Seven Strategies That Encourage Neural Branching

Teaching strategies that overcome the brain's natural tendency to limit information can open students' minds to new ideas and creative mental habits.

*Thomas Cardellichio and Wendy Field*

Imagine trying to hit a baseball and noticing all the colors of the stadium, the advertisements, and the roar of the crowd. The overwhelming amount of stimuli might make it impossible for you to hit the ball.

When we are born, our brains have the potential to assimilate a large variety of stimuli. Over time, we develop mental routines and patterns in response to the stimuli that are critical to our lives. Scientists call the process by which we develop selective mental patterns "neural pruning." It is a natural brain function since we could not possibly survive if we had to learn to interpret stimuli anew each time we experience them. We would be overwhelmed with input to the point of being unable to function.

Recognizing this, it is nevertheless advantageous to be able to attend, selectively, to many stimuli—to overcome our neural pruning. In biological terms, we might call this "extending the neural network" or, in more poetic terms, "neural branching"—the opposite of neural pruning. Current research indicates that this type of significant "brainwork" strengthens the brain—creating more synapses between nerve cells—just as exercise builds muscle tissue.

**The Effects of Neural Pruning**

A personal example illustrates how neural pruning closes down our ability to perceive information. This summer, we participated in a workshop on visual thinking at the Metropolitan Museum of Art in New York City. In the first exercise, we observed a slide that was completely out of focus. What was visible was a blur with barely distinguishable smudges of color. We were asked to draw what we saw. In the next phase, the focus was adjusted slightly so that the blurs became unformed patterns of color. In the third phase, the focus was sharpened a little more so that the shapes became more obvious. Finally, the slide was brought completely into focus to reveal Rubens's *Venus and Adonis.*

In the discussion that followed, the instructor asked us to comment on what we had observed. One of us, at phase two, thought he saw an angel and the Madonna. At phase three, he was
sure he had this "problem" "figured out." He knew it was a portrait of a 16th-century courtier. He was sure he could "see" a ruffled collar around the courtier's neck.

During the discussion, the instructor made this point: "If you look for information, you won't see what is there." We were so conditioned to discover the content of the picture that we failed to notice or appreciate the aspects of color, line, patterns, and other elements that were present in the object itself. We were imposing our meaning on the data, and in the process, we were creating something altogether wrong. The process we used was wrong, and the results obtained were wrong. When looking at a picture, our neurons had been predisposed to function according to a certain established routine.

The Implications of Neural Branching
Working to extend our neural networks has important implications for education. Good teaching requires that students have the opportunity to select and assimilate enough data to force them to challenge misconceptions and to create strong, accurate conceptions. They cannot do this if the curriculum or the methodology or the structure of the school is so rigid that students experience only the presentation of data without the opportunity to make sense of it. That kind of teaching only accelerates neural pruning where we want to encourage neural branching.

The first step in encouraging neural branching is to develop a structure or framework that will support the kind of inquiry we need to do both in the classrooms and in the organization. We need to create a mechanism that will accomplish the same effect as blurring the focus on the slide projector so that we can look at familiar things with new eyes—the things that might not be obvious at first glance given our predispositions. In effect, we are trying to create the opportunity to look at something for the first time—before our mind-set becomes rigid.

The following seven strategies, or types of thinking, are particularly suited to extending the neural network. We have incorporated these strategies into our supervision and coaching of teachers and in our classroom teaching. Underlying all seven is the assumption that questioning is a far more powerful way to encourage neural branching than is explication or narration. The seven strategies can shape a generalized structure for inquiry that should undergird the framework needed to apply these strategies in various arenas—particularly in the design of curriculum. Such a structure would consist of a series of questions that we could apply to new data or to our old paradigms. The examples that follow show how we have used these strategies to effectively extend students' thinking in all areas of the curriculum.

Seven Strategies
1. Hypothetical thinking. Hypothetical thinking is a powerful technique for creating new information. It is said that Einstein developed his theory of relativity by asking, "What would it look like to ride on a beam of light?" Hypothetical thinking is a powerful stimulant to neural growth because it forces us to conceive of issues and consequences other than the standard and expected ones.

Here are examples of hypothetical questions one might use in a social studies class:

- What would have happened if Columbus had landed on the West Coast of North America?
● What if the colonies had lost the Revolutionary War?
● What if Washington, D.C., were situated in Kansas?

The key to the use of hypothetical questions is not in asking the question itself but in the follow-up questions that clarify both the complexity of forces that create events and the interrelated web of circumstances that follow from them.

Hypothetical questions take the following general forms:

- What if this had happened?
- What if this were not true?
- What if this had not occurred?
- What if I could do something I can not do?

2. Reversal. One of the techniques used in visual thinking to get outside the context or beyond the information is to blur the picture or turn it upside down. What is a verbal equivalent of turning the picture upside down? One possibility is to go backward from results to causes. We could ask, "What could have happened to create this situation?" Reversal is a specific kind of hypothetical thinking that highlights attributes of events or situations that might otherwise go unnoticed.

Here are a few examples of questions that use the reversal strategy:

- What happens if I reverse the addends in a math problem? Can I do this in a subtraction problem?
- What if Nixon had been elected president before Kennedy?
- What if your mother had your father's job and your father had your mother's job?
- What if Japan had won World War II?

In some cases, asking students to generate other questions may be even more profitable than looking for answers.

General questions that solicit this kind of thinking are the following:

- What caused this?
- How does this change if I go backward?
- What if I turn this upside down or sideways?
- What if ____ had happened first?

3. Application of different symbol systems. Sometimes we get locked into rigid ways of thinking by applying the rules and procedures of particular thinking systems. Another way to extend the neural network is to apply a symbol system to phenomena for which it is not usually used. For example, we use language (the verbal symbol system) for interpersonal communication. What happens if we apply the verbal symbol system to a problem for which we ordinarily use the
numerical symbol system? We could, for example, ask students to explain the Pythagorean theorem in words after we teach its mathematical representation. Continuing, we could ask students to draw a picture (visual symbols) of the Pythagorean theorem that shows us they understand it.

We can also move from verbal systems to quantitative systems. Students could graph or chart relationships in a social situation or in a literary work. Perhaps they could write an equation to show how human interactions are related.

General questions that prompt this kind of transference include the following:

- Can I make this into a word problem?
- Can I make this into a number problem?
- Can I draw a picture of this?
- Can I represent this in musical terms?
- Can I act it out?
- Can I make a dance to represent this?

4. Analogy. Another process of mental extension is to look for correspondences: What is like this? Looking for forced correspondences requires a greater "stretch"—more creativity. For example, how is the Pythagorean theorem like a cooking recipe? Looking for correspondences will create new insights about both elements of the analogy.

The general question that stimulates analogical thinking is "How is this like _____?"

5. Analysis of point of view. This viewpoint is the act of determining why someone holds a particular opinion or belief. It can be taught in a very behavioral and rigorous fashion by forcing students to question for details and evidence. Considering specifically the reasons why a person may hold a particular belief or opinion is a way of extending our own mind-sets.

The general forms of questions that provoke analysis of point of view are:

- What else could account for this?
- Who would benefit if I thought this?
- What harm might occur if _____?
- How many other ways could someone look at this?
- What would _______ (for example, my mother) say about this?

6. Completion. When something is incomplete, there is a natural urge to complete it. If you show students a picture with a hole in it, they will immediately ask what was taken out before they attend to other aspects of the picture. This urge can be used to extend students' thinking in multiple ways. Here are a few examples:

- Remove the conclusion from a short story and ask the students to create their own ending.
Tell the students that chapter one is about the Revolutionary War and chapter three is about the Civil War. Ask what they expect to find in chapter two.

Give the students the steps in a process or a solution (to a math problem, for example) with one or two steps missing. Ask what they think is missing.

This exercise involves greater or lesser degrees of ambiguity, depending on the context set. Two aspects of the exercise are important. First, questions should guide students toward reasonable answers—answers with evidence—so that they are forced to think of reasons for their responses. Second, encouraging a variety of answers will help students see that things can be connected in multiple ways, so that they do not become rigid in their approaches.

General forms of questions that provoke this kind of thinking include:

- What goes in the blank space?
- What is the missing piece or step?
- How would you end the story?
- Write the beginning of _____.
- What if ____ did not happen?

7. **Web analysis.** One of our premises is that events and phenomena are related in complex ways. To make sense of things, our brains tend to oversimplify these relationships. The exploration of the complexity of relationships provides exercise that encourages neural branching. To experience this, answer the following questions with a partner, and during the process, reflect on how the experience feels to you:

- How many people's lives do you think were affected by the deaths of Nicole Brown Simpson and Ronald Goldman? How were they affected?
- What would happen if people stopped drinking Coca-Cola?
- How was subsequent history affected by the death of John F. Kennedy?
- What happened when the first settlers in Puget Sound clear-cut all the timber?

At least two significant differences distinguish web analysis from hypothetical thinking. First, web analysis is concerned with what actually happened, not with possibilities. Second, hypothetical thinking may focus on one or two results; in web analysis the goal is to uncover the complex multitude of effects that may flow from a single source.

The power of web analysis to stimulate neural branching lies in moving beyond the obvious answers to uncover connections that we may not have realized previously. After we begin to "trace the web," the operative question becomes, "And what else?"

The following questions are the type that stimulate web analysis:

- How extensive were the effects of _____?
- How many effects can you imagine from _____?
• Track the relationship of events following from ____.
• How is ____ connected to ____?

The Ultimate Goal

All these strategies are related to one another in that they provoke divergent thinking. Using the strategies can extend students' neural networks and deepen their understanding—not just of the issue in question but also of the way our minds create meaning, of our biases. The more adept we become at understanding the tool that is our mind, the more power we gain over our own mental processes. It's like gaining the ability to see things as new, like the child who is full of wonder and questions, in order to force the brain into more assimilation and more accommodation.

The intent is not to diminish the importance of basic skills, content, or convergent thinking. These are essential for the growth of understanding. But there is a paradox in creating meaning. We need a framework to organize new information, to guide our search for more knowledge, to help us decide what should be selected for attention. We need a methodology to allow us to explore and to help us make sense of the results of those explorations. We need theory for its power to generalize and extend our knowledge. At the same time, we need to avoid becoming victims of our own knowledge, theories, and beliefs. That is, we need a way to look beyond the information we have, beyond our theories, and beyond our beliefs.

This is important work. What we are attempting to do is to protect students and ourselves from the curse of the closed mind. It is fundamental to our business as educators.

It is also important because we are not just talking about new ways of looking at the world. We are talking about plans for changing the structure of brains—educating brains that are fundamentally more powerful because they are able to assimilate a greater range of data and educating brains that are structured differently because they accommodate more diverse data. The goal is to create explorers who have an idea of what they are looking for, who have a methodology with which to search, but who come to the exploration with open minds so that, should they discover America, they will not assume they have landed in India just because that's where they intended to go.