LIMITLESS MIND

LEARN, LEAD, AND LIVE WITHOUT BARRIERS

JO BOALER

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Designed by Terry McGrath

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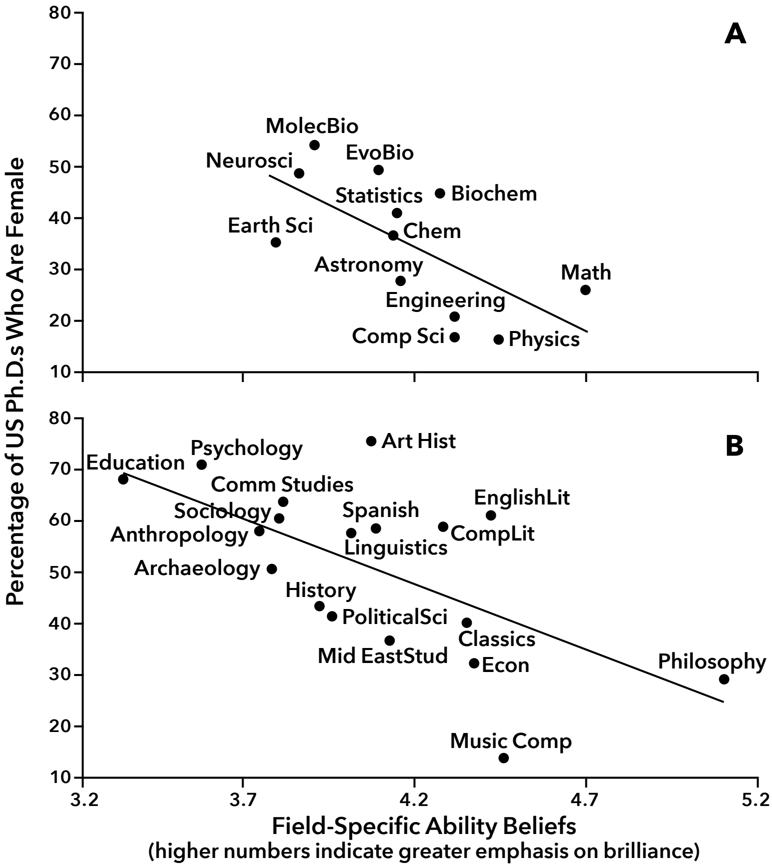
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B
MolecBio
Neurosci
EvoBio
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Biochem
Earth Sci
Chem
Astronomy
Math
Engineering
Comp Sci
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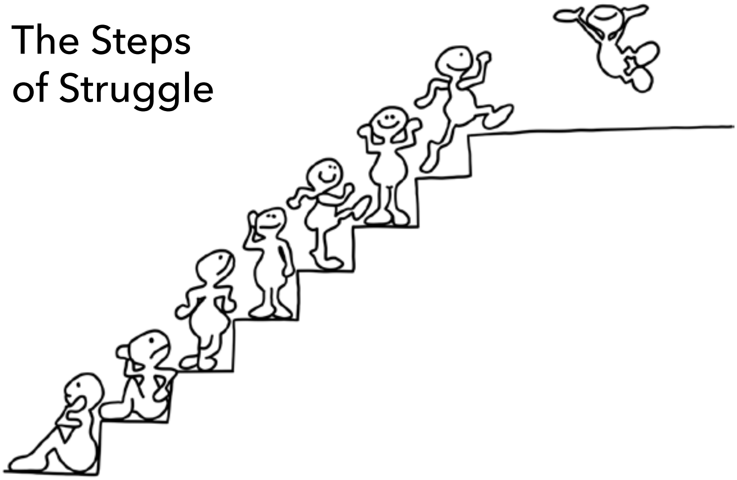
Comm Studies
Sociology
Spanish
EnglishLit
Anthropology
CompLit
Linguistics
Archaeology
History
PoliticalSci
Classics
Mid EastStud
Econ
Philosophy
Music Comp
Percentage of US Ph.D.s Who Are Female
Field-Specific Ability Beliefs
(higher numbers indicate greater emphasis on brilliance)
80
70
60
50
40
30
20
10
3.2
3.7
4.2
4.7
5.2


Gisele
Mrs. sanders
Thank You!
JO BOALER
MATHEMATICAL MINDSETS

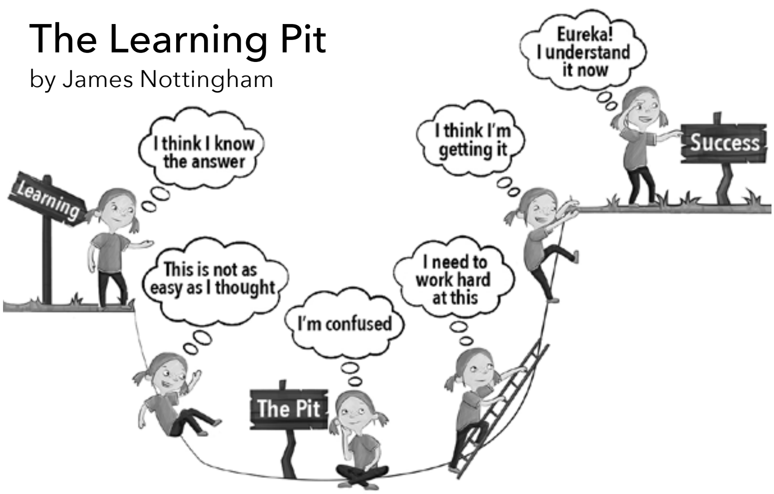
The Steps of Struggle

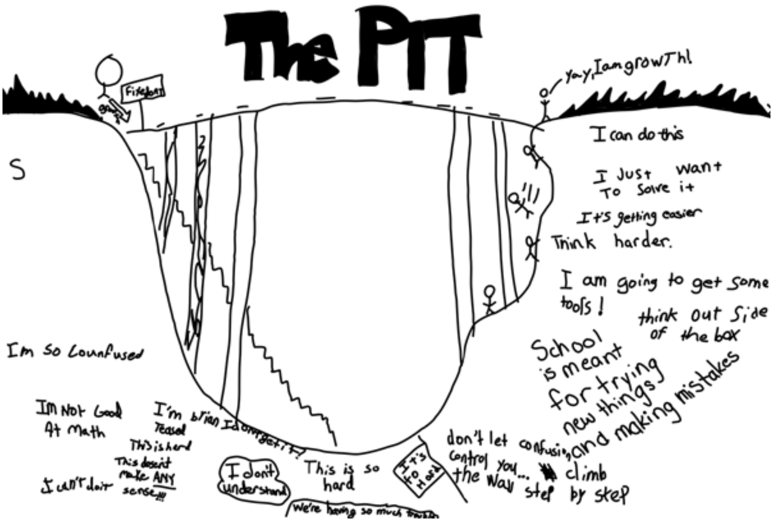


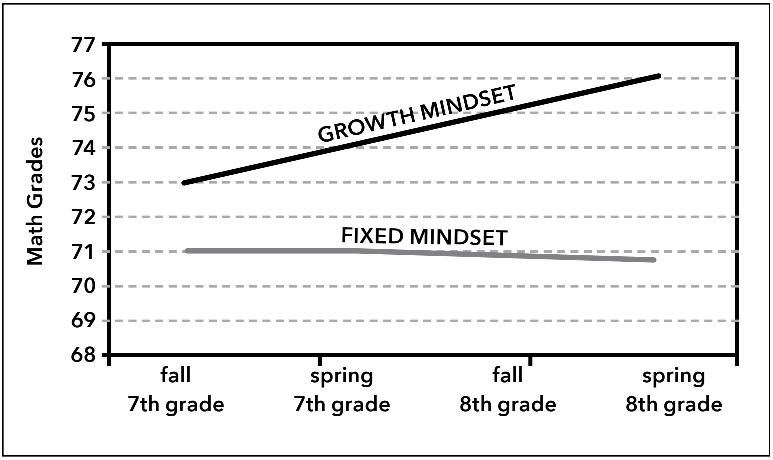
Which step have you reached today?

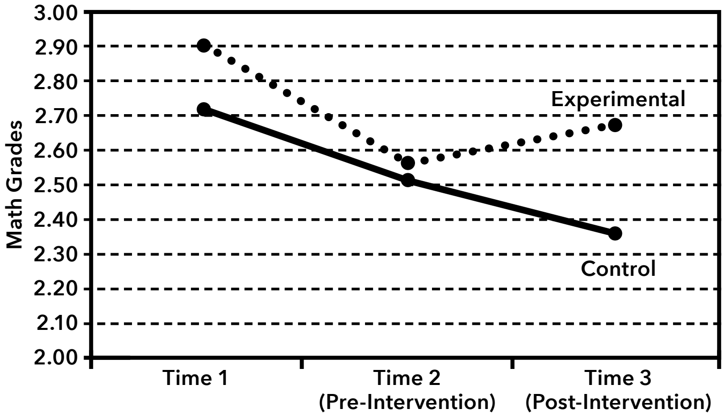
The Learning Pit

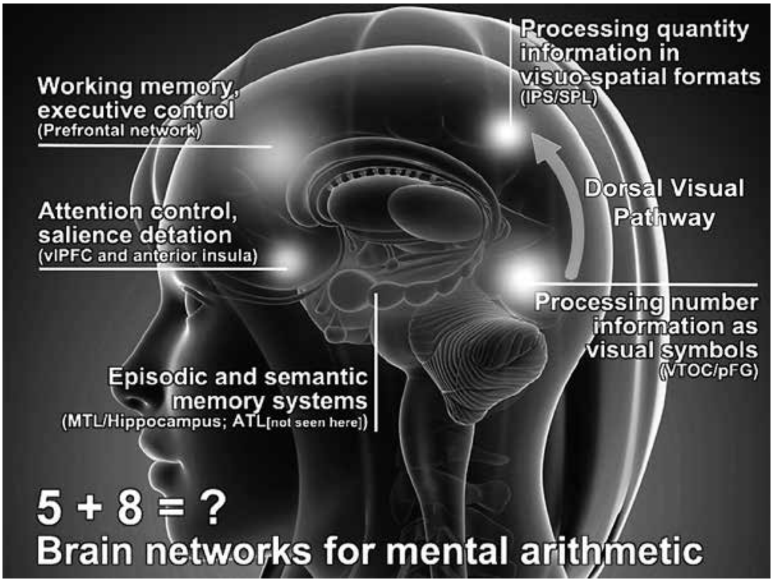
by James Nottingham



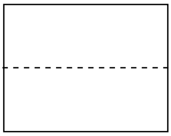
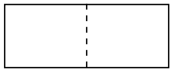
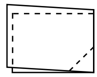
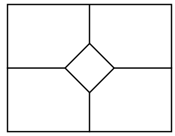

The PIT
Yay, I am growTh!
Fixed
S
I can do this
I Just want To Solve it
It's getting easier
Think harder.
I am going to get some tools!
think out Side of the box
School is meant for trying new things and making mistakes
I'm so Counfused
IM Not Good At Math
I'm brian I dont get it!
Teased
This is hard
This doesn't make ANY sense!!!
I can't do it
I don't understand
This is so hard
We're having so much trouble
It's to Hard
don't let confusion control you... climb the way step by step


77
76
75
74
73
72
71
70
69
68
Math Grades
GROWTH MINDSET
FIXED MINDSET
fall
7th grade
spring
7th grade
fall
8th grade
spring
8th grade


3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
Math Grades
Experimental
Control
Time 1
Time 2
(Pre-Intervention)
Time 3
(Post-Intervention)


Processing quantity information in visuo-spatial formats (IPS/SPL)
Working memory, executive control (Prefrontal network)
Dorsal Visual Pathway
Attention control, salience detation (vlPFC and anterior insula)
Processing number information as visual symbols (VTOC/pFG)
Episodic and semantic memory systems (MTL/Hippocampus; ATL[not seen here])
5 + 8 = ?
Brain networks for mental arithmetic

LANG CHEN

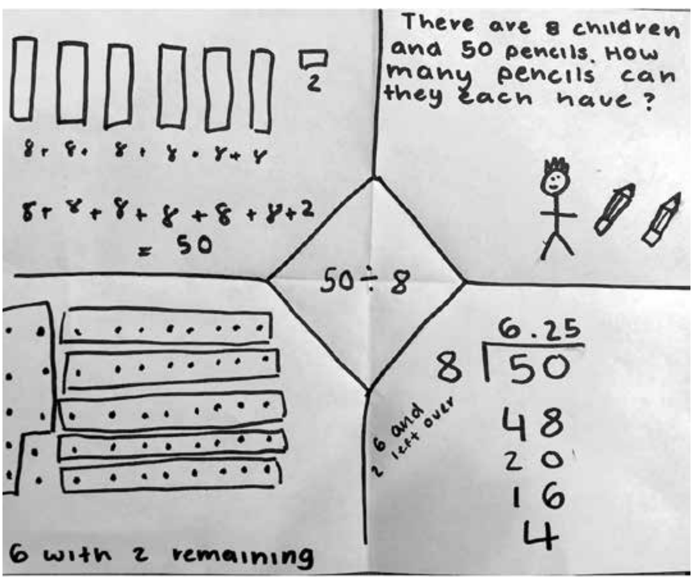
First fold the paper in half	Then in half again	Then fold a triangle	Then open the paper
			

From this:

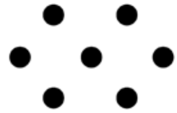
Division 6–12 Name:

9)81	11)121	7)21	10)10	10)10
10)50	7)49	10)50	9)27	8)64
10)90	9)63	8)96	7)77	10)90
12)36	11)11	11)11	12)132	6)30
6)54	11)55	12)84	11)55	9)45

To this:



These are the seven dots:



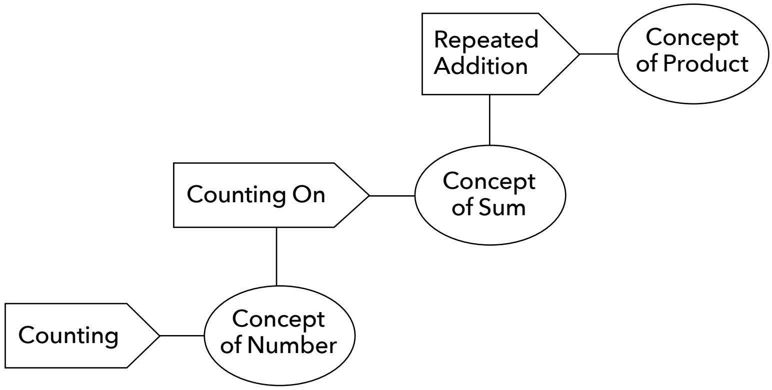
These were their twenty-four ways of seeing the dots:

Multiplying by 12

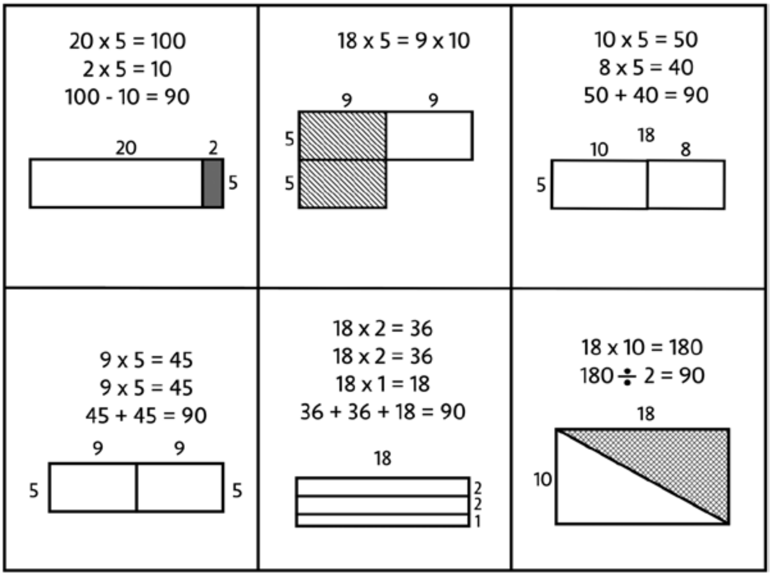
NAME ______________________

2 x 12	12 x 12	6 x 12	7 x 12	6 x 12	12 x 12	4 x 12	8 x 12	2 x 12	5 x 12	12 x 12	4 x 12
9 x 12	4 x 12	12 x 12	2 x 12	3 x 12	3 x 12	6 x 12	4 x 12	11 x 12	6 x 12	7 x 12	2 x 12
1 x 12	8 x 12	5 x 12	12 x 12	9 x 12	7 x 12	11 x 12	6 x 12	2 x 12	2 x 12	7 x 12	12 x 12
7 x 12	5 x 12	1 x 12	12 x 12	8 x 12	6 x 12	8 x 12	3 x 12	0 x 12	6 x 12	4 x 12	2 x 12
5 x 12	12 x 12	4 x 12	2 x 12	6 x 12	11 x 12	4 x 12	9 x 12	3 x 12	8 x 12	3 x 12	2 x 12
6 x 12	4 x 12	12 x 12	12 x 12	12 x 12	0 x 12	9 x 12	4 x 12	8 x 12	5 x 12	2 x 12	7 x 12
5 x 12	1 x 12	8 x 12	12 x 12	7 x 12	4 x 12	12 x 12	5 x 12	9 x 12	1 x 12	3 x 12	7 x 12
8 x 12	9 x 12	5 x 12	5 x 12	6 x 12	11 x 12	7 x 12	3 x 12	6 x 12	5 x 12	8 x 12	5 x 12

Goal ____________________ **Number Correct** ______________

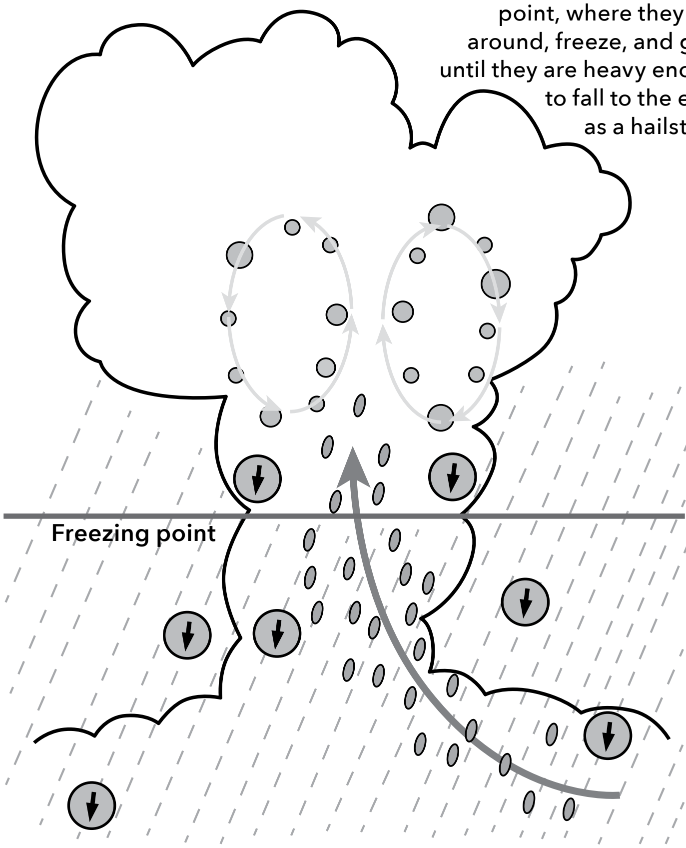

Repeated
Addition
Concept
of Product
Counting On
Concept
of Sum
Counting
Concept
of Number

Here are six different ways of calculating 18 × 5 (there are more) with their visual representations.



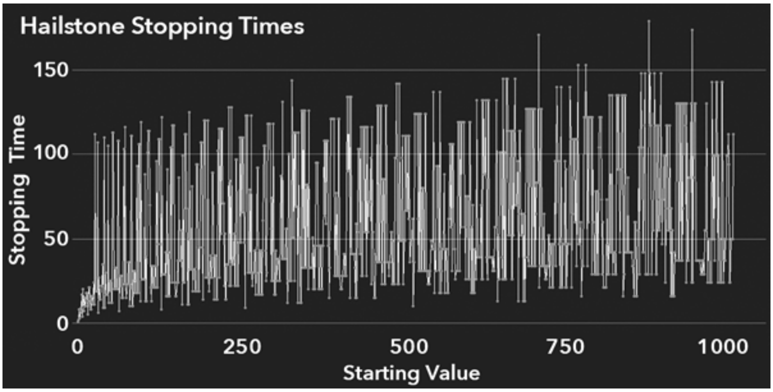
How Hailstones Are Formed

Raindrops are pushed by wind above the freezing point, where they spin around, freeze, and grow until they are heavy enough to fall to the earth as a hailstone.



KEELY HULME AND BETSY DENNY

Visual Representations of Number Patterns



JORDAN BENEDICT

Students Plot the Stopping Times of Each Number

RESOURCES
to Help Change Mindsets and Approaches

Four Boosting Messages for Students:

https://www.youcubed.org/resources/four-boosting-messages-jo-students/

Free Online Class, in English and Spanish, to Improve Students' Mindset and Approach to Mathematics:

https://www.youcubed.org/online-student-course/

A Range of Mindset Videos for Students:

https://www.youcubed.org/resource/mindset-boosting-videos/

Rethinking Giftedness Film:

https://www.youcubed.org/rethinking-giftedness-film/

Different Experiences with Maths Facts Film:

https://www.youcubed.org/resources/different-experiences-with-math-facts/

Visual Creative Maths Tasks:

https://www.youcubed.org/tasks/

Free Downloadable Posters:

https://www.youcubed.org/resource/posters/

Two Online Courses for Mathematics Teachers and Parents:

https://www.youcubed.org/online-teacher-courses/

K–8 Book Series:

https://www.youcubed.org/resource/k-8-curriculum/

A Range of Short, Readable News Articles on the Book's Ideas:

https://www.youcubed.org/resource/in-the-news/

APPENDIX I

Examples of Numerical and Visual Approaches to Math Problems

Here are two standard math questions with visual solutions. These are the types of questions that may have produced anxiety and math hatred in school, with good reason. I have written at length about the damage of fake word problems and contexts that students are meant to partly believe, while ignoring everything they know about the real situation. But please have a look at the different ways of solving them, as an illustration of what is possible when we think visually.

This problem is adapted from one used by a wonderful mathematics educator, Ruth Parker. She poses this question:

> *A man wants to buy ¼ of a pound of turkey. He goes into a shop that gives him 3 slices that weigh ⅓ of a pound. What proportion of the 3 slices does he need?*

A numerical approach:

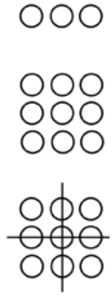
3 slices = ⅓ pound

x slices = ¼ pound

$\frac{1}{3}x = \frac{3}{4}$

$x = \frac{9}{4}$

A visual approach:



= ⅓ pound

= ⅓ pound

= ¼ pound
(or 2 ¼ slices)

The second is one of those awful, unrealistic word problems that fill mathematics textbooks:

> *Jo and Tesha each have a number of cards in the ratio 2:3. Tesha and Holly have a number of cards in the ratio 2:1. If Tesha has 4 more cards than Jo, how many cards does Holly have? Give an answer and briefly explain your reasoning.*

A numerical approach:

Jo and Tesha 2:3

Tesha and Holly 2:1

Jo and Tesha's cards are divided into 5, with a 2:3 ratio.

Tesha has $\frac{1}{5}$ more than Jo. Tesha has 4 more cards.

$\frac{1}{5} = 4$

$1 = 20$

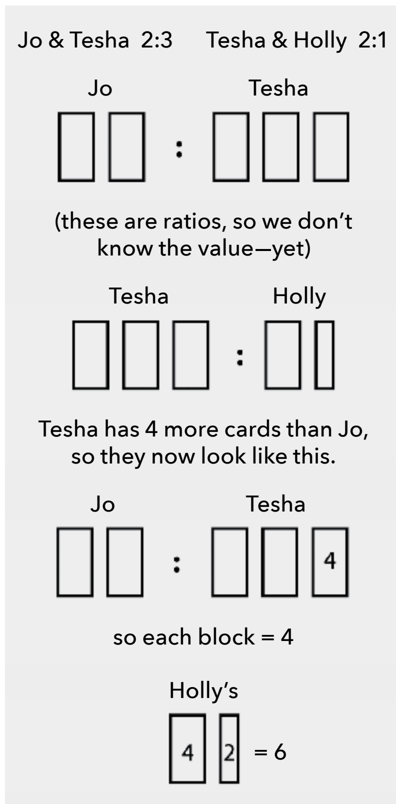
So together they have 20 cards.

Jo has $\frac{2}{5} \times 20$ and Tesha has $\frac{3}{5} \times 20$.

Jo has 8 and Tesha has 12.

Tesha and Holly are 2:1, so Holly has 6 cards.

A visual approach:



APPENDIX II

A Sample Rubric

Here is a rubric from Mark Cassar's school. In this rubric the teacher decides whether a student has met the area of learning described in the "criteria" and includes feedback for the student on ways to improve. In this case the rubric also reflects a conversation the teacher had with the student to clarify understanding.

Toothpicks Problem (Patterning)
Assessment For/As Learning

Criteria	1	2	3	4	Feedback
Create, identify, extend patterns		✓			"How could you find out the number of toothpicks for the 6th term?"
Make a table of values for a pattern	✓				A table of values (t-chart) will help you determine the pattern rule
Communicate math thinking in writing and pictures (communication and representation) & oral			✓		Conversation with student "tell me about" 22 6

1 = expectation not met; **2** = approaching expectation;
3 = meets expectation; **4** = exceeds expectation

* I had a conference with the student; her changes are noted on #2b.

"I am adding together to find the total amount."