A MATHEMATICAL MINDSET APPROACH TO STUDENT LEARNING

Jo Boaler, Nomellini and Olivier Professor in the Graduate School of Education (Mathematics) at Stanford University, explores a mathematical mindset approach to student learning

I am a Professor at Stanford University, and I work to improve students' mathematics learning in and out of school. I started working with Carol Dweck in 2010 when we agreed together that her powerful work on mindset could be shared with mathematics teachers and their students.

Dweck has found that students who believe in their own potential, and embrace times of challenge and struggle, achieve at higher levels (Dweck, 2006). For the last decade, I have been sharing a "mathematical mindset" approach, with free resources for educators and parents, and researching its impact. One of the ways we share this approach is through our Stanford website: youcubed. This is a website sharing thousands of free resources. It is also a research center at Stanford, where I work with undergraduates, masters, and doctoral students, building resources and studying their effectiveness.

A mathematical mindset approach and student learning

A mathematical mindset approach starts from the premise that it is not enough to share mindset messages with students – messages that they can learn anything and that times of struggle are critical – if those messages are not supported by the teaching approaches they experience. In a mathematical mindset approach students are taught with rich mathematical tasks that give them opportunities to learn and grow, rather than short, closed questions. These tasks give students opportunities to struggle, and teachers support students with positive messages as they work. For example, many students work through short questions, such as 1 divided by 2/3 in their mathematics classes. But students could be asked, instead, to work with peers, and provide a visual proof of the answer to 1 divided by 2/3.

Although this may appear to be a small change in the question, in the short version, students are looking for an answer, probably by using a memorized method, while in the more open question, they are working with others, reasoning and visualizing, and they have space inside the question to learn and grow. Our youcubed website provides thousands of lessons and tasks for students, across the age range, that engage students more actively, visualizing, thinking, and reasoning about mathematical ideas.

One of the resources we have developed for students is a free online course. In six short sessions (approximately 15 minutes each), students learn about mindset and the ways their brains develop. The myth of the fixed brain is countered and a new way to approach mathematics is shared. This course, which is offered to parents, educators, and students, has been taken by over 1 million people. To study the effectiveness of the course, we conducted a randomized controlled trial.

We recruited middle school teachers, across multiple school districts, who taught two classes. The teachers gave students the online course in one of their classes at the start of the school year. Classes in the control and treatment conditions were taught by the same teachers, using the same curriculum and teaching approach. At the end of the school year, the students who took the online class achieved significantly higher levels on state tests, and teachers rated the students as 68% more engaged in their mathematics classes (Boaler et al, 2018).

Changing teachers' and students' mindsets

We have also shared this different approach to teaching with teachers of mathematics at all grade levels. In one initiative, we worked with fifth-grade teachers in the Central Valley of California. The teachers took one of our online teacher courses and met in groups with their local math leaders to plan changes. Even during the first year of the initiative, students of the teachers who learned a mathematical mindset approach achieved significantly higher levels on state tests, with changes being particularly strong for girls, language learners, and socioeconomically disadvantaged students – the students who often underachieve in mathematics.

A research study conducted on the initiative found that teachers first had to change their mindsets in order to change their teaching approaches and their ideas about the potential of the students they teach. Many adults, including teachers, do not think they can learn mathematics to high levels. When teachers changed their ideas about their own potential, they were able to change their teaching approaches, starting to value student thinking and reasoning – and the potential of all students (Anderson et al, 2018).

A mathematical mindset summer camp

We have also designed and studied a summer camp curriculum based on a mathematical mindset approach. We first taught the curriculum ourselves to middle school students at a summer camp on the Stanford campus. After four weeks of the approach, the students improved their achievement on standardized tests by the equivalent of 2.8 years of school. In later years, we shared the curriculum with teachers from across the U.S. and the world. The camps have now been taught in Scotland, Italy, Brazil, and the U.S. In a study of the camps taught in ten U.S. school districts, we found that students achieved significant gains in their mathematics achievement (Boaler et al, 2021).

Additionally, the teachers who taught the camps also learned to teach differently (Leshin, Boaler & LaMar, 2024) and took the new approach back to their regular school classrooms. The camp curriculum is available for students across the five to 13 age range.

Some people are critical of the ideas of mindset – rightly pointing out that it is not fair to expect students to carry the burden of change. This is why our approach has been to share mindset teaching, where the messages are supported by the teaching approach offered. When students experience a mindset-oriented classroom, in which their growth and learning are valued through tasks, assessments and messaging, then mindset ideas can take root – students start believing in their own potential. When they do, they are able to learn effectively.

Mindset cultures

The latest research on mindset has shown that what is needed is not just the sharing of mindset messages but the development of mindset cultures in schools and workplaces (Hecht et al., 2023). I shared these ideas for parents, employers and leaders in a book called Limitless Mind (Boaler, 2019), which recommends changing all situations, in workplaces and homes, to help people learn that they can do anything, that struggle and mistakes should be valued, and barriers to growth and change should be removed. When people take a limitless approach to challenge, to mathematics, and everything else, their learning and their lives are changed.

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