness, a state where you feel your best and perform your best. More specifically, the term refers to those moments of rapt attention and total absorption, when you get so focused on the task at hand that everything else disappears. (para. 1)

Kotler (2021) also provides four triggers for that have facilitated flow with artists and adventure sports athletes:

- **High consequences** (that is, some kind of risk: physical, mental, social, emotional, etc.)
- **Deep Embodiment** (the engagement of multiple sensory streams at once, learning through doing)
- **Rich Environment** (lots of novelty, complexity, and unpredictability in the environment)
- **Creativity** (specifically, pattern recognition, or the linking together of new ideas) (para. 24)



So where do educators begin? It starts with course design, assessment, feedback, and time. Much of the research on flow focuses on finding that balance between boredom, flow, and overload – much like the Goldilocks principle. Time must be built into courses to support cognition, metacognition, creativity, and flow. Educators are encouraged to review Csikszentmihalyi's nine dimensions that facilitate flow as detailed by Biasutti (2011).

Nine Dimensions to Flow

1. **Challenges and skills balance**. A good match between challenges and skills is a necessary condition. Flow is controlled by the ability of balancing challenges with skills.

2. **Action and awareness merging**. The action must be combined with awareness in order to facilitate concentration and high performance of the task.

3. **Clear goals.** There is a clear purpose and a precise idea of what to do next. Although the activity advances towards a higher goal, the activity is driven by the progressive realization of the next small goal.

4. **Unambiguous feedback.** Feedback is used for controlling the progression of the activity and the achievement of the goals. It is a process that happens in real time without it being necessary to stop. This allows adjustments to be made in order to meet the objectives.

5. **Concentration on the task.** In flow, people are focused on aspects relevant to the task and distractions are excluded from consciousness. All attentional resources are used for the performance of the task which becomes the exclusive content of the working memory buffer.

6. **Sense of control.** In flow, people do not worry about failure and possible loss of control, because they are deeply involved in the activity and all the external elements, such as failure, are less relevant.

7. **Loss of self-consciousness.** Self-consciousness can be considered a meta-representation involving higher order processes. In a flow state, people are too focused on an activity which requires most of their mental resources to be self-conscious.

8. **Distorted sense of time.** In flow the perception of time can be transformed. Time generally flies when people are performing activities in which they are engaged. On the contrary, time seems to slow down when doing tasks in which they are not really involved.

9. **Autotelic experience.** Flow is a pleasant experience which is intrinsically rewarding. This gratification is directly connected with the activity. Autotelic is a word used to describe people who are internally driven and have a purpose within themselves. (p. 2)

As instructional designers and faculty are developing courses, activities, and assessments, it is important to consider how to facilitate flow in and outside of the classroom to support optimal learning and performance.

8 REGULAR & SUBSTANTIVE INTERACTION (RSI)

Rules & Regulations

On **July 1, 2021**, new requirements from the US Department of Education took effect as part of the Distance Education and Innovation regulations (Office of Postsecondary Education, 2020). One of the key regulation changes was greater clarity on **regular and substantive interaction** for distance education.

According to NC SARA (2020): "**regular** is defined as taking place on a **predictable and scheduled basis** and **substantive** means students are engaged through **teaching, learning, and assessment** as well as at least **two of these five activities**:"

- providing direct instruction
- assessing or providing feedback on a student's course work
- providing information or responding to questions about the content course or competency
- facilitating a group discussion regarding the content of a course or competency
- or other instructional activities approved by the institution's or program's accrediting agency (para. 3)

With the new regulations, distance education and correspondence education are "more clearly distinguishable through five critical factors:"

- Distance education should be delivered through an **appropriate** form of online media.
- Distance education must use instructors that **meet accreditor requirements** for instruction in the subject matter.
- There should be **at least two forms of substantive interaction**.
- There must be **scheduled and predictable** opportunities for instructor/student interaction.
- Instructors **must be responsive** to students' requests for support. (para. 7)

> "Every lesson, assignment, and interaction shapes your students' brains"
>
> **- McTighe & Willis, 2019**

Furthermore, the regulations state that "**academic engagement** can be fulfilled through **virtual/augmented reality activities"** (NC SARA, 2020, para. 5).

Why are the Distance Education and Innovation regulations important, particularly the focus on regular and substantive interaction?

Neuroplasticity and learning are experience dependent as shared by Dr. Lara Boyd (2018), Neuroscientist and Physical Therapist at the University of British Columbia. There is a critical relationship between **learning, practice, and memory**. As shared by McTighe and Willis (2019), "**Every lesson, assignment, and interaction shapes your students' brains**" (p. 3). Therefore, how instructional designers and faculty design courses is important to learning since the brain continues to change as a result of experience and interactions with the environment both in and outside of the online classroom.

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