



## New Teaching for a New Age: Neuroscience, Psychology & Technology in the Modern Classroom

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### Abstract

*Over the past few decades, research in the fields of neuroscience and psychology have made various new insights into how our brains function and how we best learn. Coinciding with this, internet technologies have drastically changed our relationship with information. In the past, students came to school mainly to gain access to knowledge, yet today's students have more access to information on their smartphones than they can get from any textbook or teacher. Due to this, the way students think, behave, and learn has undergone profound changes. Perhaps most significantly, these internet technologies are leading to a fluid, constantly-evolving job market in which much of what students will need to know they will need to learn on their own after they leave our classrooms.*

*Yet while today's students have an overabundance of information, many aren't proficient at understanding and using it. The ability to fluently analyze, interpret, and manipulate information has become much more critical in both the classroom and the business world. Thus in the face of all these changes we teachers need to rethink our concept of what 'normal' classrooms and lessons should look like, and our own roles as teachers. Going forward our main value will not be (just) our knowledge base. The future belongs to self-regulating, lifelong learners, and we need to know how to create them.*

*This paper will briefly discuss several key areas in neuroscience, educational psychology, and classroom management that modern-day teachers should become knowledgeable in, and provides some tips and resources to aid in adapting and evolving our teaching pedagogy.*

*Keywords: Education Psychology, Neuroscience, Technology, Classroom Management, 21<sup>st</sup> Century Skills, Critical Thinking*

### Introduction

Over the past few decades, thanks largely to improvements in brain-imaging technology, research in the fields of neuroscience and psychology have made various new insights into how our brains function and how we best learn. Coinciding with this, internet technologies have drastically changed our relationship with information. In the past, students came to school mainly to gain access to knowledge, yet today's students have more access to information on their smartphones than they can get from any textbook or teacher. Having been immersed most of their lives with internet technologies, the way students think, behave, and learn has undergone profound changes. Perhaps most significantly, these internet technologies are leading to a fluid, constantly-evolving job market in which much of what students will need to know they will need to learn on their own after they leave our classrooms.

Yet while today's students have an overabundance of information, many aren't proficient at understanding and using it. The ability to fluently analyze, interpret, and manipulate information has become much more critical in both the classroom and the business world. Thus in the face of all these changes we teachers need to rethink our concept of what 'normal' classrooms and lessons should look like, and our own roles as teachers. Going forward our main value will not be (just) our knowledge base. "Our job as faculty is to understand how the brain learns, what motivates students, and how to create environments that encourage good learning behaviors on the part of students" (Bowen, 2012). The future belongs to self-regulating, lifelong learners, and we need to know how to create them.

The following sections will briefly discuss several key areas in neuroscience, educational psychology, and classroom management that modern-day teachers should become knowledgeable in, and provides some tips and resources to aid in adapting and evolving our teaching pedagogy to better fit with this new age of student and internet technologies.

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## Neuroplasticity & Learner Mindsets

Mind, Brain, and Education is a new and growing transdisciplinary academic field that has grown out of the intersection of neuroscience, psychology, and education (Tokuhama-Espinosa, 2010). It seeks to extract key research findings in each respective field and make it accessible to teachers and students alike.

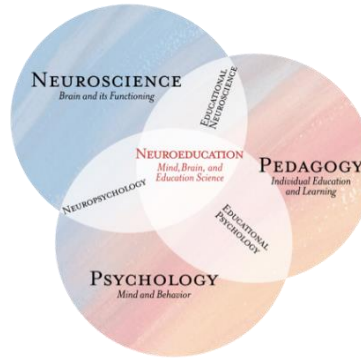


Figure 1

To start, teachers should have a basic understanding of how our brains work and how we learn best, and explicitly explain this to their students in order to maximize learning in their own classroom. “Designing educational experiences without an understanding of the brain is like designing a glove without an understanding of the human hand” (Hart, 1983). Research over the past decade has shown that our brain (and thus intelligence) is not ‘fixed’ by the time we become adults but is malleable (neuroplasticity). Certain experiences and environmental input cause new connections to form or strengthen, making the brain smarter by literally ‘rewiring’ it. This isn’t true just for young children — neuroplasticity can continue throughout our entire lives provided it gets the necessary requirements to do so (Sousa, 2010). Thus, “a great positivity-building tool comes from students’ learning about their brain’s ability to change through this neuroplasticity process. When students understand that their brains can develop stronger, more efficient, accessible, and durable neural networks through their actions, they have the positivity, resilience, and motivation to do their part to develop the skills, knowledge, and intelligence to achieve their goals” (Willis, 2010).

Along with learning about the brain, understanding and teaching students about learner mindsets is also imperative. In her groundbreaking book *Mindset* (2006), Carol Dweck explains students fall into one of two categories about how they think of skills and intelligence— a fixed mindset or a growth mindset. The fixed mindset believes intelligence and skills are fixed traits that cannot be significantly developed. These students focus on looking smart over learning, see effort as a sign of low ability, and wilt in the face of a challenge. They also tend to feel a need to prove themselves to others, and believe that mistakes are something to be feared and hidden from others. Conversely, the growth mindset believes intelligence and skills can always be developed with effort, learning, and dedication over time. These students focus on learning over just looking smart, see effort as the key to success, and thrive in the face of a challenge. They also aren’t afraid of making mistakes, because they values feedback (about their strengths *and* weaknesses). This leads to a passion for growth and lifelong learning, which is something we want to foster in all our students.

FIXED MINDSET		GROWTH MINDSET
<ul style="list-style-type: none"> <li>SOMETHING YOU'RE BORN WITH</li> <li>FIXED</li> </ul>	SKILLS	<ul style="list-style-type: none"> <li>COME FROM HARD WORK</li> <li>CAN ALWAYS IMPROVE</li> </ul>
<ul style="list-style-type: none"> <li>SOMETHING TO AVOID</li> <li>COULD REVEAL LACK OF SKILL</li> <li>TEND TO GIVE UP EASILY</li> </ul>	CHALLENGES	<ul style="list-style-type: none"> <li>SHOULD BE EMBRACED</li> <li>AN OPPORTUNITY TO GROW</li> <li>MORE PERSISTANT</li> </ul>
<ul style="list-style-type: none"> <li>UNNECESSARY</li> <li>SOMETHING YOU DO WHEN YOU ARE NOT GOOD ENOUGH</li> </ul>	EFFORT	<ul style="list-style-type: none"> <li>ESSENTIAL</li> <li>A PATH TO MASTERY</li> </ul>
<ul style="list-style-type: none"> <li>GET DEFENSIVE</li> <li>TAKE IT PERSONAL</li> </ul>	FEEDBACK	<ul style="list-style-type: none"> <li>USEFUL</li> <li>SOMETHING TO LEARN FROM</li> <li>IDENTIFY AREAS TO IMPROVE</li> </ul>
<ul style="list-style-type: none"> <li>BLAME OTHERS</li> <li>GET DISCOURAGED</li> </ul>	SETBACKS	<ul style="list-style-type: none"> <li>USE AS A WAKE-UP CALL TO WORK HARDER NEXT TIME</li> </ul>

Figure 2 (adapted from Dweck, 2006)



Numerous research studies have all shown the same thing – explicitly teaching students about their brain and the growth mindset lead to significantly improved student academic performance. “Given that students with a growth mindset try harder in school, especially in the face of a challenge, it's no surprise that they do better in school” (Blackwell et al., 2007). Students who believe intelligence is malleable are more likely to value learning, believe in effort, and show more resilient reactions to setbacks. Helping students understand that failure is an opportunity, and that learning is largely about work and not talent is a prerequisite for effective learning to occur at all. Thus a teacher who holds and fosters a growth mindset environment transforms a student’s ability to learn not just in their classroom, but everywhere.

## Motivation, Attention, & Engagement

Some of the greatest challenges that can affect student learning are largely outside of teacher control – factors such as student health, amount of sleep, home and social life, etc. However, there are two key factors within the purview of the teacher that are core to effective schooling – attention and engagement. In their model on learning, Marzano and Pickering (2013) identify several factors (teacher perspective) paired with emblematic questions (student perspective) as crucial determinants. Positive student responses to the first two factors affect attention, while positive responses to the latter two affect engagement. Thus for maximum learning to occur, teachers should strive for positive student responses to all four as often as possible.

Marzano & Pickering's Model of Attention and Engagement	
Four Factors	Four Emblematic Questions
1.) Emotions (E)	→ 1.) How do I feel?
2.) Interest (I)	→ 2.) Am I interested?
3.) Perceived Importance (PI)	→ 3.) Is this important?
4.) Perceptions of Efficacy (ability) (A)	→ 4.) Can I do this?
<ul style="list-style-type: none"> <li>• Positive responses to Questions 1 &amp; 2 → Student Attention</li> <li>• Positive responses to Questions 3 &amp; 4 → Engagement</li> </ul>	
<p><i>For maximum learning to occur, need positive student responses to ALL 4</i></p>	

Figure 3 (adapted from Marzano & Pickering, 2013)

**1.) Emotions:** Learning occurs in the brain, and emotions arise in the brain. In every situation the emotions our students feel influences their behavior. Likewise, emotions also affect their level of motivation in and out of the classroom. When students are in a state of positive emotion, they are more likely to be motivated and engaged on the task at hand, but if student emotions are negative, they are less likely to pay attention and engage in activities, especially those that are challenging or require an element of risk-taking. For optimal learning to occur, teachers should know a bit about the neurophysiology of learning and how we can positively (or negatively) impact it. We should strive to provide students with a physically safe and secure environment, as well as have their mental well-being fostered (Skinner et al., 2009). Some strategies to do this include effective classroom pacing, incorporating physical movement in the classroom, use of enthusiasm and humor, and fostering positive teacher-student and peer relationships.

**2.) Interest:** Student interest, in the lesson and in their teacher, is the second factor affecting their motivation. Without some degree of interest, students will not pay attention or find themselves getting easily distracted. Some strategies to increase interest include beginning lessons with an interesting ‘hook,’ ensuring variety, and using novelty and unusual information throughout the lesson.

**3.) Perceived Importance:** What makes something important to a student is if and how (much) it pertains to their goals. We bring our goals to every situation we encounter; thus engagement is dependent on whether we perceive an activity as relevant to one or more goals in our self-system. Students need to feel what they are learning is important, not just to get a good grade in our class but for the achievement of their goals as well. Connecting classroom learning to students’ academic, future professional, and/or personal goals, and providing choice and flexibility whenever possible can help maximize engagement.

**4.) Perceptions of Efficacy:** Students may be highly motivated and feel the content is important, but unless they also feel capable of completing the task they will not be fully engaged. They need to believe



they have the ability to succeed. Some strategies to aid this include teaching students self-theories (growth and fixed mindsets), using feedback and praise correctly, and explicitly teaching metacognitive skills (how to think, reflect, use effective study strategies, etc.).

Utilizing these four factors can significantly increase student attention, engagement, and motivation and help in making our classrooms places of learning, high energy, and positive feelings.

## Technology & Metacognitive Strategies

Our students have been immersed most of their lives with internet technologies, and this has significantly affected the way they think, behave, and learn. Technology also provides teachers with a plethora of new and interesting potential teaching tools. However, teachers need to know *how* and *when* to implement it in their curriculum effectively to maximize learning. We “need to design much better environments that include vastly more thorough understandings of both how technology works and how learning works” (Bowen, 2012). Used properly, new technology should aid in increasing student preparation between classes, as well as increasing motivation, attention and engagement in class. Using new communication technologies, supplementing textbooks/courses with online resources (ex. YouTube, TED, Coursera, Khan, etc.), and creating online quizzes and games for testing-as-retrieval purposes can all help with this. More significantly, internet technologies are leading to a fluid, constantly-evolving job market in which much of what students will need to know, they will need to learn on their own after they leave our classrooms. Hence, more than ever university is not just about passing on knowledge to students, but about the ability to fluently analyze all that information. “The point of college is increasingly to prepare the mind for the unknown, to prepare students to be lifelong learners in diverse contexts” (Bowen, 2012). If anything, students have too much information available to them. Our main goal must ultimately be to improve the way students think, and provide them with an arsenal of metacognitive tools that can help them become able to independently analyze new knowledge and integrate it into their thinking.

Metacognition (thinking about our thinking) is key not only to students’ ability to adjust and improve their own mental processing, but for learning to happen at all. “Even if we are the best teachers on the planet, as long as students do not come to our classrooms prepared to learn efficiently and independently, we will never see the kinds of learning gains that are possible. Conversely, if students are actively engaged in the learning process, they will be able to learn even in circumstances where the teaching is mediocre” (McGuire, 2015). Put simply, if we teach students how to learn more effectively by giving them simple, straightforward strategies to use, they will be able to independently increase their learning and performance, regardless of the environment they find themselves in.

One strategy to accomplish this is to utilize self-reflection activities often, which helps students to think critically. Routinely asking students to pause and reflect will improve the quality of both their discussion and thinking as well as help them remember. Also, using Bloom’s updated taxonomy of educational objectives as a lesson planning guide and explicitly teaching it to students will help them understand that there is a progression of thinking skills that they will develop over time.

### Bloom’s Taxonomy (Revised)

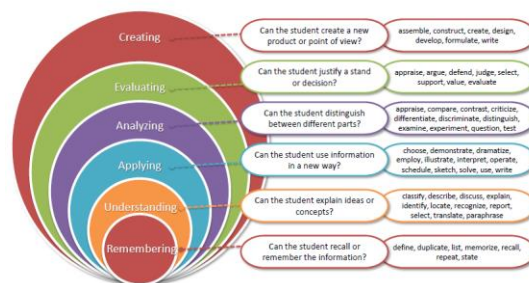


Figure 4

Other useful metacognitive strategies include:

- Previewing the section headings, boldface and italicized words, and charts/graphs before reading to get the big picture; then preparing for active reading by coming up with questions the reading should answer



- Pausing to paraphrase in own words after reading each paragraph to confirm understanding
- Reading/listening actively, via activities like highlighting, taking notes, and creating flashcards, outlines, and graphic organizers
- Teaching material to a real or imagined audience
- Monitoring and adjusting self-talk so that it is compassionate and encouraging
- Attributing results to one's actions, not to external factors out of individual control (attribution theory) (McGuire, 2015)

In conclusion, we teachers need to rethink our concept of what 'normal' classrooms and lessons should look like, and our own roles as teachers. By keeping up to date with articles and books (research findings) in the field of mind, brain, and learning, integrating them into our lessons, and passing them on to our students, we can most effectively help them become not only knowledgeable, but self-regulating and lifelong learners who will be prepared to tackle any challenges they may encounter, in or outside the classroom.

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