

Note: I had originally planned to implement a “Marvelous Monthly Math” rotation for the primary classes at my school, Fieldbrook Elementary, for my HEMLT project. The rotations would focus on a monthly theme with the following rotations: Read Aloud, STEM Project, Games, and Art. Unfortunately, due to COVID, I was not able to see my project through to fruition. I am hoping to do so when we return to “normal” post COVID. As a project alternative, I chose to read the book, Limitless Mind, by Jo Boaler and provide a list of my favorite quotes from the book. I found this to be extremely interesting as I have an interest in neuroscience as it applies to education.

Limitless Mind

Learn, Lead and Live Without Barriers

By: Jo Boaler

“Researchers now know that when people with math anxiety encounter numbers, a fear center in the brain is activated-the same fear center that lights up when people see snakes or spiders.”-page 4

“We are not born with fixed abilities and those who achieve at the highest levels do not do so because of their genetics.”-page 4

“The myth that our brains are fixed and that we simply don’t have the aptitude for certain topics is not only scientifically inaccurate; it is omnipresent and negatively impacts education and many other events in our everyday lives.”-page 5

“The knowledge that every time we learn something our brains change and reorganize comes from perhaps the most important research of this decade-research on brain plasticity, also known and neuroplasticity.”-page 5

“Growth Mindset-They believe as they should, that they can learn anything. Others have a damaging “fixed mindset.” They believe their intelligence is more or less fixed, and although they can learn new things, they cannot change their basic intelligence.”-page 9

“We now know that when we praise children for being smart, they at first thing, “Oh good, I am smart,” but then later when they struggle, fail, or mess up in some way, as

everyone does, they think, “Oh I am not so smart”; they end up constantly evaluating themselves against this fixed idea. **It is fine to praise children, but always praise what they did and not them as people.**”- page 10

“Learning Key#1- Every time we learn, our brains form, strengthen, or connect neural pathways. We need to replace the idea that learning ability is fixed, with the recognition that we are all on a growth journey.”-page 13

“Part of the reason so many students are dissuaded from thinking they are capable of learning math is the attitudes of the teachers and professors who teach them.”-page 35

“We all have to develop the brain pathways needed for success, and we all have the potential to learn and achieve at the highest levels.”-page 42

“Importantly, we should communicate to all students that they are on a growth journey, and there is nothing fixed about them, whether it is called a “gift” or a disability. We are not longer in the fixed-brain era; we are in the brain growth era. Brain-growth journeys should be celebrated, and we need to replace the outdated ideas and programs that falsely deem certain people more capable than others, especially when those outdated labels become the source of gender and racial inequalities. **Everybody is on a growth journey.**”-page 43

“We have grown up in a “fixed-brain” world that judges everyone on their “smartness.”-page 45

“The first step in living a limitless, unlocked life is to know brains are constantly reorganizing, growing, and changing. Remembering that every day of our lives, we wake up with a changed brain. In every moment of our lives our brains have opportunities to make connections, to strengthen pathways, and to form new pathways. When we face a challenging situation, rather than turn away because of fear of not being good enough, we should dive in, knowing that the situation presents opportunities for brain growth.”- pages 45-46

“Most of us have grown up with the ideas that mistakes are bad.”-page 47

“Learning Key#2- The times when we are struggling and making mistakes are the best times for brain growth.”-page 47

“When we are willing to face obstacles and make mistakes in the learning process, we enhance neural connections that expedite and improve the learning experience.”- pages 47-48

“Releasing people from the idea that they must always be correct and not make any mistakes turns out to be transformative.....**everytime we make mistakes, synapses fire in the brain, indicating brain growth**...researchers found that when we make mistakes, brains were more active, producing strengthening and growth, than when people got work correct. Neuroscientists now agree that mistakes positively contribute to the strengthening of neural pathways.” -pages 47-49

“Work should be challenging to foster mistakes; the environment must also be encouraging, so that the students do not experience challenge or struggle as a deterrent. Both components need to work together to create an ideal learning experience...people who achieved at very high levels engaged in a particular kind of practice that caused the coating of brain pathways with myelin.”-page 49

“Super-duper pathways occur when people are working at the edge of their understanding, making mistake after mistake in difficult circumstances, correcting mistakes, moving on and making more mistakes-constantly pushing themselves with more material.”-page 50

“Unfortunately, most learners think they should always be getting work correct, and many feel that if they make mistakes or struggle, they are not good learners-when this is the very best thing they can be doing.”-page 52

“The best way to build a highly effective circuit is to “fire it, attend to mistakes, then fire it again.” -page 55

“Mistakes are not only good for learning, but for brain growth and connectivity.”-page 56

“...when students don't want to struggle, it is because they have a fixed mindset; at some point in their lives they have been given the idea that they cannot be successful and that struggle is an indication that they are not doing well.”- page 61

“...struggle is a really important place to be and that student should be celebrated for being in a place of struggle, not saved from it.”-page 66

“Mistakes grow your brain.”-page 68

“Those who fail and continue on undeterred, those who get knocked down and get right back up again, those who get pushback and see it as a positive sign that they are doing something important are the people who are truly limitless. It is easy to feel open and free when things are going well; it is when things are going badly and challenges or aggression stand in our way that it is most important to be limitless.”-pages 72-73

“Learning Key#3-When we change our beliefs, our bodies and our brains physically change as well.”-page 77

“When our mind imagines in a focused way the development of muscles, the muscles actually strengthen through the development of enhanced signaling in the brain.”-page 80

“...found that people with fixed mindsets have a heightened drive for aggressive retaliation during conflicts...feel more shame, view their adversaries as bad people, and express hatred toward them.”-page 81

“...with a growth mindset respond to conflict with less hatred, less shame, and less desire to be aggressive. Their improved response to conflict comes about because they view others as being capable of change.”-page 81

“...growth mindsets are less prejudiced about race.”-page 82

“If you enter a challenging situation believing in yourself, but then mess up, your brain will react more positively than if you go into a situation thinking, “I don’t think I can do this.” If we enter difficult situations with positive beliefs, our brains will become more resilient and adaptive when we make errors than if we are doubting ourselves. This change in belief alters the physical structures of the brain and creates avenues for higher-level thinking and creative problem solving.”-page 84

“We now know that the ideas that some people are “math people” and some are not is a harmful myth.”-page 84

“When students receive the information that the brain is like a muscle that grows with effort and work, their levels of achievement change.”-page 86

“What they do not realize is that brains are growing and changing every day. Every moment is an opportunity for brain growth and development. Some have simply developed stronger pathways on a different timeline. It is critical that students

understand that they too can develop those pathways at any time--they can catch up with other students if they take the right approach to learning.”-page 88

“...that when we have positive self-beliefs about what we can do, our brains and bodies function differently and lead to more positive outcomes.”-page 96

“...teachers and others should praise the learning process and if students are not making progress, help them find other strategies and different approaches. Crucially, praise should be linked to effort that leads to something important.”-page 98

“Learning Key#4-Neural pathways and learning are optimized when considering ideas with a multidimensional approach.”-page 101

“Effort is key for students’ achievement, but it is not the only thing. Students need to try new strategies and seek input from others when they are stuck.”-page 102

“...for students to develop a growth mindset, teachers need to teach with a growth perspective, opening content to the multiple ways students can learn, so that students can see the potential for growth inside it. It is challenging for students to develop a growth mindset when subjects are presented in a fixed way---as a series of questions with one answer and one method to get to it.”- page 102

“...neuroscientists have also found that communication between the different brain areas enhances learning and performance.”- page 103

“We can learn mathematical ideas through numbers, but we can also learn them through words, visuals, models, algorithms, tables and graphs, from moving and touching,; and form other representations. But when we learn by using two or more of these means and the different areas of the brain responsible for each communicate with each other, **the learning experience is maximized. This has not been known until recently and has rarely been made use of in education.**” -page 104

“When we stimulate all of those pathways by looking at knowledge in a multidimensional approach, our brains are strengthened, and learning is maximized.”- page 104

“Neuroscientists know that it is important for young children to develop the finger area of the brain, which comes about when they use their fingers to represent numbers...Finger perception in first grade is a better predictor of mathematics achievement in second grade than tests.”-page 105

“Fluid and flexible brains, neuroscientists conclude, come from the synchrony that occurs when multiple brain areas are working together. Communications between brain areas are working together. Communication between brain areas comes about when we approach knowledge through multiple avenues, encountering ideas in different forms and representations.”-page 111

“...I know that homework has limited, if any, benefits and is often harmful to students' well-being...it continually baffles me why teachers think students should be working on repetitive and boring content in the evenings when they are tired.”- pages 113-114

“One of the saddest, most central characteristics of fixed-brain thinking is the fear of being wrong. People's minds are literally locked, immobilized, by their fear, which is why an approach to life that values multidimensionality, growth and struggle is so liberating.”-page 124

“Multidimensionality is the perfect complement to a growth-mindset approach. Each one works better with the other in place.”- page 125

“When problems are changed to become “low floor and high ceiling”- problems that are accessible by all but lead to more challenging work--everybody can access them and take them to different places.”- page 125

“Learning Key#5-Speed of thinking is not a measure of aptitude. Learning is optimized when we approach ideas, and life, with creativity and flexibility.”- page 134

“We now know that timed math-fact tests given to young children are the beginning of math anxiety for many.”- page 135

“The working memory is sometimes referred to as the “search engine of the mind,” and like all areas of our brains, is developed through practice...When we are stressed or under pressure, our working memory is impeded. The students who are the most compromised are those with the most working memory.”-page 135

“...parent and teacher messages about math can reduce students' achievement.” -page 137

“Some of the strongest mathematical thinkers are very slow with numbers and other aspects of mathematics. They do not think quickly; they think slowly and deeply.” -age 138

“...when people learn something quickly, they are probably strengthening existing neural connections. These are “easy come, easy go” neural connections, which can be rapidly reversed...More permanent brain changes come from the formation of new structures in the brain--sprouting of neural connections and synapses. This is always a slow process.” -page 140

“Research shows that the students who struggle more and learn more slowly are achieving the most in the long term.”- page 141

“When we value memorization over depth of understanding, we harm the deep thinkers who turn away from the subject. We also harm the successful memorizer who would have been helped by an approach to knowledge that gave them access to deep understanding.”-page 143

“...number flexibility is extremely important, but when students are trained to memorize math facts blindly and work with algorithms before they understand them, they automatically resort to memorization and never develop the ability to think of numbers flexibly...they need instead of being drilled, to engage with numbers flexibly and creatively. They need to approach numbers differently.”-page 147

“When we learn new knowledge, it takes up a large space in the brain--it literally occupies more room--as the brain works out what it means and where it connects with other ideas already learned. But as time goes on, the concepts we have learned are compressed into smaller spaces. The ideas are still there so that when we need them, we can quickly and easily “pull” them from our brain and use them; they just take up less space.”-page 148

“Number flexibility is at the heart of number sense...people think that number flexibility is not allowed and that math is all about following rules.”-pages 151-152

“They have been taught that mathematics is a set of rules to follow. The idea is not of answering the question given to you but asking a different one, adapting the question, is completely foreign to them and seems to break the “rules” of math.”-page 154

“...taking a memorization approach to learning does not lead to high achievement, whereas thinking about ideas and relationships does.”-page 161

“When people encounter knowledge differently, doors open for them into a different world. They learn concepts that are compressed in the brain, and they build a solid foundation of understanding. They are able to welcome

mathematical thinking into their tool kit and use it not only in math class, but in all subject areas.”-page 161

“Those who do go on to change the world are creative and flexible thinkers, people who think outside rather than inside the box.”-page 163

“When we combine mathematics with creativity, openness, and out-of-the box thinking, it is wonderfully liberating. This is something everybody deserves to know about and experience, and when they do, they do not look back.”-page 163

“Learning Key#6-Connecting with people and ideas enhances neural pathways and learning.”-page 166

“An important change takes place when students work together and discover that everybody finds some or all of the work difficult.”- page 168

“Connecting with another person’s idea both requires and develops a higher level of understanding. When students work together, they get opportunities to make connections between ideas, which is inherently valuable for them.”-page 169

“When you connect with someone else’s ideas, you enhance your brain, your understanding and your perspective. -page 170

“One of the goals of schools should be to produce citizens who treat each other with respect, who value the contributions of others with whom they interact, irrespective of race, class, or gender, and who act with a sense of justice, considering the needs of others in society.”-pages 186-187

“Just as information about mindsets teaches students to move from fixed to growth thinking, teaching the respect of varying ideas about content leads to a valuing of difference and diversity in other areas. Valuing both growth and difference is a powerful way of opening minds.”-page 188

“Teachers should embrace uncertainty and be open about not knowing something or making a mistake...It is much better to model a mindset of discovery, of finding out, of being curious, and of being happy living in a place of uncertainty-because that allows you to find out something new.”-page 195

“It is very important, perhaps the essence of learning, when we develop the capacity to connect with another person’s ideas, to build them into our thinking, and to take them forward into new areas.”-page 199

“It is my firm belief that all students want to learn, and they only act unmotivated because someone, at some time in their lives, has given them the ideas that they cannot be successful. Once students let go of these damaging ideas and someone opens a learning pathway for them, the lack of motivation goes away.”- page 213

“ A change from believing there are limits to learning, and life to believing that anything can be learned or achieved is a change from a fixed to growth mindset...we change our minds, but also our hearts and spirits as we became more flexible, fluid, and adaptable. If we face roadblocks, we find ways around them, refusing to accept the negative judgements of others.”-page 220.

“Even young children who learn about brain growth and change, mistakes and multidimensionality, often take it upon themselves to share the news with all the people around them.”-page 221

“A change in mindset not only changes the way we think about reality; it changes our reality.”-page 222

“There may be nothing more important for our own or for our learners’ lives than knowing that we can always reach for the stars. Sometimes we won’t succeed, and that is okay, but we will always be helped by setting out on the journey--especially if the perspective we take on that journey truly is limitless.”-page 223