

A Perfectly Good Explanation

For Peabody researcher Bethany Rittle-Johnson, math provides the backdrop for how explanation powers cognition

BY Ashley Crownover

Learning math may not be the most exciting activity for some kids, but determining how best to teach it has the full attention of Peabody researchers. At the fore of the current interest in mathematics education is the work of Assistant Professor of Psychology Bethany Rittle-Johnson, whose research combines an exploration of cognition—how people understand the world—with an investigation of teaching practices in the classroom.

Self-Explanation

To examine how people acquire the knowledge they need to learn mathematics, Rittle-Johnson focuses on self-explanation—the explanations people give to themselves, as opposed to those that are provided by someone else. “Self-explanation is a very promising way to get people to understand things better,” she says. “It’s been shown in a large number of studies across a diverse age group that kids learn more if they’re explaining things.”

Rittle-Johnson’s interest in self-explanation began with her work as a graduate student, exploring the relationship between concep-

tual knowledge—a person’s understanding of how things work—and procedural knowledge—a person’s understanding of how to solve problems step by step. Psychologists have historically debated which comes first: Do people figure out concepts from procedures, or the other way around? Rittle-Johnson theorized that the two kinds of knowledge might be acquired in a back-and-forth (or iterative) process, with each kind building off the other.

She began to examine the best ways to help develop conceptual and procedural knowledge, and eventually came to focus on self-explanation. “At the core of my research, I’m looking at kids explaining,” she says, “but then also at what things matter. What if you put explanation in combination with direct instruction? What if you have kids explaining to somebody else? What if you’re having them explain contrasting ways of doing things? These are all different ways of figuring out how to maximize explanation.”

Why Math?

Though she was never “math phobic” as a child, Rittle-Johnson

admits she “did not start studying how children learn math because I always loved it.” Rather, the very nature of the subject makes it perfect for exploring these types of cognitive issues.

“At the core, I’m interested in how people develop both conceptual understanding and problem-solving skills,” she says. “Mathematics is an obvious domain where we have to develop both of those kinds of knowledge and integrate them somehow.” Further, the use of real-world problems rather than lab-created tests appeals to the practical-minded researcher. “From day one as a psychologist, I wanted to study tasks that people really do. I didn’t need to make up a lab task that was weird and convoluted, because there are plenty of math tasks out there that to kids seem weird and convoluted.”

The tasks used in Rittle-Johnson’s work all fall under the umbrella of algebraic thinking, but at different levels. Children ages four and five are asked to guess what comes next in a repeating pattern, while older children are assessed on their understanding of

mathematical equivalence (use of the equal sign), and middle-school students are asked to solve linear equations such as $3x+4=15$.

“It strikes people as odd initially that you think about algebraic thinking in a four- or five-year-old,” Rittle-Johnson says. “But when you look at the misconceptions and confusion in older students, it appears that they are gaining them from earlier instruction. The hope now is that if you go younger, there are things students could be thinking about that would productively both avoid these misconceptions or at least reduce them, and get students thinking algebraically from a much younger age.”

Rittle-Johnson echoes the concern of many researchers about the need for improvement in mathematics in the United States. “Algebra has become a required class for high-school graduation,” she points out, “and some people say it’s like a requirement to good jobs. Kids really need to succeed at algebra, and they really struggle with it.”

Working Toward a Common Goal

Correcting early misconceptions can provide students with a more solid foundation for learning algebra at higher levels, something math education researchers are also interested in.

“Psychologists are interested in learning processes, and math education researchers are interested in the content learned,” Rittle-Johnson says, though it’s the collaboration between the two that helps to connect research with practice in the classroom. While she relies on her math colleagues’ mastery of content and ability to envision what improved instruc-

tion might look like, they benefit from her expertise in determining what cognitive strategies work best. “It helps them make choices,” she says. “If you can turn to cognitive science literature and say, this idea of having kids self-explain, time and time again people have found it’s a really good idea, then that seems like a good thing to try in the classroom.”

One project that aims to further this joint work has been proposed by Rittle-Johnson’s longtime collaborator Jon Star, a math education researcher at Harvard University. Star intends to conduct teacher professional development that builds on the researchers’ prior work on self-explanation. Rittle-Johnson will play a supporting role. “That kind of collaboration is really the only way this range of issues is going to be addressed,” she says.

To help further apply her research to the practice of teaching mathematics, Rittle-Johnson acts as a consultant for a software

company that is developing a fractions software unit. And she has discovered that even at the local level, her work is having an impact.

“When we went back to one of the classrooms we worked in the year before,” she says, “30 percent of students were doing certain things at pretest; the year before, it was zero. That wasn’t so great for our study, but it was an indicator that we had changed the teacher’s working practices to incorporate these things.”

And of course, national interest in Rittle-Johnson’s research—one of her studies was examined for the recent report from the National Math Panel—has her looking toward the future. “The fact that I can do work that is theoretically interesting and moves this set of theoretical issues forward, but at the same time really has some possibilities for influencing how kids are going to learn in school,” she says, “now that’s exciting.”

