Ask the Cognitive Scientist

Why Students Think They Understand—When They Don't

By Daniel T. Willingham

Question: Very often, students will think they understand a body of material. Believing that they know it, they stop trying to learn more. But, come test time, it turns out they really don't know the material. Can cognitive science tell us anything about why students are commonly mistaken about what they know and don't know? Are there any strategies teachers can use to help students better estimate what they know?

Answer: There are multiple cues by which each of us assess what we know and don't know. But these cues are fallible, which explains why students sometimes think that they know material better than their classroom performance indicates.

* * *

How do we know that we know something? If I said to you, "Could you name the first President of the United States?" you would say, "Yes, I could tell you that." On the other hand, if I said, "Could you tell me the names of the two series of novels written by Anthony Trollope?" you might say, "No." What processes go into your judgment of what you know? The answer may at first seem obvious: You look in your memory and see what's there. For the first question, you determine that your memory contains the fact that George Washington was the first U.S. President, so you answer "yes." For the second question, if you determine that your memory contains little information about Trollope (and doesn't include the novel series named *Barchester* and *Palliser*), you would answer "no."

But, if the mechanism were really so simple, we would seldom—if ever—make mistakes about what we know. In fact, we do make such mistakes. For example, we have all confidently thought that we knew how to get to a destination, but then when put to the test by actually having to drive there, we realize that we don't know. The route may seem familiar, but that's a far cry from recalling every turn and street name.

ABOUT THIS COLUMN

How does the mind work—and especially how does it learn? Teachers' instructional decisions are based on a mix of theories learned in teacher education, trial and error, craft knowledge, and gut instinct. Such knowledge often serves us well, but is there anything sturdier to rely on?

Cognitive science is an interdisciplinary field of researchers from psychology, neuroscience, linguistics, philosophy, computer science, and anthropology who seek to understand the mind. In this regular American Educator *column, we consider findings from this field that are strong and clear enough to merit classroom application.*

The feeling of knowing has an important role in school settings because it is a key determinant of student studying (e.g., Mazzoni & Cornoldi, 1993). Suppose a third-grader has been studying the Vikings with the goal of understanding where they were from and what they did. At what point does the third-grader say to him or herself: "I understand this. If the teacher asks me, 'Who were the Vikings?' I could give a good answer."

Every teacher has seen that students' assessments of their own knowledge are not always accurate. Indeed, this inaccuracy can be a source of significant frustration for students on examinations. The student is certain that he or she has mastered some material, yet performs poorly on a test, and may, therefore, conclude that the test was not fair. The student has assessed his or her knowledge and concluded that it is solid, yet the examination indicates that it is not. What happened? What cues do students use to decide that they *know* something?

Cognitive science research has shown that two cues are especially important in guiding our judgments of what we know: (1) our "familiarity" with a given body of information and (2) our "partial access" to that information. In this column, I'll discuss how these two cues can lead students to believe that they know material when they don't. And, in the box on page 41 (//www.aft.org/newspubs/periodicals/ae/winter0304/willinghamsb.cfm), I suggest ways that teachers can help students develop more realistic self-assessments of their knowledge.

"Familiarity" Fools Our Mind into Thinking We Know More Than We Do

The idea of familiarity is, well, familiar to all of us. We have all had the experience of seeing someone and sensing that her face is familiar but being unable to remember who that person is or how we know her.

Psychologists distinguish between *familiarity* and *recollection*. Familiarity is the knowledge of having seen or otherwise experienced some stimulus before, but having little information associated with it in your memory. Recollection, on the other hand, is characterized by richer associations. For example, a young student might be familiar with George Washington (he knows he was a President and maybe that there's a holiday named after him), whereas an older student could probably recollect a substantial narrative about him. (See Yonelinas, 2002, for an extended review of the differences between recollection and familiarity.)

Although familiarity and recollection are different, an insidious effect of familiarity is that it can give you the feeling that you

know something when you really don't. For example, it has been shown that if some key words of a question are familiar, you are more likely to think that you know the answer to the question. In one experiment demonstrating this effect (Reder, 1987), subjects were exposed to a variety of word pairs (e.g. "golf" and "par") and then asked to complete a short task that required them to think at least for a moment about the words. Next, subjects saw a set of trivia questions, some of which used words that the subjects had just been exposed to in the previous task. Subjects were asked to make a rapid judgment as to whether or not they knew the answer to the question—and then they were to provide the answer.

If the trivia question contained key words from the previous task (e.g., "What term in golf refers to a score of one under par on a particular hole?"), those words should have seemed familiar, and may have led to a feeling of knowing. Indeed, Reder found that subjects were likely to say that they knew the answer to a question containing familiar words, irrespective of whether they could actually answer the question. For questions in which words had not been rendered familiar, subjects were fairly accurate in rapidly assessing their knowledge.

A similar effect was observed in an experiment using arithmetic problems (Reder & Ritter, 1992). On each trial of this experiment, subjects saw an addition or multiplication problem (e.g., 81 + 35) and they had to rapidly decide whether they would calculate the answer or answer from memory. If they chose to calculate, they had 20 seconds to do so; if they chose to answer from memory, they had just 1.4 seconds. Sometimes problems repeated, so subjects might have had the answer to a complex problem in memory. Subjects were paid depending on their speed and accuracy, so the decision about whether or not to calculate was important. As in the trivia question experiment, subjects were accurate in knowing when they could retrieve an answer from memory and when they needed to calculate it—except in one situation, when the experimenters repeated a two-digit problem but changed the operation (e.g., addition to multiplication). In that case, subjects were just as likely to try to retrieve an answer from memory for a problem they had actually just seen (e.g., 81 + 35) as they were for a problem they had *not* just seen but which used familiar operands (e.g., 81 – 35). The experimenters argued that subjects made their judgment about whether to calculate based on the familiarity of the problem components, not on the whether the answer was in memory.

"Partial Access": Our Mind Is Fooled When We Know Part of the Material or Related Material

A second basis for the feeling of knowing is "partial access," which refers to the knowledge that an individual has of either

a component of the target material or information closely related to the target material. Suppose I ask you a question and the answer doesn't immediately come to mind, but some related information does. For example, when I ask for the names of the two series of Trollope novels, you readily recall *Barchester* and you know I mentioned the other series earlier; you even remember that it started with the letter P, and you believe it had two or three syllables. Your quick retrieval of this partial information will lead to a feeling of knowing the relevant information—even if *Palliser* is not actually in your memory.

The effect of partial access was demonstrated in an experiment (Koriat & Levy-Sadot, 2001) in which subjects were asked difficult trivia questions. If subjects couldn't answer a particular question, they were asked to judge whether they would recognize the answer if they saw it (i.e., to make a feeling-of-knowing judgment). The interesting twist: Some of the questions used categories for which lots of examples came to mind for their subjects (e.g., composers) and matching questions used categories for which few examples came to mind (e.g., choreographers)—that is, these subjects could easily think of at least a few famous composers, but couldn't think of more than one or two choreographers, if any.

The results showed that whether or not they could actually recognize the right answer, people gave higher feeling-of-knowing judgments to questions using many-example categories (e.g., "Who composed the music for the ballet *Swan Lake*?") than to questions using few-example categories (e.g., "Who choreographed the ballet *Swan Lake*?"). The experimenters argued that when people see the composer question, the answer doesn't come to mind, but the names of several composers do. This related information leads to a feeling of knowing. Informally, we could say that subjects conclude (consciously or unconsciously), "I can't retrieve the *Swan Lake* composer right now, but I certainly seem to know a lot about composers. With a little more time, the answer to the question could probably be found." On the other hand, the choreographer question brings little information to mind and, therefore, no feeling of knowing.*

* * *

These studies, and dozens of others like them, confirm two general principles of how people gauge their memories. First, people do not assess their knowledge directly by inspecting the contents of memory. Rather, they use cues such as familiarity and partial access. Second, most of the time these cues provide a reasonable assessment of knowledge, but they are fallible.

How Students End Up with "Familiarity" and "Partial Access" to Material

If a student believes that he knows material, he will likely divert attention elsewhere; he will stop listening, reading, working, or participating. Mentally "checking out" is never a good choice for students, but all the more so when they disengage because they *think* they know material that, in fact, they do not know. The feeling of knowing becomes a problem if you have the feeling without the knowing. There are some very obvious ways in which students can reach this unfortunate situation in a school setting. Here are several common ones:

1. Rereading. To prepare for an examination, a student rereads her classnotes and textbook. Along the way, she encounters familiar terms ("familiar" as in she knows she's heard these terms before), and indeed they become even more familiar to her as she rereads. She thinks, "Yes, I've seen this, I know this, I understand this." But feeling that you understand material as it is presented to you is not the same as being able to recount it yourself.

As teachers know, this gap between feeling that you know and genuine recollection can cause great frustration. I have frequently had exchanges in which one of my students protests that despite a low test grade, he or she really knew the material. When I ask a general question or two, the student struggles to answer and ends up sputtering, "I can't exactly explain it, but I know it!" Invariably, a student with this problem has spent a great deal of time reading over the course material, yielding a lot of familiarity, but not the necessary and richer recollective knowledge.

2. Shallow Processing. A teacher may prepare an excellent lesson containing a good deal of deep meaning. But this deep meaning will only reside in a student's memory if the student has actively thought about that deep meaning (see "Students Remember ... What They Think About," in the Summer 2003 (//www.aft.org/newspubs/periodicals/ae/summer2003/willingham.cfm) issue of *American Educator*). Let's say, for example, that a teacher has prepared a lesson on the European settlement of Australia and on the meaningful issue of whether that settlement should be viewed as a colonization or invasion. But, let's say that a given student did not process and retain the deep meaning intended by the lesson. He did absorb key terms like "Captain Cook" and "Aborigines." His familiarity with these key terms could mislead him into believing he was ready for a test on the subject.

3. Recollecting Related Information. Sometimes students know a lot of information *related* to the target topic, and that makes them feel as though they know the target information. (This is analogous to the subjects in the experiment who knew the names of many composers and so felt that they knew who composed *Swan Lake*.) Suppose that a fifth-grade class spent three weeks studying weather systems, including studying

weather maps, collecting local data, keeping a weather journal, learning about catastrophic weather events like hurricanes, and so on. In preparation for a test, the teacher says that there will be a question on how meteorologists use weather maps to predict hurricanes. When the student hears "weather map," she might recall such superficial information as that they are color coded, that they include temperature information, and so on; she feels she knows about weather maps and doesn't study further. In fact, she hasn't yet come to understand the core issue—how weather maps are used to predict weather. But her general familiarity with the maps has tricked her into believing she had the necessary knowledge when she didn't. (Ironically, the problem of recollecting related information is most likely to occur when a student has mastered a good deal of material on the general topic; that is, he's mastered *related* material, but not the target material. It's the knowledge of the related material that creates the feeling of knowing.)

* * *

Cognitive science research confirms teachers' impressions that students do not always know what they think they know. It also shows where this false sense of knowledge comes from and helps us imagine the kinds of teaching and learning activities that could minimize this problem. In particular, teachers can help students test their own knowledge in ways that provide more accurate assessments of what they really know—which enables students to better judge when they have mastered material and when (and where) more work is required.

Daniel T. Willingham is associate professor of cognitive psychology and neuroscience at the University of Virginia and author of Cognition: The Thinking Animal*. His research focuses on the role of consciousness in learning.*

Readers can pose specific questions to "Ask the Cognitive Scientist," American Educator, 555 New Jersey Ave. N.W., Washington, DC 20001 or to amered@aft.org (mailto:amered@aft.org?subject=article%20request). Future columns will try to address readers' questions.

*Another important aspect of this phenomenon is that the accuracy of partially retrieved information is irrelevant to the feeling of knowing. In an experiment illustrating this phenomenon, Asher Koriat (1993) asked subjects to learn strings of letters. Later, subjects were asked to recall as many letters as possible and then judge whether they would successfully recognize the entire string from among several choices. Subjects' confidence that they would recognize the letter string increased with the number of letters that they had recalled, regardless of whether or not those letters were

correct. The more they thought they were pulling out of memory, the more confident they were that they really knew the whole string and would recognize it when they saw it. (back to article)

References

Koriat, A. (1993). How do we know that we know? *Psychological Review*, 100, 600–639.

Koriat, A. & Levy-Sadot, R. (2001). The combined contribution of the cue-familiarity and accessibility heuristics to feelings of knowing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27, 34–53.

Mazzoni, G. & Cornoldi, C. (1993). Strategies in study time allocation: Why is study time sometimes not effective? *Journal of Experimental Psychology: General*, 122, 47–60.

Reder, L. M. (1987). Strategy selection in question answering. *Cognitive Psychology*, 19, 90–138.

Reder, L. M. & Ritter, F. (1992). What determines initial feeling of knowing? Familiarity with question terms, not with the answer. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 435–451.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, 46, 441–517.

Related Articles

Ask the Cognitive Scientist
Why Students Think They Understand—When They Don't
By Daniel T. Willingham

How to Help Students See When Their Knowledge Is Superficial or Incomplete
(//www.aft.org/newspubs/periodicals/ae/winter0304/willinghamsb.cfr