Growth Mindset and Mistakes

Creating a Culture that Increases Student Willingness to Investigate “Mistakes” as Learning Opportunities

by

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The following paper captures the results of a multiple-year investigation of growth mindset and mistakes conducted by the CPM Educational Program Teaching Redesign Corps (http://cpm.org/trc). Our investigations began in July of 2016 as a set of research proposals crafted during the TRC 3.0 meeting in Las Vegas, Nevada. Since that initial meeting, several cohorts of Teacher Researchers have collaborated to explore the instructional practice of investigating mistakes as learning opportunities by systematically changing our teaching behavior while observing and recording differences in student learning. We, the lead authors, would like to acknowledge the exceptional effort made by our fellow researchers Laura Bell, Kerry Cardoza, Alycia Clarkson, Beckie Frisbee, Shelly Grothaus, Anthony Johnson, Elizabeth Johnson, Tammy Kaufman, Julie Kiedrowski, Heather Kosmowski, Tanya Lantrip, Claudine Margolis, Megan McGregor, Marc Petrie, Brooke Raven-Sandberg and Thor Tillberg. Our collective student populations were diverse, with representation from multiple SES levels, rural, urban, suburban, large and small schools, grades 6 -12, and courses including pre-algebra through calculus. We have synthesized what we feel are the best practices and activities that were effective in all of our classrooms.

Disclaimer: CPM is glad to share the findings from the TRC investigations, but these are just ideas. It is expected that teachers will rely on their knowledge of their students, the mathematics they are teaching, and the circumstances surrounding their specific teaching assignment when modifying their own behavior and selecting appropriate instructional strategies. A given strategy may have a positive effect on student learning in some situations and a negative effect in others. Please use your own best judgement as you continue to improve your teaching practice.

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Introduction

What are some feelings that come to mind when you hear the word “MISTAKE”? Jot them down.

Did you write words like “embarrassment,” “disappointment,” “failure,” “horrible,” “angry”, “stupid,” “disgrace,” “wrong,” “mess-up,” and “dumb?”

What would think if your students wrote “try again,” “wrong,” “sad,” “improve”, “fix,” “grow” and “learn from?”

“Learn from?” Yes, this was our key to transforming our classrooms into places where students could embrace mistakes as tools for learning.

In our own classrooms, we have seen that students who learn to learn from mistakes do change; they become captains of their own learning and realize that they can be successful math learners. Research (Moser et al., 2011, Steur et al., 2013) backs up this idea and has shown that mistakes can make our brains grow.

Yes, we do learn from making mistakes and then correcting them. Remember when you were trying to learn how to ride a bike. Did you just hop on the seat, start pedaling and then off you went - the first time? No! It took many attempts. But you kept trying, didn’t you? You didn’t say after the first try, “I’ll never learn how to ride a bike,” and give up! By making mistakes and persevering, we demonstrate a growth mindset.

A growth mindset alone, however, did not provide our students with opportunities to demonstrate meaningful change. A growth mindset needs to be coupled with activities that provide formative assessment space, a safe pathway to revision, and confidence building interactions. Just like balancing while moving forward leads to riding a bike.

It’s not magic! By implementing some key activities spaced throughout the year, we and our students saw positive change in our classroom environment and attitudes toward learning.

We will provide some initial activities that we used to help get you started in your classroom transformation. Once you and your students see a positive change, you can continue with the initial activities and/or supplement them with others that we have provided for you. Then you can develop your own tasks that fit your students’ needs or modify ours.

Let the journey begin!

Background

Students investigating mistakes for learning is both a means and an end in the process of developing a growth mindset. In order for students to come to see mistakes as natural, they must develop a more positive mindset about math. Our natural impulse is to see mistakes as negative, and many students view them negatively. However, mistakes are a natural part of many deep learning experiences. Students must develop a mindset of improvement to investigate their mistakes, and through investigating mistakes, they will cultivate a growth mindset (Dweck, 2006) and vice versa.

Initially, we saw growth mindset, as a fairly radical idea - that is, intelligence is not set at birth, but can develop over time. We learned, however, that this development is not achieved by wishful thinking but through perseverance and believing that one can achieve at the highest levels through deliberate practice. Our students were able to achieve and leverage a growth mindset not via a formulaic rule but rather by employing a multitude of tools.

We chose mistakes for exploration because of the integral role that they play in learning mathematics. Students too often see mistakes as a failure to be forgotten about rather than an attempt to be improved upon. Students must make mistakes and correct them to learn math deeply, and they will become more open to investigating mistakes if they view them as one step on the path to mastery. The ubiquity of mistakes, both in the classroom and outside, warranted our further investigation in how to develop a culture where students investigated and learned from their mistakes.

Teacher Behavior Changes

Prior to our experience in working with mistakes and growth mindset, we felt like many educators in that mistakes (or should we say the number of mistakes) was an indication of a student's ability to learn math. Students who made fewer mistakes were considered capable learners while those who made many mistakes were not really good at math. We and our students never examined the mistakes and what we could learn from them. Instead, we would, in many cases, just tell the students where the mistake was and maybe how to fix it. All the student cared about was having the right answer rather than demonstrating understanding. And we thought that by telling them how to make the corrections, they would not make the same mistakes again. Not so.

From working with students on growth mindset and fixing mistakes, we as teachers noted our own behavioral changes. Perhaps the most significant change was that we no longer brushed over mistakes. In the past, we might have downplayed a mistake whereas now we celebrated them as a

way to reinforce a growth mindset. We realized that mistakes happen to everyone, every day. We showed our students that mistakes are truly powerful learning tools, and we continue to learn more from our own.

Moving forward, each of us committed to helping students learn that making and correcting mistakes is an essential part of the learning process and they no longer needed to hide them or feel embarrassed. Developing a growth mindset culture in the classroom led directly into this idea that mistakes are welcome and that the math classroom is a safe place to learn from them. Students and teachers both understood the power of making mistakes, took ownership of their mistakes, and used mistakes as a learning tool. This new perspective about mistakes made it easier to support a growth mindset culture in the classroom.

Activity Connections Diagram

Pictured below is a graphic that displays the seven transformative activities that we embedded into our teaching practices and how they are interconnected. There are two major activities - Assessment Analysis and Growth Mindset Activities - to which all other activities feed into and are related to (hence the arrows in both directions).

While this may appear to be a complicated web, it is actually very straightforward once you review the Implementation Activities Calendar that follows.

Here is an example of how you might get started at the beginning of a school year:

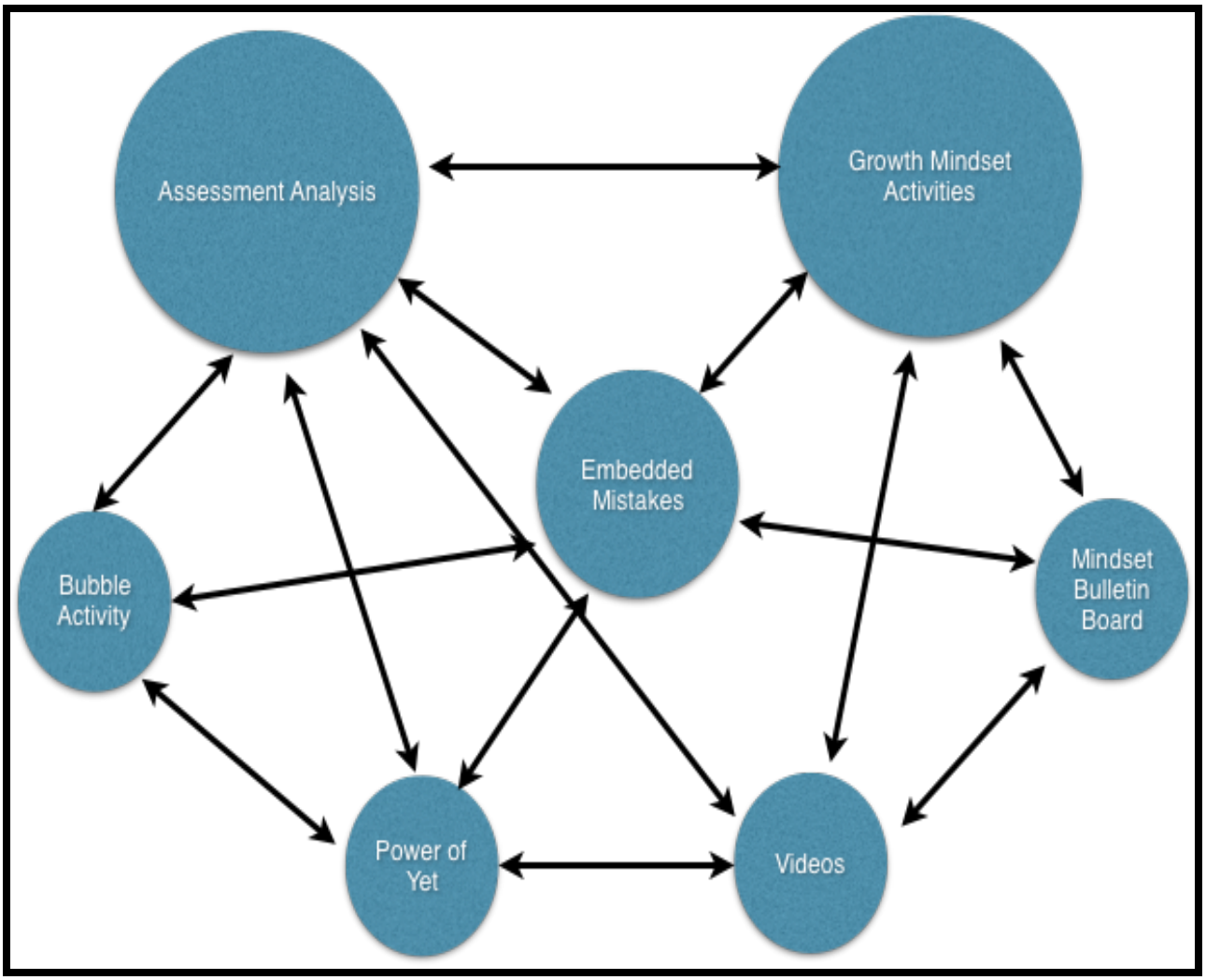
- Show a growth mindset video
- Create a growth mindset bulletin board
- Implement the Power of Yet
- Choose a growth mindset activity (we have used the balloon tower or sugar cubes as a beginning-of-the-year choice)
- Do the Mistake Bubble activity

Again, this represents a suggested order and you should do what works for your students. We have implemented these activities before delving into the texts but they can also be done as an adjunct to the regular curriculum.

Throughout the year, on an iterative basis, we suggest that you and your students work on assessment analysis, embedded mistakes, and growth mindset activities with a sprinkling of growth mindset videos. These three activities represent the core of how our students were tasked with learning from mistakes into our classrooms. While initially, it may seem to take a good deal of time, in

the long run, we have seen that students embrace their mistakes, make corrections, and take responsibility for their learning.

The goal for students has thus shifted from assessments to earn a grade to assessments as a tool for learning. We all make mistakes - it's how our brain grows (just check the research). It's what we do with those mistakes that enhances learning. And once students understand that making mistakes and correcting them are part of the learning process, they embrace them and no longer view them as negative but rather as steps that could help them toward mastery.



Implementation Calendar

Activity	Aug. Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Assessment Analysis		X	X	X	X	X	X	X	X	X
Embedded Mistakes		X	X	X	X	X	X	X	X	X
Growth Mindset	X		X		X		X		X	X
* Mindset Bulletin Board	X									
* Mistake Bubble Activity	X								X	
* Power of Yet	X									
* Videos	X		X		X		X		X	

* Activity occurs one time per “X”.

Other activities occur 1-2 times per “X” or more, if needed.

This represents a general guideline for implementation. The most important consideration is the sequencing of the activities. In particular, the August/September activities are critical to the successful implementation of the other activities. Think about them as “setting the stage” activities for your students.

Seven Activities

1. Mistake Bubble Lesson Plan

Description:
We had students fill in a “mistake bubble” template with words that they think about when they saw the word “mistake.” They then shared their responses with the class.

Purpose:
This activity measures students’ perception about what it means to make a mistake. More important was that these bubbles provided an opportunity to get a pulse on classes and monitor student thinking both at the beginning of the year and toward the end of the school year. The objective was to learn if students changed their mindsets about making mistakes.

Implementation guidelines:
Two times per year, once in September, once in May.

Student Outcomes for initial task:
Initially most, if not all students, focused on negative words such as “bad,” “wrong,” “failure,” etc. and took these words to heart personally. Many see those words as a reflection of themselves and their worth. This was very common. Generally only a few students arrived in our classroom with an understanding of growth mindset already intact, so there were very few positive words sprinked in. We found it important to specifically acknowledge those positive words (see task instructions for guidelines).

Student Outcomes for final task:
Initially, students saw mistakes as negative. By the end of the year, most viewed them as ways to grow their brains. In May, students chose to describe mistakes with words that were much less emotionally charged and far less personal. “Learning” topped the list on many students’ responses. “Failure,” “wrong,” and “sad” were still present, but they were tempered with “try,” “fix” and “growth.”

Students added statements such as, “I used to think making a mistake was embarrassing and now I see it as a learning opportunity,” and “Before, I never really tried to learn from my mistakes, but now I find myself trying to figure out what I did wrong and try to learn to do it right.”

Mistake Bubble Activity	
Learning Targets	 Students can identify and record words and emotions that they associate with the term "mistakes."  Students will open up to the possibility that "mistakes" can be a catalyst or opportunity for learning.
Mathematical Practice	SMP #1: Make sense of a problem and persevere in solving them ● Students will persevere in generating a list of words that they associate with the word mistake.
Time	● Early September and late May ● Classroom time (11-17 minutes); Teacher prep time (10-15 minutes)
Materials	● 1 copy per student ~Mistake Bubble Activity Sheet ● Word Cloud Generator (Like Wordle or Tagul) ● Word Spreadsheet to record student responses for each word for multiple classes (teacher completes) - optional
Lesson	**Introduction/Launch: (1-2 minutes)** ● Let students know that the purpose of the activity is to uncover each student's perception of a mistake. Then, as you review the responses from the class, you will look for common threads. **Activity: (3-5 minutes)** ● Distribute a copy of the Mistake Bubble Activity Sheet to each student. ● Say, "Write down all the words that come to mind when you see or hear the word 'mistake.'" Students work on this activity independently. **Closure: (7-10 minutes)** ● Whiparound as described below. o Have each student in class say one of the words s/he wrote on their Mistake Bubble Activity sheet. o No repeats are allowed. o If all the words are used from the student's sheet when it gets to her/his turn, s/he says, "Pass." o If a students says a word that has a positive connotation to the word "mistake" such as "learn" or "opportunity," the teacher will pause and make a comment about the word. For example, if a student said, "learn," you might respond with, "That's an interesting word." This is not meant to be a time-consuming piece but rather a touchstone for this activity.

	○ After all students have given their words for "mistake", pose the question, "Are mistakes always bad?" and elicit responses from the students. ○ Ask students to share other positive connotations to the word "mistake" as a way to open up the door to seeing mistakes as an opportunity for learning. The point of this wrap-up for the beginning of the year activity is to have students begin to understand that mistakes are not always negative.
Teacher Follow-up	**Create a Word Art** ● The teacher will tally the number of times each word was used. This may be done manually or via the Word spreadsheet. ● Using a Word Cloud generator, the teacher will create a word art picture using the words about "mistakes" that the students generated. ● Change words to the same tense to help make entering them easier. ● The more times a word is recorded by the students, the larger it becomes. ● Save the word art picture to show students what the class perception is about "mistakes." Discuss high frequency words and also point out words that appeared with a more positive connotation to them. ● Optionally, you may want to have the students keep a copy of the word art in their notebooks. Hopefully, over the year, they and you will notice a shift from negative to positive.

Blank Forms

Mistake Bubble Template:

Write down all the words you think about when you see the word mistake.

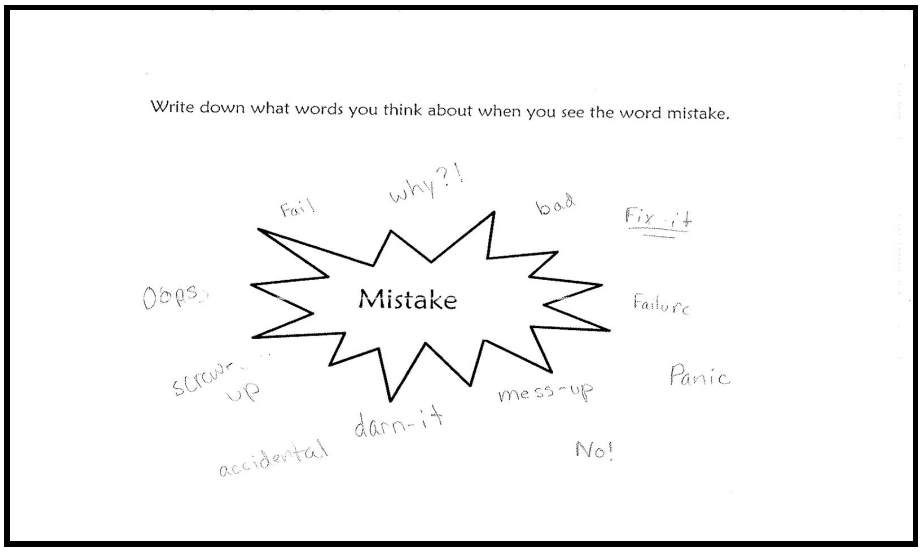
Blank Spreadsheet:

Phrase	Class 1	Class 2	Class 3	Total:
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0

Examples

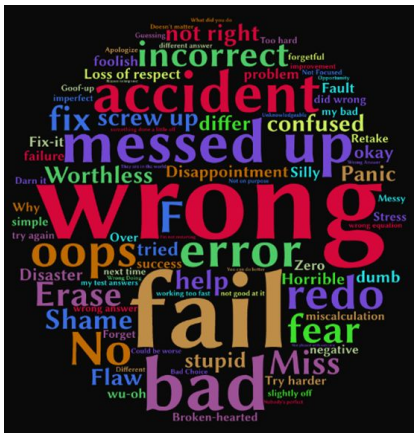
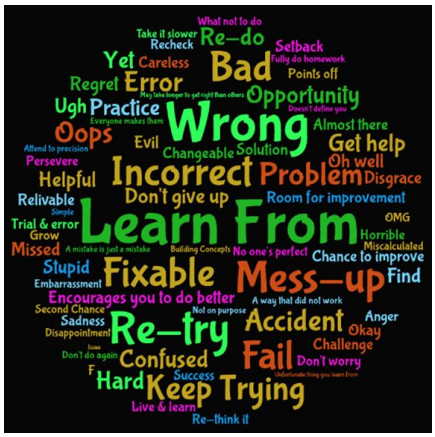
Mistake Bubble Student Example:

Write down all the words you think about when you see the word mistake.



Blank Spreadsheet Sample:

Phrase	Class 1	Class 2	Class 3	Total:
Wrong	10	9	8	27
Learn from	9	13	12	34
Problem	6	3	2	11
Mess-up	7	6	4	17
Incorrect	6	4	5	15
Opportunity	3	3	2	8
Re-try	2	13	3	18
Practice	1	4	2	7
Points Off	2	1	0	3
Re-think it	2	1	0	3
Fully do homework	0	1	0	1
Recheck	2	1	0	3
Keep Trying	4	4	5	13
Don't give up	1	2	3	6
Room for improvement	0	2	2	4

	Tagul Word Art Samples:  September  May

2. The Power of Yet

Description:
While we and our students understand the importance of developing and maintaining a growth mindset, there are times when we all fall back to a fixed mindset. In our classroom, this may happen when students lack confidence, encounter stressful events, or have lots of school work to complete. It also might be due to factors not related to school, like bad weather or having an off day in a sports event.

According to Carol Dweck, praising students for the effort may not be sufficient to maintain growth mindset. And it's when they're faced with these fixed mindset triggers that we need to provide some motivation to re-emphasize growth mindset. By consistently doing this, students will be able to get unstuck and refocus their energy toward the task at hand.

Purpose:
This activity allows students to create a "permanent" display in the classroom as a reminder to maintain a growth mindset and persevere, especially during difficult times. A copy may also be placed in each student's notebook (preferably in a place that is visible each day). It will be important to refer to this poster and its message throughout the year and help students do the same.

As an extension, you may decide to create stickers and have them available for students to place in their notebook, on their laptop, on their backpack, etc. This will, as the poster does, serve as a constant reminder of how to turn a fixed mindset into a growth mindset.

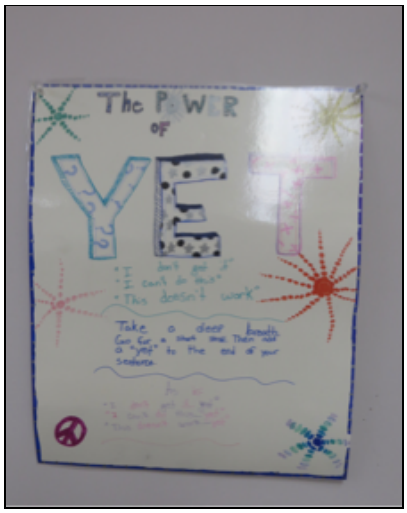
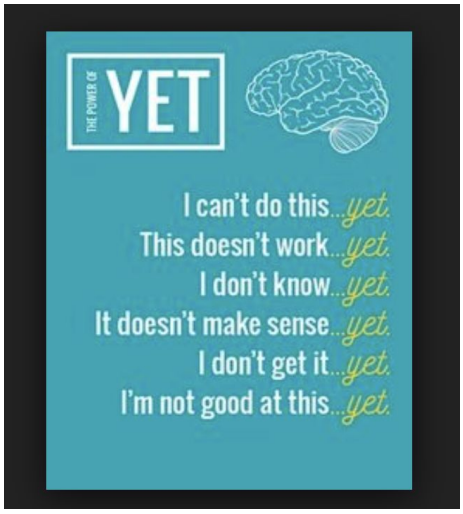
Implementation guidelines:
This activity is best completed at the beginning of the year in August or September.

Student Outcomes for initial task:
Working together, students will create a poster that will remain posted throughout the school year. It serves as a reminder to persevere in the face of challenging work. "You are not there … yet."

Student Outcomes for final task:
Throughout the year, we practiced using the statements to help students change their fixed mindset to growth mindset. We also noticed that our students did the same with other students. Adding this simple three-letter word to the end of their sentences allowed students the time and freedom to work on their math activities without the pressure of feeling as though they needed to master the concept immediately.

The Power of "Yet"	
Learning Targets	 Students will demonstrate how to turn an "I can't" (fixed mindset) statement into "I can't yet" (growth mindset) statement.  Students will understand that using the word "yet" allows them the time to continue persevering towards mastering a concept by growing from their mistakes.
Mathematical Practice	**SMP #1: Make sense of a problem and persevere in solving them** ● Students will continue to work towards making sense of a problem and persevere in solving them by using the growth mindset word "yet" at the end of a fixed mindset statement.
Time Frame	● Complete within the first month of school ● 20-25 minutes
Materials	● The word "YET" printed in large letters and posted in the classroom ● A projector to show a you.tube video ● ½ sheet of paper ● Poster paper ● Markers and/or colored pencils ● Suggested videos: ○ Sesame Street's Power of Yet video **(2:42 minutes)** ○ The power of Yet: Carol Dweck **(11:18 minutes)**
Lesson	**Introduction/Launch:** (2 minutes) Note: Display the word "Yet" in large letters somewhere in the classroom at the start

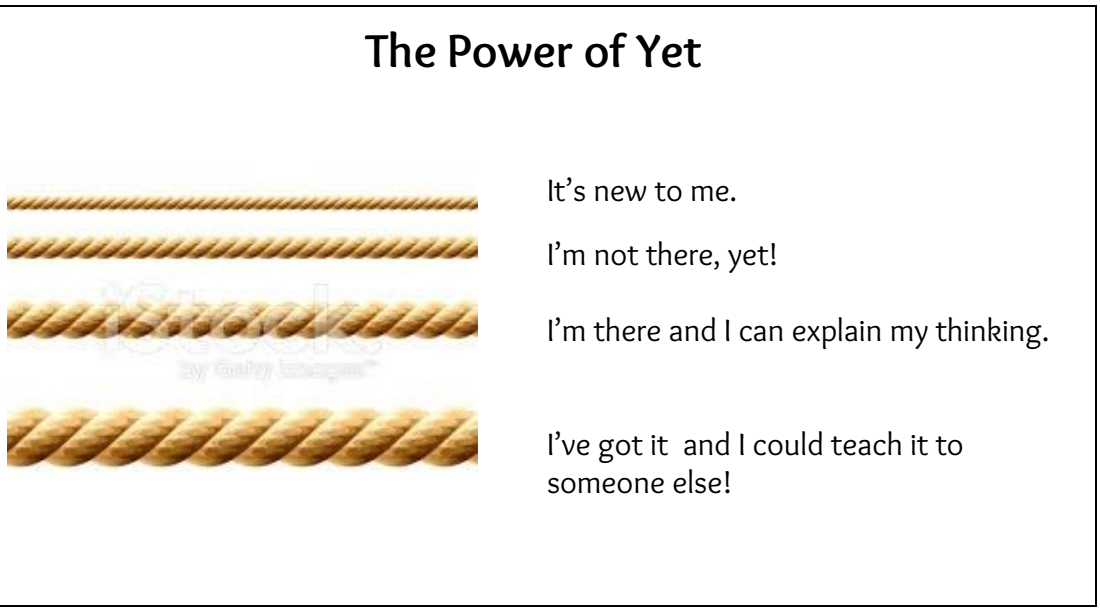
	of the year. Do not mention the word at all, let students inquire or wonder about it because they are curious. https://www.youtube.com/watch?v=J-swZaKN2Ic ● When you are ready to do this activity, allude to the word that has been posted in the classroom. Challenge teams to write down what they think the word "yet" means. Why is it posted in the classroom? **Activity:** (7-10 minutes) ● Whiparound the room and have the Recorder/Reporter report out the team results. ● Show one of the two suggested videos to the class. ● Repose the following question to teams and allow them the chance to refine their answer: ○ After watching this video, what does your team think the word 'yet" means and how do you think we will use it in the math classroom this year? **Poster:** (10-15 minutes, in class; may need time to finish outside of class) ● Students, working in groups of 2-3, will create a poster that contains the following elements: ○ At the top in large print "The Power of Yet" ○ In the body of the poster: I can't do this … yet; This doesn't work ,,, yet; I don't know … yet; It doesn't make sense … yet; I don't get it … yet; and I'm not good at this … yet. Let students decide the order of the statements. **Closure:** (5 minutes) ● Practice using the statements with students. This might include saying, "I don't know how to divide fractions… yet." ● We have found it to be a good idea for you, the teacher, to model by stating something that you are struggling with.
Teacher Follow-Up	It will be important throughout the year that you encourage students to use the language in the Power of Yet poster. This is especially important during those times when students are frustrated, stuck, and lack self-confidence. The Power of Yet helps students not only persevere but serves as a reminder to try to maintain a growth mindset even when a fixed mindset wants to take over.

Examples	The form on the left was generated by students; the form on the right was not but does show the results more clearly.  
Extensions	**Power of Yet sticker on each desk** ● Post a power of yet sticker on each desk as a reminder to students that mistakes are welcomed in your classroom. **Power of Yet personal note to self** ● Give students a notecard or a pre-made template and have them list one thing that they are not good at yet, but will work to improve by the end of the quarter/trimester. This goal may or may not be something they hope to achieve in the math classroom, although that would be preferable. ● The statements can be evaluated throughout the selected timeframe. Once a student has achieved their goal, the notes can be celebrated by posting them near the posted word "yet." **<u>Example:</u>** Mathematician: _____ **The Power of YET…** Everyone has something that they are not good at yet. Tell me one thing that you are not good at yet, but will work to be good at by the end of the _____.

Visual learning rubric for the Power of Yet!

- Each rope below represents the strength of connections that a student has for a particular concept. The rubric can be used to quickly assess where students are in terms of a concept during any lesson.
- This could also be used as a tool on assessments.

Example:



3. Change Your Words, Change Your Mindset Bulletin Board Activity

Description:

Establishing class norms around a growth mindset is perhaps the most important activity for students to engage in at the beginning of the year. We have found that it sets the stage for everything else that occurs and serves as a both a springboard and daily reminder of the importance of having a growth mindset as well as understanding how to change a fixed mindset statement into one that embodies a growth mindset.

Purpose:

The purpose of this activity is twofold: first, to provide students with an opportunity to both write and practice changing fixed mindset statements into growth mindset statements and second, to allow for a display of that information which remains in the classroom during the year. For the latter, we have found that it is important that the bulletin board be located in a place where it will be seen by all students (for example, when they walk into the classroom).

Implementation guidelines:
Once a year, as close to the beginning of school as possible.

Student outcomes for initial task:
Students worked collaboratively to create bulletin boards where they changed fixed mindset statements (on white paper) into growth mindset statements (using sticky notes). For example, they changed, "I'm not good at this," to, "I'm not good at this … yet" or "I need to persevere more."

Student outcomes for final task:
These bulletin boards were displayed throughout the year and acted as a reminder to students that the power of their words influenced their actions within the classroom.

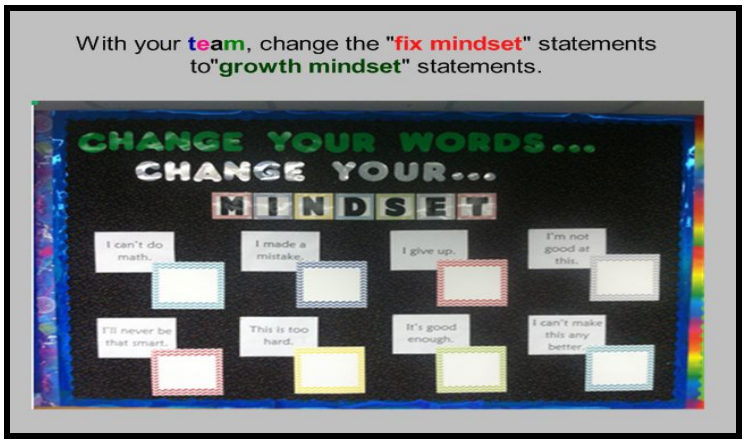
Lesson: Change Your Words…Change Your Mindset Bulletin Board Activity	
Learning Targets	Students can identify growth statements to combat fixed mindset statements. Students will utilize class generated growth mindset statements in the classroom as a means to demonstrate that they are open to learning mathematics.
Mathematical Practice	SMP #1: Make sense of a problem and persevere in solving them ● Students will persevere in generating multiple ways to turn a fixed growth mindset statement into a growth mindset statement.
Time Frame	● Complete within the first month of school ● 30-40 minutes
Materials	● Print and post one copy of each Sample Fixed Mindset Bulletin Board Statements ● One different colored Post-it note pad per team (2-3 students) ● Bulletin board space to display mindset statements ● Bulletin board letters ● Growth Mindset Statement Tracking form
Lesson	**Introduction/Launch:** (5-7 minutes) ● Show a mindset video that highlights the difference between growth mindset and fixed mindset ○ Growth Mindset Animation video ○ https://www.youtube.com/watch?v=Xv2ar6AKvGc ● Share a growth mindset story of your own. ○ John Legend: https://www.youtube.com/watch?v=LUtcigWSBsw ○ Overcoming Obstacles:

https://www.youtube.com/watch?v=2MGMvEnoD6U
- Khan Academy: Overcoming Obstacles https://www.youtube.com/watch?v=JC82Il2cjqA
- Mel Radtke story

Activity: (15 minutes)

- Refer to the fixed mindset bulletin board in the classroom.
- Challenge students with the task of changing the posted fixed mindset statements into growth mindset statements that can be used throughout the school year. You may want to hand out the Growth Mindset Tracking Form to do this initially.

Example:



- Distribute a different colored Post-it note pad to each team. Have students collaborate within their team to generate growth mindset statements. Once they have a growth mindset statement, the recorder/reporter will record it on the Post-it note. The resource manager will then go and place the colored Post-it on the corresponding fixed mindset statement.
- Set the timer for 10 minutes. Teams must generate at least one growth mindset statement for each fixed mindset statement posted. Each group will place a Post-it note on each of the fixed mindset statements. It is best to avoid duplication so you may ask a group to come up with another growth mindset statement.
- If time remains, teams may post additional growth mindset statements.
- The colored Post-its will allows for an easy visual to see which teams have not posted their growth mindset statement and may need a little support on this activity.

	Example with Post-its:  **Closure:** ● Whiparound ○ Have teams present what they feel is their best growth mindset statement and why. ○ Options to determine final growth mindset statements that will be posted: ■ Take a class vote on each posted statement ■ Give each team a set of stickers and have them place the sticker on the growth mindset Post-it statement that they feel is the best. The Post-it with the most stickers will be the one that is typed and left up for the remainder of the school year. ■ Teacher chooses the best growth mindset statements and posts them. **Note:** Put the bulletin board up a few weeks prior to doing this activity as it will give students the chance to view it ahead of time and wonder what it's for.
Teacher Follow-up	● Type up the agreed upon growth mindset statements and post them on the bulletin board in front of the fixed mindset statements. This part is optional. You may choose to leave the stickers and/or have students replace them with different responses during the year.
Example	This will be used as a teacher reference only and to help the teacher guide her/his students. ● Student samples of Growth Mindset statements

4. Embedding a Mistake in Homework

Description:
The homework problems in each chapter are a part of the mixed space practice that is essential for learning mathematics. We found that these problems could be used to task students with analyzing fabricated mistakes. Formative assessment was used for problem selection; we selected items that often have common errors.

Each team receives two copies of the solution set and one mistake analysis sheet to complete collaboratively. Together they work to find the mistake embedded in one of the solutions. Once found, teams complete the mistake analysis handout by copying the incorrect work and highlighting the exact point where the mistake occurred. The mistake is then corrected by the team, including a complete solution demonstrating their work, and then together they craft advice for the hypothetical student who made the error. The mistake is revealed to the class by the teacher. The reveal slide has two key components. First, the problem with the incorrect solution and the associated work is shown so teams can share the mistakes, thus taking the emphasis off of the answer. Second, a strategy to solve the problem along with the solution were shown. After the big reveal, teams were asked to share the advice they had for the hypothetical student who made the error to help this person avoid it in the future.

Purpose:
Embedding a mistake in the solution set of homework has three purposes. First, it causes students to carefully analyze their own work with the purpose of finding the embedded mistake within the homework answer key. Second, it leads to purposeful discourse among team members as they work together to unearth the embedded mistake. They need to critique each other's reasoning, give justification for their own work, and come to a final consensus as a group. Finally, having students embark on finding the mistake transforms the purpose of homework from getting the right answer to actually investigating the process and the "why" behind the math.

Implementation guidelines:
We recommend doing this activity throughout the school year, whenever homework is assigned.

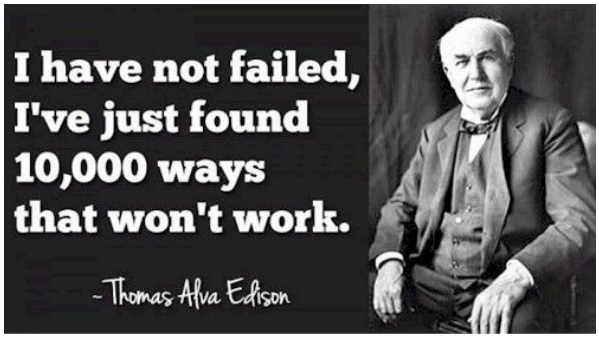
Student outcomes for initial task:
Articulating advice will be difficult for students at first since it needs to be precise and to the point. You may find that your students have not had practice doing this. As a result, expect that when students begin this task, the advice that they share might be very generic. Students might respond with, "Check over your work carefully," or "Make sure to calculate correctly next time." At this point, the teacher will want to use guiding questions to prompt the students to dig a little deeper into the mistake. Questions such as, "Where exactly did the mistake enter into the students work?", "If a

student thinks their calculations are correct, how will your advice help them to see exactly where the mistake came into play?", or "Is telling someone to check over their work specific enough to help shed light on the mistake, why or why not?"

Student outcomes for final task:
The daily prospect of finding the embedded mistake became a challenge that our students embraced with enthusiasm. Using this activity to correct homework was valuable even to those students who came to class unprepared. Each student has access to analyzing the mistakes and could actively participate in the debates that ensued. Many mathematical ideas will be furthered by students through their questions. This can spark the interest of others and provide a connection and extension to their learning that would not have happened otherwise. In addition, using their own work to debate the presence of a mistake, students will naturally be exposed to multiple strategies to solve the problem and more mathematical vocabulary.

Note:
Teachers should continually observe the types of mistakes that their students are making as a way to naturally weave these mistakes into homework solutions. It can help shed light on some of the common misconceptions that your students are having regarding a particular type of problem. This activity allows for teachers to individualize the choice of the embedded mistake to tailor it to their class's needs.

Lesson: Embedding a Mistake in Homework	
Learning Targets	 Students will critique the mathematical reasoning of others as they search for and pinpoint the mistake in the homework.  Students will understand that "to err is human" and that mistakes act as a springboard for learning by allowing our synapses to double fire and strengthen in the process.
Mathematical Practice	SMP #3: Construct viable arguments and critique the reasoning of others • Students will be able to construct viable arguments and critique the reasoning of their teammates as they determine which question contains the mistake.
Time	• Throughout the entire school year • After students have completed the homework problems • 10-15 minutes
Materials	• Mistake Analysis template ~ 1 copy per team • Printed homework questions, work, and answers with **one** mistake embedded in the solution~ 2 copies per team

	● Digital copy of homework questions, work, answers along with a reveal slide of the mistake (Google slides, Smartboard, Mimio, scanned IPEVO, etc.) ● Projector ● Highlighters ~ 1 per team
Teacher Planning (prior to embedding a mistake)	**Which question should be selected to embed a mistake in?** ● **Ideas to think about when choosing which questions solution to embed the mistake in for the homework:** ○ A question that contains a concept missed by a high percentage of students on a quiz, test, daily work or on past homework ○ A question that contains a concept where misconceptions commonly occur ○ A question where you want to prompt higher-level thinking and open the door to differentiate for those students who are ready for additional information ○ A question with a concept where you want to highlight the subtle difference between two ideas ○ A question that contains a concept that you feel students should have mastered up to this point ○ A question that contains a variety of pathways to arrive at the correct answer
Lesson	**Introduction/Launch:** (1-2 minutes)  ● Promote a growth mindset prior to starting this activity. Share this quote or another of your favorites with the students and tell them that the student who did the homework last night just found another way like Thomas Edison that did not work for one of the problems. Can your team figure out which solution contains the mistake? Can your team find the pathway to successfully complete the problem and share some advice with the student who took a wrong pathway? ● The Resource Manager from each team will gather the materials ~ 2 sets of answer keys and 1 mistake analysis template.

Activity: (7-10 minutes)

- Students will be checking their own homework for mistakes utilizing the given answer key.

- Within the context of their team, their mission is to determine which solution from the answer key contains a mistake. They need to work together using the tenets of good teamwork to accomplish this task.

  Note: Mathematical discourse should be heard.

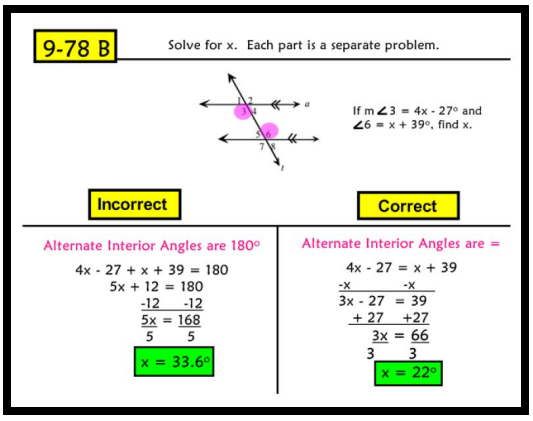
- While circulating, listen to the discourse, question teams, assess the level of understanding in the room and evaluate which teams should be selected to share with the class based on their Mistake Analysis Template.

- Once the team has agreed on which question contains the mistake, each team member must fulfill their role as they write up the Mistake Analysis.
  - Recorder/Reporter: Write up the problem that contains the mistake exactly how it appears in the answer key.
  - Facilitator: Pinpoint the mistake by highlighting where it occurred.
  - Task Manager: Record the team's agreed upon way to correctly solve the problem and shows all the steps.
  - Resource Manager: Record the advice that the team will share.
  - Teams will put up their red card when they are done.

- Teacher reveals the question that contains the mistake in the solution via the projector so that all students can see.

Example:

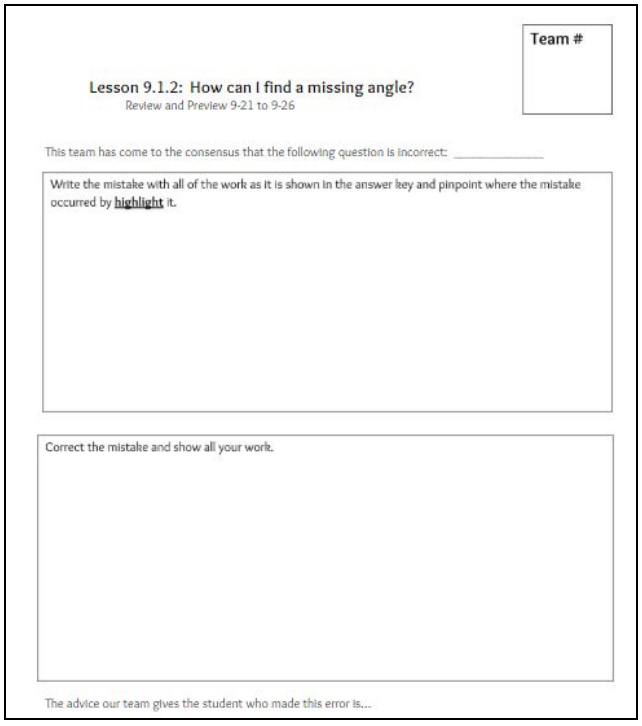
Tap the star to reveal the mistake question

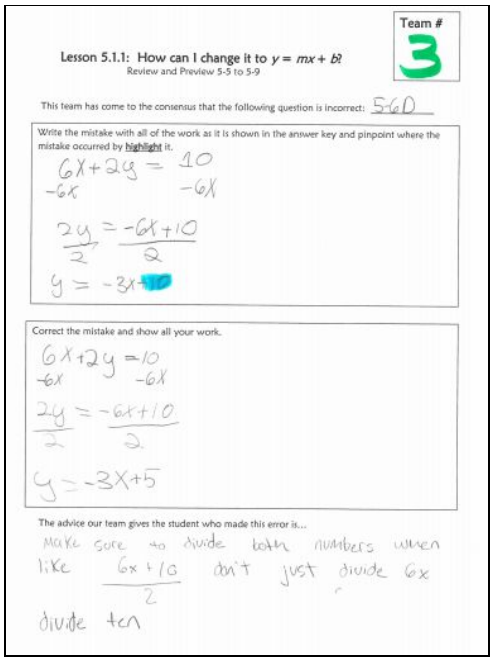
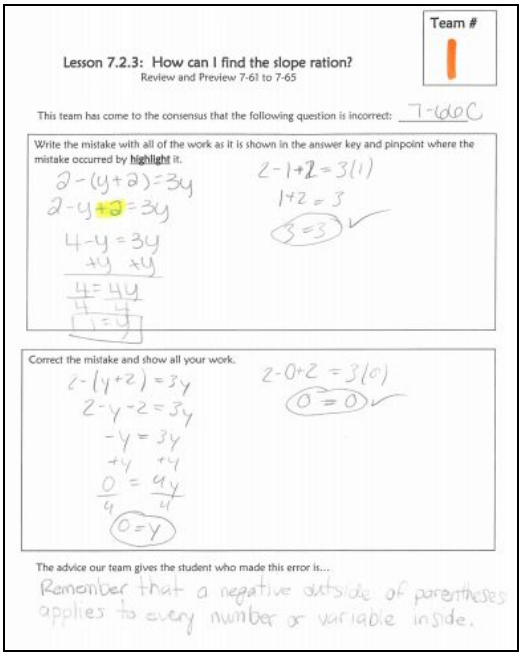


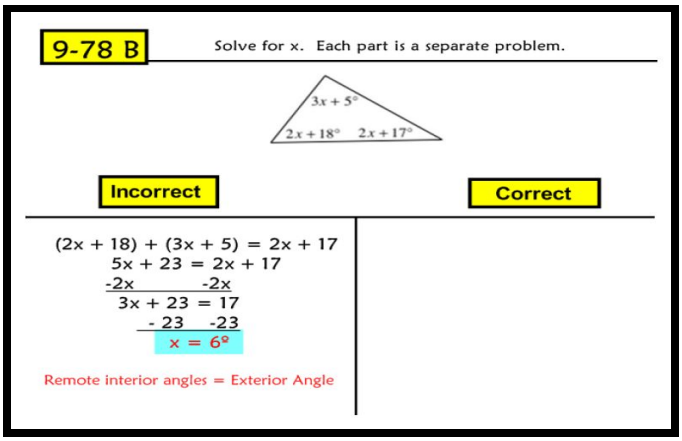
Mistake and correction slide

Closure: (5 minutes)

- **Advice Sharing**

	o Celebrating the "right" within the "wrong" helps students to see that they do in fact know something about every problem that can help them get started. Ask a team to celebrate something that the fictional student who made the mistake did correctly in the problem. o Ask for a team to volunteer to pinpoint exactly where the fictional student's mathematical thinking went wrong. o Select a different team to share the advice their team generated for the fictional student who made the mistake on the homework. Try to get them to elaborate through questioning. Try to toss out an "I wonder if" question to the class to see if students are able or ready to think about the question on a higher level. o If a variety of teams offer different advice, or advice that is the same but stated in a different manner, encourage them to share it with the class. Note: The advice sharing portion can also be done utilizing the whiparound method.
Teacher Follow-Up	The follow-up for the teacher is to watch student reactions when they encounter this type of problem in the future. Analyze whether this team mistake analysis reduces the frequency of this type of error. In addition, the teacher should continually be on the lookout for other common errors that his/her students are making so when a homework question arises with this type of concept, they are prepared.
Blank Forms	 Team # Lesson 9.1.2: How can I find a missing angle? Review and Preview 9-21 to 9-26 This team has come to the consensus that the following question is incorrect: _____ Write the mistake with all of the work as it is shown in the answer key and pinpoint where the mistake occurred by highlight it. Correct the mistake and show all your work. The advice our team gives the student who made this error is...

Examples	 
Extension	**Leave the reveal slide open ended** ● Sometimes teams locate the mistake and complete the team mistake analysis handout at different rates of time. To help with this inequity of time, leaving the correct answer and work off of the final reveal slide is an option. This will allow a team to record their work on the slide for the entire class to see and give the team the opportunity to share their own method of solving. ● Have the team that finishes the Mistake Analysis Template first, come up to complete the correct portion of the slide. This will include modeling how their team solved it along with showing all the calculations needed. This team will then present where the mistake happened, articulate why the thinking was flawed, and explain the new thinking process along with the correct answer. ● If other teams had another method of solving the problem, they too can come up and share or add to the ideas of the team that is presenting. Note: Hearing and seeing multiple ways to solve the problems is extremely important when addressing mistakes and offering advice. ● The team providing the correct solution can also present the advice sharing or they can call on another team to do so.

	Example: 
Example	• Homework Answer Key distributed to students

5. Assessment Analysis

Description:
In an effort to eliminate the desire to crumple up and throw away or quickly hide an assessment upon return, a new way to interact with a returned assessment was created. New expectations were communicated; students were made aware that re-quiz and/or re-test opportunities would be made available to help them master the material. It was made clear at the onset of the quiz/test that we expected that many of them might not YET have mastered all that was being assessed and that opportunities would be afforded to both learn from their mistakes and to reassess. We developed test/quiz self-assessments which allowed students to really evaluate the concepts that they were struggling with and to pinpoint exactly where their mistakes were. Once they could locate the exact place where the mistake occurred, students would then categorize their mistakes as careless, computation or lack of knowledge. The mistake would be fixed and all their thinking would be documented on the analysis form. Once this process was completed, students would submit their new work to the teacher for review. From here, a time would be set for the student to retake the assessment.

Purpose:
This activity allows students to take responsibility for their learning and changes assessments from a measure of performance to a learning opportunity. Students should see that the final grade on a paper does not mean that the learning is done, but rather as a tool to investigate their own mistakes to further their future learning.

Implementation guidelines:
After a chapter test and/or quiz.

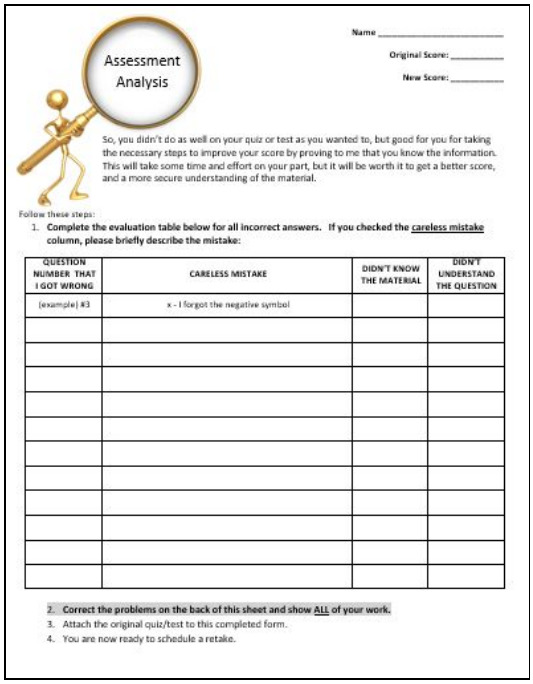
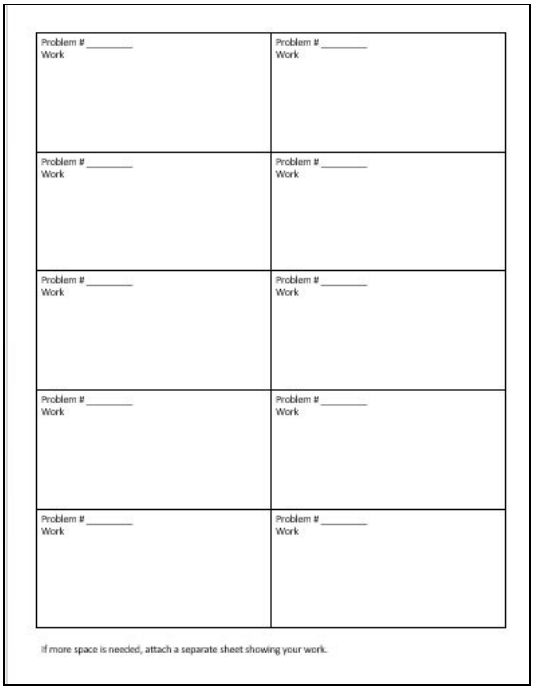
Student outcomes for initial task:
Since this is a new process for students, you may initially see students quickly hide or crumple up an assessment upon return. You may also notice that some students are reluctant to spend time correcting their mistakes. This is quite normal early in this process as students still view mistakes as a direct reflection of who they are and not yet as a powerful tool to help them grow in their math knowledge. On the other hand, we have found that the majority of the students will embrace this opportunity as a way to really pinpoint their errors so they can avoid them in the future.

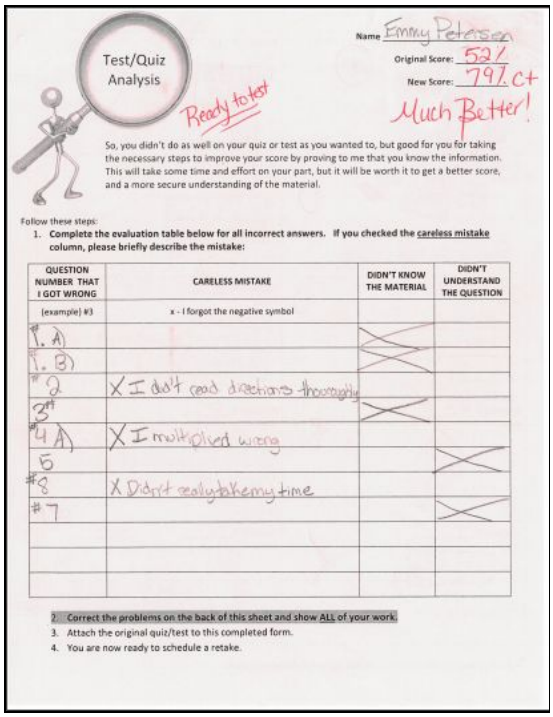
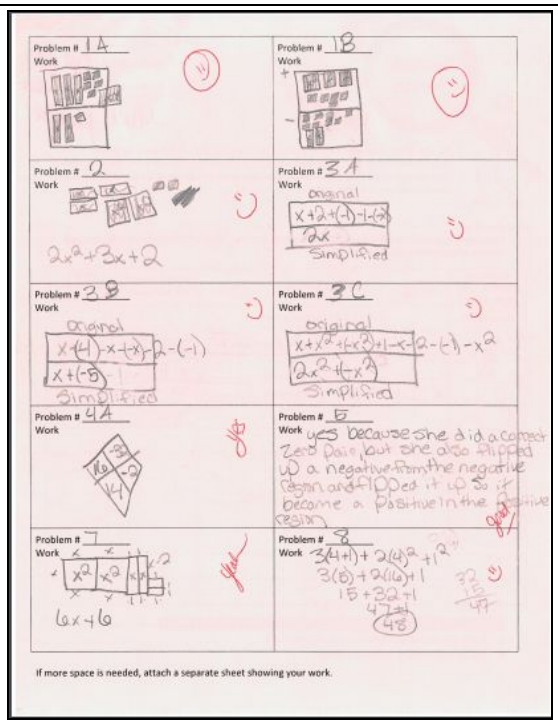
Student outcomes for final task:
The benefit of this activity is that it shows students that learning is a continuous process and allows them the opportunity to analyze their mistakes and persevere through them. In addition, this activity allows students to take responsibility for their learning and changes assessments from a measure of performance to a learning opportunity.

Assessment Analysis	
Learning Targets	 Students can identify and pinpoint the type of mistakes (careless, content, calculation or other) that were made on their assessment.  Students will analyze mistakes and readjust their thinking by making corrections to each problem (or part of a problem) that contains a mistake.  Students will view their mistakes as opportunities to learn and grow from.
Mathematical Practice	SMP #6: Attend to precision ● Students will be able to pinpoint the exact point in their mathematical thinking where they took a wrong turn and adjust their thinking to correct each problem. SMP #1: Make sense of a problem and persevere in solving them ● Students will understand their mistake and persevere in solving the problem, documenting their solution.
Time Frame	● End of September/early October through the end of the school year. ● Done after an assessment. ● Classroom time: for introducing the task (25-35 minutes); after that, it varies as the process is completed by the student outside of instructional time. ● Teacher prep time: for understanding the process and identifying common mistakes for the first use (20-25 minutes); for creating new assessments for re-takes (varies) after that, copying forms.

Materials	• Assessment Analysis Form

Lesson	**Initial Introduction of Task: (**25 to 35 minutes)
	
	• Return the assessment.
	• Individually, have students complete the first page of the form where they identify their mistakes and classify the type of mistake that they made on the assessment.
	• Teacher will model how to complete mistake corrections by using an identified common error made by several students. See examples below for a visual on what this might look like.
	• Students should then be assigned to groups of 2-4. Here are some options for groups:
	  ○ Use random assignments (e.g. fair sticks).
	  ○ Allow students to self-select to help facilitate a safe working environment.
	  ○ Pre-select groups so that each group has at least one student who did well on this assessment (this might take a little extra preparation time).
	
	• Students in groups will go through all problems in the assessment and stop when they encounter a problem that at least one student made a mistake. Students who got the problem will serve as a resource to assist student(s) who made a mistake. Only the student(s) who made the mistake will need to show her/his corrected work on page 2 of the Assessment Analysis Form. Alternatively, students may use attached paper, if needed, especially if the problem may need more space than is provided on the form (Note: make sure that students put the problem number next to their work).
	• When this process is complete, all students turn in both the analysis form and their assessment.
	• Offer a retake opportunity for each student.
	• Set a deadline of when they need to take the retake by. Generally, this will occur within a two-week time frame but you may allow a retake up to the week before the end of the term (quarter, trimester, semester) which you time for grading.
	
	Ongoing (options):
	
	Use of the form
	• Students work independently outside of class to make their corrections. They still turn in both the assessment and the form when they are done.
	• Provide students an opportunity to consult with peers and/or the teacher to help start the correction process (about 5-10 minutes) Students can finish the process outside of class. It's the teacher's option to either require that the first page be completed or not prior.

	• Teacher may decide to discuss common errors first, depending upon the situation. **Retakes** • You may require that a parent signs off on the form so that he/she recognizes that their child has made an effort to correct their mistakes. • Teacher may decide that a student re-takes the entire assessment or only those portions for which the student corrected her/his mistakes. Both of these require a new assessment. If the latter is used, then the teacher will need to re-calculate the student's grade/level of understanding to incorporate the results from both assessments.
Teacher Follow-up	**Teacher work after initial introduction:** (30 minutes): • The teacher reviews each student's corrections and discusses any key areas that still need to be addressed. This discussion must occur before the retake and may be done in class or outside of class. Retakes need to be created and assessed (varies).
Blank Forms	 Name _____ Original Score: _____ New Score: _____ Assessment Analysis So, you didn't do as well on your quiz or test as you wanted to, but good for you for taking the necessary steps to improve your score by proving to me that you know the information. This will take some time and effort on your part, but it will be worth it to get a better score, and a more secure understanding of the material. Follow these steps: 1. **Complete the evaluation table below for all incorrect answers. If you checked the careless mistake column, please briefly describe the mistake:** 2. **Correct the problems on the back of this sheet and show ALL of your work.** 3. Attach the original quiz/test to this completed form. 4. You are now ready to schedule a retake. **Front**  Problem # _____ Work If more space is needed, attach a separate sheet showing your work. **Back**

Examples		
	Front	Back

6. Growth Mindset Videos

Description:

Growth mindset videos were shown periodically at varying times throughout the school to keep a positive culture in the classroom. Videos were used for varying reasons depending on the specific classroom needs. Some specific instances for use included when spirits were low, after a test, in the middle of a challenging unit, or simply on Mondays. Selecting videos that were relevant to the class was extremely important, however, reflecting on what was seen in the video was even more important as the discussion carried the weight of the message that was to be internalize by the students. A variety of quick activities immediately followed the video to provide opportunities for students to debrief. Some of these include a quick write, journaling, whip arounds, team shares and posting quotes from the videos that students found powerful in the classroom.

Purpose:

The purpose of the videos was to continue to help students maintain a growth mindset about mistakes throughout the entire school year. We realized that impacting students feelings, some of which were very intense and very person, required ongoing care throughout the year. Sharing others' struggles and how they overcame them was beneficial for students. By showing these videos, it provided students with hope that their mistakes were part of the learning process.

Implementation guidelines:

Throughout the entire school year as needed

Student Outcomes for initial task:
Students will reflect on on the mindset messages that are evident in the video that is shown.

Student Outcomes for final task:
Students will not only reflect on the mindset messages that are within the video, they will internalize how they can apply it to their own lives. In turn, the culture of the classroom will continue to prosper with growth mindsets.

Growth Mindset Videos	
Learning Targets	 Students will continue to foster a growth mindset within the math classroom.  Students will recognize that maintaining a growth mindset takes time and effort and can increase their level of perseverance and math knowledge.
Mathematical Practice	SMP #1: Make sense of problems and persevere in solving them ● Students will gain a renewed sense of how to promote a growth mindset by persevering through challenging mathematical problems.
Time Frame	● Throughout the school year
Materials	● Computer with Internet access ● Video Projector ● Pre-selected video (See examples for possible videos)
Lesson	**Introduction/Launch: (1-2 minutes)** ● Promote a growth mindset prior to starting this activity. Set the stage for why you are sharing the video. Remember the selection and timing of the video should be situational to the needs to your classroom. ○ **Example:** "Here is the Mindset Monday video that I wanted to share with the class today. Jot down any messages that you feel are powerful to you." ○ **Example:** "I wanted to share this video with all of you because it reminded me of how you did on this last chapter test. See if you can figure out what message I wanted you to take away from the video as it pertains to this test." **Activity: (1 to 5 minutes depending on the length of the video)**

	● Play the pre-selected video ● Possible Activities to use after the video: ○ **Quickwrite:** ■ Pose a possible question prior to the start of the video and have students place it at the top of their paper. Have students reflect on this question after the video ● **Example:** Could you make a personal connection to this video? Please explain. ● **Example:** How would you help promote this motivational growth mindset message to your friends/classmates? ● **Example:** Do you agree or disagree with the message that this video is sending? ● **Example:** What is one thing that you can take away from this video that you can start using immediately? Why did you chose this? ○ **Journaling:** ■ Have students write about the message that was in the video and how it pertains to them personally. ○ **Whiparound:** ■ Go around the room and have each student share one thing that stood out to them in the video. It can be a connection, a quote, something they could use in the future, something they did not know etc. ○ **Team Shares:** ■ Have teams discuss the video and then share one thing they learned. You can also have students select one message from that video that their team will work on during their time together as a team. **Closure:** ● Bring the class together to reiterate the message. At this time, you could as a class decide on the most powerful message and write it down and post it in the classroom as a reminder to keep a growth mindset. Another option would be to record what the class feels was the most powerful statement and turn it into a goal for the class. When the teacher sees a team employing it, a celebration of recognition could take place.
Teacher Follow-up	The teacher needs to continually keep a pulse on the classroom to see when a mindset video is needed. Also, there may be recognition needed to teams or students who are

	displaying a mindset that parallels one of the videos that was shown, so make note of this occasions and celebrate them.
Examples listed by categories	**Teaching Mindset: Mindset Mondays** • **Growth Mindset Animation** https://www.youtube.com/watch?v=-_oqghnxBmY • **Growth Mindset Video** https://www.youtube.com/watch?v=ElVUqv0v1EE • **Everyone can learn** https://www.youtube.com/watch?v=JC82Il2cjqA • **Believe in Yourself** https://www.youtube.com/watch?v=AjZ0KbJcav0) --- **Motivational about Mistakes or When Spirits low** • **Sesame Street: Bruno Mars ~ Don't give up!** https://www.google.com/url?q=https://www.youtube.com/watch?v%3DpWp6kkz-pnQ&sa=D&ust=1466549968776000&usg=AFQjCNENrPKUgXhsWhK7dt0NR5tJV7K5Kg • **Mindshift Motivational Video** https://www.youtube.com/watch?v=fviFNrWKzZ8 • **Never give up** https://www.google.com/url?q=https://www.youtube.com/watch?v%3DPjP9r-HU4fk&sa=D&ust=1466549968777000&usg=AFQjCNGYaonnANoMZmKVaZfpj6nA1G78kA • **Famous Failures with music but no words** https://www.youtube.com/watch?v=U0lGcESiLWM • **Best inspirational Video** https://www.google.com/url?q=https://www.youtube.com/watch?v%3DR5TlS7BR3X4&sa=D&ust=1466564021397000&usg=AFQjCNG_NCiut9y4s0og19NGqd2yuER8QA --- **Teaching how the brain learns** • **The learning brain** https://www.google.com/url?q=https://www.youtube.com/watch?v%3DcgLYkV689s4&sa=D&ust=1466567962605000&usg=AFQjCNEluwh7m8B6PcACvfqbd-

	tumXMapQ **After a test** NOTE: Videos were carefully selected after chapter assessments were graded. The message needed to match the message the teacher wanted the students to take away from their exam. • **You can learn anything** https://www.khanacademy.org/youcanlearnanything • **Growth mindset video: How do I train my brain (Steve Jobs)** https://www.youtube.com/watch?v=ElVUqv0v1EE • **Audri's Rube Goldberg** Expect failures, and try again https://www.youtube.com/watch?v=IMboI4cOAuQ • **Thank You Mom** https://www.youtube.com/watch?v=1SwFso7NeuA • **Maybe it's my fault (Michael Jordan)** https://www.youtube.com/watch?v=9zSVu76AX3I • **Famous failures** https://www.youtube.com/watch?v=zLYECIjmnQs • **Never Give up (Olympic track star falls)** https://www.youtube.com/watch?v=kZlXWp6vFdE
Student Examples/Feedback	• You should believe you can accomplish anything. • Have confidence and trust in yourself. • Belief + effort = success • Give 100% effort. • Everyone has moments of doubts, but s/he does not live in those moments. • Be your own person. • We all start at zero but we can grow to become anything. • Don't be afraid to make a mistake. • Our brains are designed to learn - keep trying. • Everyone's brain can grow. • You can accomplish things at the highest level.

7. Activities That Promote a Growth Mindset

Description:
Reinforcing growth mindset, making mistakes and learning from them are important norms to maintain throughout the school year. We have selected a few tasks that have been used in our classrooms; all require some sort of preparation, but in most cases, it is minimal.

Purpose:
This collection of activities will assist in keeping growth mindset concepts ever present in students' minds. Remember that this is just a sampling of growth mindset tasks that we have tried in our classrooms. There are many more excellent ones to be found. Keep in mind that the purpose of engaging in these activities is "process" rather than "outcome." You need to look at how students are working together as a team.

Implementation guidelines:
Throughout the school year (every other month at a minimum). We have provided five (5) different activities, which may be completed in any order. These activities include:

- Balloon Tower
- Painted Cube
- Tom's Tile Company
- Building Shapes
- Paper Table

All of these activities have been used in our classrooms and proved a "hit" with our students. We have also included a few other activities that you might want to consider doing with your students.

Student Outcomes for initial task:
After completing each task, words such as "teamwork," "experimenting," "mistakes," "growth mindset," and "perseverance" all came up during their reflections of the activities.

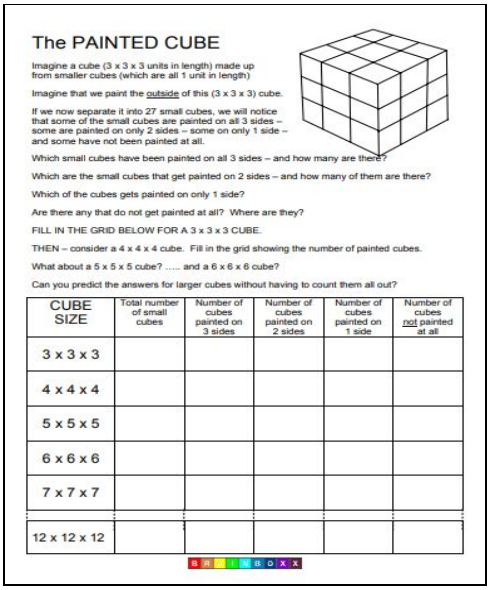
Student Outcomes for final task:
The final outcome is for students to transfer the words and their growth mindset to everyday classroom tasks.

Activities that promote Growth Mindset	
Learning Targets	 Students will engage in team activities that promote growth mindset.  Students will come to understand the importance of both group and individual processes, including learning from mistakes, persevering, collaborating, and

	experimenting.
Mathematical Practice	SMP #6: Attend to precision ● Students will work collaboratively in activities that aim not only to promote growth mindset but also focus on the problem-solving process.
Time Frame	● One to two times per month during the school year. ● Tasks would be done after initial August/September activities have been completed. ● Tasks need not be done in any particular order.
Materials	● Vary, depending upon the activity.
Activity 1 Balloon Tower	**Materials: 10 balloons and 1 meter of masking tape per group** **Introduction/Launch: (3-4 minutes)** ● Students, working in teams of 3-4 build the tallest, freestanding tower using balloons and masking tape. ● They will have 12 minutes to build the tower. ● Teams are responsible for blowing up balloons, cutting tape, and making sure that the tower is freestanding on a desk/table. If a balloon pops during this activity, you do not replace it. **Activity: (12 minutes)** ● Remind students about the importance of a sturdy base. ● Remind students about managing their time (you may want to write how much time is remaining and/or provide a two-minute warning). At the end, walk around and measure the different heights while pointing out the differences in structures. **Closure:** (5-7 minutes) ● Walk around and measure the different heights while pointing out the differences in structures. ● You may want to ask students why they believe some structures worked better than others.
Teacher Follow-up	● You may want to repeat this activity using the same or different groups after debriefing the first attempt. ● Have students reflect on this activity (individually) and share their thoughts with the class.

Example	 **How did the students put the balloons together to create the tallest structure possible?**

Activity 2 **Painted cube**	**Materials: Sugar cubes (make sure to have plenty of extra cubes) and markers** **Introduction/Launch: (3-4 minutes)** ● Students, working in teams of 3-4 work on the following problem: ● Imagine that we paint a 3 x 3 x 3 cube blue on every side. ● How many of the small cubes have 3 blue faces? ● How many have 2 blue faces? ● How many have 1 blue face? ● How many have not been painted at all? ● How many faces would be painted in a cube of any size? ● Students should be prepared to justify their solutions. **Activity: (30-40 minutes)** ● Teams work independently to map out their solutions. ● You may want to suggest they try a smaller case first. ● You may want to suggest that teams using some sort of color-coding scheme. ● You may want to remind teams to document their solutions as they progress. **Closure:** (6-8 minutes) ● Ask team members how they came up with their solutions for each of the sides. ● This could be done at the end of this activity or same for the next day as a number talk.
Teacher Follow-up	● You may want to extend this activity to include cubes of varying sizes (e.g., 1x1x1, 2x2x2, 4x4x4, 5x5x5, and 6x6x6). This will lend itself to students seeing

	a pattern and coming up with a rule. For a cube of any size. Creating a table works best in this scenario. ● Have students reflect on this activity (individually) and share their thoughts with the class.
Blank Forms	● http://www.brainboxx.co.uk/a4_resource/pages/Maths/PAINTED_CUBE.pdf  ● The above link has a description of the tasks as well as a table for both the initial cube (3 x 3 x 3) as well as the extension activities.
Example	 **How did the students figure out how many faces would be painted?**

The PAINTED CUBE

Imagine a cube (3 x 3 x 3 units in length) made up from smaller cubes (which are all 1 unit in length)

Imagine that we paint the outside of this (3 x 3 x 3) cube.

If we now separate it into 27 small cubes, we will notice that some of the small cubes are painted on all 3 sides – some are painted on only 2 sides – some on only 1 side – and some have not been painted at all.

Which small cubes have been painted on all 3 sides – and how many are there?

Which are the small cubes that get painted on 2 sides – and how many of them are there?

Which of the cubes gets painted on only 1 side?

Are there any that do not get painted at all? Where are they?

FILL IN THE GRID BELOW FOR A 3 x 3 x 3 CUBE.

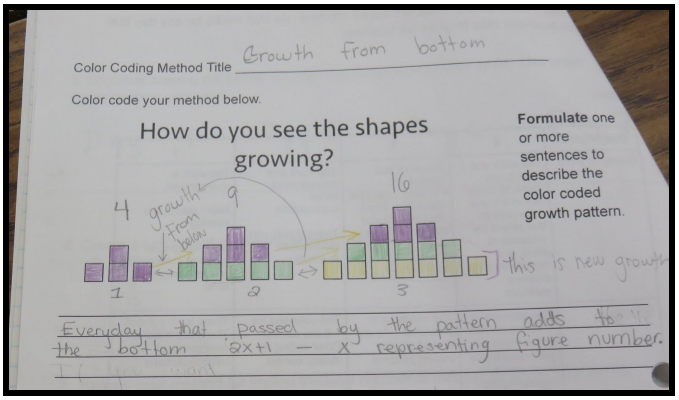
THEN – consider a 4 x 4 x 4 cube. Fill in the grid showing the number of painted cubes.

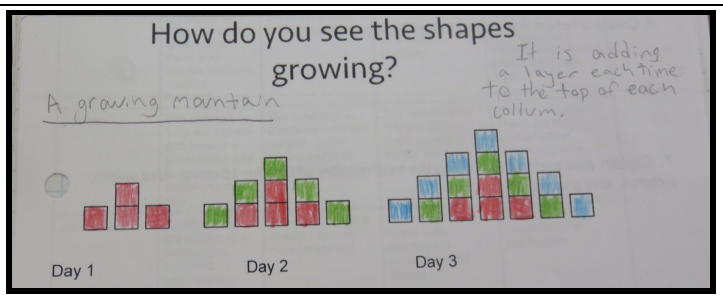
What about a 5 x 5 x 5 cube? ..... and a 6 x 6 x 6 cube?

Can you predict the answers for larger cubes without having to count them all out?

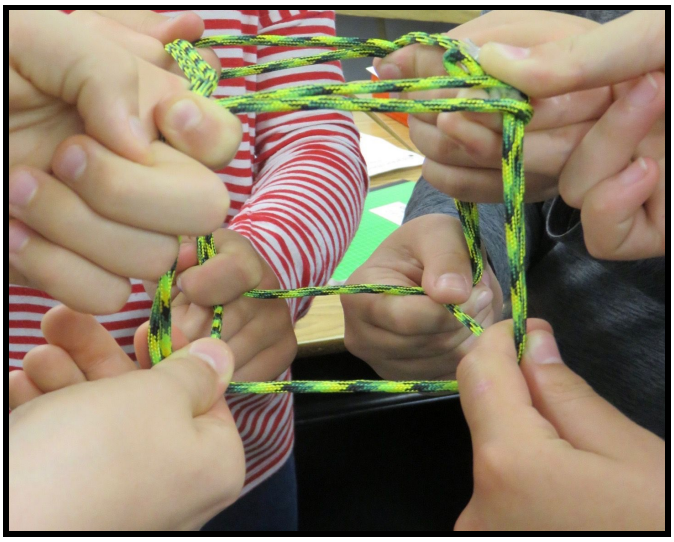
CUBE SIZE	Total number of small cubes	Number of cubes painted on 3 sides	Number of cubes painted on 2 sides	Number of cubes painted on 1 side	Number of cubes not painted at all
3 x 3 x 3					
4 x 4 x 4					
5 x 5 x 5					
6 x 6 x 6					
7 x 7 x 7					
12 x 12 x 12					

Activity 3 **Tom's Tile Company** **A variation of** **Squares upon Stairs**	**Materials:** Form and colored pencils **Introduction/Launch: (3-4 minutes)** ● Let students know that they will be working both individually and in teams of 3-4. ● The goal is to initially find up to 4 different ways to see how the pattern grows.

	• Go over Items 1 through 4 before starting the activity. **Activity: (20-40 minutes)** • Allow time for individual's to work independently on items 1 through 4 (about 10-15 minutes). • Use colored pencils to draw each pattern and its growth. • Once this is completed, have each member of the team share at least one way s/he saw the pattern growing. • You have an option to stop here or continue with teams working together on items 5 through 11 on the form. Again, your choice may be dependent upon time. Certainly, items 5 through 11 could be done on a different day. **Closure:** (5-8 minutes) • Using a Whiparound, ask each group to present one way the members saw the pattern growing. • Ask each member to show the pattern (overhead) while explaining their work.
Teacher Follow-up	• Have students reflect on this activity individually and in writing.
Blank Forms	• https://docs.google.com/document/d/1opnzMCmz-O4cquO6Wu_aBH35B0EVXzU9eWzKELeUd-Q/edit • NOTE: This document contains both an introduction to the task as well as the student sheets and a rubric (optional).
Example	

	 How did these students see the shapes growing?

Activity 4 **Building Shapes (from Week 3 of the Week of Inspirational Math at youcubed.org)** 	**Materials:** Each group has a 7-8 foot piece of rope (see picture for sample) that is tied securely in a loop. **Introduction/Launch: (3-4 minutes)** ● Students will work together in groups of 4 to make the following shapes: square, 5 pointed star, square pyramid, tetrahedron, octahedron, and cube. **Rules:** ● All group members must have at least one hand on the rope. ● You cannot untie the rope. ● You must use all of the rope. ● Groups must check in with the teacher before making the next shape. You can make the shapes in any order. ● As there is a reflection at the end of this activity, let students know that they should focus on the following ways we learn math: draw it out, experiment, teamwork, look for different resources, and start with a smaller case. It will be important that the teacher allow students to use out-of-the-box thinking and use of materials. For example, to verify that a shape was in fact a square, a group could use square tiles on the floor. **Activity: (30-35 minutes)** ● Groups work together to form each shape (order does not matter). ● As the teacher, you check each shape before the group can move on. ● It will be important to ask students in each group why they believe their shape is correct (in effect, the teacher plays the role of a skeptic). **Closure:** (5-8 minutes) ● Ask a group to demonstrate how they formed their shape to the class. In this case, let other students act as skeptics.

Teacher Follow-up	• The purpose of the activity was to focus on how we learn math: Draw it out, teamwork, experiment, look for different resources, start with a smaller case. • Ask students to write a reflection of the activity and then have them share their reflection with 1-2 students.
Example	 Students construct a cube. The question is - how can they prove it's really a cube?

Activity 5 **Paper Table** Adapted from http://pbskids.org/designsquad/parentseducators/resources/paper_table.html	**Materials:** • 1 piece of cardboard (approximately 8 1/2 x 11 inches) • heavy book (e.g., a textbook) • masking tape • 8 sheets of newspaper **Introduction/Launch: (3-4 minutes)** • Students will work together in groups of 2 to first design and then construct a table out of newspaper tubes. • The table must be at least eight inches tall. • The table must be strong enough to hold **at least** one heavy book for 30 seconds. **Activity: (25-37 minutes)** • Ask students in their groups to look at their materials and think about the questions below. • Have students sketch their ideas on a piece of paper. (limit 5-7 minutes)

	• Questions: 1. How can you make a strong tube out of a piece of newspaper? 2. How can you arrange the tubes to make a strong, stable table? 3. How can you support the table legs to keep them from tilting or twisting? 4. How level and big does the table's top need to be to support a heavy book? • You can limit the building portion to anywhere from 20-30 minutes. **Closure:** (10-15 minutes for testing and feedback) • Provide a level area (e.g., desk) for students to place their finished product. • Measure that the table is at least 8 inches tall. • The teacher will test one group's table at a time. • Let students know that you will place a heavy book on the table's top for 30 seconds and continue adding books with the timing until the table collapses. • Students should observe what they think caused each table to "fail" and discuss this with the class.
Teacher Follow-up	• Repeat the building/testing process to see if students can make a better model the second time around. This is beneficial in that it provides an opportunity for students to learn from their mistakes. Use the same groups as before or shuffle.
Example	 **How many heavy books will this paper table hold?**

Additional Growth Mindset Activity Options	• Week of Inspirational Math (Jo Boaler) - great activities for the beginning of the school year https://www.youcubed.org/week-inspirational-math/ • Tasks from youcubed.org (lots of low floor/high ceiling tasks) https://www.youcubed.org/tasks/

	• Nine Colors (create a Rubik's cube-like structure) https://nrich.maths.org/768 • Marshmallow challenge (similar to Activity 1) http://coop8th.weebly.com/uploads/1/3/3/8/13389650/marshmallowchallenge.pdf

Conclusion

We think it's fair to say that this work has opened our eyes to what is possible toward helping students develop a growth mindset and acknowledge/celebrate that making mistakes (and correcting them) constitute an integral part of learning.

No longer were most of our students afraid to make a mistake. This was a big leap forward in their learning. The same can be said about us - we may have been a bit hesitant to focus on students' mistakes at the beginning of this process. It involved continual learning and refinement for both students and teachers.

By the end of the school year, assessment was no longer viewed merely as a performance task, but rather as a learning opportunity. This was a significant change for our students.

We realized the importance of setting up the classroom at the beginning of year to reflect a growth mindset and recognized the value of making and correcting mistakes. This included involving students right away on activities mentioned in the Implementation Chart. This allowed for the creation of a culture which supported not only growth mindset, but the ability of students to see themselves as capable learners and, later in the year, to become able to view mistakes as a gateway toward increasing knowledge.

Furthermore, we learned that throughout the year, it was important to periodically reinforce these initial activities through:

- **Sharing our own experiences making mistakes and correcting them:** On a daily basis, we as teachers acknowledged our own mistakes and either self-corrected or had students correct them. One of us shared her new learning experience of trying to build a 3D model using software and printing the final object. This included explaining how difficult it was to keep persevering until the desired result was achieved. Furthermore, this experience provided the researcher with empathy for what students were going through every day. This same teacher

also made a point of making a daily mistake and pausing to provide an opportunity for students to correct it**.** She learned that later in the year one student told her parent that it was fine to make mistakes and that's what her teacher says. We all found that pausing and acknowledging when we made mistakes was beneficial and even celebrated. Through modeling, acknowledging and correcting mistakes, researchers found that their students started to change their views and attitudes towards mistakes.

- **Providing opportunities during the school year:** Showing motivational growth mindset videos and working on growth mindset activities benefited the classroom environment. These videos largely focused on people making mistakes and meeting challenges. They talked about how they had to struggle but were able to persevere. We both found that these videos greatly improved the culture of our classrooms. One of us had her class watch a Jo Boaler *Ted Talk* later in the year, in March (https://www.youcubed.org/oxford-tedx-talk/) and then reflected on the message. For this, students wrote the following: *No one is born with a math brain*; *Anyone can learn math*; *When you change your mindset, you change your beliefs*; *Mistakes make your mind grow*; *Your brain grows when you struggle*; and *There are many ways to do math*.

- **Working on problems, collaborating, and fixing mistakes:** This included independent work on projects, students working with other students to correct mistakes, and students demonstrating their understanding of problems by explaining their answers (correct or not) in front of their peers.

  One of us split her classes into two groups throughout the year; one group worked at a faster pace, one at a slower pace. She learned that growth mindset developed in both groups, but in the slower-paced group it was more noticeable. Instead of relying on what the students perceived as their "smarter" peers, this group invested more time struggling, fixing mistakes and figuring out solutions. Later in the year, when paired with students in the faster-paced group, these students were able to hold their own. It seemed that, for the most part, they had developed and were able to maintain a growth mindset; they were no longer shy about contributing in a group and working with anyone to solve problems.

Teacher Behavior Changes

From working with students on growth mindset and fixing mistakes, we noted our own behavioral changes. Perhaps the most significant change was that we no longer brushed over mistakes. In the past, a teacher from our research team might have been prone to downplay a mistake whereas now it was celebrated as a way to reinforce a growth mindset.

We realized that mistakes happen to everyone, every day. We showed our students that mistakes are truly powerful learning tools, and now consider their own as such. Moving forward, each of us is committed to helping students learn that making and correcting mistakes is an essential part of the learning process and they no longer need to hide them or feel embarrassed.

Developing a growth mindset culture in the classroom fed right into this idea that mistakes are welcome and that the math classroom is a safe place to learn from them. Students and teachers both understood the power of making mistakes, took ownership of their mistakes, and used mistakes as a learning tool. It is often when teachers and students fail, that we learn the most.

Advice for Teachers on Assessment Analysis

To help a new teacher implementing assessment strategies, we would advise starting by selecting one strategy and making it his/her own and then tailoring it to the needs of the students. Keep it simple and don't make it too cumbersome for the students otherwise they will be reluctant to participate. Also, allow time to interact with these self-assessing strategies if you want students to take them seriously. Modeling them might be helpful for those students who have never had to really self-assess themselves before. Ultimately, once students see the benefits of self-assessment, the buy-in will increase, and student empowerment can enhance student learning.

Time was one of the key elements. It was imperative to ensure that students have ample time to analyze their mistakes and embrace them as an opportunity to learn. Allowing class time to begin this process allowed students the opportunity to engage in discourse with their peers and the teacher regarding their mistakes. It provided that additional support that many students needed to work through their mistakes. An additional side effect of allowing class time was that those students who did well on a test/quiz were more than willing to help those students who had questions by guiding them through their mistakes. Time was provided for one-on-one help, whether it be teacher-student or student-student, to occur within the context of the classroom. We found this to be a beneficial way to engage all students with embracing mistakes as an opportunity to learn within the classroom. Failure to allow this valuable class time to investigate mistakes resulted in fewer students taking advantage of the opportunity to retake tests and quizzes.

Final Thoughts from Students

Finally, growth mindset and making mistakes can be seen in part of a song written by some students (modeled on "Let it go" from the movie *Frozen*):

I used to think that making mistakes was wrong.
And I was mad
I always made them in math class,
I felt so very sad.

The teachers told me that mistakes are fine to make,
Can't stop making them, even though I try.

Don't let them know, don't let them see,
Don't make mistakes, it's not part of me
Conceal, don't feel, don't let them know!
Well now they know!

Make mistakes, make mistakes,
Can't hold them back anymore,
Make mistakes, make mistakes,
It's okay to make mistakes

I don't care, what they're going to think,
Let mistakes happen,
They'll help my brain grow anyway.

It's funny how some people,
Think mistakes are wrong,
Even though that used to happen,
It doesn't get to me at all.

It's time to see what I can do,
To make mistakes and break through,
No right, no wrong this is who I'll be
It's me.

Make mistakes, make mistakes,
Can't hold them back anymore,
Make mistakes, make mistakes,
It's okay to make mistakes.

Here I am, and here I learn,
Let mistakes be made.

Here I stand, in the midst of mistakes,

My mistakes are mine
I'll make mistakes everyday.

Make mistakes, make mistakes,
Can't hold them back anymore,
Make mistakes, make mistakes,
It's okay to make mistakes.

Appendix

Mistake Bubble

Write down what words you think about when you see the word mistake.

Write down what words you think about when you see the word mistake.

Mistake Bubble Word Spreadsheet

Phrase	Class 1	Class 2	Class 3	Total:
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
	0	0	0	**0**
Total Words:	**0**	**0**	**0**	**0**

Power of Yet Note to Self

Mathematician: _____

The Power of YET…

Everyone has something that they are not good at yet. Tell me one thing that you are not good at yet, but will work to be good at by the end of the _____.

Mathematician: _____

The Power of YET…

Everyone has something that they are not good at yet. Tell me one thing that you are not good at yet, but will work to be good at by the end of the _____.

Visual Learning Rubric for Power of Yet

The Power of Yet

It's new to me.

I'm not there, yet!

I'm there and I can explain my thinking.

I've got it and I could teach it to someone else!

The Power of Yet

It's new to me.

I'm not there, yet!

I'm there and I can explain my thinking.

I've got it and I could teach it to someone else!

I can't do math.

I D K

I'll never be that smart.

I made a mistake.

This is too hard.

It’s good enough.

I give up.

I'm not good at this.

Growth Mindset Statement Tracking Form

Fixed Mindset Statement	Growth Mindset Statements
I made a mistake.	

Fixed Mindset Statement	Growth Mindset Statements
I can't do math.	
	.

Fixed Mindset Statement	Growth Mindset Statements
I'll never be that smart.	

Fixed Mindset Statement	Growth Mindset Statements
I am not good at this.	

Fixed Mindset Statement	Growth Mindset Statements
It's good enough.	

Fixed Mindset Statement	Growth Mindset Statements
This is too hard.	

Fixed Mindset Statement	Growth Mindset Statements
IDK	

Fixed Mindset Statement	Growth Mindset Statements
I can't make this any better.	

Fixed Mindset Statement	Growth Mindset Statements
I give up.	

Change your words, change your mindset bulletin board activity sample student responses

Fixed Mindset Statement	Growth Mindset Statements
I made a mistake.	I made a mistake, but I will try again.
	Mistakes help me learn.
	I made a mistake and I'll learn from it.
	I will work on fixing and learning from my mistakes.
	I will learn from my mistake.
	I will fix my mistake.
	Mistakes improve my learning.
	I made a mistake, but I will fix it.
	I made a mistake, but now I'll learn from it.
	I made a mistake, but I'll try to fix it.
	I learned from my mistake.
	I made a mistake, how can I fix it?
	I made a mistake, but I know I can go back and fix it.
	I made a mistake, which is good.
	I made a mistake that can be fixed.
	I made a mistake and learned from it.

Fixed Mindset Statement	Growth Mindset Statements
I can’t do math.	**I can do math.**
	I can improve in math.
	I can get better at math.
	I can do the math; I just need more time.
	I can practice more.
	I can try harder.
	I can’t do math, but I can learn if I stay with it.
	I can’t do math …right now, but I'm going to keep working on it.
	I can try to do math.
	I can’t do math, yet.
	I’ll try to do math.
	The math is difficult, but I can learn.
	I can’t do math, but I will keep on trying.
	I can’t do math, but I will do my best.
	I can do math.
	I got this!

Fixed Mindset Statement	Growth Mindset Statements
I'll never be that smart.	**I'll never be that smart, but I'll never give up.**
	I will never give up!
	I am smart, but I may have to work on this a little bit more.
	I will be smart if I continue to try.
	I will continue to work at getting smarter by trying my best.
	I have to work to get smarter.
	I will be the best that I can be!
	I will grow to be smarter.
	I can try to be smart.
	I will never be that smart unless I try.
	I will never, not be smart.
	I will never be smart for less than a second.
	I can be smart.
	I'm not that smart, yet.
	I will get smarter.
	I will never be smart if I don't put myself to it and try.
	I'll never be smart unless I try to learn.

Fixed Mindset Statement	Growth Mindset Statements
I am not good at this.	**I am not good at this yet!**
	I'm not good at this until I get it right.
	I'm not good at this right now.
	I can work to be better at this.
	I will try harder.
	I am not good at this, but I can learn.
	I'm not good right now, but soon I'll be great.
	I'm not good at this, so I'll work to get better.
	I'm not good at this, but if I try harder I will be better.
	I am not good at this until I practice and study.
	I'm not good at this, but I'm getting better.
	Even though I'm not good at this, I will still try my best.
	I can try to be good at this.
	I am not good at this until I learn.

Fixed Mindset Statement	Growth Mindset Statements
It's good enough.	**It is almost good enough.**
	It is not good enough yet.
	Everything can be improved upon.
	It can be good enough it I have tried my best.
	What can I do better?
	I can make it better.
	It is not good enough and I will improve what I can.
	It is not good enough until I try my hardest.
	It is okay, but I can make it better.
	I can try harder.
	It is not good enough.
	It's good enough although it can be better.
	If I do this even more, it will be great!
	I can do better.
	It's good enough, but I could add more work.
	It's good enough for someone else, but not for me.
	It's not good enough until we fix it.
	It is not good enough, but I'll try harder.

Fixed Mindset Statement	Growth Mindset Statements
This is too hard.	**What can I do to make it easier?**
	This is not too hard, I got this.
	This is hard, but I can do it.
	This is hard at the moment but if I work at it, it will get easier.
	This is too hard for now, but I will continue to work on it.
	This is too hard, but I will try.
	This isn't too hard.
	This is pretty difficult, but I can do it.
	This is too hard, for now.
	This is too hard, but it will get easier as I work on it.
	This is too hard, but I can work on it.
	This is too hard, but I will keep trying.
	If I try, it won't be hard later.
	This is too hard, but I'll figure it out.
	This is a bit hard although if I try, it will be easier.

Fixed Mindset Statement	Growth Mindset Statements
IDK	**I do know.**
	I don't know, but I will find out.
	I can figure this out.
	I will find the answer.
	I don't know yet.
	I will know because I am going to keep trying.
	I don't know right now.
	I don't quite understand this.
	I don't know, but I will try.
	IDK, but I will figure it out.
	IDK, how can I help myself so I do know?
	I'm not sure, but I will try to figure it out.

Fixed Mindset Statement	Growth Mindset Statements
I give up.	**I won't give up.**
	You can do it!
	I'll keep trying.
	Never give up.
	I won't stop until I have figured this out.
	Don't give up.
	I give up not trying.
	I'll try again.
	I give up for now, but I will come back to this.
	I won't give up and I will try again.
	I will never give up.
	I will never, ever give up.
	I give up, but I'll try again later.

Mel Radke Story

Mindset and Songbirds

By: **Penny Smits**

Mel Radeke. He is one of the wisest men I have ever been fortunate enough to meet. The story he conveyed to me beautifully dovetailed into the concept of mindset as it has been a key area of investigation for CPM's Teaching Redesign Corps this past year.

Spending time at a friend's cabin afforded me the chance opportunity to meet their neighbor, Mel Radeke. This 80ish-year-old man gave me much pause as we spoke. As it turns out Mel was talking about the songbirds that he carves out of wood. Mel was too humble to convey that he has won multiple National woodworking competitions, but our friends were more than eager to brag on his behalf. He showed us photos and they were breathtakingly beautiful!

Long story short, he was at a trade show, displaying his birds. He said many people commented on how beautiful they were and how talented he was. But the thing that really stuck out to him was the comment many people made, "I would never be able to create something like that."

This really bothered Mel and he said we wanted to change the way people thought about their ability to try something. So, the next trade show that he went to, he had a plan. When someone brought up the fact that they could never make something like his songbirds, he said all you need to do is try. Many people still disbelieved that they could make such a beautiful songbird. He then reached below the table and brought out a songbird that was of less beauty and quality than those on the table. He then asked the people, "Do you think you could do this?" The overwhelming majority said that they could and almost laughed at the lack of quality in the songbird.

Mel's response was, "Well, this was my first songbird. All you see is my beautifully crafted songbirds that I've created after years of practice, and you tell yourself that you can't do it. But, you can do this just like I did. You see, I began to research birds and study their photographs. I played about with the wood to try out new carvings. You too can learn."

He also went on to say how afraid he was to actually paint one of his birds. He was so afraid that he would ruin the beautiful carved wooden bird because you see, he was no painter. So afraid to make a mistake, he did not paint them at first. But one day, he got brave and started to experiment with the paint and the colors. Once again he practiced and studied the colors of the birds. He began to paint and paint. The beauty of this story is that painting was at one time the part of creating the wooden songbird that Mel dreaded the most, but today, he says it is the best part of creating the bird.

I know that I did not do justice to the story that he told me as it was so eloquent. I just could not stop thinking about what he said. Could I apply this to my teaching? To my classroom climate of a growth mindset? How can I show my students the first "songbird" that was created? How can I give

them the tools to understand that your first bird may be the hardest? How can I get them to not focus on my most recent bird but instead have the courage to make their first bird? How do I get my students to not always be fixated on the end result of years of practice and effort? How can I naturally do this within the context of my classroom? Mel really opened my eyes to how growth mindset needs to be promoted in all areas of our lives. He showed me how self-talk can either be destructive and hold us back, or inspirational and carve a path forward for us. It made me see how powerful my words are and that they need to be chosen very carefully when working with my students. It also made me see that a growth mindset can be found everywhere, if you are willing to keep your mind open and are willing to look and listen for it. I can honestly say, that since beginning this project, I have noticed it more than ever. I see it in my colleagues' classrooms, in my son's karate instructors conversation with the kids, in the media, and in the ways that others encourage one another. I know now how extremely important it is to teach the students about mindset so that they too can become aware of how much their world is filled with it.

I am forever indebted to Mel for sharing his story and I know that I too need to show my students that first songbird.

Sample Mistake Analysis Template

Team #

Lesson _____

Homework Questions _____

This team has come to the consensus that the following question is incorrect: _____

Write the mistake with all of the work as it is shown in the answer key and pinpoint where the mistake occurred by **highlight** it.

Correct the mistake and show all your work.

The advice our team gives the student who made this error is…

Sample homework answer key with embedded mistake

Lesson 9.2.2

What is special about a right triangle?

Pythagorean Theorem

Lesson 9.2.2

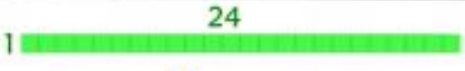
Homework:

Review & Preview

9-74 to 9-79

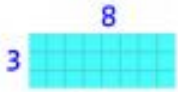
9-74 If you have 24 square tiles, how many different rectangles can you make? Each rectangle must use all of the tiles and have no holes or gaps. Sketch each rectangle on graph paper and label its length and width.

1 x 24



2 x 12

3 x 8



4 x 6

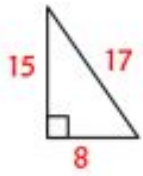
9-75 Lydia has four straws of different lengths, and she is trying to form a **right triangle**. The lengths are 8, 9, 15, and 17 units. Which three lengths should she use? Justify your answer.

8, 15 and 17

$8^2 + 15^2 = 17^2$

$64 + 225 = 289$

$289 = 289$



9-76 The Wild West Frontier Park now offers an unlimited day pass. For $29.00, visitors can go on as many rides as they want. The original plan charged visitors $8.75 to enter the park, plus $2.25 for each ride. Write an equation to determine the number of rides that would make the total cost equal for the two plans. Solve the equation.

Let X = # of rides

equation: $\longrightarrow 29 = 8.75 + 2.25x.$

$-8.75 \quad -8.75$

$$\frac{20.25}{2.25} = \frac{2.25x}{2.25}$$

x = 9 rides

9-77 Complete the table.

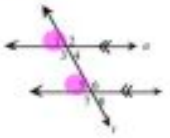
x	4	$\frac{1}{2}$	−2	0	−1	7
y	−11	-4	1	−3	−1	-17

A. Rule: y = -2x - 3

B. Slope: -2

C. y-intercept: (0, -3)

9-78 Solve for x. Each part is a separate problem.



A. If $m\angle 1 = 3x - 18°$ and $\angle 5 = 2x + 12°$, find x.

Corresponding angles are =

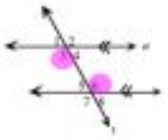
$3x - 18 = 2x + 12$

$-2x \quad -2x$

$x - 18 = 12$

$+18 \quad +18$

$x = 30°$



B. If $m\angle 3 = 4x - 27°$ and $\angle 6 = x + 39°$, find x.

Alternate Interior Angles are 180°

$4x - 27 + x + 39 = 180$

$5x + 12 = 180$

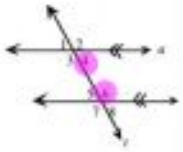
$-12 \quad -12$

$\frac{5x}{5} = \frac{168}{5}$

$x = 33.6°$

9-78 Solve for x. Each part is a separate problem.

C. If $m\angle 4 = 49°$ and $\angle 6 = 5x + 41°$, find x.



Same side Interior Angles =180°

$49 + 5x + 41 = 180$

$90 + 5x = 180$

$-90 \quad -90$

$5x = 90$

$5 \quad 5$

$x = 18°$

9-79 Calculate the value of x.

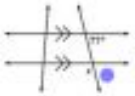
A.

$x = 90 + 46$

$x = 136°$

Exterior Angle Theorem

B.



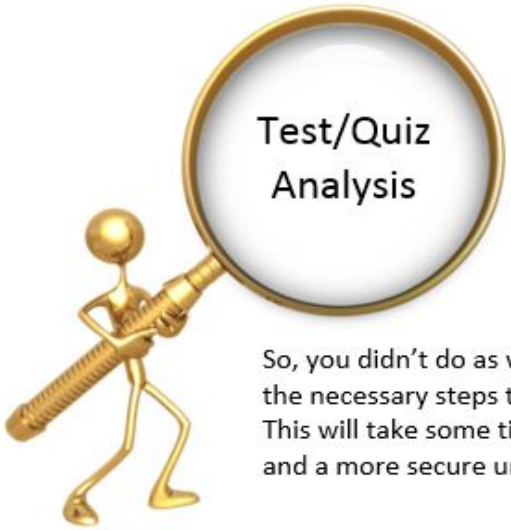
$x = 180 - 77$

$x = 103°$

m< 7 and m< ● are corresponding which makes them equal

m< ● and m< x are straight

Assessment Analysis Form



Name _____

Original Score: _____

New Score: _____

So, you didn't do as well on your quiz or test as you wanted to, but good for you for taking the necessary steps to improve your score by proving to me that you know the information. This will take some time and effort on your part, but it will be worth it to get a better score, and a more secure understanding of the material.

Follow these steps:

1. **Complete the evaluation table below for all incorrect answers. If you checked the careless mistake column, please briefly describe the mistake:**

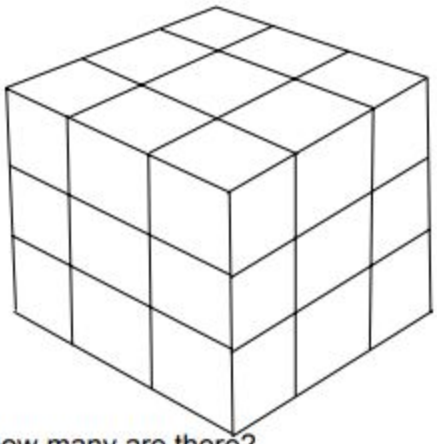
QUESTION NUMBER THAT I GOT WRONG	CARELESS MISTAKE	DIDN'T KNOW THE MATERIAL	DIDN'T UNDERSTAND THE QUESTION
(example) #3	x - I forgot the negative symbol		

2. **Correct the problems on the back of this sheet and show ALL of your work.**
3. Attach the original quiz/test to this completed form.
4. You are now ready to schedule a retake.

Problem # _____ Work	Problem # _____ Work
Problem # _____ Work	Problem # _____ Work
Problem # _____ Work	Problem # _____ Work
Problem # _____ Work	Problem # _____ Work
Problem # _____ Work	Problem # _____ Work

Activity 2: Painted Cube

The PAINTED CUBE



Imagine a cube (3 x 3 x 3 units in length) made up from smaller cubes (which are all 1 unit in length)

Imagine that we paint the outside of this (3 x 3 x 3) cube.

If we now separate it into 27 small cubes, we will notice that some of the small cubes are painted on all 3 sides – some are painted on only 2 sides – some on only 1 side – and some have not been painted at all.

Which small cubes have been painted on all 3 sides – and how many are there?

Which are the small cubes that get painted on 2 sides – and how many of them are there?

Which of the cubes gets painted on only 1 side?

Are there any that do not get painted at all? Where are they?

FILL IN THE GRID BELOW FOR A 3 x 3 x 3 CUBE.

THEN – consider a 4 x 4 x 4 cube. Fill in the grid showing the number of painted cubes.

What about a 5 x 5 x 5 cube? ….. and a 6 x 6 x 6 cube?

Can you predict the answers for larger cubes without having to count them all out?

CUBE SIZE	Total number of small cubes	Number of cubes painted on 3 sides	Number of cubes painted on 2 sides	Number of cubes painted on 1 side	Number of cubes not painted at all
3 x 3 x 3					
4 x 4 x 4					
5 x 5 x 5					
6 x 6 x 6					
7 x 7 x 7					
12 x 12 x 12					

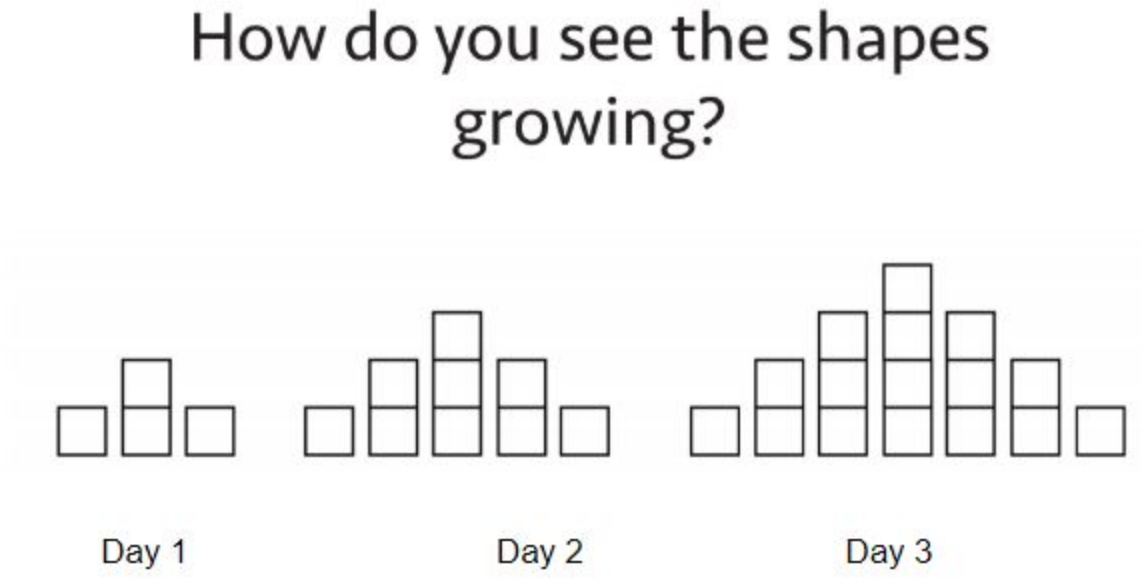
Activity 3: Tom's Tile Company

Name_____

Date _____

Tom's Tile Company, A Growing Business

1. Tom's Tile Company is trying to grow his business. Every day he builds onto his tile design. His twins, Jo and Jolina, are trying to describe how the tile pattern is growing. They used color tiles to show how the shape grows. They want to post a meaningful, complete sentence describing how the pattern grew on their tile Company website. They need your help.



2. Color code day 1, 2, and 3 in as many ways as possible in 10 minutes. Give your growing pattern a descriptive 1-3 word title. Include a meaningful sentence to describe how the pattern grows that can be posted on their website.

3. Show each of your color coded growing patterns on the method handout. (Include an interpretive title for the color coding method)

4. **Formulate** a sentence to describe the color coded growth pattern. Draw an arrow from your sentence to the color coded diagram it describes.

5. Continue drawing the pattern through day 7. Be sure to color code. Use the back of this paper if necessary.

6. Create a t-chart that shows the growing pattern.

7. Explain your method for finding the total number of tiles for 15 days. Use words, pictures, and a table.

8. Generalize the pattern. What do you notice? Explain.

9. How many total squares will there be on the 100th day?

10. Write a sentence that clearly explains how to find the total number of tiles.

11. How many squares are in the nth case? Write a rule that works for any day that Tom's Tile business tries to grow his business.

Rubric

Descriptor	4	3	2	1
Quality of Work	The work and models are correctly done, extremely well organized so that others can understand them, and include multiple, creative methods.	The work and models are correctly done and organized. There are several color coded examples.	The work and models need better organization. There is only one color-coded example.	The work is unorganized. Major pieces are missing. No attempt was made or color coding was at a not yet level.
Solution	The answers in 1-10 are correct and include a generalized rule or sentence explaining the rule.	The solutions in problems 1-7a are correct. Color coding patterns are recognizable.	The solutions for 1-6 are correct. Color coding is mostly correct.	There is no solution. There are major mathematical misconceptions.
Justification	Justifications are written in a meaningful, complete sentence(s). The generalization is mathematically sound.	The justification is mostly correctly mathematically.	An attempt was made with developing understanding shown.	There is no explanation or justification.

How do you see the shapes growing?

Formulate one or more sentences to describe the color coded growth pattern.

_____

_____

_____

_____

Color Coding Method Title _____

How do you see the shapes growing?

Formulate one or more sentences to describe the color coded growth pattern.

_____

_____

_____

_____

Color Coding Method Title _____

How do you see the shapes growing?

Formulate one or more sentences to describe the color coded growth pattern.

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Color Coding Method Title _____

How do you see the shapes growing?

Formulate one or more sentences to describe the color coded growth pattern.

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Color Coding Method Title _____