Recent technological breakthroughs make research in human biology and cognitive science more relevant for education than ever before. With powerful brain imaging tools, neuroscientists can for the first time study the learning brain in action. New technologies in genetics are revealing the complex interactions between a learner’s genetic makeup and the external environment, while cognitive scientists are tracking the development of alternative learning pathways. Such advancements have led to the emergence of the field of mind, brain, and education. Christina Hinton, Kurt W. Fischer, and Catherine Glennon consider student-centered approaches to learning in light of important findings from this trans-disciplinary field. The authors suggest that such approaches support learning in the brain, giving them the potential to support academic achievement and close achievement gaps, particularly for underserved youth. Ultimately, student-centered programming could lead to a more effective and equitable education system for all students.

The authors point to a number of significant implications of findings about the brain for student-centered approaches to learning (see table).

<table>
<thead>
<tr>
<th>FINDINGS ABOUT THE BRAIN</th>
<th>IMPLICATION FOR STUDENT-CENTERED APPROACHES TO LEARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>The brain is continually changing, as learning experiences shape its architecture; students' abilities are always developing.</td>
<td>Student-centered approaches to learning use a variety of ongoing assessments to monitor learning and tailor instruction to promote learning.</td>
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<tr>
<td>The brain is learning virtually all the time, in both formal and informal contexts.</td>
<td>Student-centered approaches can capitalize on this through a range of nontraditional learning experiences, such as afterschool enrichment, internships, and community programs.</td>
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<tr>
<td>The brain changes that underlie learning occur when experiences are active, not passive.</td>
<td>Student-centered approaches empower students to engage in active learning experiences that are relevant to their lives and goals.</td>
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<tr>
<td>Learning and emotion work together in the brain.</td>
<td>Student-centered approaches address emotion's central role in education by nurturing positive relationships, teaching emotional regulation skills, and providing shelter from harmful stresses.</td>
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<tr>
<td>Each student has a complex profile of strengths and limitations and learns best through experiences tailored to his or her needs and interests.</td>
<td>Student-centered approaches customize instruction in each subject to each individual.</td>
</tr>
<tr>
<td>Underserved students, including low-income youth and English language learners, sometimes thrive with different instructional techniques than their middle-class peers.</td>
<td>Student-centered approaches have the flexibility to focus on their particular needs.</td>
</tr>
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</table>
DIVERSE, ONGOING ASSESSMENTS

Arguably the most important insight for education from the field of neuroscience is that the brain is highly adaptive, a property called plasticity. As a result of experiences in different environments, students’ brains change continuously, from preschool through high school and beyond. Students learn not only at school but also at work, at home, in community centers, and in other settings.

As students engage in various activities—from mastering reading to playing online chess to practicing word processing—these experiences gradually sculpt the physical architecture of their brains. The brain is made up of networks of interconnecting nerve cells, called neurons, and supportive glial cells, which nourish the neurons. Learning experiences are translated into electrical and chemical signals, which cascade among many neurons in many areas of the brain. Gradually, the signals modify connections among neurons in certain areas of the brain and those areas are reorganized. Over time, the connections are affected in a “use it or lose it” way: the ones used the most are strengthened, while the less active are weakened or eliminated.

A significant body of research now contradicts the longstanding notion that individual abilities are fixed at birth. Indeed, the brain’s plasticity means that individual abilities develop continuously. The more a student learns in a particular area, the more intelligent the brain becomes in that area.

The brain’s adaptability also helps students overcome many learning challenges, as alternative pathways develop to compensate for biological limitations. For example, students with dyslexia, a reading difficulty typically involving impaired phonological processing, often can develop alternative neural circuitry to support reading if they receive appropriate instruction.

The continually changing nature of the brain underscores the potentially negative effects of certain traditional educational practices, such as tracking. Sorting students into rigid tracks based on their current levels of ability could deny lower-tracked students the rich learning experiences their brains need to reach their full potential. By contrast, a central aspect of student-centered approaches to learning—flexible and meaningful active learning experiences that are relevant to their lives and goals, both inside and outside the classroom. Brain research is consistent with the student-centered principle of giving credit for mastery of core skills in formal and informal contexts, rather than awarding credit just for spending time in a classroom.

LEARNING THROUGH ACTIVE, RELEVANT EXPERIENCES

Neuroscience research shows that the brain’s active engagement is a prerequisite for learning. Changes in the brain’s neuronal connections that underlie learning occur only when experiences are active; passive activities do not affect the brain the same way. In educational terms, this suggests that sitting in a classroom listening to a lecture will not necessarily lead to learning.

Student-centered approaches empower students to engage in active learning experiences that are relevant to their lives and goals, both inside and outside the classroom. Brain research is consistent with the student-centered principle of giving credit for mastery of core skills in formal and informal contexts, rather than awarding credit just for spending time in a classroom.

A VARIETY OF NONTRADITIONAL LEARNING EXPERIENCES

Research on brain plasticity indicates that the brain is learning virtually all the time, in both formal and informal contexts. Traditional schooling, where a teacher stands in front of a classroom and delivers content through lecturing, is only one of many potential learning experiences. Student-centered approaches to learning value a variety of student-driven activities, both within the classroom and in other school spaces. Nor is learning restricted to the confines of the school building or the typical school day. The idea of “anywhere, anytime” learning is central: education can occur far beyond a school’s walls, at any hour, on any day.

Student-centered approaches encourage a wide range of nontraditional learning experiences, such as afterschool enrichment, internships, and community programs. Learning can occur in settings ranging from local businesses to community centers to cyberspace. Educators can include teachers, professionals, parents, and community members. With a student-centered approach to learning, these are not just “extracurricular” activities. Schools would formally recognize them—and award credit for them—provided that students are working toward core skills and can demonstrate their proficiency in them.

POSITIVE RELATIONSHIPS AND EXPERIENCES

Learning and emotion are integrated in the brain. In fact, strong skills in emotional regulation strongly predict academic achievement. Emotion acts as a rudder to guide learning. The emotions students feel during an experience become salient labels that steer future learning and decision making. People gravitate toward situations they have tagged positive and away from situations they have tagged negative or worth avoiding.

Neuroscience research shows that emotion and learning are integrated in the brain. This research settles longstanding ideological debates about whether educators should be
responsible for emotional development because if educators are involved in intellectual development, they are inherently involved in emotional development. Students are still developing emotional skills and learning to regulate their emotions in childhood and adolescence. Education can support the development of emotional regulation skills. Indeed, this should be a priority, given their critical role in academic performance.

Students are more likely to thrive academically when educators provide a positive learning environment, nurture teacher-student relationships, encourage a sense of community, teach emotional regulation strategies, and provide shelter from toxic stress. Student-centered learning approaches recognize the importance of emotion, calling for a supportive community of educators that can help reduce student stress and apply a knowledge of individual differences in motivation to engage each student.

Emotion is also physically integrated in the brain with executive functioning, a set of mental processes that are critical to learning. Executive function skills connect past experience with present action and include planning, selecting learning strategies, and assessing outcomes. The brain’s prefrontal cortex, which regulates executive functioning and some emotional processing, is maturing during adolescence and into early adulthood. It is important for educators to support this development.

Student-centered approaches to learning require students to be self-directed and responsible for their own learning, including goal setting, planning, and monitoring progress. Student-centered approaches teach students the necessary executive function skills to do these tasks, initially offering significant support, then gradually removing it as students become more self-directed.

CUSTOMIZED INSTRUCTION TO ADDRESS DIFFERENCES

Mind, brain, and education research on individual differences contradicts the simplistic notion that each student is either intelligent or not. It points to a more nuanced perspective that recognizes that each student has a complex profile of strengths and limitations. A student may struggle in one area, such as mathematics, yet thrive in another, such as linguistic ability or interpersonal intelligence. Even within single domains, students can have both strengths and weaknesses.

The wide range of individual differences result from an interaction of each student’s genetic tendencies and experiences. Experiences can reinforce or counteract genetic inclinations. This explains, for example, why someone born with a genetic predisposition for shyness can grow into a gregarious person.

Mind, brain, and education research on individual differences, language learning, literacy, and mathematics suggests that students can follow different learning pathways to master the same core skills. Each individual learns most effectively through experiences tailored to his or her needs and interests. Traditional instruction and standard curriculum most often do not accommodate individual differences. Uniform approaches lose a host of students because they fail to take into account their different ways of learning—or the different languages, cultures, values, goals, and interests they bring to school. Adjusting instruction to meet each student’s particular needs often can move students from failure to proficiency.

Without such instructional flexibility, difficulties in a certain domain may unnecessarily interfere with learning in another. For example, students with limited English proficiency in a traditional math class would struggle to access knowledge from a typical textbook or demonstrate their understanding on a written test. However, if given alternatives, such as a computer program that can translate English instructions into their native language, they would be far less likely to fall behind in math while their language skills were developing.

A FOCUS ON THE NEEDS OF UNDERSERVED STUDENTS

While all students can benefit from student-centered approaches to learning, it is important to note how underserved students in particular may thrive with different instructional techniques than their middle-class peers. For example, neuroscience research on literacy shows that English language learners use a somewhat different brain network for reading than native English readers, because of differences between the rules of English and other languages. This suggests that ELL students may require alternative means of reading instruction. Many of the practices associated with student-centered learning provide a flexible framework for education that can accommodate these types of individual differences through differentiated instruction.

Neuroscience research also indicates that there are sensitive periods early in life for learning certain aspects of language, including grammar and accent. Students who receive non-native language instruction in preschool or primary school have a biological advantage for mastering those aspects of the language. Since proficiency in the language of instruction strongly predicts academic achievement among immigrants, teaching ELL students English as early as possible, with complementary instruction in their native tongue, gives them a critical advantage for learning the language and, ultimately, academics.

Recent research highlights a key difference between disadvantaged students who succeed in school and those who do not: their emotional skills. Resilient disadvantaged students tend to have more self-confidence and higher motivation than non-resilient peers. Therefore, using an educational approach that nurtures emotional development is especially important for underserved students. As noted, student-centered approaches pay particular attention to emotional development and motivation.

Sheltering students from major stresses is important to these efforts. Research suggests that students from disadvantaged backgrounds are more likely to experience toxic stressors—poverty, abuse, bullying, trauma—but receive little support in
dealing with them. Toxic stress can disrupt brain circuitry and cause learning problems. It also can change an individual’s stress system such that situations that might not threaten most students can trigger a stress response, which can interrupt learning and manifest in problematic aggressive attitudes that damage students’ relationships with teachers and peers.

Fortunately, supportive school environments can buffer students’ brains from the impacts of unhealthy levels of stress. Recent research on students of low- and middle- socioeconomic status reveal that low-SES students typically come to school with higher levels of the stress hormone cortisol. However, when students from disadvantaged backgrounds are in high-quality schools, their cortisol levels decrease during the day. The better the school, the greater the drop. This suggests that a quality learning environment can lead to better emotional regulation and more favorable learning outcomes. This research underscores the need for child-friendly learning spaces that promote students’ intellectual, emotional, and physical well-being both during and outside of regular school hours.