‘Math Anxiety’ Confuses the Equation for Students

Researchers delve into causes and implications of fear of the subject.

By Sean Cavanagh

Stellar athletes, successful entrepreneurs, and motivational speakers like to say that pressure makes diamonds. The higher the stakes and the harder the circumstances, the thinking goes, the more likely we are to overcome our fears and doubts and produce results.

If only it were that simple in mathematics.

In recent years, researchers and educators have delved further into the topic of “math anxiety,” or the ways in which students’ lack of confidence in that subject undermines their academic performance. Today, the issue is receiving renewed attention from academic scholars and others, who believe that developing a better understanding of the causes and implications of math anxiety is a key to improving achievement for many students.

Emotional and cognitive factors in learning, including math anxiety, were scheduled to be explored at a seminar in San Francisco this weekend at the annual meeting of the American Association for the Advancement of Science. The AAAS, which is based in Washington, is an international professional association of scientists.

“It’s easy for people to hear of this and dismiss it. They hear of it and say, ‘Why is this a problem?’” said Mark H. Ashcraft, a professor of cognitive psychology at the University of Nevada, Las Vegas, who was slated to speak on the topic at the AAAS gathering.
“It affects people’s academic performance,” he said of such anxiety. “It affects people’s career choice. It’s not just an attitude or feeling that can be ignored.”

When he first began examining the impact of anxiety on math performance, Mr. Ashcraft assumed that students’ unease or nervousness amounted to “an attitude,” as he recalls it, rather than a phobia with a direct link to the brain’s processes. “I was wrong,” he says now.

A number of researchers, including Mr. Ashcraft, say there is evidence that anxiety disrupts student performance in math by wreaking havoc with “working memory.” Such capacity is a type of short-term memory individuals use to retain a limited amount of information while working on a task—and block out distractions and irrelevant information. Anxiety can sap students’ working memory during tests, but in other problem-solving situations, too.

**Conceputal Barriers**

Some evidence also suggests that anxiety is more of a factor in math than in other subjects.

While students who are anxious about math sometimes are equally apprehensive about other subjects, that anxiety does not undermine their performance in areas such as verbal skill to the same extent it does in math, Mr. Ashcraft and others say. And while the public may be inclined to see anxiety as simply a byproduct of a student not understanding a math concept or topic, researchers believe students’ self-doubts can in fact be a prime cause of those struggles.

Students feel more anxiety in math partly because they are dealing with so many concepts and procedures that are foreign to them, said Robert S. Siegler, a professor of cognitive psychology at Carnegie Mellon University, in Pittsburgh, who has examined children’s thinking abilities in math and science. Once students realize they do not grasp a math concept, the internal pressure grows.

“Math entails certain conceptual barriers that lead people to read the same passage over and over again and not understand it,” Mr. Siegler said. By contrast, in reading a history lesson, students are likely to recognize vocabulary, themes, and ideas, even if they do not understand them. The same is not true in math. The problems are more abstract, he said, and the gaps in understanding can seem insurmountable.

**Math Pressure Cooker**

A 2005 study found that students with relatively strong working-memory capacity—a form of short-term memory—were more susceptible than their peers to performing poorly because of stress, or “choking under pressure,” as the authors put it, on difficult math problems.

*Click image to see the full chart.*
vocabulary, themes, and ideas, even if they do not understand all the implications of a particular passage.

"You don't feel like you totally didn't understand it, and you're just floundering," he said.

Mr. Siegler is one of 17 people serving on the National Mathematics Advisory Panel, a White House-commissioned group charged with identifying effective strategies for improving instruction in the subject. The panel includes a number of cognitive psychologists, along with education researchers, mathematicians, and others.

Members of the panel, who are expected to produce a final report for President Bush next year, have discussed the impact of math anxiety "in general terms" as one of several variables that affect student performance, Mr. Siegler said.

In his research, Mr. Ashcraft has found that anxiety tends to have the most powerful impact on students when they are working on certain types of math problems—typically those with larger numbers, or those requiring multiple steps.

Individuals with high levels of math anxiety tend to rush through problems, making them prone to errors, the UNLV researcher has concluded. Those math-anxious students also have far more difficulty on problems that require processes such as "carrying" numbers than on questions where such steps are not necessary.

In a 2001 study, published by Mr. Ashcraft and Elizabeth P. Kirk, now a postdoctoral fellow at the Georgia Institute of Technology, the researchers concluded that math-anxious students struggle on problems involving carrying, borrowing, and long division. Those processes require a lot of working memory, they concluded, a function that is easily disrupted among students prone to math anxiety.

"[A]nxious individuals devote attention to their intrusive thoughts and worries, rather than the task at hand," Mr. Ashcraft explained in a 2002 paper discussing that study. "In the case of math anxiety, such thoughts probably involve preoccupation with one's dislike or fear of math, one's low
paper discussing that study. "In the case of math anxiety, such thoughts probably involve preoccupation with one's dislike or fear of math, one's low self-confidence. ... [P]laying attention to these intrusive thoughts acts like a secondary task, distracting attention from the math task."

'Choking Under Pressure'

Others have sought to better identify which students are most prone to the effects of anxiety in math. Sian L. Beilock, an assistant professor of psychology at the University of Chicago, found that students who had high amounts of working-memory capacity were, in fact, most susceptible to seeing their performance fall in math, on more complicated problems.

Ms. Beilock and Thomas H. Carr, a professor of psychology at Michigan State University, in East Lansing, summarized their findings in a 2005 paper published by the American Psychological Society, titled "When High-Powered People Fail: Working Memory and 'Choking Under Pressure' in Math."

Students with a good amount of working memory rely on 'really intensive strategies' to solve math problems, such as keeping track of numbers in their heads as they move from step to step, Ms. Beilock explained in an interview. That approach serves them well on relatively simple math problems, but not more complicated ones, she said.

In higher-pressure situations, such as timed tests, or where researchers put students under additional stress, those high-memory students fare more poorly. Performance pressure sucks the working-memory that has served them so well previously. By contrast, individuals with relatively little working-memory capacity do not seem to suffer as much, Ms. Beilock said.

The idea that students with a lot of working memory—who tend to be better students—fare more poorly under pressure is counterintuitive, Ms. Beilock acknowledged. And it has implications for evaluating student performance through tests, she said.

"Testing is hitting people who would normally perform the best, the hardest," she said. Because of the impact of pressure on exam performance, she said, "It's dangerous to [make] conclusions about ability from the test."

Performance pressure among top students, she added, could be pulling them down on tests.

Still, research has shown that students can learn to overcome anxiety, Ms. Beilock said. One strategy simply involves practice with math problems, which can make it easier to retrieve answers from memory. Another is to train students to become more accustomed to working under pressure by having them take timed practice tests, for example. Although there has been
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Sheila M. Ford, a former elementary math resource teacher and principal in Washington, believes anxiety is just as likely to affect students in other subjects. But she also believes students' uneasiness in math tends to rise faster if they sense that a teacher does not have mastery of the material.

"It goes back to teacher preparation and knowledge of the subject matter," said Ms. Ford, a former member of the governing board that sets policy for the National Assessment of Educational Progress. "If the teacher's uncomfortable with the curriculum, it will be noticeable to the students."

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