Activity 28

The Stroop Effect: The Persistent Power of Prior Knowledge

Expected Outcome

The teacher asks learners to state, as fast as they can, the colors of a sequence of words that appear in different colors than the colors named (e.g., the word red printed in blue). The first inclination of most people is to read the words rather than naming the colors in which the words are printed (this inclination is called the Stroop Effect). They can accomplish the color identification task without errors or “miss-takes” only by going very slowly with great concentration.
Science Concepts

The Stroop Effect and Selective Attention Theory: When people who can read look at words printed in color, they both see the color and recognize the word. When those two pieces of information are in conflict—that is, when there is a discrepancy between what color the words represent and what color the words are printed in—most readers will automatically, without consciously thinking, focus on the word’s meaning as being more important than font color, despite the stated demand of the assessment task (i.e., to name the color sequence). In this case, prior knowledge of reading interferes with the ability to focus on font color.

In science (and science teaching), the discrepancies between what students expect to “see” and what they actually experience provide teachers with “teachable moments” that can challenge prior conceptions and move students to more refined conceptual understandings. The history of science contains many examples of so-called failed experiments and serendipitous discoveries that led to new insights and fruitful lines of research. Part of the nature of science is the idea that “chance favors the prepared mind” (Louis Pasteur). The prepared mind notices and seeks to explain puzzling discrepancies.

Science Education Concepts

For students of all ages, prior conceptions either can support valid versions of science concepts or they can interfere with learning more scientifically valid versions of science concepts. In this activity, a prior knowledge-assessment task “mismatch” is used as a visual participatory analogy for the idea of science misconceptions. In many cases, commonly held misconceptions have historical antecedents that took scientists many years to replace (e.g., the idea of gases as being “nothing” and moving objects “naturally running out of energy”). If teachers intentionally activate and challenge such misconceptions, the misconceptions can be modified or replaced (in part or whole).
Conceptual evolution or the survival-of-the-fittest mental model takes time and requires experiences with multiple discrepant events. Some prior conceptions are especially tenacious (displaying “cognitive inertia”) and resistant to change, especially in a quick, cover-the-content approach to teaching. This pedagogical problem is analogous to the short-lasting improvement of painting over a rusty door (rather than properly preparing the surface by removing the layer of old rust before painting).

**Materials**

Several websites contain both static and interactive versions of the Stroop Effect:

- Neuroscience for Kids: [http://faculty.washington.edu/chudler/words.html](http://faculty.washington.edu/chudler/words.html) (highly interactive)
- NOVA Online Adventure: Shockwave Demonstration version (as well as a static version): [www.pbs.org/wgbh/nova/everest/exposure/stroopintro.html](http://www.pbs.org/wgbh/nova/everest/exposure/stroopintro.html)
- Scientific American Frontiers: [www.pbs.org/saf/1302/teaching/teaching2.htm](http://www.pbs.org/saf/1302/teaching/teaching2.htm)

Alternatively, instructors can easily make their own colored transparency or PowerPoint slide by typing various color words (e.g., red, orange, yellow, green, blue, indigo, and violet) in intentionally mismatched colors.
Points to Ponder

The foundation upon which education builds is the equipment of instincts and capacity given by nature apart from training…. The relation between psychology and education is … that action in the world should be guided by the truth about the world; and that any truth about it will directly or indirectly, soon or late, benefit action.


If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

—David Ausubel, American cognitive psychologist (1918–2008) in Educational Psychology: A Cognitive View (1968)

Procedure

Use the interactive websites or type up your own colored-word “tests.” Use, for example, overhead transparencies, PowerPoint slides, or T-shirt transfers. Ask for a volunteer to state out loud (as quickly as possible) the sequence of colors in order from left to right, top to bottom, while the rest of the group attempts to do the same task silently. Repeat with another volunteer.

The Stroop Effect readily lends itself to use as a novel “fun”omenon for further inquiry. Run one or more of the following tests in the classroom and/or challenge learners to come up with their own variations of the tests and to use logical argument and skeptical review to explain the empirical results. Ask: What do you think would happen if you…
• tested a younger child who had not yet learned to read (but already knew his or her colors)?
• tested someone who was just learning to read English?
• tested the performance of individuals who had some form of color blindness?
• used the same order of ink colors but used noncolor words (e.g., school, books, or science)?
• used unrecognizable foreign words or nonsense words? [no cognitive conflict occurs]
• tested if accuracy is affected if the colors of the first couple of words are the color words themselves—e.g., the word red appears in red; the word blue appears in blue—before the mismatched examples?
• turned the words upside down so that the mismatched words were not easily readable?

Debriefing

When Working With Teachers and Students

Both teachers and students need to directly experience the power of prior cognitive conceptions and to become aware of the mental effort that is needed to identify and confront our own misconceptions. The skills of disciplined scientific inquiry have utility in day-to-day life as well as in a science classroom. The metaphor of conceptual survival of the fittest helps us to understand the cognitive growth of any individual and the history of science. In the classroom, different ideas and theories “compete for survival” in the minds of individual students. Unfortunately, the correct science theory often loses out to the erroneous prior conceptions (or misconceptions) the students bring to class.

The metaphor of conceptual survival also points to the need for disciplined inquiry. Simple interpretations of uncontrolled everyday natural phenomena often lead to incorrect personal, “scientific” theories. Ausubel’s quote suggests that when planning curriculum, instruction, and assessment, teachers need to assess what students already know (some of which is “not so” in terms of scientifically valid theories). Novel discrepant-event activities are especially useful as diagnostic and instructional tools for activating prior conceptions and catalyzing cognitive processing, two strategies that lie at the heart of constructivist science teaching.
Extensions

1. **Scientific Snooping on the Stroop Effect.** See the websites in the Materials section, as well as Bower 1992; MacLeod 1991; and Stroop 1935.

2. **More Modeling of Mental Blinder.** Repeat the Stroop Test with volunteers who are wearing color-tinted sunglasses. They will find that words printed in the complementary color of the lenses (i.e., red-green, orange-blue, and yellow-violet) become black. For example, orange-tinted blue blocker sunglasses absorb blue light before it reaches the eye, so words printed in blue will not be visible. Tinted glasses can be used as another analogy for how our prior conceptions can influence or “color” how we subjectively perceive, interpret, and reconstruct reality. Creative insights and new technologies often advance scientific understanding by removing conceptual blinders or human sensory limitations. See also Activity #26 in this book.

3. For connections to serendipitous scientific discoveries and to explore the research on misconceptions in science, see Internet Connections.

Internet Connections

(These sites are in addition to those listed above in the Materials and Points to Ponder sections.)

- Duit, R. Free download (March 2009 update): About 8,400 entries related to “misconceptions”: Bibliography of STCSE (Students’ and Teachers’ Conceptions and Science Education). www.ipn.uni-kiel.de/aktuell/stcse/stcse.html
- Kind, V. 2004. Beyond appearance: Students’ misconceptions about basic chemical ideas: www.rsc.org/education/teachers/learn-net/pdf/LearnNet/rsc/miscon.pdf (book; 84 pages)
The Stroop Effect

- Operation Physics: Children's misconceptions about science:
  www.amasci.com/miscon/opphys.html

  (2) Color blindness: http://en.wikipedia.org/wiki/Color_blindness
  (5) Serendipity (links to many examples): http://en.wikipedia.org/wiki/Serendipity