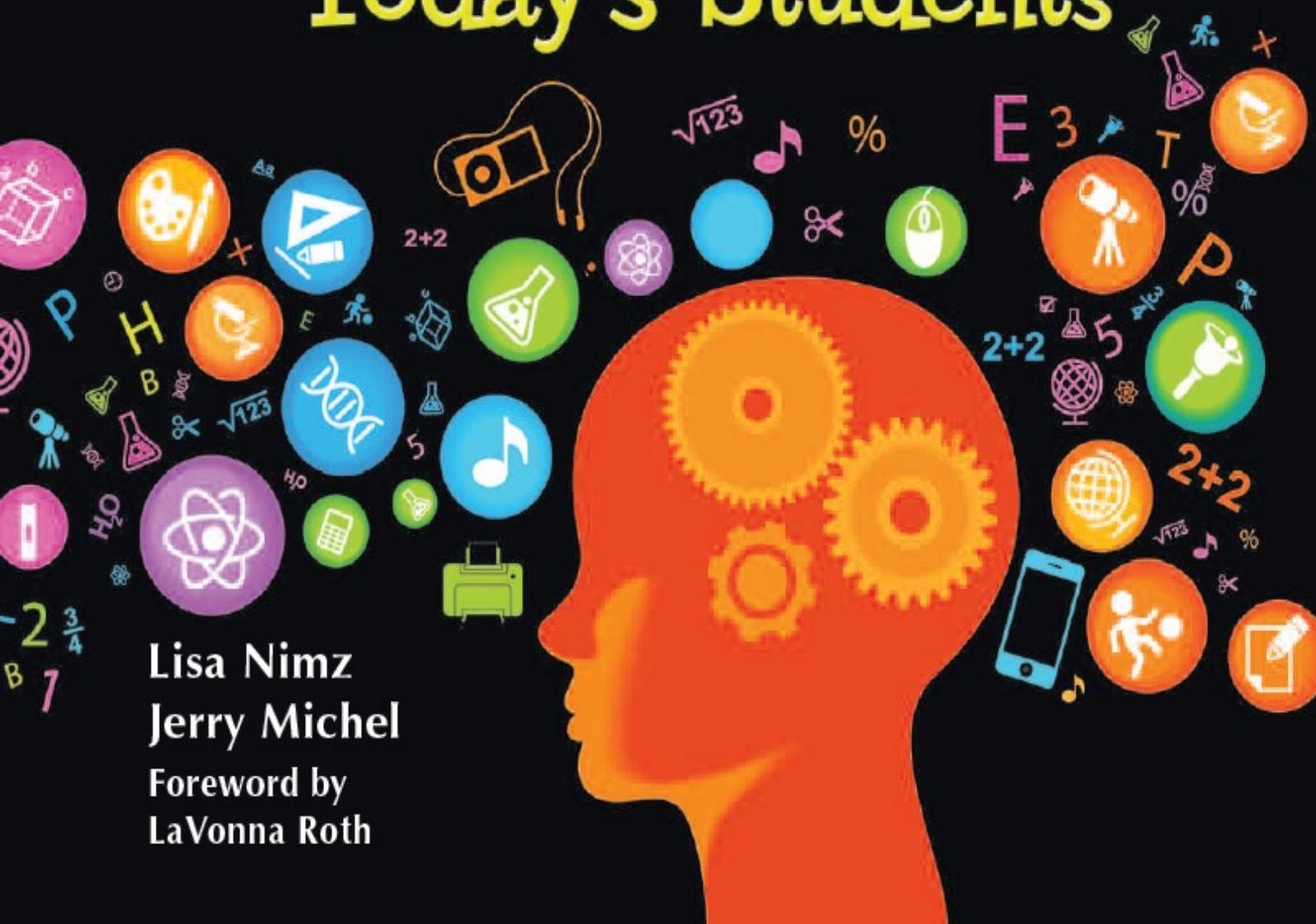




SHELL
EDUCATION

Can You Hear
Me Now?

Applying Brain Research and Technology to Engage Today's Students



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Foreword by
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Chapter 1

Student 1.0 Is Still Alive and Well in Your Classroom

Ruminations



The shift is subtle at first. You un-tether your phone from the landlines in your house and take it with you wherever you go. Instead of heading to the bookshelf for information, you perform a Google™ search. You do not worry about having a map in your car or even a printout of the directions from an online mapping service because you have a GPS enabled on your phone that reads the directions aloud to you and recalculates them when you go off route. Finally, technology is making life easier, rather than more complicated. Before you know it, you have an e-book reader in your hand, music on your smart phone, and you cannot remember the last time you rented a video or DVD.

Then, the trouble begins. You wait impatiently for your flight to reach cruising altitude so that you can take out your personal electronic devices and start working. You pull up your online version of the newspaper and realize, as you click away on the embedded links in the advice column, that you never finish reading the paper front to back (or back to front) like you used to. You realize this shift again when you are in the car and reach for the rewind button on the radio station, just like you do with your DVR when you watch TV.

Soon, you will fondly remember the good old days when you actually had to type your queries into the search engine on your desktop computer that was hardwired to the Internet, rather than using your hands-free smart phone's voice recognition application.

Too late for nostalgia in that regard. There is already an app for that.

How is our mental acuity faring since we do not have to work as hard to find the information that helps us answer our questions? How is life different today now that technology is serving us better? Perhaps life will not be as different as we think.



Sharing Our School Day with the Digital Natives

Ninety-seven percent of today's teachers have one or more computers in their classrooms; the average ratio of students to computers in these classrooms is 5.3 to 1, with well over ninety percent of those computers connected to the Internet (Gray, Thomas, and Lewis 2010). And, some days it may seem as if the most accessible technical support for those computers is the students who are sitting at the keyboards.

These same students are growing up in a world where they are more likely to buy individual songs instead of albums, where they can download a library book rather than physically check it out, and where they have a virtual network of friends and acquaintances that number in the hundreds (or thousands) and span the globe. Are we prepared for these brave new wired—or perhaps more correctly, wireless—citizens of the world? Does instruction need to be substantially different to ensure that we reach these digital natives of the 21st century?

To be sure, there are those who will try to cajole educators into thinking that the doors of our schools and classrooms are portals to the past (Christensen and Horn 2010; Davidson 2011; Foundation for Excellence in Education 2010; Heffernan 2011; Johnson, Adams, and Haywood 2011). They tell us that thinking nowadays is a whole new beast, and that adults will always be foreigners in the new digital world. They speak of rich new worlds that our students inhabit outside the school walls, a world they must leave behind when they come to learn in school. To these authors, perhaps this otherness seems exotic or provocative. We certainly can draw a digital line in the sand and put all the techies on one side and everyone else on the other, but to do so seems counterproductive. In fact, it is a turn off. It is disconcerting to think that the unceasing movement of time that forces our travel into the future will leave us stranded as strangers in a strange land. In a time when we are gaining unprecedented insights into how human beings learn and have a

massive array of tools and resources at our disposal, it is unlikely that we will be marooned.

Chances are you have read an article, seen a report, or been to a workshop where the drumbeat was sounding, broadcasting concerns that schools today are not evolving fast enough to address all these changes in learning or taking advantage of all that technology has to offer learners. Some may even opine that nothing short of a major overhaul of the education system will save our students in time to be prepared for the 21st century. Davidson (2011), for example, observes that 65 percent of today's grade-school students may end up doing work that has not been invented yet. Nonetheless, it is true that educational institutions have changed. Technology has advanced, transforming the way we live, work, play, and learn. Attitudes have shifted. Society has progressed. However, the evolution of a species usually takes longer than a decade—by a magnitude of a thousand or more. The process of thinking has not changed much since *Homo sapiens* first realized that they were doing it (Rotherham and Willingham 2010).

So, even as our students' ability to find and share information via online devices continues to grow in ways we cannot begin to imagine, the same communication skills—both intracranial or intercranial—that were valuable in the past will continue to be so today.

Students need to learn to read—whether they learn from a book on paper or on a screen. They need to learn to write, not just use a keyboard. Research shows that writing by hand trains the brain in ways that keyboarding cannot (Bounds 2010). Students need to be able to observe the conventions of their language so that those reading it can understand it. Reeves (2010) highlights the importance of writing, particularly nonfiction writing, as having “significant and positive effects in nearly every other area of the curriculum. Nonfiction writing is the backbone of a successful literacy and student achievement strategy” (46). In addition, students need to be able to speak intelligibly and listen carefully. They need to be able to organize their thoughts on paper, in a word-processing document, and in their heads.

The great part about today's world is that we have so many new, effective tools to help students read, write, and think! But in using these advanced tools, we will not find ourselves transported to an utterly unknown space and time where thinking is new and different. The tools might be new, but the thinking? It is the same old thinking as before—a difficult, wonderful march from sparse, disconnected chaos, to a rich, ordered network.

Finding Clarity in a Sea of Distraction!

“Immersing myself in a book or a lengthy article used to be easy,” Nicholas Carr, a writer and researcher, explains. “My mind would get caught up in the narrative or the turns of the argument, and I’d spend hours strolling through long stretches of prose” (Carr 2008a, 57). Anyone who has taught middle school students, especially those with unlimited text messaging, knows what a permanent state of partial attention looks like. Reading or searching online, for most of us, replicates this state of mind.

It seems as if the Internet has had the effect of maximizing our predisposition for distraction. Links to other articles, ads, related products, and a myriad of keywords with related content are embedded in nearly every page you access. Clicking a link leads you to a new site, which you are likely to scan in seconds to determine whether or not the site is of interest or importance to you. Before too long, you can easily be twenty clicks away from the original article you intended to read and find yourself shopping for Aunt Sally’s birthday present.

In a report broadcast on National Public Radio on June 11, 2007, David Weinberger aptly describes a hierarchical diagram of connected facts on the Internet by noting that “the map of links looks like it’s been drawn by drunken spiders.” He goes on to say, “but that messiness enriches what we know.” Information is embedded “in multiple contexts and we get to walk down the paths we find inviting.”

Have we unwittingly designed the Internet in our brains’ own image? Yes and no. It is true that in both systems, the connected points number in the billions. It is also true that in both systems, there are multiple contexts for accessing and understanding the information that we have. However, the brain appears to be far more organized than the Internet. It is methodically organized, regularly pruned, and becomes more efficient in the areas that are used repeatedly.

Activity involving the brain does not always look organized and efficient. For example, consider the teen who believes she is multitasking as she opens a chat window, her Facebook™ page, an online article about osmosis she is suppose to read for homework, and a blog post she is writing about the concert she is going to over the weekend. If she is a reflective thinker, she often asks herself why it takes her so long to finish her homework. That is an important question, and the answer is telling. In this case, we are observing Student 1.0, the learner who has the same brain structure as a child in ancient times, who has been left high and dry. She does not understand why it takes her so long to do her homework—assuming, of course, that she actually does it! Her thinking and use of time are not in the least organized or efficient. In the classroom, this same restless student scans the room every five minutes to

see what all of her friends and classmates are doing.



Some Thoughts about Multitasking

William Deresiewicz (2010) noted that multitasking impairs your ability to think. He states:

A study by a team of researchers at Stanford came out a couple of months ago. The investigators wanted to figure out how today's college students were able to multitask so much more efficiently than adults. How do they manage to do it, the researchers asked? The answer, they discovered—and this is by no means what they expected—is that they don't....And here's the really surprising finding: the more people multitask, the worse they are, not just at other mental abilities, but at multitasking itself.

They [multitaskers] were worse at distinguishing between relevant and irrelevant information and ignoring the latter. In other words, they were more distractible. They were worse at what you might call “mental filing”: keeping information in the right conceptual boxes and being able to retrieve it quickly. In other words, their minds were more disorganized. And they were even worse at the very thing that defines multitasking itself: switching between tasks (5).



It is important to remember that the girl in our example has a brain that, in a different place or time, would have saved her village because she was constantly watching the horizon for predators and danger. She is tapping into genes and patterns of attention that served human beings well in both our recent and distant past.

As our imagination fills with images of foraging bands of teenagers crossing the ice and snow, texting one another as they spot saber-toothed tigers amongst the glaciers (“OMG! C@ on ur left!”), it is important to realize that our species survives because of genes. But it is equally important to understand that our species flourishes because of memes. *Meme*, a term coined by Richard Dawkins in his book *The Selfish Gene* (1976), is a transmission device like a gene. “Just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation” (192). Instead of

transmitting genetic information, a meme transmits cultural information.

In evolutionary terms, reading and writing are still new. These memes, perhaps the most important inventions of humankind, have helped advance our cultures, the sciences, and understanding at an increasingly accelerated pace throughout our history on this planet. Reading and writing can seem so natural that it is easy to forget we have only been using our brains to become literate for a few thousand years. Some researchers say that it is likely we are recycling neurons previously associated with survival and repurposing them for tasks associated with literacy (Dehaene 2009; Wolf 2007). From survival to culture. From genes to memes; and even newer than memes, memes: what Susan Blackmore calls “technology memes”—the dizzying array of tools with which we now process and present the written word (Blackmore 2008).

Remember the first time students started using word-processing or multimedia presentation programs in the classroom? Were they more focused on font styles, sizes, and how they could animate the pictures and text than on the content of their paper or presentation? However exciting any new tools may be, educators have to be judicious in choosing and applying them—and then teach students how to be judicious in their choice and application of the same tools and techniques. Underneath all of these programs, websites, and mobile applications is a human learner. Educators’ focus must be on the students in the classroom and the key content they must learn.

If they are truly dealing with an increasingly distracted student population, then clarity in communication, curriculum, and instruction becomes even more important. If educators are to make abstract concepts more accessible to students, they must carefully select the images, objects, sounds, and actions present to make these concepts more readily understood. If our time becomes increasingly constrained, they must make their choices thoughtful, cogent, concise, and informed by what they know about how students learn and the influence their choices will have on their learning.

Inner Space: The New Frontier

Take a moment and look back on the teachers who not only influenced how you learned, but inspired you to continue learning outside of their classrooms. Think about the teachers you hope your own children will have. What characteristics do they possess? Are they curious? Energetic? How can you tell they still study, read, and learn?

Can you remember the teacher who loved wordplay? Who got worked up about a science experiment? Who read as many new books as he or she assigned to their students? Who loved the patterns and beauty behind solving

problems with numbers? Chances are you achieved more in each of these classes; your vocabulary grew, you picked up at least one or two more books, and math seemed challenging, not daunting. Try this experiment: whatever subject you are teaching, ask your students what kind of teacher they most enjoy learning from—someone who loves her subject and shares her passion, or someone who teaches her subject without revealing her passion for it. Who do you think they will pick? Most of us are well aware of our predilections when it comes to subject matter. It is not a coincidence that the units educators love most are likely to be the ones in which their students' performance and engagement is the highest. When students learn, they do not simply learn the content, they also learn whether or not to like or appreciate what they are learning.

As we work our way through the 21st century, educators must add a new topic to their list of beloved subjects—neuroscience. At the end of this century's first decade, there were more than 30,000 books in print that were related to the brain (Goldberg 2010). Even more importantly, this fascination must be shared with students and colleagues with the same enthusiasm as the vocabulary-loving English teacher, the “mad scientist” chemistry teacher, the number puzzle aficionado mathematics teacher, and the kindergarten teacher who finds a new favorite story to share every day.

Neuroscience Moves Out of the Laboratory

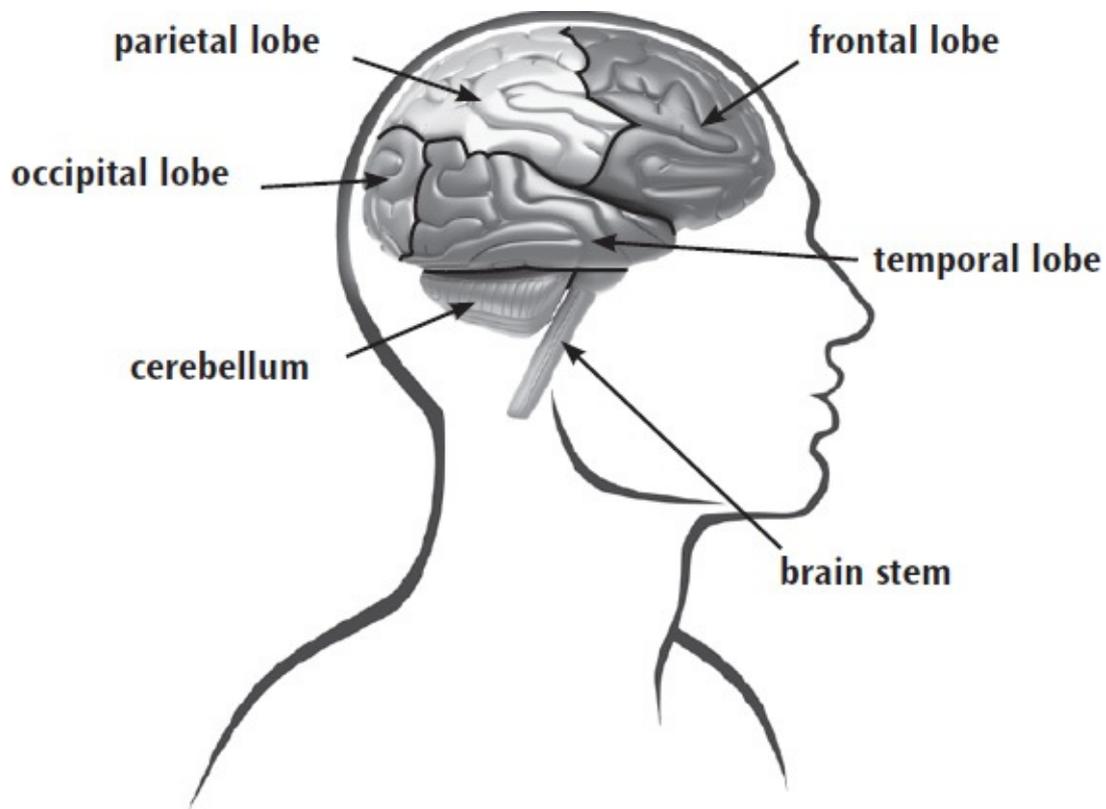
Neuroscience is not just for the laboratory anymore. What does a competent educator need to know about the primary engine behind learning in the human brain? How do educators find reliable, intelligible sources of information about how the brain works? How do they translate all the scientifically based research they encounter into classroom practice?

It turns out that teaching is like brain surgery—a deliberate wiring or rewiring of the brain. The brain is complex, multilayered, interconnected, and immensely powerful. It follows to reason that, if educators are to develop their students' intellect, their instruction and curriculum must likewise be complex, multilayered, interconnected, and immensely powerful. To take advantage of the processing power of the 100 billion neurons and 100 trillion connections (Zimmer 2010) in our students' (and our own) brains, it behooves us to develop a working understanding of how our minds access, process, remember, recall, and apply information.

Each part, or lobe, of the brain is responsible for specialized functions. The occipital lobe processes visual information. The temporal lobe processes auditory information, including speech, and stores long-term memories. Sensory integration is handled by the parietal lobe. And the frontal lobe is

responsible for the crowning achievements of judgement, problem solving, and planning. [Figure 1.1](#) shows the different areas of the brain.

Fig. 1.1. Parts of the brain



Imagine what it would be like if our instruction could make use of each of these areas to create a more robust understanding of important concepts. Certainly, if you can feel it, experience it, see it, touch it, and hear it, you are more likely to understand and remember and recall it at a later date. Take a moment to reconsider Weinberger’s metaphor of the Internet being organized like a web made by drunken spiders (2007). That might be just what our neural network looks like when it lights up and starts recognizing and making sense of facts, figures, and new ideas. Learning and understanding deeply depend on the learner’s will to repeatedly focus on the content. This is what builds foundations and develops increasingly efficient neural networks; it always has and always will. Whether a settler is building a sod house on the prairie or an architect is building an undulating skyscraper in a bustling downtown area, there are common foundational elements that must be understood and employed to make each structure stable and habitable.

In later chapters, we will explore the role practice plays in developing expertise in any given area. Being that success in school depends largely on expertise in reading, writing, and developing number sense, educators must first look at how learners make sense of new information and integrate it into the pattern-seeking networks and structures tucked in the folds of their brains.

Appropriately titled, Learning Sciences is emerging as a program of study at more than thirty major universities and research centers around the world, including Northwestern, McGill, Stanford, Tufts, and the University of Sydney. This exciting field combines multiple disciplines (often including cognitive science, computer science, educational psychology, and anthropology) and seeks to uncover what makes for the most effective learning environments. By focusing on real-world settings and taking a multifaceted exploration of how we learn, researchers and students in this field are building exciting bridges between research and practice. Tracey Tokuhama-Espinosa (2011) includes an exhaustive list of these institutions in her book *Mind, Brain, and Education Science: A Comprehensive Guide to the New Brain-Based Teaching*.

Educators can do the same thing in their classrooms and schools by actively engaging themselves in the science of learning, both with and without technology. The following possibilities can be considered: forming a book study group to discuss *Proust and the Squid: The Story and Science of the Reading Brain* (Wolf 2007), getting a subscription to *Scientific American: Mind*, following cognitive psychologist Daniel Willingham's Facebook page, or starting a social bookmarking group to collect and share interesting articles, websites, YouTube™ videos, and more with friends and colleagues. The important thing is simply to share findings, challenge ideas, and look for ways to continually improve how students learn and perform in the classroom.

Shaping Our Future: Outside Forces and How They Influence Education

It used to be that building a computer lab was all that a school or district needed to prepare students for the future. You can almost hear the whisper coming from the computers' cooling fans, "build it, and they will learn." Teachers and administrators struggled with how to integrate technology meaningfully into the curriculum. Should a separate teacher handle technology, because there was not time to squeeze one more thing into the curriculum? In elementary schools, should a computer lab class be added to the art, music, and physical education rotation, so teachers can have more time to meet and plan with grade-level teams?

Slowly but surely, in school board meetings, newspaper columns, and online forums, school communities are grappling with what it means to teach students in the 21st century. To test your own ideas about 21st century skills, imagine that these ideas have been put on trial and you are on the jury. When the prosecuting attorney asks what knowledge you have of 21st century skills,

what will your answers be? You might say critical thinking is one of the concepts near the top of your list, although there are those who would disagree. One such example shares a sentiment often echoed by those who follow the movement for greater focus on 21st century skills: “With so much new knowledge being created, content no longer matters; that ways of knowing information are now much more important than information itself” (Rotherham and Willingham 2009, 16). Students believe it when they say, “Why do I have to memorize this? I can always Google it on my smart phone if I need the answer.”



Taking advantage of technology to find information rather than learning and recalling facts may be a persuasive argument. That is until your ophthalmologist says, “Huh. Now that’s funny. The laser really should not leave a mark like that on your cornea. Hold still a minute. Let me Google that. Oh, don’t blink now!”



There are many situations and professions in which one must know the content so well it seems second nature. Such knowledge is crucial to basic competency—let alone expertise. These notions that place ways of knowing information above the information itself will make the 21st century skills movement “a weak intervention for the very students—low-income students and students of color—who need powerful schools as a matter of social equity” (Rotherham and Willingham 2009, 16).

The media and other public voices are constantly questioning the current state of our children’s education. It does not take much digging to find expressions of concern that our school systems are hopelessly mired in the past. Pundits and policymakers alike sound clarion calls to draw attention to which partnership, foundation, coalition, or task force needs (or will provide) funding and how their vision will lead to the solutions for our children’s future (for examples, see Foundation for Excellence in Education 2010; Johnson, Adams, and Haywood 2011).

Educators cannot avoid addressing the outside forces that are marshaling their arguments for change in the content of the curriculum, the manner in which we instruct, or the tools we share with students. By focusing on a series of critical questions, educators can avoid being led astray from their primary mission—providing a sound education for all their students. Questions such as the following enable educators to move forward with change that benefits

teaching and learning:

- How do we know this particular innovation, tool, or resource is important?
- How do we explain why it is important to students, colleagues, and the community?
- How do we convince and teach others that it is important?
- How do we help others implement the change?

In the end, what matters most is how these questions are asked and addressed in each classroom. As educators move forward with new technological tools that are more meaningfully integrated into the curriculum, they must be thoughtful and patient in equal measure. As any teacher will tell you, there is an inverse relationship between our confidence in any tool and how many times it crashes when put to use. It is days like those when we are ready to open the pod bay door and shove HAL right out, plummeting him back to Earth.

Time is a finite and overtaxed resource in any school, especially when it comes to providing classroom teachers with the resources and opportunities to deepen their understanding of how and why we all learn. Between determining how to address grade-level standards, making sense of the data collected from student assessments, designing differentiated learning activities, and preparing sub-plans, the times to process and share scientific research on learning and cognitive development might seem few and far between. Working with tools and media that seem to change between lesson planning and delivery in the classroom can make even the most confident teachers feel wobbly and uncertain.



Challenges in education are always present. Finding and refining the best ways to help young minds grow is hard work. Now, rather than making sure new copies of a classroom novel are the same edition so the pagination on our handouts from the ditto machine do not have to change, we make backup plans for when our interactive whiteboard ignores our attempts to interact with it.



The full potential of education is expressed through the interaction between our experiences and our openness to new ideas and understandings. The

argument will never be whether or not to use the new media, technology, and information now at our disposal, but how to use it to better develop understanding and intellect, in both literacy and numeracy. While it is clear that technology (at least until the next operating system is released) is here to stay, educators must continue to remember that their brains have been here all along.



Thinking and Teaching in 2.0: Point/Counterpoint

Consider the difference between a trend and something that is trendy. Headlines, online and in print, often make texting, social networking, and other new media alternately frivolous window dressing to our students' lives or dangerous distractions that will lead to lower standards for literacy and numeracy development. Sit with a colleague and, in point/counterpoint style, use the two stems below to explore your views on 21st century learning tools in school. After your first round, switch sides and make your new arguments based on the opposing stem.

- Technology and new media open these doors to learning...
- Technology and new media create these barriers to learning...

As a result of this conversation or activity, work with colleagues to identify how our perspectives on technology influence our ability to integrate technology into instruction in meaningful ways.

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