



Mistakes “Grow” Your Brain

by Jo Boaler

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Psychologist Jason Moser studied the neural mechanisms that operate in people’s brains when they make mistakes (Moser et al., 2011). Moser and his group found something fascinating. When we make a mistake, synapses fire. A synapse is an electrical signal that moves between parts of the brain when learning occurs.

Moser found that when people make a mistake the brain has two potential responses. The first, called an ERN response, is increased electrical activity that is thought to occur when the brain experiences conflict between a correct response and an error. Interestingly, this brain activity occurs whether or not the person making the response knows they have made an error. The second response, called a Pe, is a brain signal thought to reflect conscious attention to mistakes. This happens when there is awareness that an error has been made and conscious attention is paid to the error.

When I have told teachers that mistakes cause your brain to spark and grow, they have said, “Surely this only happens if students correct their mistake and go on to solve the problem correctly.” But this is not the case. In fact, Moser’s study shows us that we don’t even have to be aware we have made a mistake for brain activity to occur.

When teachers ask me how this can be possible, I tell them that the best thinking we have on this is that the brain grows when we make a mistake, even if we are not aware of it, because it is a time of struggle; and the times when we struggle and are challenged are the best times for brain growth.

So what is brain growth? Some people read this research and say our brains would be huge if they grew each time we made a mistake! But what is meant by growth is not an increase in volume but an increase in connectivity. Research suggests that when learning occurs there are 3 possible forms of growth/connectivity:

- 1) New pathways can form in the brain
- 2) Pathways can become strengthened in the brain
- 3) Pathways can connect in the brain.

In the Moser study there was greater brain activity and growth when people had a growth mindset than when people had a fixed mindset. This strikes me as really significant as it tells us that having a growth mindset can cause greater brain growth when mistakes occur. This helps us understand why a growth mindset is associated with higher achievement – people with a growth mindset have greater brain activity when they make mistakes. This underlines again the importance of changing people’s mindsets and encouraging them always to believe in themselves.

In our work with students we have found that when students realize that mistakes are helpful for their brains it changes them,

significantly. They become more willing to struggle and try harder mathematics, and keep going. Understanding the power of mistakes is critical, as children and adults everywhere often feel terrible when they make a mistake in math. They think it means they are not a math person, because they have been brought up in a performance culture (see Boaler, 2014) in which mistakes are not valued—or worse, they are punished.

In a second study Gabriele Steuer and her colleagues looked at the climate of math classrooms to consider the impact of “mistakes friendly” or “mistakes unfriendly” environments on students’ reactions to errors and the amount of effort they would put into classes (Steuer et al., 2013). They found that when students perceived their classroom as mistakes friendly – above and beyond other aspects of their classrooms environment – they increased their effort in their work.

We created mistakes friendly environments in our youcubed summer camp for 6th and 7th graders. We valued mistakes, we valued all of the students’ thinking (not just the thinking of some students) and we helped students know that mistakes ‘grow’ your brain. The mistakes encouragement and messages had a huge impact on the students who were freed to contribute ideas in the camp, without the fear of being wrong. Here are some of the students talking about the impact of youcubed’s math camp:

“I guess in a way making the mistakes in it was super fun, and just learning from the mistakes, it was interesting, ‘cause I’ve never had such a visual version of math, where making mistakes was so acceptable and you were able to look at it as, as you were so close but you could get there from learning from that mistake, and I’ve never had that experience in another classroom and that’s probably what made it so special.”

“I like it because the problems are harder here, not harder but like more challenging, and if you don’t know the answer, you can raise your hand and we’ll think about it together, and try to come up and we’ll do talks in our group, and we’ll all try to figure it out if we don’t understand, we’ll try to explain it to each other.”

“There’s a lot of those messages, but my favorite one is that no one is born good at math, and I thought that was true, and now that I know that it’s not than it really helps me, ‘cause I can know that I can, I can learn so much, just as much as others do. Yeah.”

You can see the camp in this short film:

<https://www.youcubed.org/resources/solving-math-problem/>

References: Boaler, J. (2014). [The Mathematics of Hope](#), Heinemann

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