

Assessment and the Learning Brain

What the Research Tells Us

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If you really want to see how innovative a school is, inquire about its thinking and practices regarding assessment. For the students, does the mere thought of assessment trigger stress? Do the teachers rely heavily on high-stakes, multiple-choice, Bell Curve-generating tests? Or do the students seem relaxed and engaged as teachers experiment with new forms of assessment designed to support deep and lasting learning?

Clearly, there continues to be a place for traditional assessments of learning that prepare students for standardized tests such as ERBs, AP exams, SATs, and college midterm exams. However, we believe that independent schools, unrestrained from the chains of public education policies, can take on an important leadership role in transforming K-12 assessments from a mere measure of short-term learning to a crucial component of the teaching and learning process. In this system of assessment, learning becomes personalized, encouraging students to adopt a mindset focused on discovery and engagement rather than grades and test scores. Most important, in such a system, the sharp lines between teaching, learning, and testing diminish.

This shift in thinking about assessment is a central issue for all schools. As the research strongly suggests, when students focus on mastery of learning rather than on their performance on tests, they

significantly increase their intrinsic motivation for learning.

New forms of assessment can be found in an increasing number of independent schools today. One example is in a 10th-grade United States History class at St. Andrew's Episcopal School (Maryland) taught by coauthor Glenn Whitman. Instead of offering students a typical final exam, Glenn offers them a choice: "What type of final exam would help you to best demonstrate what you have learned in this class?" Based on their reflection, students select the format of their final exam. The more traditional and familiar option allows students to sit for two hours and complete an array of multiple-choice, document-analysis, historical-geography, and free-response questions. The alternative option is to complete what Glenn calls the "Historian's Head"¹ — a collage of images and scholarly narratives that respond to the essential questions of the course.

In any given year, 60 to 80 percent of the students choose the assessment that asks them to demonstrate their understanding through images and scholarly narratives — even though this alternative is more demanding when it comes to higher-order thinking and executive functioning skills. It is also more time intensive. So why do so many students choose this option?

Here is what a few representative students have said:

I function better on projects than on tests because I do not work well under time constraints. In a two-hour exam, I get too stressed and I take too long on one answer. With the project, I am not timed and therefore I will not be stressed.

My primary reason for creating a "head" over a traditional exam is because it will allow me to be creative and use my knowledge in a different way besides memorizing what I have to know. Also I will be able to dedicate more time to it than I would to studying for an exam.

I chose this option over the regular exam because it has an artistic element to it and we are able to spend more time on it that enables a process of deeper thinking in contrast to the quick memorization that would be necessary for the traditional final.

The journey to designing this assessment has been long. Not surprising, when Glenn first began his independent school teaching career in 1991, his assessments looked a lot like those he experienced as a student. And while

instinct and intuition, and student feedback, suggested that there must be a better way to measure student understanding, ultimately the growing body of research in educational neuroscience became the game changer for his 10th-grade history final exam.

The field of educational neuroscience is still quite young — converging developmental psychology, cognitive science, and education. While some of its initial findings merely support what educators have intuitively believed, it is also challenging many assumptions and providing new insight into best educational practices, especially regarding assessment.

What we do know is that a plethora of assessment-related research has shed light not just on the importance of students' mindsets, but also on the importance of continual feedback and how active retrieval of information (memorization recall), in carefully spaced intervals, can produce long-lasting learning. Research also shows that providing students with assessment choice enhances attention and engagement — and confirms that the arts can help deepen long-term memory consolidation.² These latter points were instrumental in driving the changes to Glenn's 10th-grade history final exam.

Specifically, the following research is helping to change our understanding of the correlation between teaching and learning — and altering our approaches to student assessment.

Mindsets: Performance vs. Mastery Goals

Research on the connection between motivation and learning has focused on two types of mindsets that students develop, based on the kind of experiences (including assessments) we present them with in school. Students tend to develop either *performance-related goals* or *mastery goals*.³

Performance-related goals are those that are linked to more traditional types of assessments. Students become motivated by the grades they achieve, their rankings compared with other students, and extrinsic rewards such as honor rolls or school awards. In contrast, students who develop *mastery goals* are motivated by the actual learning experiences. Their rewards arise from the challenges of acquiring and applying new knowledge and skills.

While students may possess a combination of both types of goals, those motivated primarily by performance goals tend to lose motivation and confidence when faced with difficult academic challenges or when set back by failures. In contrast, students who are motivated by mastery goals are more likely to persevere in the face of such challenges. Difficult tasks or setbacks do not diminish their motivation or self-esteem.⁴ Students with a mastery mindset, similar to those students who described their experiences in the history class at St. Andrew's, are more likely to choose more difficult but rewarding ways to demonstrate learning.

Feedback on Performance

Another focal point of research is the timeliness and method of providing feedback to students. Timely feedback has been shown to deepen one's memory for the material assessed.⁵ Moreover, in a study comparing immediate versus delayed feedback, the mere anticipation of timely feedback produced better performance. Students who knew that they would get immediate feedback performed better on a task than those who were told that feedback would be delayed.⁶ Finally, studies suggest that marking answers right or wrong (as in multiple-choice tests) has little effect on learning. However, providing the correct response only after a student has spent time "struggling" to find the correct answer significantly increases retention of the material.⁷

Researchers have also discovered that the spacing of assessments and feedback produces more effective learning. If students revisit content over carefully spaced intervals, they retain information longer than if presented with information once and then only assessed immediately after initial (short-term) mastery.⁸

These findings, among others, show us the reciprocal relationship between assessment and learning. Providing timely and effective feedback can improve students' mastery of the content and produce more efficient — and satisfying — learning experiences.

Active Retrieval of Information

A growing body of research suggests that actively retrieving information (self-testing) produces significant long-term benefits for learning compared with passive studying (merely reading one's class notes).⁹ While any assessment requires some type of active retrieval, having students reconstruct what they know through alternative assessments (as in Glenn's U.S. history class) leads to deeper understanding and consolidates learning in more powerful ways

than traditional testing.¹⁰

Active retrieval is also crucial as students prepare for assessments. Too often, when we ask students to reflect on their study strategies, they say they simply reread class notes. Training students to build regular self-testing into their study strategies will help them embed material into their long-term memory.¹¹

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From Theory to Practice

Moving neuroscientific research on assessment into classroom practice faces two barriers. First, despite the fact that the work of educators targets the organ of learning, the brain, most teachers and school leaders have little understanding of the architecture of the brain and how it receives, filters, and applies information. Second, work that falls under the various versions of "brain-based" is too often believed to be of greatest benefit to struggling learners, those who historically might be called "learning-challenged." Such thinking is shortsighted and fails to recognize the importance of research in educational neuroscience for *all* students.

Also, it seems that too many parents do not want to believe what K-12 teachers intuitively know: that every student needs help and guidance to meet his or her peak potential. A parent of an Advanced Placement History student recently asked Glenn, "What can educational neuroscience do for my son? He is already getting all A's." This question came at a time in the school year when hundreds of thousands of students were gearing up for AP exams and/or final course exams. These cumulative assessments of learning place intense demands and stress on each student — stress that, research tells us, inhibits optimal learning and demonstration of understanding.

Glenn's response to this AP student's parent came in the form of a question: "What if I told you that the lessons from educational neuroscience research could potentially reduce the number of hours your son spends studying?" This question should pique any parent's interest. Research on multitasking challenges the way most students study today — especially the transaction cost of switching between social media and academic responsibilities. Additionally, research also highlights the importance of active versus passive studying and how crucial sleep is for both resting and learning.

What teachers assess should be what they want students to know, not just for an upcoming test, but also for the long term. And how we assess students has important implications for whether students will retain content or procedural knowledge for the short or long term. Far too often, as neuropsychology professor Tracey Tokuhama-Espinosa points out, "While students manage to keep enough dates, facts, and formulas in their head to pass the test, this knowledge never made it to long-term declarative memory, it was never truly learned at all (only memorized in the short term)."¹² Research in educational neuroscience, therefore, should not only inform the types of assessments teachers give students but also help shape the strategies students use to prepare for assessments, or to work through projects, which Glenn prefers to call "learning opportunities."

Assessment Tic-Tac-Toe

The following assessment options can be used with middle school and high school students. Assessment Tic-Tac-Toe is designed to offer students options that both play to their strengths and encourage the development of new skills.

During the school year, each student must score tic-tac-toe by choosing a row, column, or diagonal assessment "chain" to be used as a summative assessment for three different units. Students are responsible for creating a grading rubric for each assessment they select as part of their assessment choice.

Podcast	3-D Medium (trifold poster, diorama)	PowerPoint/Prezi/Keynote Presentation
Student-Designed Flipped Classroom Lesson	Hypertext Essay	iMovie/Final Cut
Public Speaking/Oral Presentation	Free Space (What else is available that your teacher has not learned about yet?)	2-D Medium (painting, drawing, PowerPoint poster)

How can all this research impact assessment at your school? Think of this as a challenge to teachers to embed richness in assessments — to think about how to foster optimal long-term learning when designing assessments for their classes or for individual students. We recognize that students — *all* students — have areas of evolving strength and weakness, passion and disinterest. When we get the richness right, we both challenge and support all students. What is important to understand about the human brain is that it changes with experience, a process often referred to as plasticity. When we create rich assessments that require deep thinking and problem solving, teachers are expanding students' cognitive capacities. How exciting to think of teachers as "brain changers."

Every year, we need to assess every student in multiple, developmentally appropriate ways (see sidebar on Assessment Tic-Tac-Toe). This is what differentiated assessment means. Some assessments will play to a student's strengths while others will pose significant challenges; some assessments will, wonderfully, do both.

Another central value of alternative assessments is that they help students learn essential skills for success in today's world — such as critical thinking, problem solving, communication, collaboration, resiliency, and grit. These skills are best developed through a variety of alternative assessments, particularly through project-based learning and design challenges in which "failing forward" — mistakes or failures that lead to breakthroughs, understanding, and student growth — is part of the assessment process.¹³

Projects enhance student engagement. We also know that when students can own their learning choices, and make an emotional connection to the material, their learning is enhanced. Moreover, when we challenge students to demonstrate their learning in an authentic, purposeful way, they become more engaged in the process and actually learn more. As University of Virginia psychology professor Daniel Willingham points out, "A teacher's goal should always be to get students to think about meaning."¹⁴ Alternative assessments do just that.

New Thinking at St. Andrew's

Here are some other important, research-informed changes in the ways St. Andrew's teachers think about assessment for their students. Such translation of research to practice further extends the school's highest-achieving students and improves student achievement overall.

- Most units begin with a pretest to assess prior knowledge and to be able to measure individual student growth from the beginning to the end of a unit.
- Teachers use more formative assessments, such as ungraded (thus low-stress) surprise quizzes, as a self-reflective process for students. Frequent formative assessments, which can be as short as one question, allow students to practice recalling knowledge from their long- and short-term memory. Frequent retrieval of information significantly enhances recall ability. This is called the "testing effect." It is a great way to have students begin or exit a class. And there are technology tools, such as Socrative, designed specifically to help with this process.
- Teachers provide students with test-correction opportunities. Delaying or "scaffolding" feedback, and having students struggle with finding the correct answer, leads to better retention than does simply providing correct answers.
- In order to help students decide appropriate study strategies, teachers ask them to reflect on what demands — attention, memory, visual thinking, executive functioning, language, neuromotor function, social or higher-order cognition — a particular assessment might be placing on their brains. This process includes providing students an opportunity to reflect — think metacognitively — on their assessment performance, particularly on how well their study strategies worked and how they might study differently in the future.
- Teachers share research into the transaction costs associated with multitasking and how limiting the toggling between websites or social media channels while studying can enhance memory consolidation (certainly no easy request of today's students).¹⁵

As designers of their classes, teachers decide the appropriate assessments for a certain body of knowledge or skill. But what research regarding choice and engagement shows is that teachers should also respect the ability of students to make decisions about how they can best demonstrate their understanding (as well as their confusion). That is why it is essential that teachers and educational leaders have ongoing professional development about how the brain learns. The Center for Transformative Teaching & Learning (www.thecttl.org) at St. Andrew's was established to do just this — enhance teacher quality through training in the principles and strategies of neuroeducation.

Recent research on teacher efficacy points to the importance of deepening each teacher's toolkit with a neuroscientific lens into curriculum design and working with every student.¹⁶ Such research supports the notion that when teachers understand the principles from educational neuroscience, they expand their teaching repertoire, including the ways they measure a student's knowledge, skills, and understanding. Assessments today, therefore, are much broader than what most of us adults experienced in our own academic journeys. And that is a good thing.

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Notes

1. The final exam idea was adapted from Jim Percoco's "Historical Head" project in *A Passion for the Past: Creative Teaching of U.S. History*. Portsmouth, NH: Heinemann, 1998.

2. See Mariale Hardiman, *The Brain-Targeted Teaching Model for 21st-Century Schools*. Thousand Oaks: Corwin Press, 2012.

3. Carole Ames and Jennifer Archer, "Achievement Goals in the Classroom: Students' Learning Strategies and Motivation Process," *Journal of Educational Psychology*, 80(3) 260-267 (1988).

4. Paul R. Pintrich, "Multiple Goals, Multiple Pathways: The Role of Goal Orientation in Learning and Achievement," *Journal of Educational Psychology*, 92(3), 544-555 (2000); Heidi Grant and Carol Dweck, "Clarifying Achievement Goals and Their Impact," *Journal of Personality and Social Psychology*, 85(3), 541-553 (2003).

5. Harold Pashler, Nicholas J. Cepeda, John T. Wixted, and Doug Rohrer, "When Does Feedback Facilitate Learning of Words?" *Journal of Experimental Psychology, Learning, Memory and Cognition*, 31(1), 3-8 (2005).

6. Keri L. Kettle and Gerald Häubl, "Motivation by Anticipation: Expecting Rapid Feedback Enhances Performance," *Psychological Science*, 21(4), 545-547 (2010).
7. Lisa K. Fazio, Barbie J. Huelser, Aaron Johnson, and Elizabeth J. Marsh, "Receiving Right/Wrong Feedback: Consequences for Learning," *Memory*, 18(3), 335-350 (2010).
8. See, for example, Nate Kornell, Alan D. Castel, Teal S. Eich, and Robert A. Bjork, "Spacing as the Friend of Both Memory and Induction in Young and Older Adults," *Psychology and Aging*, 25(2), 498-503 (2010).
9. See, for example, Jeffrey D. Karpicke and Henry L. Roediger, "The Critical Importance of Retrieval for Learning," *Science*, 319(5865), 966-968 (2008).
10. Jeffrey D. Karpicke and Janell R. Blunt, "Retrieval Practice Produces More Learning than Elaborative Studying with Concept Mapping," *Science*, doi:10.1126/science.1199327 (2011).
11. Nate Kornell and Lisa K. Son, "Learners' Choices and Beliefs About Self-Testing," *Memory* 17(5), 493-501 (2009).
12. Tracey Tokuhama-Espinosa, *Mind, Brain, and Education Science: A Comprehensive Guide to the New Brain-Based Teaching*. New York: W. W. Norton (2010).
13. See Paul Tough, *How Children Succeed: Grit, Curiosity, and the Hidden Power of Character*. New York: Houghton Mifflin Harcourt (2013).
14. Daniel Willingham, *Why Don't Students Like School? A Cognitive Scientist Answers Questions About How the Mind Works and What It Means for the Classroom*. San Francisco: Jossey-Bass, 61 (2009).
15. Eyal Ophir, Clifford Nass, and Anthony D. Wagner, "Cognitive Control in Media Multitaskers," *Proceedings of the National Academy of Science* (2009).
16. Mariale Hardiman, Luke Rinne, R. John Bull, Emma Gregory, Julia Yarmolinskaya (in review), "How Knowledge of Neuro- and Cognitive Sciences Influences Teaching Practices, Attitudes, and Efficacy Beliefs." Manuscript submitted for publication. R. John Bull, Mariale Hardiman, Luke Rinne, "Professional Development Effects on Teacher Efficacy: Exploring How Knowledge of Neuro- and Cognitive Sciences Changes Beliefs and Practice." Paper presented at the American Educational Research Association conference, San Francisco (2013).