BEGINNING TO LEARN

A NEW VIEW ON BRAIN RESEARCH & TEACHING

By Alden S. Blodget

My understanding of the growing connection between cognitive science and classroom teaching started 18 years ago in a faculty room, in the spring, shortly before graduation. The room was small and cramped and filled with laughter, the sort of trench laughter that typifies many faculty rooms on a warm, sunny morning in late May when the end is in sight and the windows are open to the smell of cut grass. Someone had a list of the seniors. "Billy Doe," he shouted, launching the name like a clay pigeon at which his colleagues could fire at random.

"Can't read, can't write, can't think — a likely candidate for a head's award."

"Remember when I asked his U.S. History class why the North won the Civil War, and he said, 'Because the South had to fight uphill'? 'What?' I cried. And he pointed at the map and said, 'Look, sir, the North is on top; they had the high ground.'"

And so it went, a litany of seniors who didn't deserve diplomas and the hilarity of faculty despair. This was my fourth school and my 20th year of this spring ritual of grumbling over the state of too many seniors. You had to wonder what we had been doing in our classrooms for four years and why we seemed so readily to accept our unhappiness with the seniors we created.

Finally, in the fall of that year at a department chairs meeting, we started to ask the right questions. Why did so many seniors read so poorly, write so poorly, reason so poorly, and remember so little? Why couldn't they formulate a thesis or hypothesis, design an experiment, find and use relevant evidence, draw a conclusion? Why couldn't they think like scientists or mathematicians or artists or writers or historians? Why didn't they care?

The answers were painfully obvious. They had no skills because we had taught them no skills. We had given them opportunities to write, but never taught them to write. Instead, we had *expected* that their teachers last year had taught them to write, so now we could simply assume they knew how to write. They couldn't formulate a thesis or think because we did most of their thinking for them — expecting them to accept our thoughts as theirs. They knew so little because we were asking them to retain facts that mattered more to us than them. And they didn't care because the classroom had little to do with their lives or their experiences or their needs.

After we recovered from the embarrassment of examining ourselves in the mirror of our students, we spent several productive years changing our curriculum and teaching. Skills became as important as facts. Applying skills and using knowledge replaced listening to lectures (including lectures disguised as class discussions). Teachers made room for the interests of their students.

We were not alone, of course. At the time, these sorts of changes were occurring in good schools across the nation. And by the end of the 1990s, like others, we had become happier with our graduates; they seemed happier with themselves — more confident, more ready for college and life. In the faculty room, the laughter of hopelessness had diminished considerably. But, as it goes in education, rather than discovering that we had arrived at a destination, we found ourselves at a second beginning.

During the 1990s, cognitive scientists and brain researchers revealed a great deal more about how we learn. So we decided to look at all our curricular and teaching changes through the lens of their discoveries and theories. As we read, we discovered that our new approaches appeared to make sense — the emphasis on skill development; linking learning to students' interests, prior knowledge, and emotions; providing opportunities for students to use skills and knowledge in ways that are meaningful to them; giving students more control of what they study; allowing for more reflection and helping students think about how they learn; creating connections among disciplines.

But as I attended brain research conferences and listened to many interesting theories about learning, I also began to long for opportunities for teachers and scientists to work together — to better apply these theories in the classroom. Teachers need to become researchers in their own classrooms, and scientists need data from real classrooms and real students in order to test their theories. At the end of each conference, I filled out the evaluation forms and suggested that future conferences do more than invite teachers to attend the lectures of researchers or the presentations given by other teachers who have packaged "brain-compatible" classroom exercises. When I finally realized that suggestion boxes are really oubliettes, I decided to take my own advice.

And I got very lucky.

Teachers need to become researchers in their own classrooms, and scientists need data from real classrooms and real students in order to test their theories.

I met Dr. Mary Helen Immordino-Yang, then a doctoral candidate at Harvard Graduate School of Education in the Mind, Brain, and Education Program (currently doing research on the neurobiology of emotions at the University of Southern California). She had been doing research on two children, Nico and Brooke, each of whom had only half his brain. Both had had a hemisphere removed to control severe seizures; Nico retained his left hemisphere and Brooke his right. Despite these traumas, both boys were functioning well in school, academically and socially. By studying how these boys had defied predictions for a bleaker future, Immordino-Yang hoped to learn more about how the brain works. Studying the adaptations of the two separated hemispheres would provide insight into the functioning of an intact brain. Based on her research and on her work with Kurt Fischer at Harvard — where the relationships among cognitive science, neuroscience, and education are important — Immordino-Yang developed some compelling theories that suggested a need for teachers to continue to rethink strategies for teaching our young.

Immordino-Yang also shared my interest in bringing teachers and researchers together. She came to Lawrence Academy (Massachusetts), where I worked, to discuss her ideas about learning and the brain and to listen to the teachers to see if their classroom experiences resonated with her theories. Then, in the summer of 2005, Dean of Faculty Arthur Karp invited Immordino-Yang to lead a four-day workshop for teachers: *Making Connections: Cognitive Development, Neuroscience, and Learning*. The workshop consisted of four sections:

1 the nonlinear way we learn and the trial-and-error process of building a skill or an understanding;

2 the idea of human development as a process of increasing complexity — with physical and mental skills becoming coordinated into more complex skills;

3 a lecture/discussion on Immordino-Yang's work with Nico and Brooke;

4 a lecture/discussion on the science of the brain.

The first two sections were the primary focus of the workshop. Together, they offered a theory of how, in general, we learn. The other two lectures (on the brain and the two boys) provided a wider context for the first two. In each section of the workshop, we constantly discussed the implications for our work with students. Ultimately, these implications were the meat of the workshop — and stimulated the thinking about how we might make our teaching more effective.

Immordino-Yang began by examining one of the dominant metaphors about teaching and learning: the ladder. This is the popular notion that learning involves a tidy sequence of steps in which, once one step is learned, the student can move to the next, higher step. For example, writing is often taught as a progression of hierarchical skills: sentence→brainstorming a topic→finding evidence→topic sentence→paragraph→five-paragraph essay→research paper. Yet anyone who writes knows that this simplistic progression does not reflect reality. Writing a good sentence is not a low-level skill, nor does writing a topic sentence always come early in the process. In addition, writers constantly move up and down this ladder as they improve their ability. The ladder, as a metaphor for learning, creates all sorts of assumptions and frustrations for teachers: "I thought they learned how to write a paragraph last year"; "We covered that in the fall, so they should know it already"; etc.

The metaphor also suggests that each skill is a separate ladder, unconnected to other abilities and understanding. While learning can reflect some ladder-like qualities, Immordino-Yang suggested that a more useful metaphor might be a more complicated structure: the web.

In a web, different skills intersect and support each other, and people move up and down the strands in fits and starts, becoming more skillful and less skillful and, then, even more skillful. The web model also highlights the individuality of each student, who brings his or her own experience to every activity. Take the example of a student writing an essay for history class. A childhood ability to play board games, for instance, helps a person understand laws and procedures — a perspective which, in turn, may join with an understanding of spending habits to produce an understanding of the U.S. economy. Another person writing on the same topic will likely have a different web of abilities and perspectives that result in a slightly different understanding.

And the process of mastering a skill becomes even messier. How well we learn the skill depends on the context in which the learning occurs. I will likely learn to drive a car well if my instructor selects or creates the best possible conditions: an uncluttered, large parking lot, a clear day with a dry surface, an automatic transmission, a driver's seat adjusted to my body, and so on. Other contextual factors will include how I am feeling physically and emotionally, the clarity and tone of the instructions, my motivation. Once I become proficient in this context, I can

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venture out on the road, but, at first, a straight, lightly traveled road may result in a better performance than the freeway at rush hour. As the context becomes more challenging, my skill level will drop a bit and then improve. If the context becomes too challenging (a blizzard, an argument with my father), my performance will deteriorate, and I might wreck the car.

For many teachers, it is this connection between context and level of performance that often receives too little attention. Ironically, although teachers spend considerable time creating ideal conditions in their classrooms to help students perform well, they tend to look at results and to forget the conditions that contribute to achieving those results. We tend to focus on, and assess, the performance alone. Immordino-Yang stressed the connection between context and performance. She presented three levels of performance. Each one results from a relationship between performance and the context in which it occurs.

1 The *scaffolded* level of performance requires both a high degree of support from the context and that the teacher actually does som e of the work for the students. The writing teacher might create a group paragraph that she writes on the board, perhaps having already supplied a topic sentence. Or a math teacher might do the logical thinking for the students — actually talk them through it — to get them to the next step in working out a solution. This level of performance is unsustainable because the students' performance depends on the teacher's performing some of the steps.

2 The *optimal* level of performance requires a high degree of support from the context in which the students perform the skill. The students do all the work; the teacher does none of the actual work, but the circumstances under which the work is done are the best they can be so that the students can perform at a very high level. This is the level teachers work to elicit in the classroom by creating the most supportive conditions possible. If, in the early stages of learning, the students want to perform at this level outside the classroom, they need to know how to recreate the same supportive conditions that were present in the classroom. At this level, the quality of their performance is likely to fluctuate as, for example, their attention waxes and wanes. Though they may write a decent paragraph with this high support, it is unlikely that the paragraph they write in front of the television or under the pressure of a timed SAT will be as good.

3 The *functional* level requires little support from the context in which the students perform the skill. This level best reflects how well the students have really learned a skill because the less support they need to perform the skill well, the better they have mastered the skill. If they can write a decent paragraph not only in the classroom, but in front of the television or on a bus or on the SAT, they probably have at least the basic skill. If they can sit in front of the television and crank out a paragraph like one of E.B. White's, their functional level is quite high.

During this part of the workshop, the participants made several discoveries. They understood that students are always working to improve their *functional* level of performance. The scaffolded and optimal levels are tools used to improve the level at which students can normally function. The teachers also realized that they tend to look at performance (results) and not to focus much on the role of context. They assume that their students, doing homework, will reproduce the optimal — or even the scaffolded — level of performance. They expect that the paragraphs the students will write at home will be the same quality as those they wrote in the classroom under ideal conditions. And, not only that, they realized that teachers tend to grade students based on that expectation.

Other implications for teaching also became apparent. Although the functional level may appear like a ladder, like a linear process of steady improvement, the processes involved in real-life learning are actually more complicated. They involve progression and regression in skill level depending on the state of the individual and the support of the context. What students can do at the scaffolded and optimal levels may be more skillful than what they do at the *functional* level, but it will be more fragile and more closely dependent on the context. Have they eaten breakfast that day? Is the teacher nearby? Such considerations matter.

In the terms schools use, they will constantly experience success and failure (usually confused with — but actually different from — high level and low level performance). In fact, "failure" (regression) becomes important to continuing to improve the functional level of performance — which suggests all sorts of implications for how we look at failure and what we slap a failing grade on. Eventually, an optimal level of performance will become functional, and we will raise the bar again creating a new optimal level as we move our students to write like E.B. White — or close to it.

choose callout pleas

The second section of the workshop focused on the theory of how representations and abstractions are built (how understanding is built). The theory is that infant reflexes (grasping or seeing, for example) combine to form more complex physical actions (grasping something in order to bring it to where we can see it: understanding the connection between grasping and seeing) that, in turn, combine to form more complex representations that we can manipulate mentally (1 + 3 = 4) that combine to form even more complex abstractions (how to solve for x). To this end, the workshop participants worked on actual lessons from their classrooms. Immordino-Yang focused on three aspects of a lesson plan: (1) The need to have a clear sense of what the outcome is. (2) The need to break this outcome into its small component parts. (3) The need to understand the relationships among all these components and understand how these relationships build on each other to create the final outcome — what we want the students to understand.

All of that may sound obvious and simple. However, the participants discovered how difficult it actually is. (Immordino-Yang said it took her graduate students a semester to be able to apply this analytic theory.) As the participants began to work with the lesson from their syllabus, they tended to select outcomes that were too complex. As they broke the outcomes into the smaller components, they discovered that the components were actually abstractions or representations that needed to become the outcomes of separate lessons and be further broken down.

For example, two participants worked on a lesson for young middle schoolers on conflict resolution. One of the basic components seemed to be "conflict," which, they said, any middle school student could recognize — "sixth graders know what conflict is." However, as they talked with Immordino-Yang, they discovered that it would be more effective to start by focusing on relationships, since conflict was only one possible relationship and students needed to understand the other possibilities and the components of relationships before they could truly understand conflict resolution. So they changed the outcome of their first lesson to an understanding that "relationships between people result from their perspectives."

They broke the lesson into its parts: the feelings, thoughts, opinions, and behaviors of two individuals. Then they worked on making sure the students would understand the relationship among these: how feelings affected thoughts and thoughts affected feelings, and so forth. The students would come to see that each individual's perspective was derived from the interplay of these four aspects. When the individuals came together in a relationship, they might disagree or agree or be indifferent to each other. Once the students really grasped this concept, they would be ready for a lesson that focused on how they might resolve conflicts; their understanding of relationships now rested on a solid conceptual foundation.

Once again, the implications for teaching and learning became apparent: the need to break down a lesson and then carefully build the conceptual relationships among the components. Some talked about what happens when a basic conceptual link is missing, how a student can become stuck and just can't move on. Perhaps this problem can look like a learning disability when it really isn't. Some talked about the difficulty of false links — linkage of a relevant component (one that is necessary to understanding the lesson) to an irrelevant one. This problem might result in a faulty preconception or a misunderstanding that pushes the lesson for that student in an entirely unintended direction.

Understanding the lessons we teach in this sort of detail makes it more likely that teachers will be able to anticipate where students might run into problems — where students might find the conceptual links difficult to make. As one teacher put it, "building connections is the key."

Although most of the workshop was devoted to creating the lesson plans using Immordino-Yang's method of analysis, it was also important to suggest some other fac-

tors that further complicate the process of learning. Even teachers who master the theory of building understanding may see their lesson plans fail. The final two parts of the workshop looked at some of these factors.

Immordino-Yang's work with Nico and Brooke suggested fascinating complications and implications. As she wrote in a research paper, the two boys "have compensated for lost abilities by transforming processing problems they should not be able to deal with... into qualitatively different problems that better suit their remaining strengths." This suggests that we all have neuropsychological capacities that organize the brain, rather than specific places in the brain that are responsible for language or math or whatever (which suggests, to me, a need to rethink some of Howard Gardner's theory of multiple intelligences). We all have different strengths and weaknesses in these capacities, and how we perceive the problems that ask us to recruit these capacities affects our ultimate ability to solve the problem.

choose callout pleas

As is true with all these theories, we need more research both to test the validity of the theory and to understand how it is manifested in the classroom. However, looking at a hypothetical example may help to understand the theory and suggest a subtle but significant implication.

A history teacher assigns a research paper to her juniors. The topic is Andrew Jackson and the significance of his presidential policies. One student, Judy, has real analytic strengths. She has a knack for getting to the heart of arguments, and she is good at Latin and geometry. Her essay offers a strong analysis of Jackson's policies and their significance for the country. Bob, another student, has very strong social skills. Not only is he a leader in school government, but he also shows real promise as an actor in school plays and is good at English, where his teacher praises him for his insights into character. His essay explores Jackson's personal life and the significance of his policies as a reflection of his character.

It would be nice to believe that all teachers would see the merits in these two approaches to the assignment, would recognize the neuropsychological strengths that allowed Judy and Bob to see this assignment in two different ways. Alas, we know that this is not always so. If the teacher tends to be analytic (and many of us are), she is likely to approve of Judy's approach and give it a higher grade than she gives Bob's. If Bob is also a weak writer, the teacher might even fail to understand Bob's approach and just become frustrated; she might meet with Bob and struggle to make him understand Judy's approach — the approach the teacher wanted in the first place but never made clear.

The implication is that teachers would likely find it helpful to learn ways of identifying these neuropsychological strengths and weaknesses in students. The work of Mel Levine and Schools Attuned certainly takes this direction. Perhaps teachers will discover less cumbersome ways to understand the different languages spoken in our classrooms.

Perhaps we will become as adept as Immordino-Yang. As she moved about the room to help each participant apply the theory to a lesson plan, Immordino-Yang listened carefully. She asked questions and listened some more, trying to determine how each person perceived the problem of developing the lesson plan. Once she understood the perception, she spoke the necessary language.

Immordino-Yang's lecture on the science of the brain suggested additional challenges posed by the developmental readiness for learning certain things at certain ages. It also looked at the relationships among learning and emotion and memory and at the question of whether we perceive reality or impose it on what we see. And we discussed the reasons that, for example, a student might understand grammar but have a difficult time with idioms, or might be fairly skillful at calculation and struggle with approximation. The ways that we recruit different parts of our brains to solve the problems we face are endlessly provocative. But Immordino-Yang urged caution.

Perhaps her most important lessons were that we are just beginning to understand the brain and how it works and that drawing premature conclusions about learning based on our current level of understanding can be dangerous. Many of us can recall various "brain-based" systems of teaching or curricula that resulted from oversimplified extrapolations of earlier theories about how the right and left hemispheres worked or about multiple intelligences or about personality types.

Immordino-Yang is a careful researcher who worries about turning preliminary discoveries into classroom fads that are unguided by controlled research and assessment. For this reason, she believes strongly in creating meaningful partnerships between teachers and researchers. They must learn from each other. They must continue to discover both in the lab and in the classroom how children learn.

So we find ourselves at another beginning — the beginning of a new

partnership. A partnership suggests more than a one-shot workshop. It suggests a sustained relationship that might result in steady change, steady improvement in our teaching skills — *sustained* professional development that maintains the energy and enthusiasm needed for change. While technology allows us to create virtual partnerships (sites for sharing ideas and data, cyber office hours, etc.), more actual partnerships are likely to be created in the future. Some colleges are forming such relationships with schools already. Perhaps soon, collaboration among teachers and researchers will change our concept of schooling. Perhaps our schools will resemble teaching hospitals, where researchers, teachers, and prospective teachers work together to educate our young in K–12 classrooms.

Learning involves change. Teachers are agents of change; we seek to change students every day, every time we walk into the classroom. So it is important for us to model change, model learning, for our students. We can't allow ourselves to believe that we have ever reached the end of our journey. We are always starting out, always arriving at another beginning. It's exhausting and may even seem like too much trouble. But, as Zorba the Greek says, "Life is trouble; only death is not."

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