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Purpose: To provide background information on recent findings in the science of learning.
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Expected Outcome: Improved understanding of the neuroscience of learning, culturally and linguistically responsive practices, and state initiatives in alignment with culturally and linguistically responsive practices.

Neuroscience of Learning, Culturally and Linguistically Responsive Practices, and State Initiatives

Background

The science of learning has historically been rooted in behavioral sciences like education and psychology. However, new discoveries in the field of neuroscience have deepened understanding of the brain's adaptability and of environments and experiences aligned with how the brain learns and develops, allowing findings from physiology and chemistry to inform theories of learning. Research in neuroscience has reinforced much classic educational theory, while enhancing the ability to recognize the needs of individual students and to provide increased opportunities for all students. Advances in brain science over the past two decades have revealed the neurological mechanisms that underlie learning and generate social and emotional effects on learning, creating opportunities for educators and policy makers to apply insights from neuroscience to promote policies and practices consistent with how the human brain best learns.

Educational practices that are culturally responsive, reflect the values and norms of students and families, and affirm students' home cultures and languages align with recent neuroscience research indicating optimal brain development requires supportive social relationships and emotional experiences, in addition to cognitive resources. An emotional connection that allows students to make learning personally relevant can distinguish deep, lasting learning from a superficial assimilation of knowledge. This grounding is also likely what makes people more resilient to forces that undermine achievement, such as stereotype threat. To learn most effectively, students need reflection time, strong social relationships, and the ability to engage in work that feels relevant. If students do not feel supported or lose who they are culturally in schools, their learning and development are inhibited. A neuroscience-informed perspective can help to create effective policies that appropriately support students' social-emotional contexts for learning, such as culturally and linguistically responsive education.

Stereotype threat is a situation in which people are or feel to be at-risk of conforming to stereotypes about their social group. It has been found to be a contributing factor to long-standing racial and gender gaps in academic performance.

The Science of Learning and Developments in Brain Science

Cognitive science, or neuroscience research has provided deeper insights into the process of learning, increasing the understanding of the neurological processes that take place in the brain during learning. Learning begins when a person's brain, through sensory input, processes information, which is then processed to the different sensory lobes at the back of the brain and finally to the expressive center of

the frontal lobes where it is organized in neural pathways. A person's unique neurological design is made up of brain hemispheres along with their expressive-receptive, rational-emotional, and sensory-intelligence preferences. All lobes in both hemispheres should be involved in processing for maximum comprehension and retention.

Research has shown the human brain develops differently depending on a number of factors, including age, predispositions, experiences, and environments. When the social, emotional, cognitive, and physical dimensions of a person's world are enhanced, brain development is facilitated and learning enabled. Conversely, when these dimensions are not adequately nourished, brain development and subsequently learning suffers. Moreover, targeted, age-appropriate interventions and supports have been found to enable brain development and improve neural and cognitive functioning.

Understanding the Brain: From Fixed to Malleable. The concept that learning produces physical changes in the brain represents a new way of thinking about both learning and neuroscience. Previous models treated the brain as more fixed with the wiring for learning already in place. Early brain science in late 20th century treated regions of the brain as isolated not only from each other but from any social, cultural, or emotional contexts. In the last few decades, however, researchers have rejected this idea in recognition of a more malleable brain that changes its own wiring and is continuously being molded and reshaped largely in response to its environment and a person's social-emotional experiences.

Environmental Factors Shape Brain Development. The degree to which the regions of the brain, apparent at birth, grow and strengthen over time is based on the way the brain is used, as well as how it is impacted by one's environment, opportunities, and relationships, which influences neural activity both within and between the brain's connectivity networks. The three major brain networks regulate and support mental capacities contributing to a person's social, emotional, and cognitive functioning. The quality of one's environment, relationships, and access to resources impact the ability of these networks to function properly. Recent research has shown the network that regulates social-emotional aspects of memory, future-oriented thinking, and conceptual understanding deactivates during times of task-oriented focus, making it neurologically impossible to simultaneously devote full attention to completing current tasks while also reflecting on their broader meaning.

Executive Control Network of the Brain facilitates attention, allowing people to hold information in mind, shift strategies as necessary, and complete goal-directed tasks. It is important for regulating emotions, maintaining goals and focus, and controlling impulses.

Default Mode Network of the Brain is employed during tasks that involve internally directed, interpretive, and reflective thought. It is important for conceptual understanding, reading comprehension, creativity, social emotions like admiration and compassion, and identity development.

Salience Network of the Brain weighs emotional relevance and perceived urgency of information to facilitate switching between mindsets supported by the task-oriented executive control network and those supported by the inwardly focused, meaning-oriented default mode network.

Emotions Impact Brain Development. In the new field of social-affective neuroscience, research on the cognitive and neural mechanisms governing social and emotional learning has found an intertwined relationship between emotion and cognition. Emotional well-being boosts overall health, brain development, and learning, while excessive stress, including from threats to emotional safety and threats of belonging, affects neural functioning, inhibiting brain development and impeding working memory. Identity- or race-related stress, or the psychological distress associated with experiences

of discrimination, negatively impacts a person's cognitive performance and may lead to premature aging of the brain and body.

Research in neuropsychology shows learning and memory systems are developed based on instincts of arousal, stress, and fear. Neural plasticity tends to shut down during times of extreme anxiety, inhibiting learning, memory, and the management of emotions. Stressors that cause learners to "misbehave" or "lack motivation," resulting in decreased learning and emotional self-management, include boredom (from having already mastered the information) and frustration from repeated failure to achieve a goal. Moreover, these stressors, when recurrent, can change the brain's neural networks and promote a "fixed mindset" with decreased effort and motivation. The field of social-affective neuroscience, viewing the brain as a social organ, has found that the way we feel directly influences our brain and its development.

Applying the Neuroscience of Learning in the Classroom

Research in the field of neuroscience presents opportunities to design school curriculum, instruction, and assessment in ways that reflect current understanding of the neuroscience of learning. Over the past 20 years, neuroimaging and brain mapping research has demonstrated that learning optimally takes place when classroom experiences are relevant to students' interests. The relationship of neural networks to knowledge and learning has indicated the existing networks of neurons in a learner's brain represent the physical form of prior knowledge. An emphasis on activating prior knowledge, or building on student's preexisting knowledge, reflects a biological basis that confirms its meaning and significance to the classroom. This lens of neuroscience represents the teacher's role as helping to expand and strengthen those networks.

Respect for and acknowledgement of tribal sovereignty should be a component of culturally and linguistically responsive practices.

This is becoming increasingly apparent as school districts and charter schools located on sovereign tribal land update school reopening plans. Holding teachers to culturally and linguistically responsive practices are more effective when such practices are infused at a school district or charter school level.

Culturally and Linguistically Responsive Practices and Neuroscience.

Studies viewing the brain as a social organ of adaptation, a skill critical to cognitive development, have indicated the critical roles that secure attachment and supportive relationships play in healthy psychological development and the building of social brain networks. By ensuring students feel respected and capable, teachers can foster a community of learning that promotes growth and development within the student's brain that enhances the brain's flexibility and willingness to grow and develop. The brain's ability to grow and learn best within healthy social contexts provides neurological backing to what leaders in culturally and linguistically responsive pedagogy have argued for decades. Academic learning is not separate from one's emotional or cultural understanding of the world. To develop the critical thinking skills students need to be successful in the future, policies must support student investment in their own learning by honoring their cultural and emotional ways of being.

One prominent definition of culturally and linguistically responsive teaching in relation to neuroscience is "the process of using familiar cultural information and processes to scaffold learning." From a social-affective neuroscience standpoint, culture is the major way that every brain constructs an understanding of the world.