
# FOSTERING GROWTH MIND-SET THROUGH PRODUCTIVE STRUGGLE IN CONCEPTUAL UNDERSTANDING

www.reneeyates2math.com

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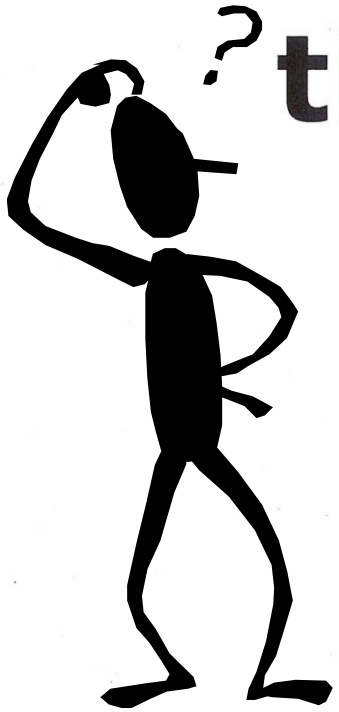
# Productive Struggle

"I have not failed. I've just found 10,000 ways that won't work."

Thomas A. Edison



# A Snail in the Well

**A snail is at the bottom of a well that is 10 feet deep. Each day he crawls up 3 feet and each night he slides back 2 feet. How many days will it take him to reach the top of the well? Show your work to defend your answer.**

# Why have students solve problems?

- What would students need to know to get started on this problem?
  - Background knowledge, choose carefully based on where my students are…ZONE a little above
- Is there more than one way to approach the problem?
  - Make sure the task is OPEN and has multiple possible solution strategies…
- How do I introduce the problem?
  - Frame the task, relating to what we are learning…
- What should I do after introducing the problem?
  - Stay quiet as much as possible, answer questions with questions only to move the learning forward…

# Collaborative work

(1) Share your method with your partner(s) and your ideas for improving your individual solution.

(2) Together in your group, agree on the best method for completing the problem.

(3) Produce a poster, showing a joint solution to the problem.

(4) Make sure that everyone in the group can explain the reasons for your chosen method, and describe any assumptions you have made.

(5) Check your work.

**This problem solving Formative Assessment Lesson is designed to be part of an instructional unit. The results of this task should be used to inform the instruction that will take place for the remainder of the unit.**

## Mathematical goals

This problem solving lesson is intended to help you assess how well students are able to use addition and subtraction in a problem solving situation. In particular, this lesson aims to identify and help students who have difficulties with:

- Choosing an appropriate, systematic way to collect and organize data.
- Examining the data and looking for patterns
- Describing and explaining findings clearly and effectively.

## Common Core State Standards

This lesson involves a range of *mathematical practices* from the standards, with emphasis on:

**1. Make sense of problems and persevere in solving them.**

**4. Model with mathematics.**

**8. Look for and make use of repeated reasoning.**

This lesson asks students to select and apply mathematical content from across the grades, including the *content standards*:

**Operations and Algebraic Thinking**

**1-OA: Represent and solve problems involving addition and subtraction.**

**2-OA: Represent and solve problems involving addition and subtraction.**

**3-OA: Solve problems involving the four operations, and identify and explain patterns in arithmetic.**

**4-OA: Use the four operations with whole numbers to solve problems.**

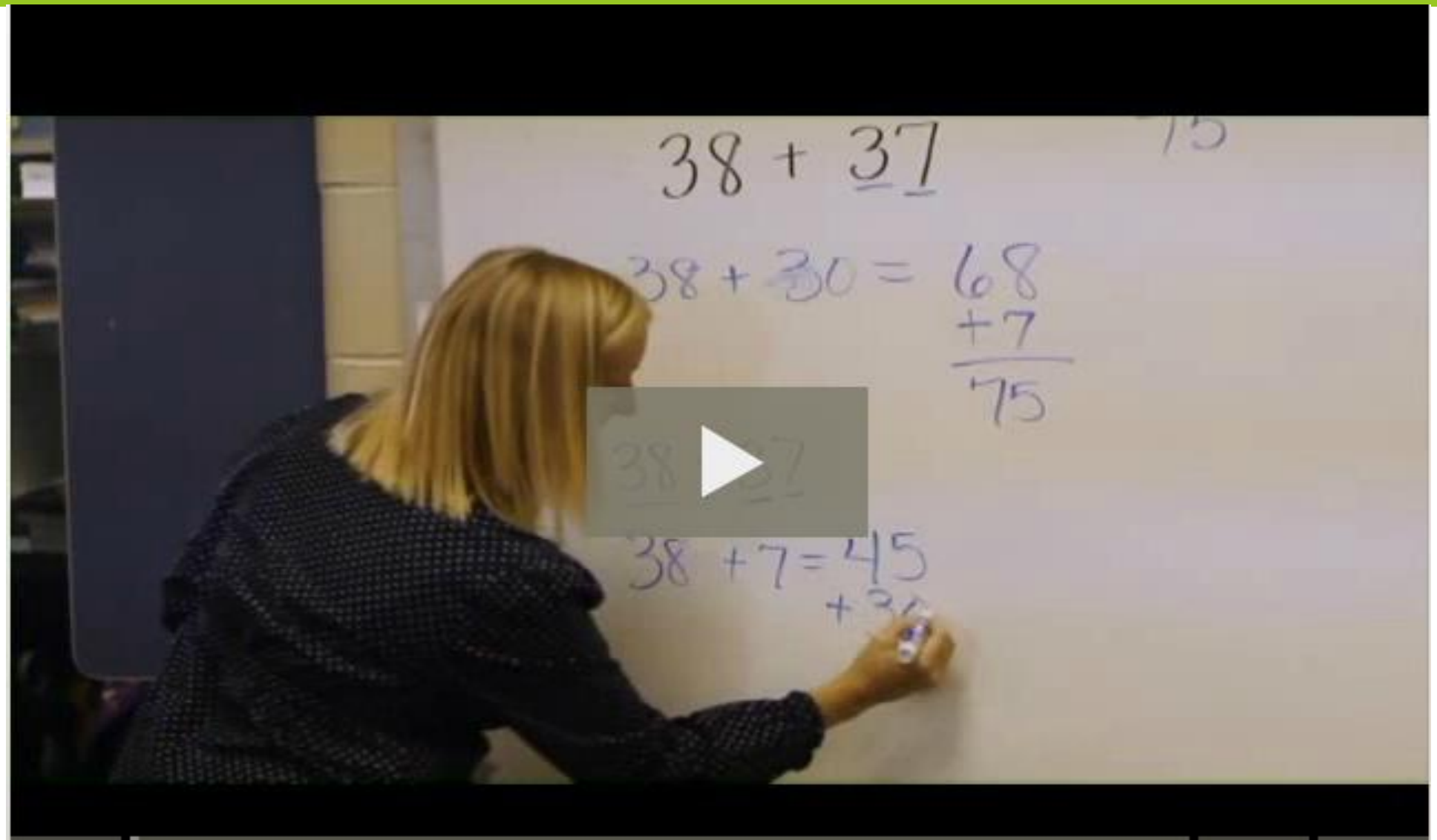
## Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

**Common Issues – Suggested questions and prompts:**

| Common Issues | Suggested questions and prompts |
|---|---|
| **Student forgets to consider what the snail does each day and each night.** | • *How could you make this task easier?*<br>• *What sort of picture could you draw that might be helpful?*<br>• *How can you show the path the snail follows until he gets out of the well?* |
| **Student work is unsystematic.** | • *What pattern do you notice?*<br>• *What is the same and what is different about how the snail moves during the day and at night?*<br>• *How can you organize your work?* |
| **Student assumes that the initial pattern continues indefinitely and over-generalizes.** | • *What do you think about how far the snail travels each day?*<br>• *Does the snail always fall back?* |
| **Student writes answer without explanation.** | • *How could you explain/show how you got your answer so that someone in another class understands?*<br>• *How can you use numbers, words, or pictures to describe the path of the snail?* |
| **Student correctly identifies when the snail gets out of the well.** | • *Think of another way of solving the problem. Is this method better or worse than your original one? Explain your answer.*<br>• *Can you make a new problem with a different size well and/or a snail that travels different amounts each day and night?* |

# Number Talk in Action:  Grade 3



# Sample Responses to Discuss

Here is some work on *A Snail in the Well* from students in another class.

For each piece of work:

1. Write the name of the student whose solution you are analyzing.
2. Describe the problem solving approach the student used.

   For example, you might:

   - Describe the way the student has organized the data.
   - Describe what the student did to calculate the day the snail reaches the top of the well.

3. Explain what the student needs to do to complete or correct his or her solution.

_____'s Solution

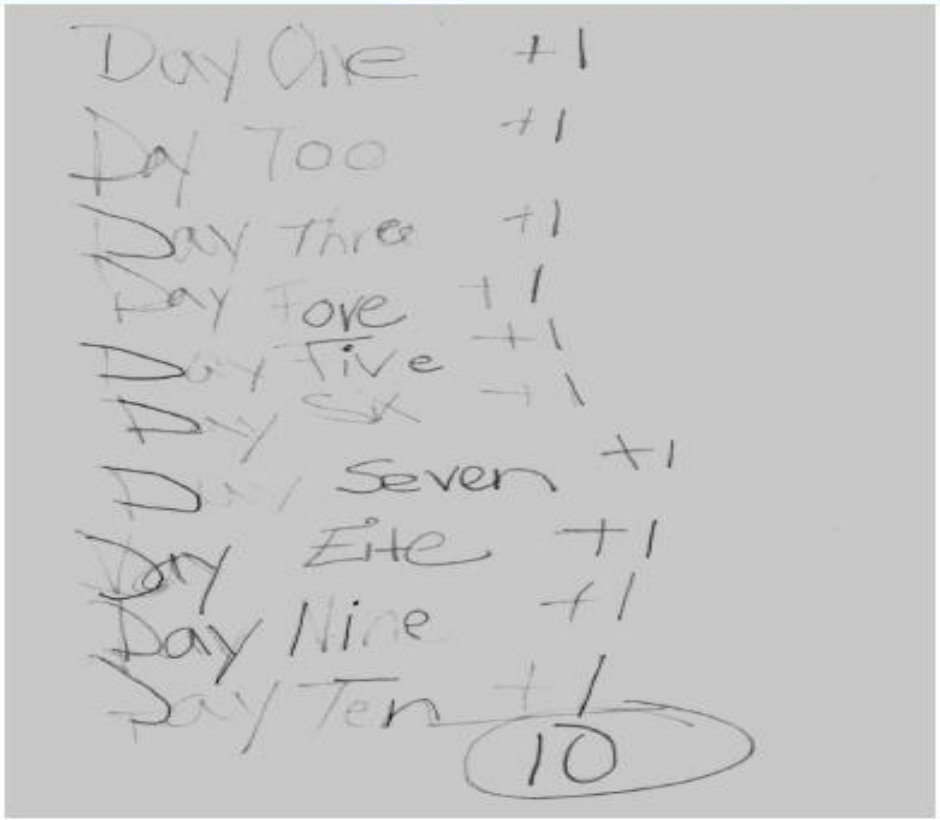
_____

_____

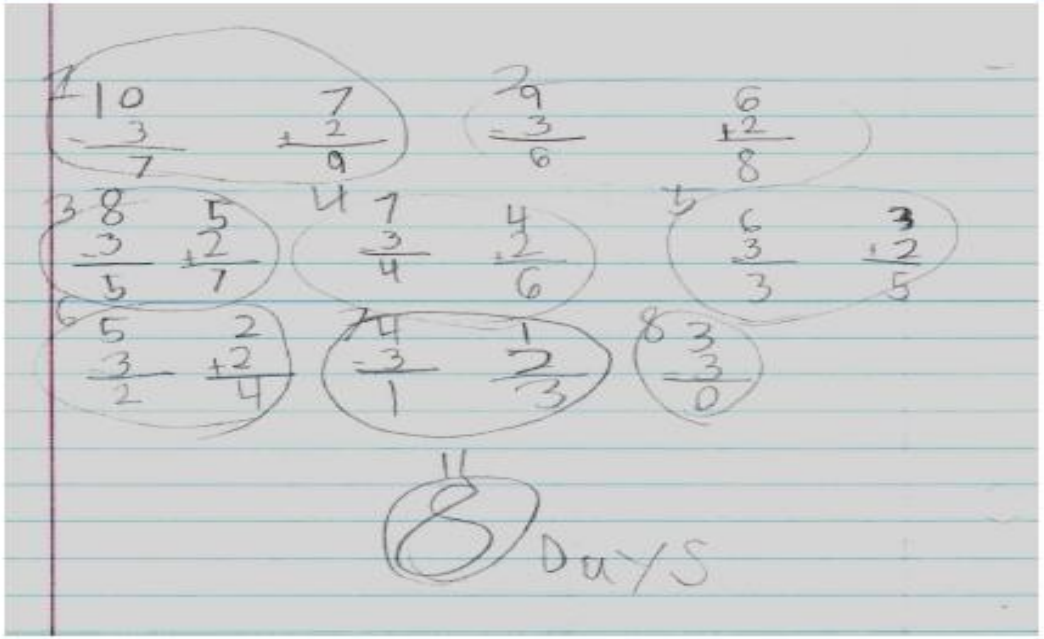
## Will's Solution

Snail = 1 ft. a day, I know this because 3 ft. - 2 ft. = 1 ft.
If it takes 10 ft. to climb to climb
out of the well, then it takes
10 days.

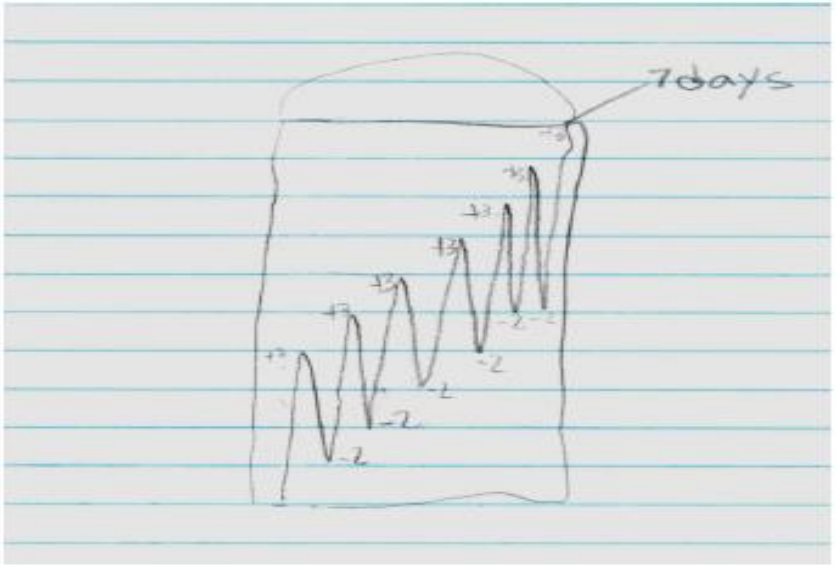
## Whitney's Solution



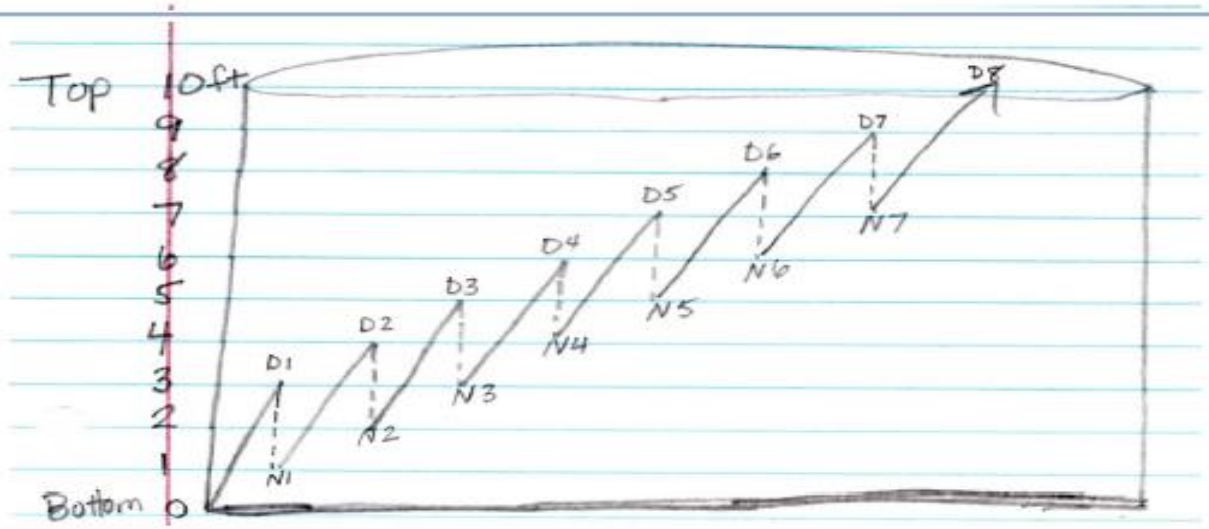
## Chuck's Solution




## Tim's Solution



## Denise's Solution



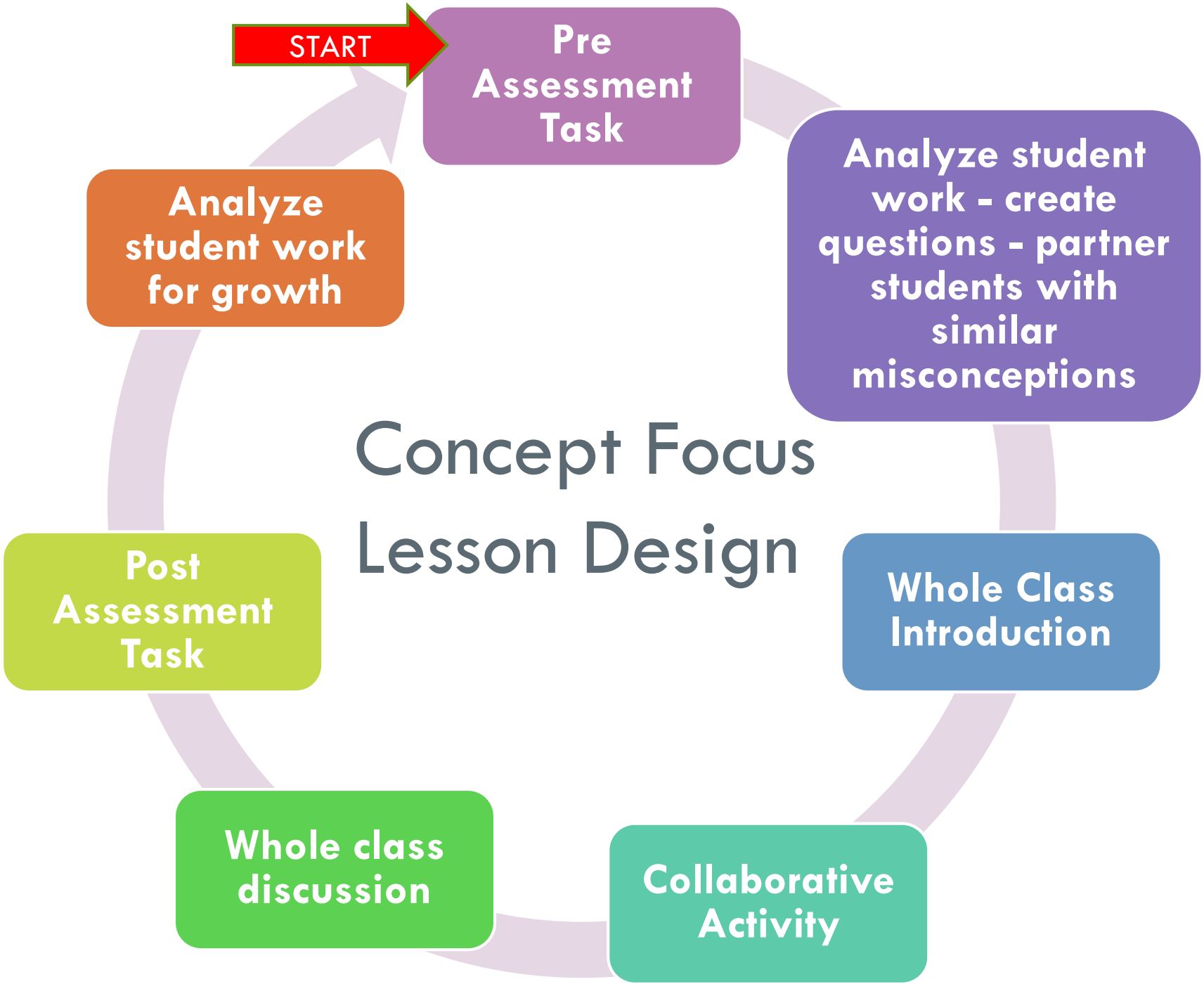

## Bill's Solution

"well 10' deep
up - 3, night down 2 foot

| day | d | N | Total |
|---|---|---|---|
| 1 | 7 | 9 | 9 |
| 2 | 6 | 8 | 8 |
| 3 | 5 | 7 | 7 |
| 4 | 4 | 6 | 6 |
| 5 | 3 | 5 | 5 |
| 6 | 2 | 4 | 4 |
| 7 | 1 | 3 | 3 |
| 8 | 0 | | |
| 9 | | | |

- Let's Try….Concept Focused Formative Assessment Lesson

# Concept Focus Lesson Design

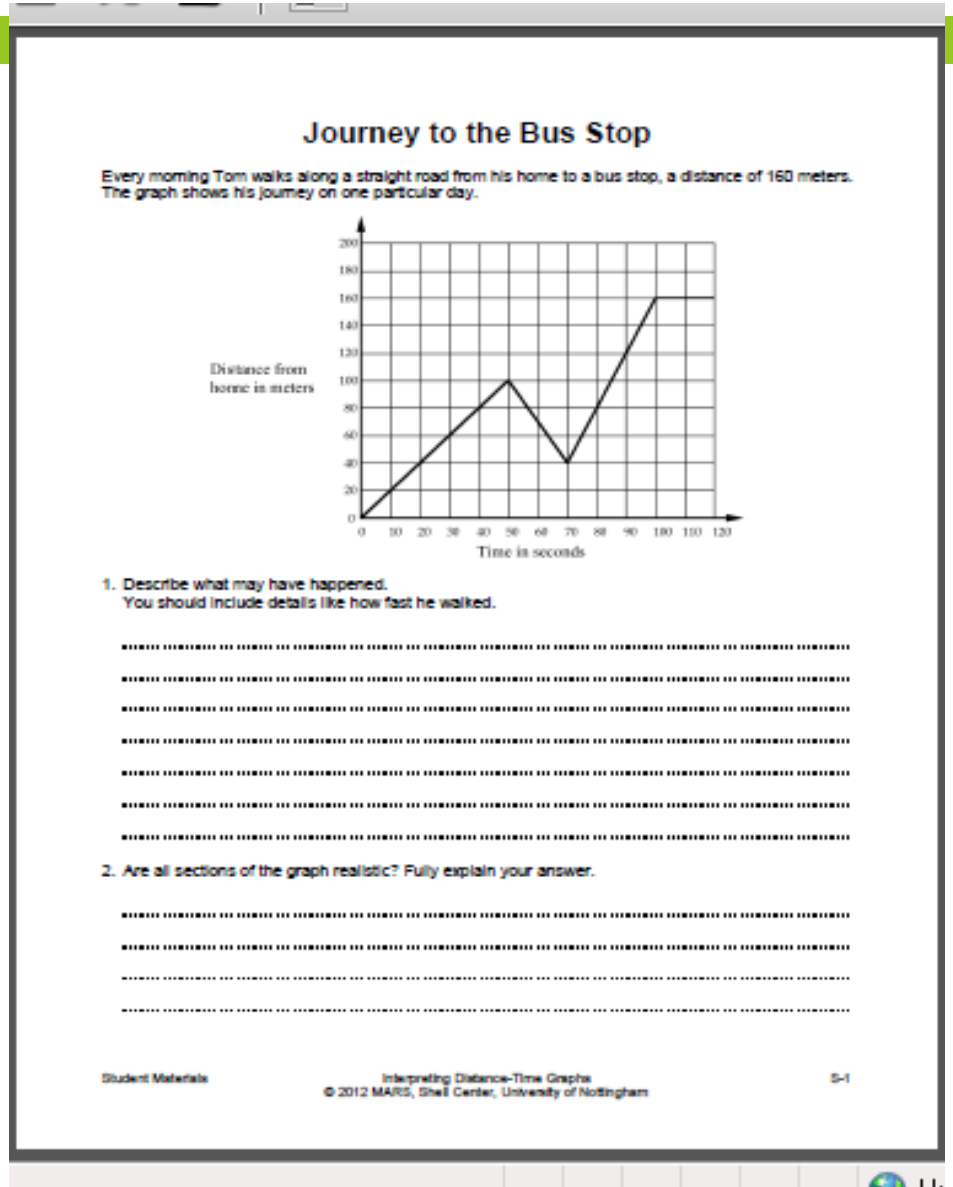


# Interpreting Distance-Time Graphs…



- 2/3 into a unit of study
- Students should have had experience with…

8.F Use functions to model relationships between quantities



Journey to the Bus Stop

Every morning Tom walks along a straight road from his home to a bus stop, a distance of 160 meters. The graph shows his journey on one particular day.



1. Describe what may have happened.
   You should include details like how fast he walked.

2. Are all sections of the graph realistic? Fully explain your answer.

# Steps to Concept Focused Lesson…



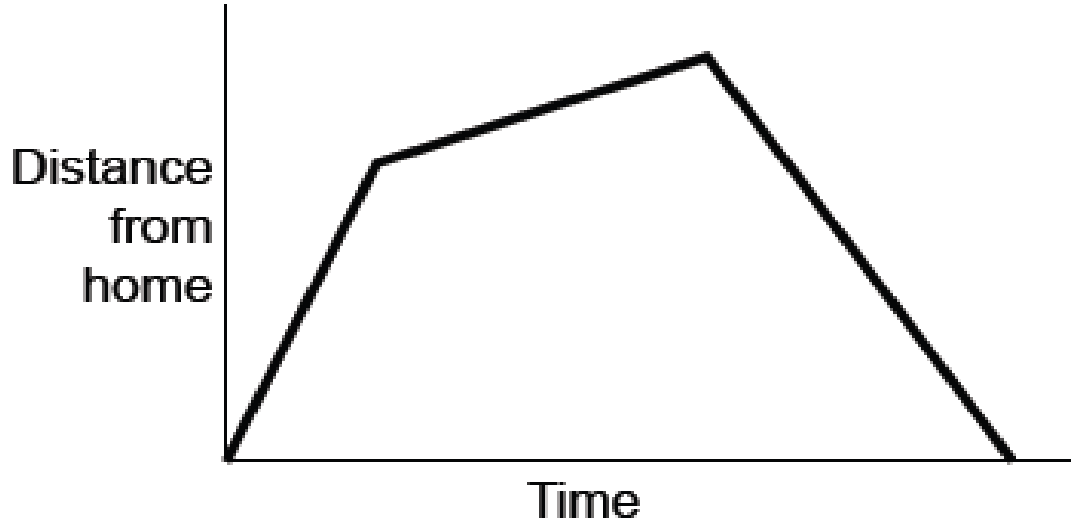
- Students work solo on pre-assessment task.
- Teacher takes up work and provides class feedback and intentional grouping of students.
- Students work in collaborative groups on a <u>different but related task</u> – usually a card sort type.
- Teacher facilitates groups, takes notes, asks questions to whole class or groups (engineers effective discussion)
- Students revisit original task to revise.

# Matching a Graph to a Story

A. Tom took his dog for a walk to the park. He set off slowly and then increased his pace. At the park Tom turned around and walked slowly back home.

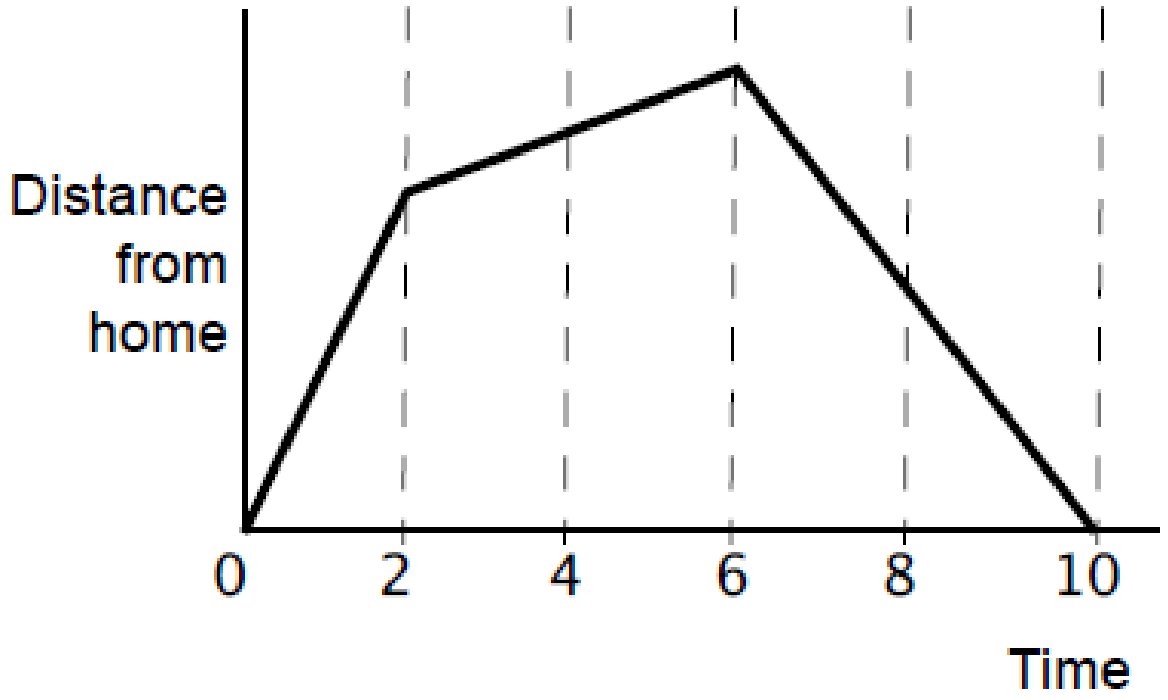
B. Tom rode his bike east from his home up a steep hill. After a while the slope eased off. At the top he raced down the other side.

C. Tom went for a jog. At the end of his road he bumped into a friend and his pace slowed. When Tom left his friend he walked quickly back home.



# Making Up Data for a Graph






| Time | Distance |
|---|---|
| 0 | |
| 2 | |
| 4 | |
| 6 | |
| 8 | |
| 10 | |

# Matching Cards



- Take turns at matching pairs of cards. You may want to take a graph and find a story that matches it. Alternatively, you may prefer to take a story and find a graph that matches it.

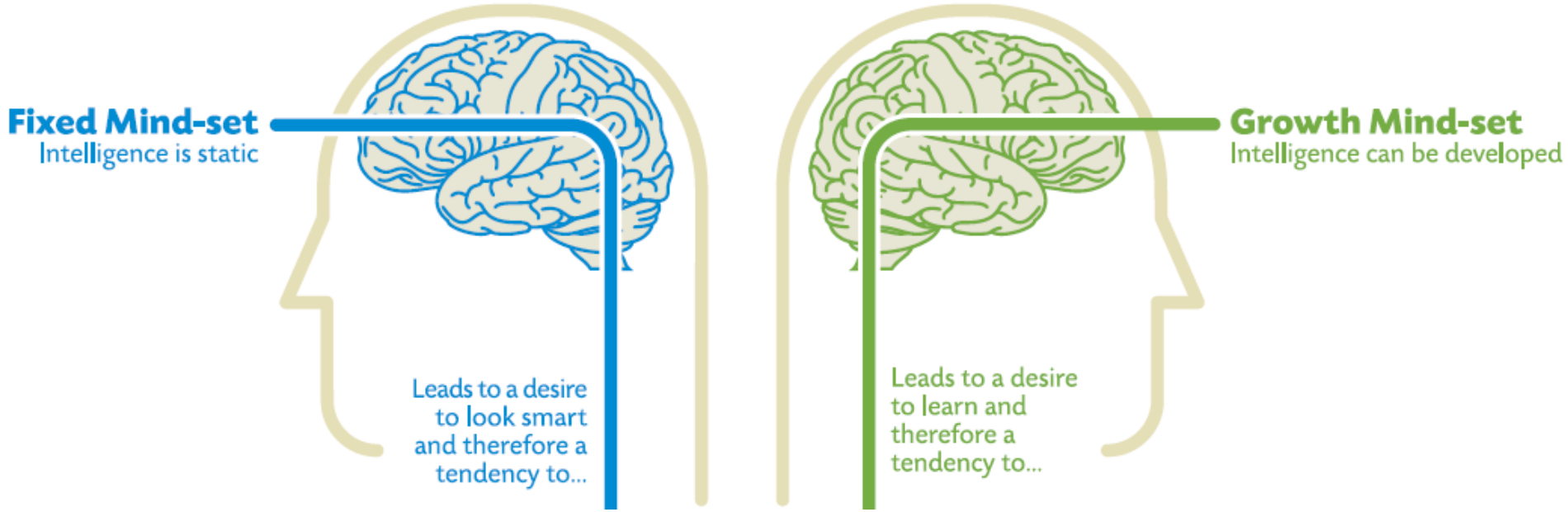
- Each time you do this, explain your thinking clearly and carefully. If you think there is no suitable card that matches, write one of your own.

- Place your cards side by side on your large sheet of paper, not on top of one another, so that everyone can see them.

- Write your reasons for the match on the cards or the poster just as we did with the example in class. Give explanations for each line segment.

- Make sure you leave plenty of space around the cards as, eventually, you will be adding another card to each matched pair.

# Fixed vs. Growth Mindset



# What Kind of Mindset Do You Have?


I can learn anything I want to.
When I'm frustrated, I persevere.
I want to challenge myself.
When I fail, I learn.
Tell me I try hard.
If you succeed, I'm inspired.
My effort and attitude determine everything.


I'm either good at it, or I'm not.
When I'm frustrated, I give up.
I don't like to be challenged.
When I fail, I'm no good.
Tell me I'm smart.
If you succeed, I feel threatened.
My abilities determine everything.

# Five Things You Can Do to Encourage a Growth Mindset in Kids

## 5 Things You Can Do to Encourage a Growth Mindset in Kids

Posted on July 21, 2011 by Lisa Dewey Wells, Wonder of Children

Words of Encouragement

The debate of praise versus encouragement continues. A quick google search will toss-up over 7,000,000 hits. No doubt, the seminal research by Alfie Kohn, Carol Dweck and others have taught us that by offering primarily praise, we create kids who crave approval and validation by adults, rather than developing the confidence and persistence requisite to self assessment, self-regulation, and learning.

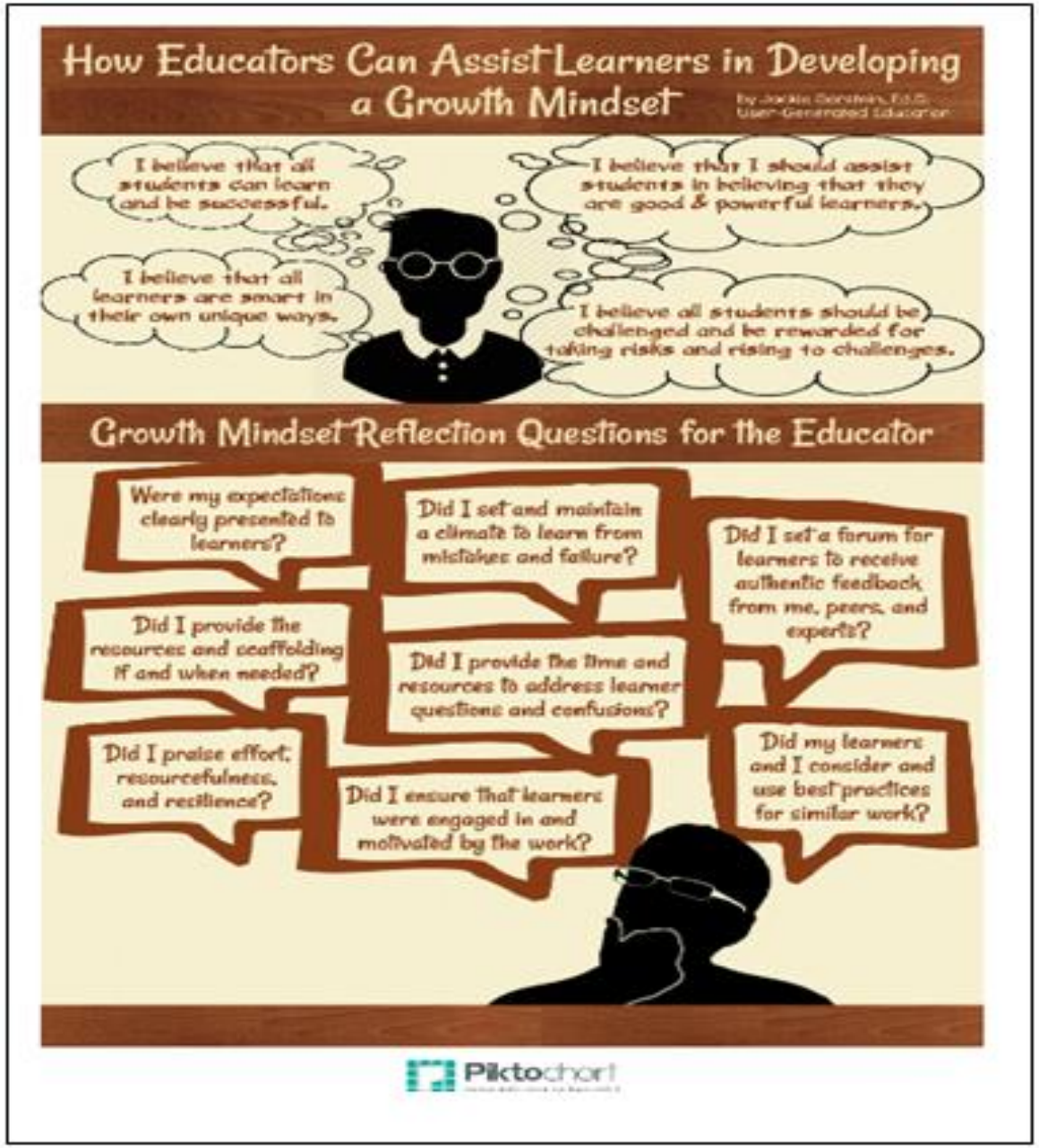
Instead of offering empty, vague or cursory praise such as "good job!" or "I like that!", specific feedback shows kids the value of their effort and persistence. Kohn begged us to Stop Saying Good Job! years ago. We're still learning what else to say. Then he told us We (were) Punished By Rewards. But why should we offer honest encouragement to children? For a more up to date discussion on the value of encouragement, listen to Rae Pica's BAM! Body, Mind and Child podcast on the topic "Creating Praise Junkies: Are You Giving Children Too Much 'Positive' Reinforcement?"

By leading children to discover the problem solving process or understand the rules, we are enabling children prosocial skills and information they can use in other settings. This often allows them to uncover new information or solve a problem or to build skills they can transfer to other situations. If children hear specific feedback about their effort, their skills and their ability to work well with others, they are armed with the skills

**Five Quick things you can do to help develop a growth mindset in kids:**

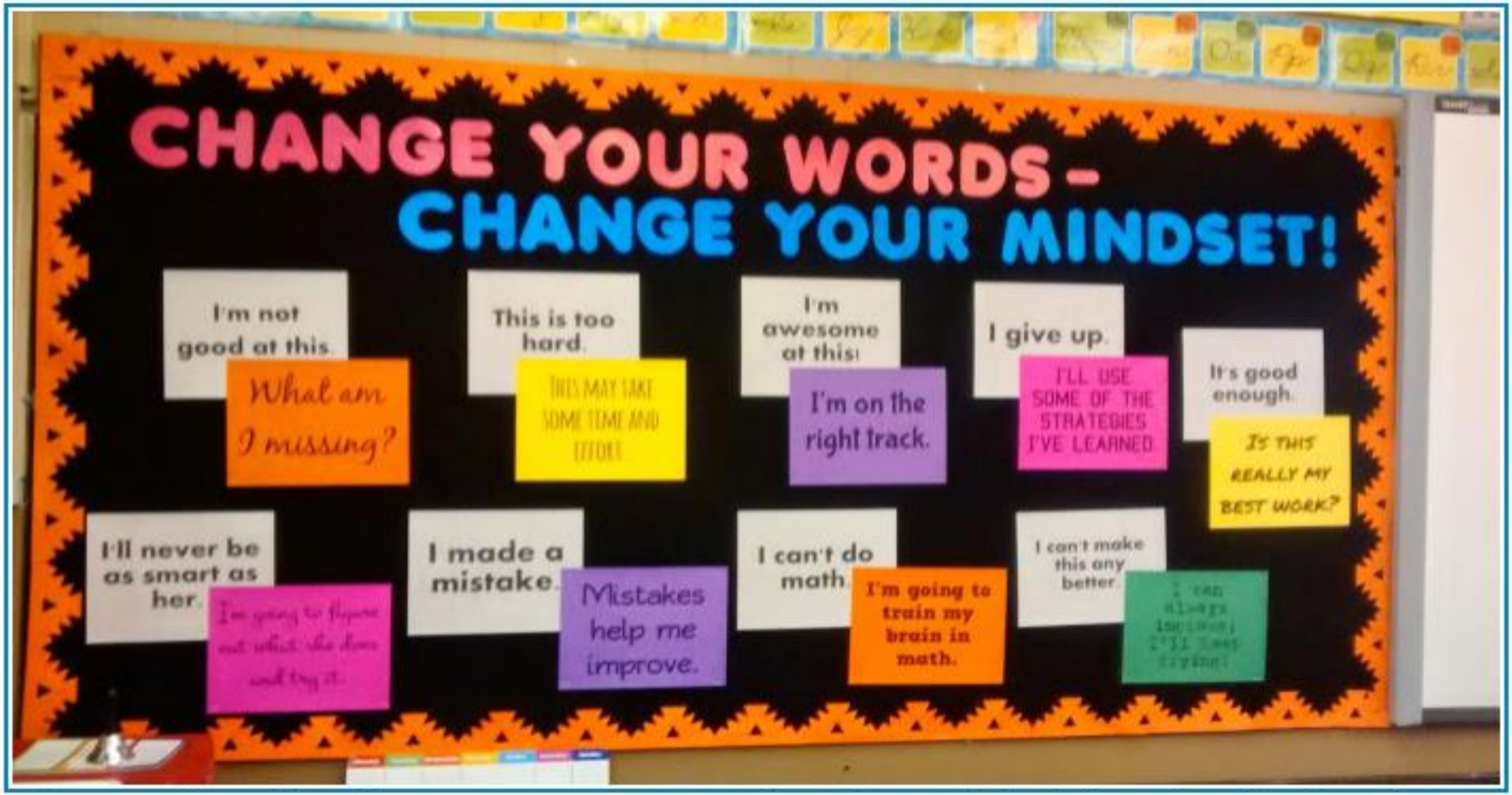
1. **Ask open-ended questions to solve a problem or achieve a goal**. "What do you think will happen if…" or "Why do you suppose…" These questions build logical thinking skills and often lead to rich discovery.
2. **Use specific feedback that identifies what the child accomplished.** What small steps led to a larger outcome? Be supportive when your child attempts something new. It might not be the way you'd try to solve a problem, but if it works, acknowledge it honestly and without judgment. Pick your battles. Hair done by a three-year old might not be ready for the runway, but it brings a child great satisfaction to say, "I did it myself!" Skills that build persistence simultaneously allow children to feel confidence and independence. When frustration rears its head, offer an encouraging word about what steps worked well.
3. **Encourage kids to take a risk.** Watch and listen to your child so you can take cues about what else they are ready to tackle. Vygotsky calls this the "zone of proximal development – when we gently nudge kids to use what they know to try something just a bit out of their reach, but yet developmentally appropriate. By offering small but achievable challenges, confidence and persistence emerge .
4. **Be persistent and growth-orientated yourself.** Narrate your thoughts as you try something new or frustrating (with a G-rating, of course!). Your child may even be able to offer some helpful tips. This allows children to see we all have to work hard to solve problems and we all continue to learn new things.
5. **Don't sweat the small stuff**. Accidents and mistakes happen. Show your child that there's something to be learned when we don't achieve what we set out to accomplish. Maybe someone else lends a hand. Maybe you return to the task at another time. Maybe it's best to abandon things for a while or break things down into smaller steps. Be specific about what worked, identify the emotions involved, and offer encouragement for the next time.

http://wonderofchildren.wordpress.com/2011/07/21/5-things-you-can-do-to-encouarge-a-growth-mindset-in-kids/




https://usergeneratededucation.wordpress.com/2014/09/28/how-educators-can-assist-learners-in-developing-a-growth-mindset/

Jackie Gerstein, Ed.D.




http://mathequalslove.blogspot.com/2014/08/growth-mindset-and-sbg-bulletin-board.html?spref=tw


Growth Mind-set
(intelligence can be developed)
VS
Fixed Mind-set
(intelligence is static)
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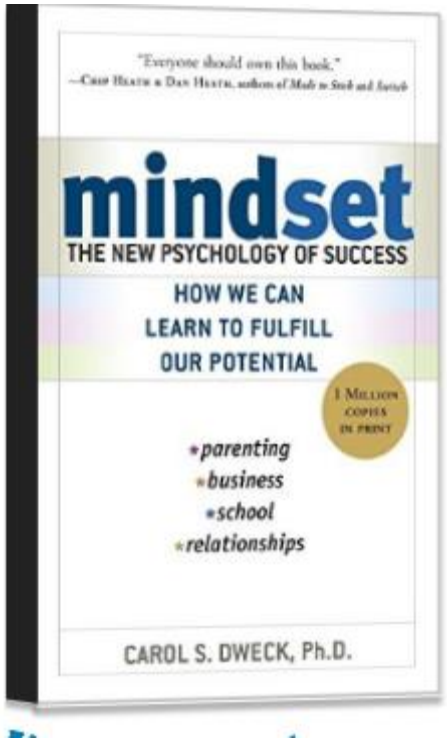
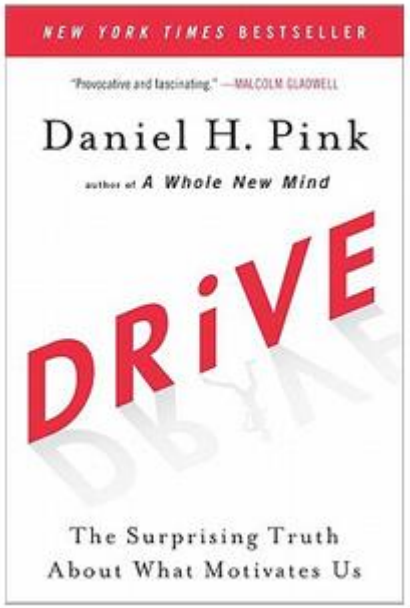
# Resources

## Carol Dweck




## Daniel Pink

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Grade 6

- Number and Quantity
- Algebra and Functions
- Geometry
- Probability and Statistics

## Index of *Classroom Challenges*

*Classroom Challenges* are lessons that support teachers in formative assessment. There are 100 lessons in total, 20 at each grade from 6 to 8 and 40 for 'Career and College Readiness' at High School Grades 9 and above. Some lessons are focused on developing math concepts, others on solving non-routine problems.

The Brief Guide for teachers and administrators (PDF) is recommended reading before using these lessons for the first time.

Each lesson is downloadable as an all-in-one PDF to print out, and a supporting PowerPoint presentation.

### Finding a Lesson

There are several ways of navigating:

1. Use the menu on the left to browse by grade and topic area, or search for a key phrase.
2. Go to the Standards tab to find lessons linked to a particular content standard or practice.
3. The complete set of lessons is listed below in alphabetic order.

### Grade 6

Adding and Subtracting Directed Numbers
Creating a Measure of Slope
Designing 3D Products: Candy Cartons
Evaluating Statements About Number Operations
Evaluating Statements: Consecutive Sums
Finding Factors and Multiples
Interpreting Equations
Interpreting Multiplication and Division
Maximizing Profit: Selling Soup
Modeling Relationships: Car Skid Marks
Optimizing Coverage: Security Cameras
Representing Data With Grouped Frequency Graphs and Box Plots

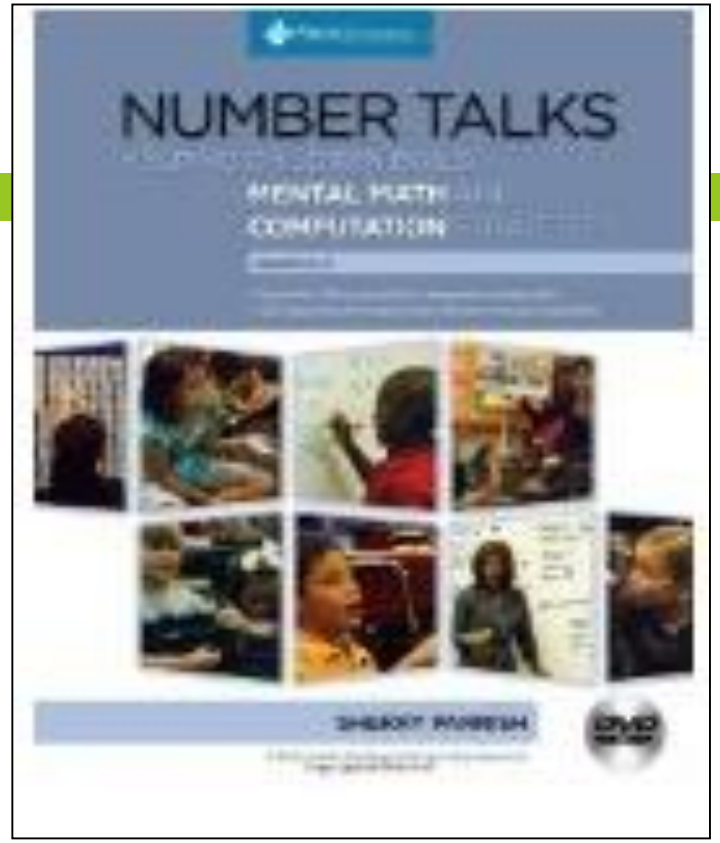
### Grade 7

Analyzing Games of Chance
Applying Angle Theorems
Classifying Proportion and Non-Proportion Situations
Comparing Data Using Statistical Measures
Comparing Strategies for Proportion Problems
Describing and Defining Quadrilaterals
Describing and Defining Triangles
Designing a 3D Product in 2D: A Sports Bag
Designing: A Game of Chance
Drawing to Scale: A Garden
Estimating Volume: The Money Munchers
Evaluating Statements About Probability

# Resources

- Author Sherry Parrish

contains video examples for grades K, 2, 3, and 5 as well as explanations of strategies shown on the video clips.




- http://mathsolutions.com/educator-tools/

*Thank you for participating.*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