



Setting up Positive Norms in Math Class

By Jo Boaler

Here are 7 of my favorite messages to give to students in math class, and some suggestions from youcubed as to how to encourage them:

Everyone
can learn math
to the
highest levels

Mistakes are
valuable

Questions are
really
important

Math is about
creativity and
making sense

Math is about
connections and
communicating

Math class is
about learning
not performing

Depth is more
important than
speed

1. Everyone can learn math to the highest levels

Encourage students to believe in themselves. There are different parts to this – first we need students to know that they can achieve at any math level, and there is no such thing as a math person. Brain information is really good for this.

Second we need them to have a “growth mindset” – believing that they can learn anything, and the more work they do the smarter they will get.

An important way to encourage a growth mindset is by praising what students have done and learned, not them as a person. So instead of saying “you are so smart”, say “it is great that you have learned that.

Some videos you might want to share with students to encourage positive brain messages and a growth mindset:

youcubed.org/teachers/from-stanford-online-how-to-learn-math-for-teachers-and-parents-brain-science

<http://youcubed.org/students/boosting-messages>



What is a growth mindset?

There is a really damaging myth that pervades the US/ UK and other countries – the idea that some people are born with a “math brain” and some are not. This has been resoundingly disproved by research but many students and parents believe this. It is really important to communicate “growth mindset” messages to students. Help them know that everyone is a math person and that the latest research is telling us that students can reach any levels in math because of the incredible plasticity of the brain.

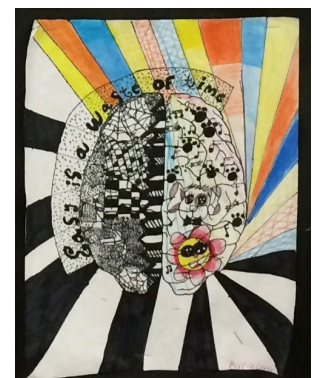
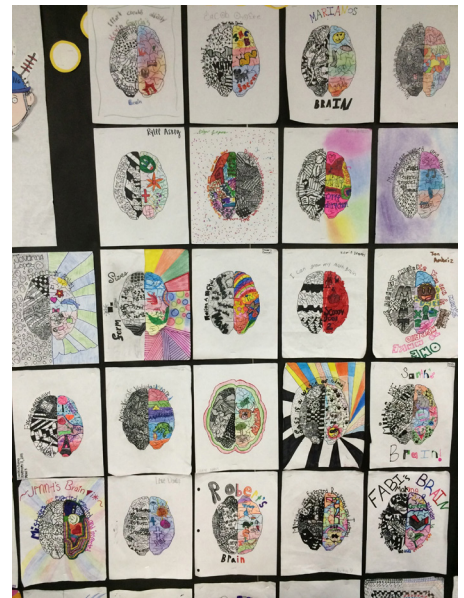
2. Mistakes are valuable

Tell students that you love mistakes and that they will be valued at all times, tell them that it is good to make mistakes as we know that when people make mistakes, their brains are growing. This single message can be incredibly liberating for students. Here are some suggestions for encouraging positive thinking about mistakes:

1. Ask students with mistakes to present mistakes (especially deep, conceptual ones) on the board so that everyone can learn from them. If one student makes a conceptual mistake, there are probably many others making the same one.
2. When students get something wrong – instead of being discouraging or sympathetic, say “your brain just grew! Synapses are firing, that’s really good”
3. Ask students to read positive brain/mistake messages and choose their favorites that they will take on for the year. Eg “easy is a waste of time” “working hard grows your brain” “it is really important to make mistakes”. Ask them to draw brains with the messages on them that you can display on your walls, see right.
4. Crumpled Paper: Ask students to crumple a piece of paper and throw it at the board with the feeling they have when making a mistake. Then get them to retrieve the paper and color in all the lines, these represent synapses firing and brain growth from making a mistake. Ask them to keep the piece of paper in their math folders/notebooks to remind them of this.

Research shows that when students make mistakes, synapses fire and brains grow. Brain activity is particularly strong in individuals with a growth mindset. It is good to make mistakes.

Activity 3 from Kim Hollowell at Vista Unified.



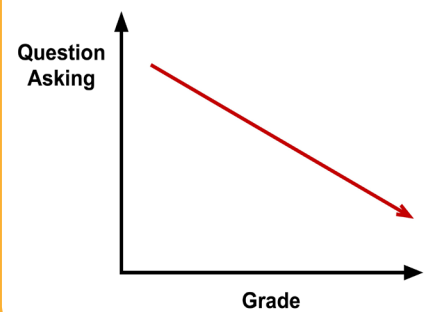
3. Questions are really important

Tell your students that you love questions about math and that they are really important. Research shows us that question asking is linked to high achievement – yet as students move through school they ask fewer and fewer questions, for fear of being thought clueless. You don't need to be able to answer every question that students may come up with, sometimes it is good to say that you don't know but you will find out, or ask other students if someone would like to answer the question.

Some suggestions for encouraging questions:

1. When good questions are asked, write them in large colored letters onto posters that you post around the room, to celebrate them. Show questions from a range of students.
2. Tell students they have 2 responsibilities in your classroom. One is to always ask a question if they have one, and the other it to always answer a question from classmates if asked.
3. Encourage students to ask questions – from you, other students and themselves, such as: why does that work? why does that make sense? Can I draw that? How does that method connect to another?
4. Encourage students to ask their own math questions. Instead of asking questions for them, give them interesting mathematical situations and see what questions arise for them.

In studies, student question asking has been shown to steadily decline as students go through the grades in the US, showing this relationship:



4. Math is about creativity and making sense

The key to understanding math is making sense of it. Many students believe that math is a set of formulas that have to be remembered - this belief is associated with low achievement. Math is a very creative subject that is, at its core, about visualizing patterns and creating solution paths that others can see, discuss and critique.

Some methods for encouraging sense making and creative math:

1. Always ask students - why does that make sense? Ask this whether their answers are correct or incorrect.

2. Encourage visual mathematics. Ask students to draw their solutions. Ask them to think about how they see math. In this video (<http://youtu.be/1EqrX-gsSQg>) Cathy Humphreys asks students to make sense of 1 divided by $\frac{2}{3}$ by drawing their solutions.

3. Show mathematical ideas through visual representations. All mathematics can be represented visually, and visual representations give many more students access to understanding. We have many examples of visual mathematics on youcubed and in the classroom video above.

4. Use number talks that value students' different ways of seeing math and solving problems. This video teaching number talks also shows visual solutions. <https://www.youcubed.org/from-stanford-onlines-how-to-learn-math-for-teachers-and-parents-number-talks-2/>

5. When students finish questions, ask them to think of new, harder questions. These could be questions to give to other students. This is a really good strategy for differentiation.

PISA data from 13 million 15- year olds worldwide shows that the lowest achieving students in the world are those who believe that mathematical success comes from memorization. The USA and UK are countries where the highest numbers of students believe this.

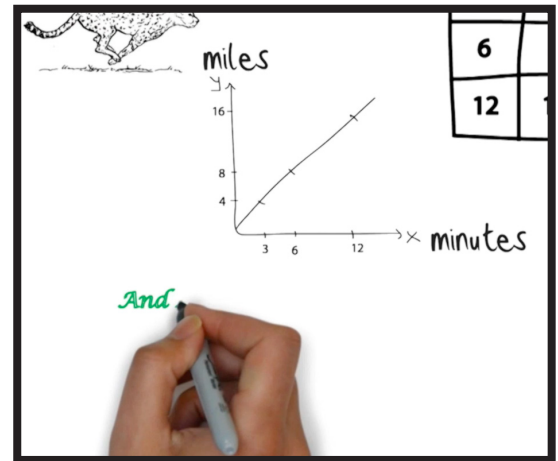


5. Math is about connections and communicating.

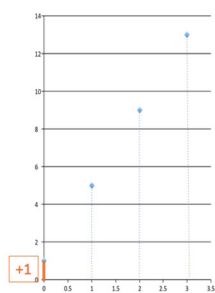
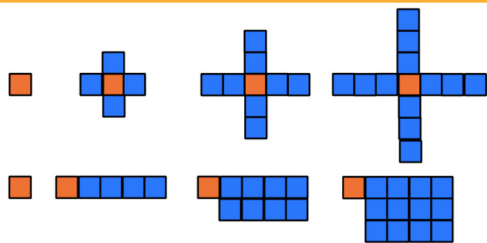
Math is a connected subject, but students often think it is a set of disconnected methods. We made a video to show some connections and students loved it.

<https://www.youcubed.org/tour-of-mathematical-connections/>

Mathematics is a form of communication, some people think of it as a language. Some strategies for encouraging connecting and communicating are:



1. Show the connections video.
2. Encourage students to represent their math results in different forms eg words, a picture, a graph, an equation, and to link between them, see below.
3. Encourage color coding, ask students to show with color where a mathematical idea is, see below.



x	y
0	$4(0)+1=1$
1	$4(1)+1=5$
2	$4(2)+1=9$
3	$4(3)+1=13$
n	$4n+1$

$$y = 4x + 1$$

- There is **one square** at stage 1
- For each additional stage a **square** is added adjacent to the original on all four sides
- The figure continues to grow to the left, right, up and down, adding **four squares** for each new stage

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

6. Value depth over speed.

Many people incorrectly believe that being good at math means being fast at math. It doesn't and we need to dissociate math from speed. When we value fast computation (as many classrooms do) we encourage a subset of learners who compute quickly and discourage many others, including deep slow thinkers who are very important to math (see sidebar).

We no longer need students to compute fast (we have computers for this) we need them to think deeply, connect methods, reason, and justify.

1. Tell students you don't value fast work. Mathematical thinking is about depth not speed.
2. Don't let mathematical discussions be driven by the fastest students.
3. When asking for hands up, don't always take answers from the fastest students.
4. Don't use flash cards, speed competitions, timed tests, instead value depth, creativity, different ways of thinking about math, and different explanations. A paper showing the research suggesting timed tests cause math anxiety is here:

<http://www.youcubed.org/wp-content/uploads/nctm-timed-tests.pdf>

news* & views*

Research suggests that timed tests cause math anxiety*

JO JOHNSON, PROFESSOR OF MATHEMATICS EDUCATION, STANFORD UNIVERSITY

Teachers in the United States are often faced with the choice of whether to emphasize speed or depth in their mathematics instruction. In a new study, researchers found that a focus on speed in mathematics instruction is associated with increased math anxiety in students. The study, published in the journal *Journal of Educational Psychology*, found that students who were taught to focus on speed in mathematics were more likely to experience math anxiety than those who were taught to focus on depth. The researchers also found that students who were taught to focus on speed were more likely to believe that math ability is a fixed trait, rather than a skill that can be developed through practice. These findings suggest that emphasizing speed in mathematics instruction may be contributing to the rise in math anxiety among students. The researchers recommend that educators focus on teaching students to think deeply and to view math as a skill that can be developed through practice, rather than a fixed trait. This approach may help to reduce math anxiety and improve student outcomes.



"I was always deeply uncertain about my own intellectual capacity; I thought I was unintelligent. And it is true that I was, and still am, rather slow. I need time to seize things because I always need to understand them fully. Towards the end of the eleventh grade, I secretly thought of myself as stupid. I worried about this for a long time.

I'm still just as slow. (...)At the end of the eleventh grade, I took the measure of the situation, and came to the conclusion that rapidity doesn't have a precise relation to intelligence. What is important is to deeply understand things and their relations to each other. This is where intelligence lies. The fact of being quick or slow isn't really relevant."

- Laurent Schwartz, Winner of the Fields Medal (A Mathematician Grappling with His Century, 2001)



7. Math class is about learning, not performing.

Many students think that their role in math class is not to learn but to get questions right – to perform. It is important for them to know that math is about learning, and to know that math is a growth subject, it takes time to learn and it is all about effort. Some strategies for making math a learning, not a performing subject:

1. Grade and test less. Math is the most over-graded, over-tested subject in the curriculum. Neither grades nor tests have been shown to increase learning, from research, and both make students feel they are performing and not learning. Grades often make students think they are a reflection not of what they have learned but who they are. There is a video reflecting this at <http://youtu.be/eoVLBExuqB0>
2. Instead, give diagnostic comments. These take longer but are extremely valuable and can be done less often.
3. Use “assessment for learning” strategies (see sidebar).
4. If you have to grade, then give grades for learning, not for performing e.g. for asking questions, representing ideas in different ways, explaining work to others, making connections. Assess the breadth of math, not just a small part of math – procedure execution.
5. You may have to give grades to your administration but that doesn't mean you have to give them to the students. Grades communicate fixed messages about learning and are often counter-productive for students.

Assessment for learning (A4L) teaching strategies have been shown to drastically increase student achievement, if they are used instead of summative tests and grades. It has been estimated that if teachers in England used A4L strategies the achievement of their students would increase so much the country would move, in international comparisons, from the middle of the pack to the top 5 (Black and Wiliam, 1998).

At <https://www.youcubed.org/category/assessment-and-grading/> we are sharing our favorite A4L strategies.





Positive Norms to Encourage in Math Class

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1. Everyone Can Learn Math to the Highest Levels.

Encourage students to believe in themselves. There is no such thing as a “math” person. Everyone can reach the highest levels they want to, with hard work.

2. Mistakes are Valuable

Mistakes grow your brain! It is good to struggle and make mistakes.

3. Questions are Really Important

Always ask questions, always answer questions. Ask yourself: why does that make sense?

4. Math is about Creativity and Making Sense

Math is a very creative subject that is, at its core, about visualizing patterns and creating solution paths that others can see, discuss and critique.

5. Math is about Connections and Communicating

Math is a connected subject, and a form of communication. Represent math in different forms eg words, a picture, a graph, an equation, and link them. Color code!

6. Depth is much more important than Speed

Top mathematicians, such as Laurent Schwartz, think slowly and deeply.

7. Math Class is about Learning not Performing

Math is a growth subject, it takes time to learn and it is all about effort.

