Learning Your ABC's Before Your 123's

222 ENHAN

Learning Your ABC's before Your 123's

10–12 Session

This session will examine the use of practical research-based literacy strategies to instruct students in their approach to understanding math content. These techniques for literacy instruction in the math classroom will assist students in understanding how to navigate both multiple-choice and free response questions with greater independence.

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NCTM

NATIONAL COUNCIL TEACHERS OF MATHEMATICS

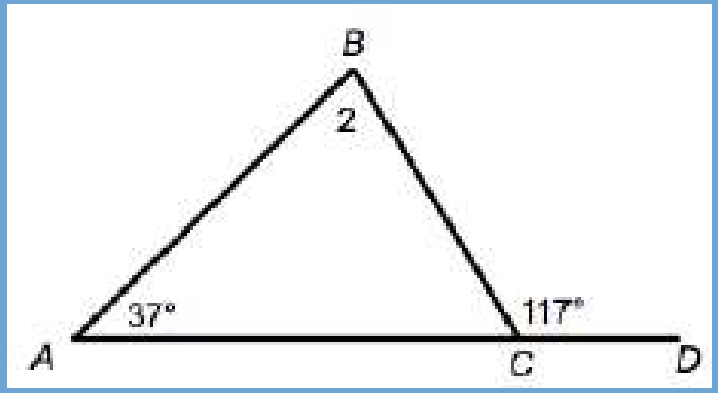
April 4, 2019

NCTM ANNUAL MEETING & EXPOSITION 2019
April 3-6 | San Diego

Solve the math problem below.

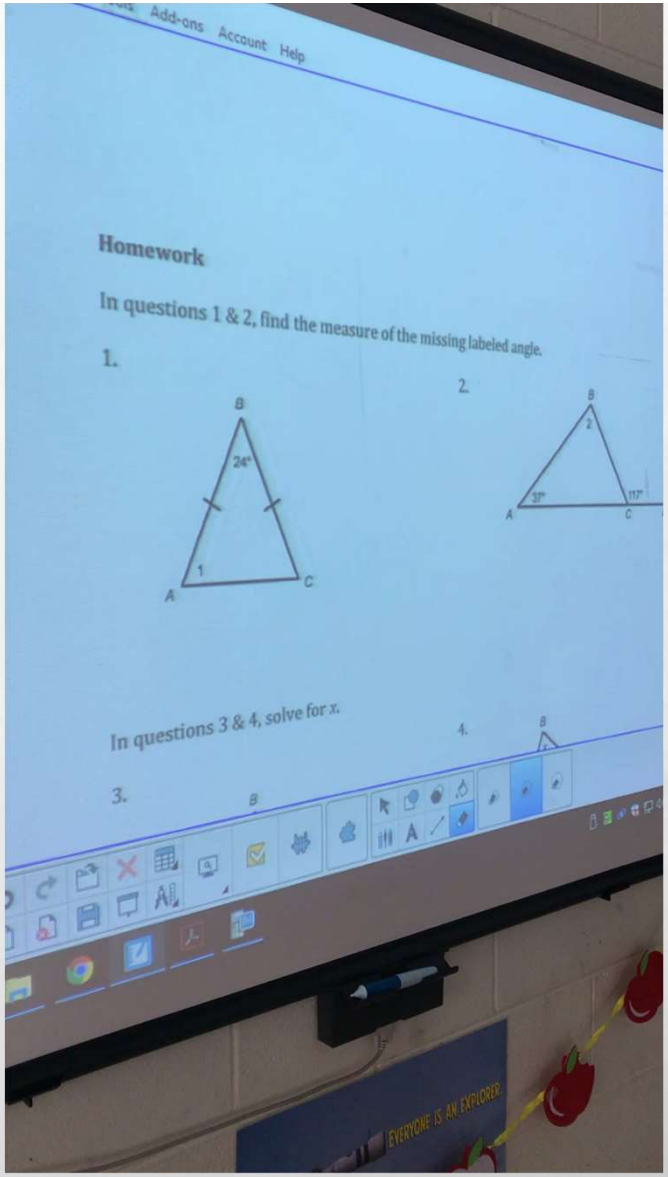
As you are working, think about what is happening in your mind and how you would teach it in your class.

Find the measure of the missing labeled angle.

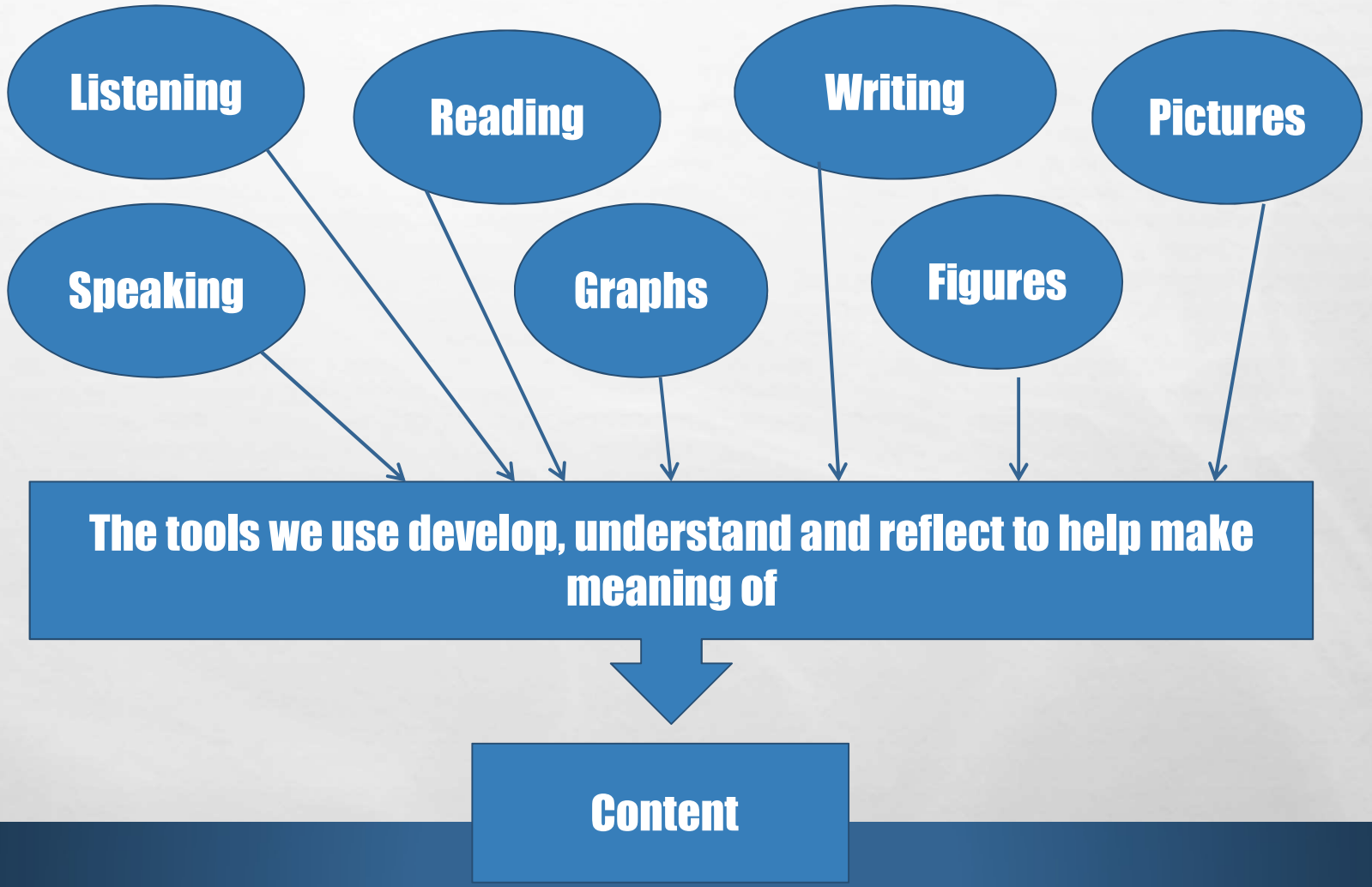


EXPECTATIONS

REALITY


Add-ons Account Help
Homework
In questions 1 & 2, find the measure of the missing labeled angle.
1.
2.
24°
37°
117°
In questions 3 & 4, solve for x.
3.
4.
EVERYONE IS AN EXPLORER

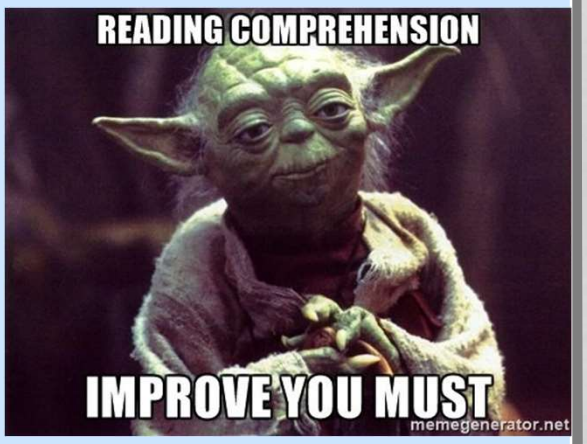
What is Math Literacy?



Why do we use Math Literacy?

- Common Core Standards for ELA/literacy.
- Standards set requirements not only for English language arts (ELA) but also for literacy in Math!!!
- What do these standards say? Students must be able to read, write, speak, listen, and use language effectively in our **content** areas.
- Specifies literacy skills and understanding required for college and career readiness in multiple disciplines.

"BUT, I AM A TEACHER OF MATHEMATICS…"

Math: *Text Structure*	Traditional: *Non-fiction Text*
Research shows: • More concepts per sentence than any other text • Compact, lots of information with little redundancy • Text can contain words as well as numeric and non-numeric symbols to decode • Page layout often leads to different pattern than traditional left to right reading • Can contain graphics that need to be understood with text intended to add comprehension but may instead be distracting • Many texts are written above grade level • Key ideas comes at the end in the form of a question • Read through problem to ascertain main idea • Reread to figure out details that relate to the question • Visualize the problem's context • Apply strategies that will lead to the solutions • Use appropriate data from the problem statements	**Research shows:** • Topic sentence near beginning • Details, support main idea • Read left to right 

WE ARE *ALL* TEACHERS OF READING.

Math IS different.

To read proficiently like mathematicians, students must read differently. Implicit general "reading" skills taught in other subject areas simply do not generalize for most students in math.

THIS SHIFT REQUIRES US TO:

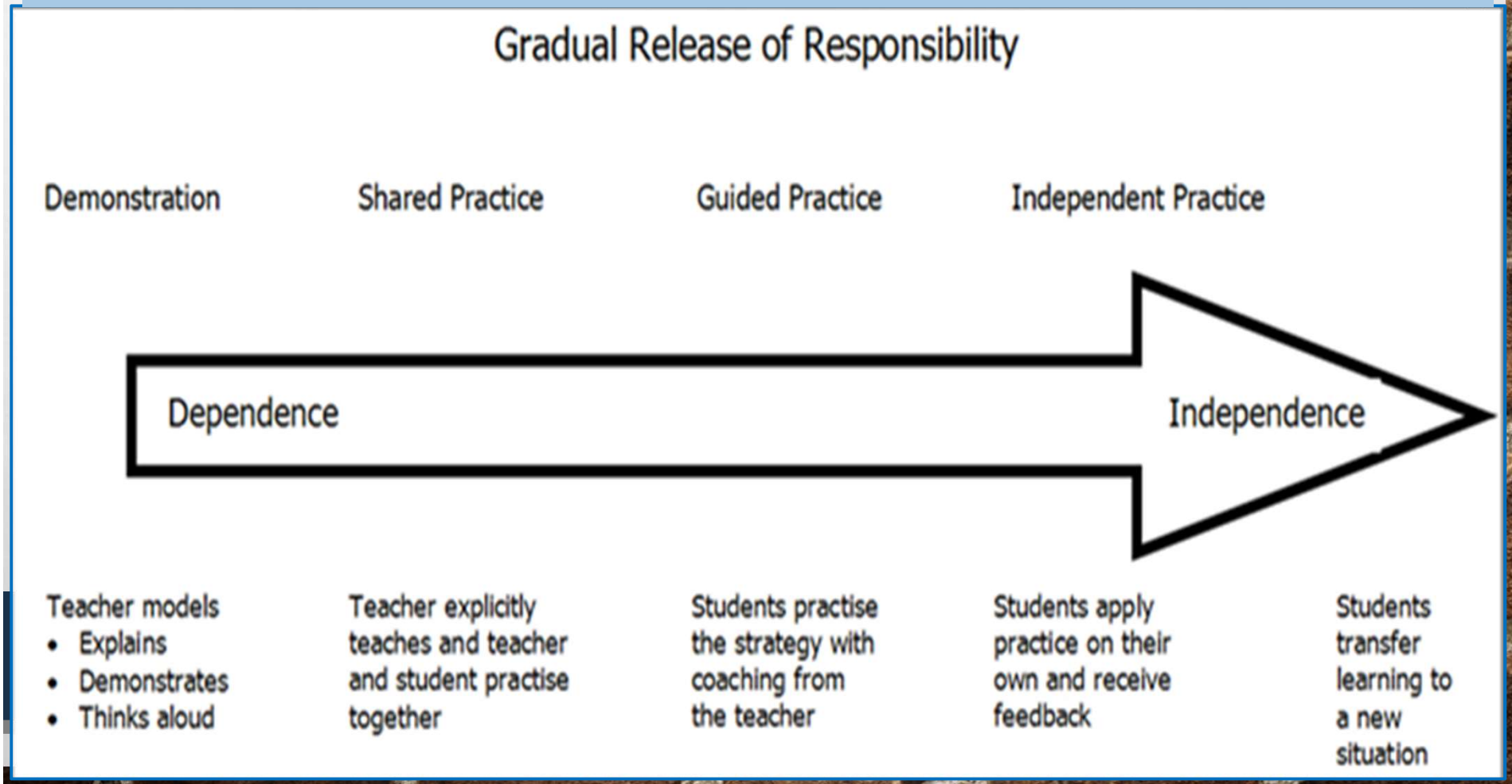
Explicitly teach and discuss metacognitive strategies **and create a culture where teachers AND schools:**

- **recognize that their years of experience and personal mastery of skills and content create a misperception that children do or should possess the same**
- **model and discuss approaches to understanding and comprehension**
- **create and model the process of understanding, *e.g.* thinking out loud, modeling, conferring, demonstrating and sharing**

Students are expected to:

- **"think about their thinking…"**
- **become *explicitly* aware of and understand their own thought processes**
- **demonstrate and communicate how they process information**

In that culture, we think, "I do, we do, you do together, THEN *you* do."



How Do I Begin to Bring Literacy into the Math Classroom?

First, believe the research on metacognition!

Then, begin by helping students to learn how to explicitly monitor for meaning in math. Focus *more* on the process to read and learn than on the process to achieve a correct answer.

Before we "Think Aloud,"
tell us how would you usually teach or process a problem like this with your class?

Skill:
Monitoring for Meaning

ALGEBRA I (COMMON CORE)

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

ALGEBRA I (Common Core)

Thursday, June 16, 2016 — 9:15 a.m. to 12:15 p.m., only

5 The Celluloid Cinema sold 150 tickets to a movie. Some of these were child tickets and the rest were adult tickets. A child ticket cost \$7.75 and an adult ticket cost \$10.25. If the cinema sold \$1470 worth of tickets, which system of equations could be used to determine how many adult tickets, a, and how many child tickets, c, were sold?

(1) $a + c = 150$
$10.25a + 7.75c = 1470$

(2) $a + c = 1470$
$10.25a + 7.75c = 150$

(3) $a + c = 150$
$7.75a + 10.25c = 1470$

(4) $a + c = 1470$
$7.75a + 10.25c = 150$

Let's "Think Aloud."

Let f be a function such that

$$\lim_{h \to 0} \frac{f(2+h) - f(2)}{h} = 5$$

Which of the following statements is true?

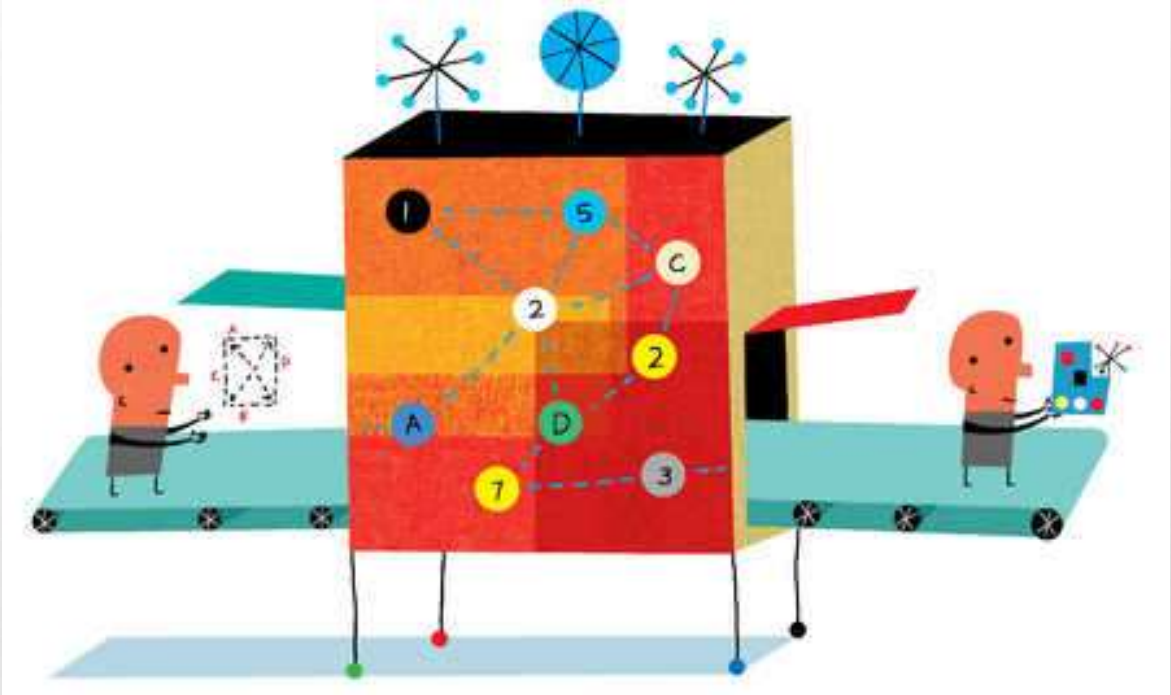
(1) f is continuous at 2

(2) f is differentiable at 2

(3) the slope of the tangent line to f at 2 is equal to 5.

Skill: **Monitoring for Meaning**

LET'S PROCESS.



Where Else to Start?

Monitor for Meaning

- **Model "Think Alouds"; allow students to think aloud for you, with peers, etc.**
- **Think-pair-share about PROCESS frequently.**
- **Pause to process. Assume confusion!**

- **Establish your "Instructional Purpose."**
- **Create "Signposts."**
- **Scaffold and embed metacognitive questions into existing material or discussions.**
- **Use post-its, highlighters, and annotations with a purpose – until proficiency and mastery are clear.**

How to Begin? Set a Purpose

Instructional Purpose
(What Is Essential for Students to Know?)

1. What two places may cause students difficulty?

2. What will you model that will help students negotiate the difficult parts?

3. What do they need to do with the information they are reading?

4. How will they hold their thinking while they read?

RESEARCH-BASED Strategies for EXPLICITLY:

- identifying text structure (question at end)
- annotating word problems
- reading, annotating and processing with a partner or think-pair-share
- modeling a think aloud
- having students think aloud in pairs or conference with teacher
- scaffolding, breaking down tasks in steps
- rephrasing questions and ideas "in plain English"
- highlighting important information
- summarizing, reworking the questions
- using post-its for questions/where students are struggling with meaning
- having students pair/share questions, confusion before answering questions
- asking 3 before me
- using research-based vocabulary strategies (*e.g.* K.I.M. (V.I.P) vocabulary or Marzano model)

Example of Instructional Purpose (middle school):

1. **What is essential for students to know? Correctly identifying angles**
2. **What two places may cause students difficulty? Vocabulary and definitions**
3. **What will you model that will help students negotiate the different parts?**

   How will you model and think aloud for students? How will you assess their thinking and processing?

   Explain the vocabulary word, provide the visual, then the definition is needed to understand the angles.

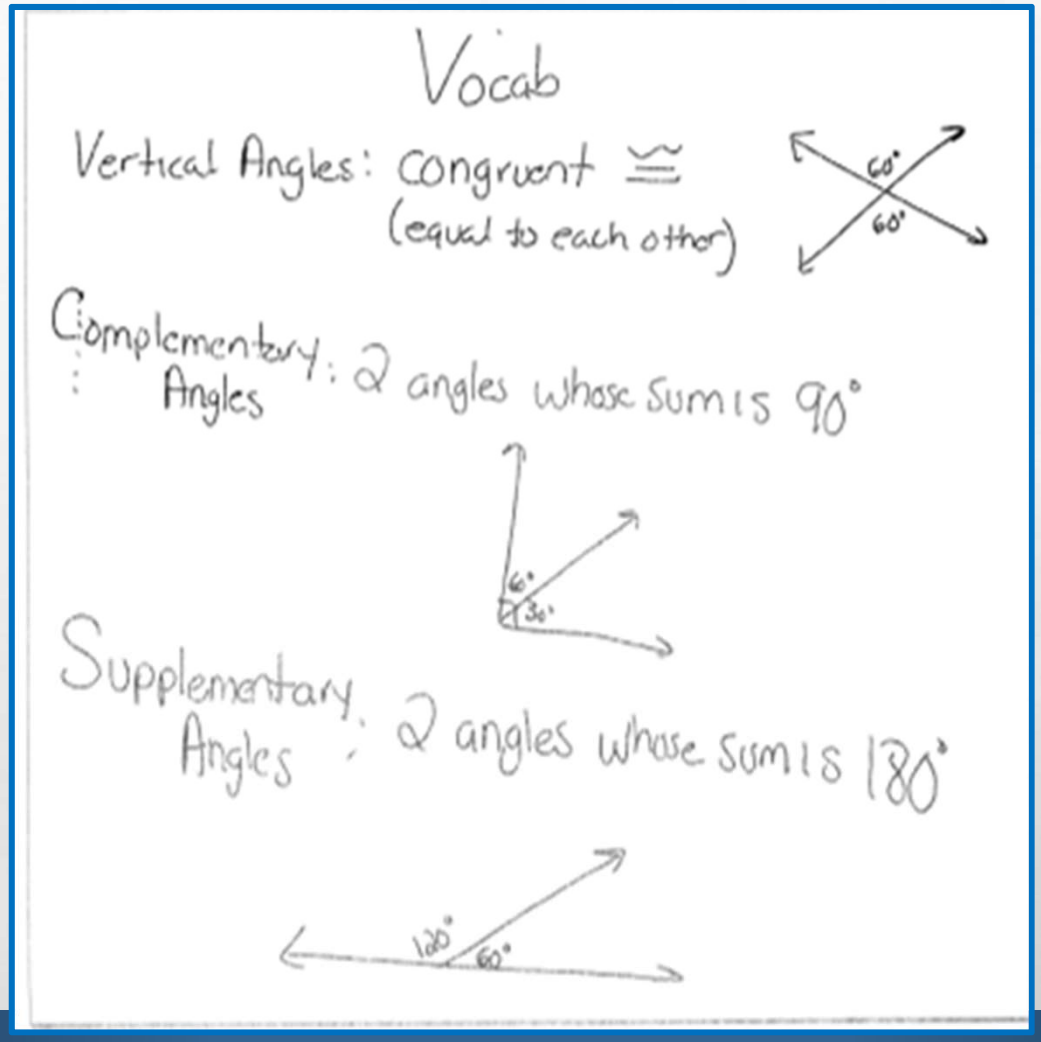
4. **What do students need to do with the information they are reading?**

   We organized the vocabulary and definitions so all the information was in one convenient place for the students.

5. **How will they hold their thinking while they read? How will they retain their learning and new concepts and monitor for meaning?**

   We considered the KIM Vocabulary sheet, which led to a Vocab, Info, Picture (VIP) chart. This became the students' study guide. We then decided the guides should be cut up and folded over if copied on one side for the students to remember and reuse to help them to retain their learning.

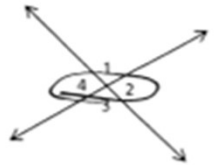
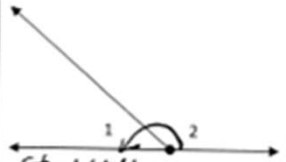
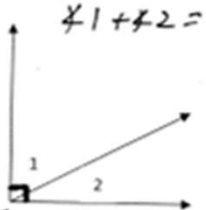
Before considering "Instructional Purpose":



After considering "Instructional Purpose":

Angle Relationships: Graphic Organizer

V = Vocabulary Word I = Information P = Picture

V. (Vocabulary Word)	I. (Information)	P. (Picture)
Vertical Angles	• Across from each other • they are congruent • Algebra ___ = ___	
180pplementary Angles	• 2 ∠'s Sum = 180° • add up to 180 • Algebra ___ + ___ = 180	∠1 + ∠2 = 180° 
90mplementary Angles	• 2 ∠'s Sum = 90° • they add up to 90° • Algebra ___ + ___ = 90	∠1 + ∠2 = 90°  Symbol for 90° (right ∠)

Signposts:

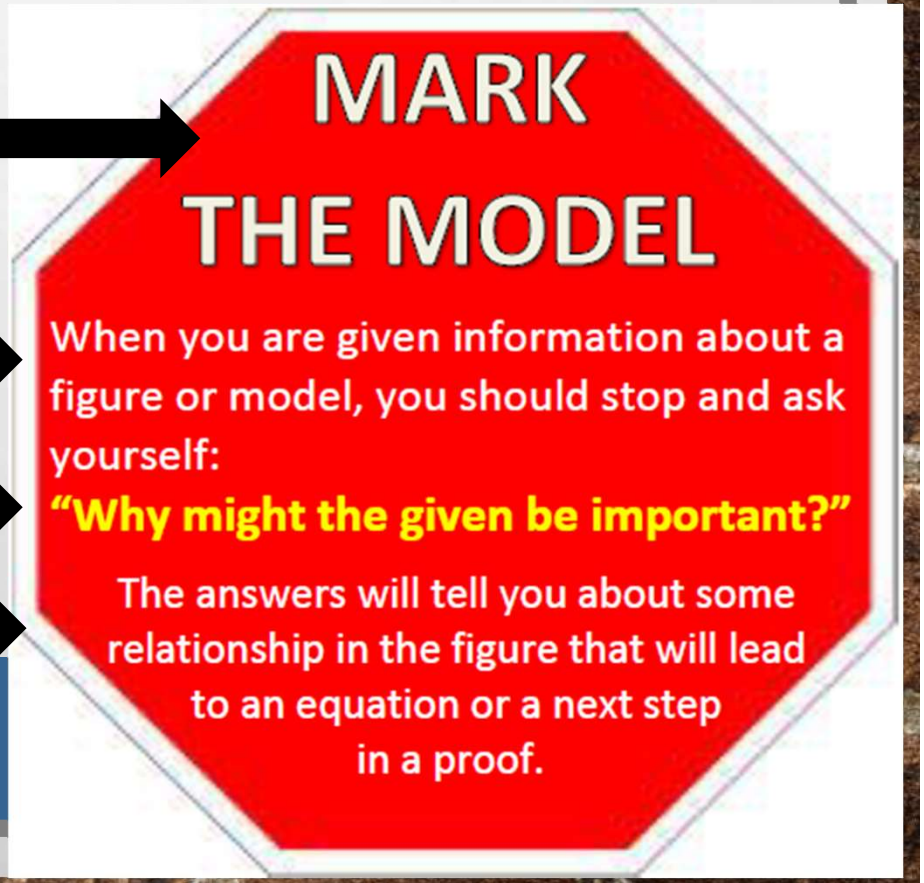
Signs for critical patterns to help students decode and comprehend a difficult problem/text/vocabulary

Catchy title

Explanation of **WHY** we are "stopping"

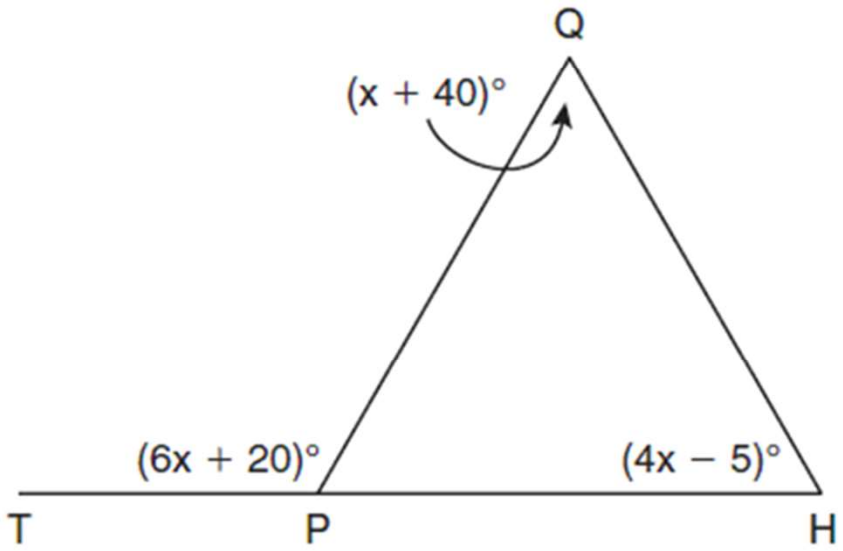
Anchor question

Answer to the question



Pre-Signpost Assessment:

10) In the diagram below of ΔHQP, side $\overline{HP}$ is extended through P to T, $m\angle QPT = 6x + 20$, $m\angle HQP = x + 40$, and $m\angle PHQ = 4x - 5$. Find $m\angle QPT$. (8 points)



(Not drawn to scale)

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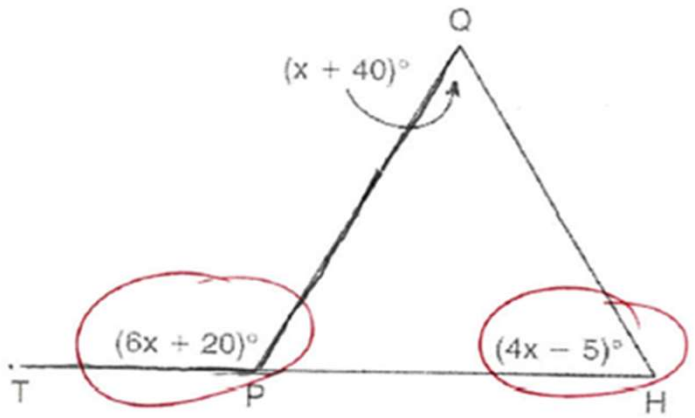


(Not drawn to scale)

$m\angle QPT = 119°$

$6x+20$

$6(16.5)+20$

$99+20=$

~~119~~

$4x-5+6x+20=180$

$10x+15=180$

$-15 \quad -15$

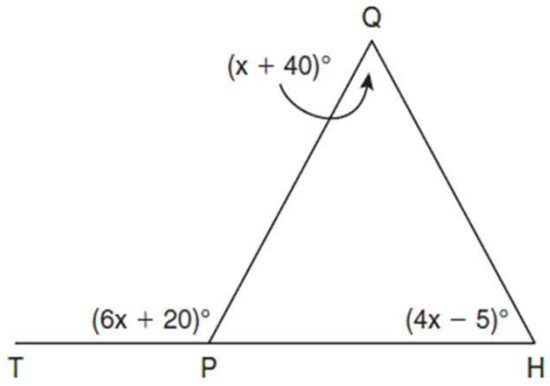
$\frac{10x}{10} = \frac{165}{10}$

$x = 16.5$

not adjacent so can't be a linear pair

Using Signposts

10) In the diagram below of ΔHQP, side $\overline{HP}$ is extended through P to T, $m\angle QPT$ = 6x + 20, $m\angle HQP$ = x + 40, and $m\angle PHQ$ = 4x – 5. Find $m\angle QPT$. (8 points)



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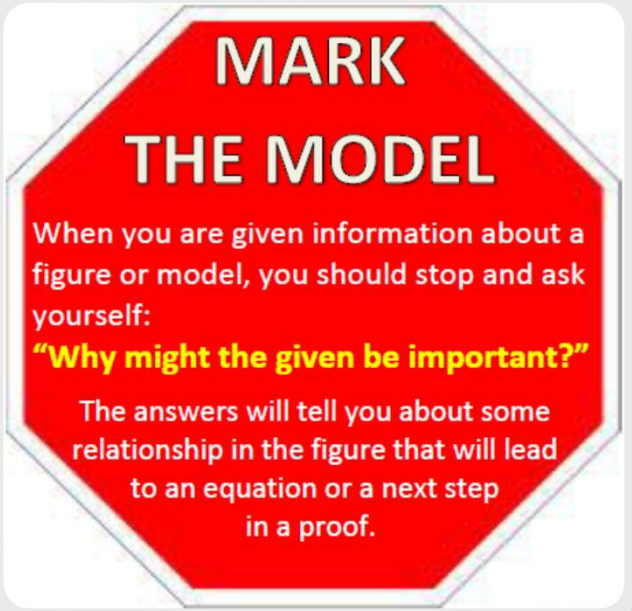


After Signpost Assessment:

19) Given ΔCMP, $\overline{CM} \cong \overline{MP}$, $\angle C = 5x - 10$, $\angle P = x + 30$. $\overline{CP}$ is extended to create exterior $\angle MPD$. (8 points)

a. Find the $m\angle M$.

b. Find the $m\angle MPD$.

$5x - 10 = x + 30$

$+10 \quad +10$

$5x = x + 40$

$-x \quad -x$

$\frac{4x}{4} = \frac{40}{4}$

$x = 10$

$5x - 10$

$5(10) - 10$

$50 - 10 =$

40

$x + 30$

$10 + 30 = 40$

180

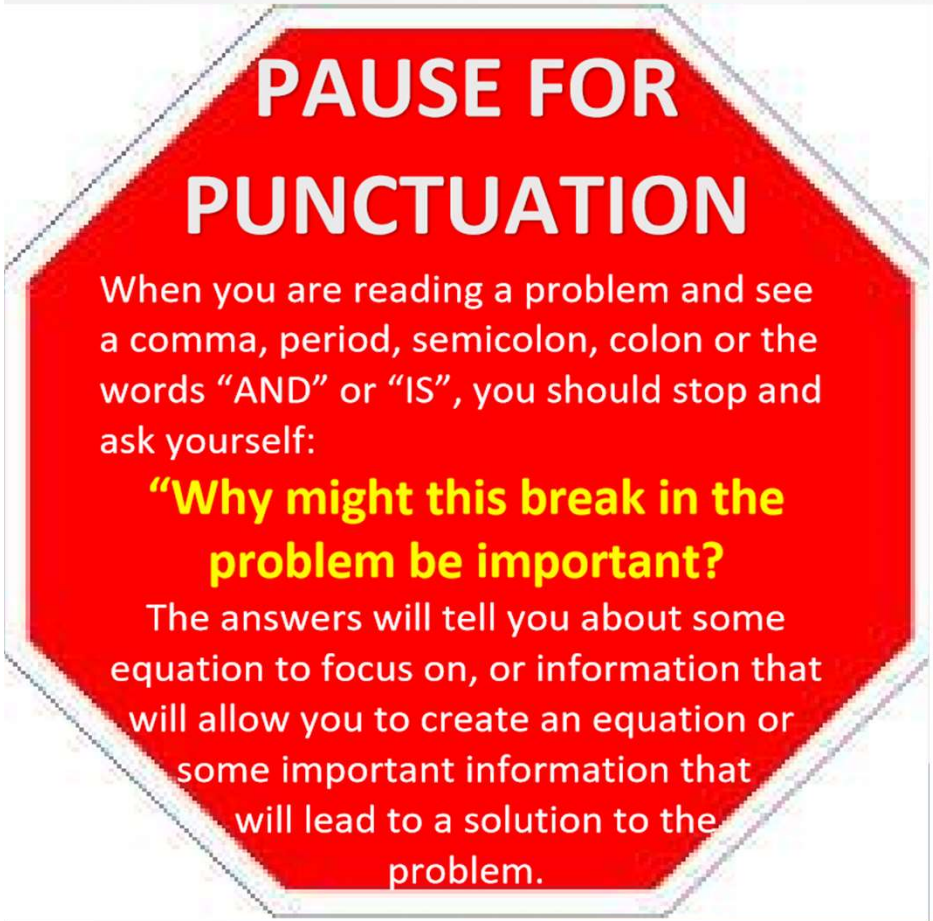
-80

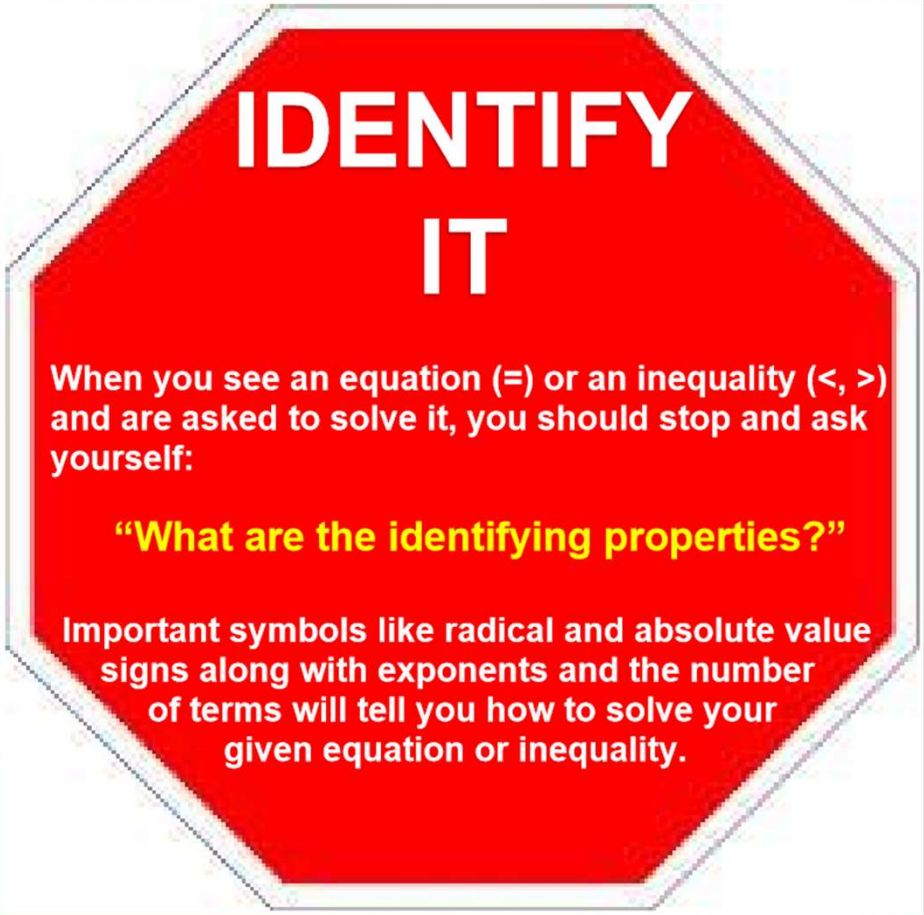
100

$m\angle M = 100$

$m\angle MPD = 140$

Not all concepts work with the same signpost.





GUESS THE SIGNPOST

In ΔABC, the measure of $\angle B$ is 21 less than four times the measure of $\angle A$, and the measure of $\angle C$ is 1 more than five times the measure of $\angle A$. Find the measure, in degrees, of each angle of ΔABC.

MARK THE MODEL

When you are given information about a figure or model, you should stop and ask yourself:

"Why might the given be important?"

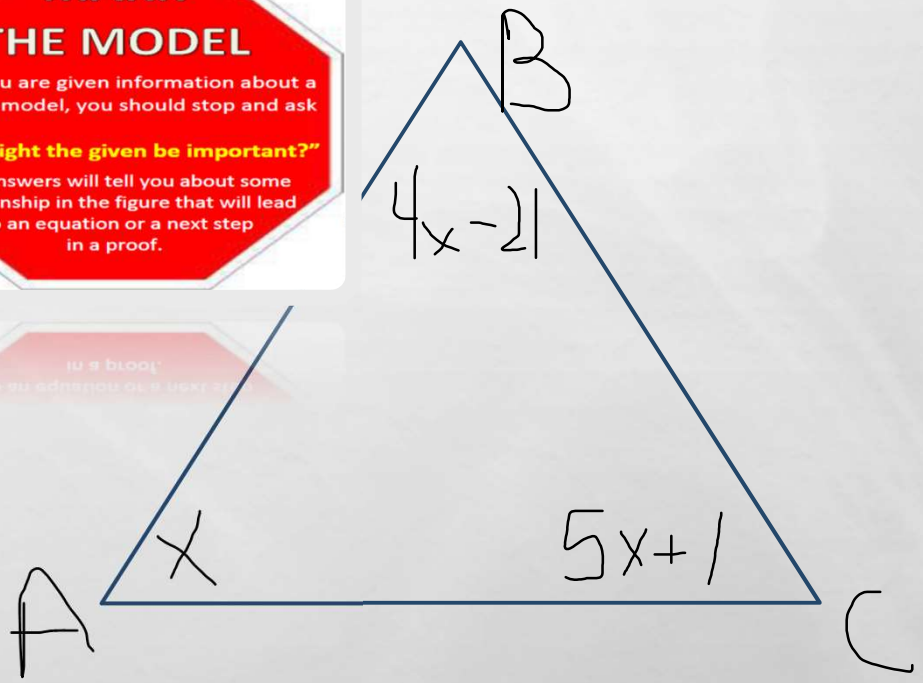
The answers will tell you about some relationship in the figure that will lead to an equation or a next step in a proof.

PAUSE FOR PUNCTUATION

When you are reading a problem and see a comma, period, semicolon, colon or the words "AND" or "IS", you should stop and ask yourself:

"Why might this break in the problem be important?

The answers will tell you about some equation to focus on, or information that will allow you to create an equation or some important information that will lead to a solution to the problem.



Christina Pawlowski
@MsCPawlowski

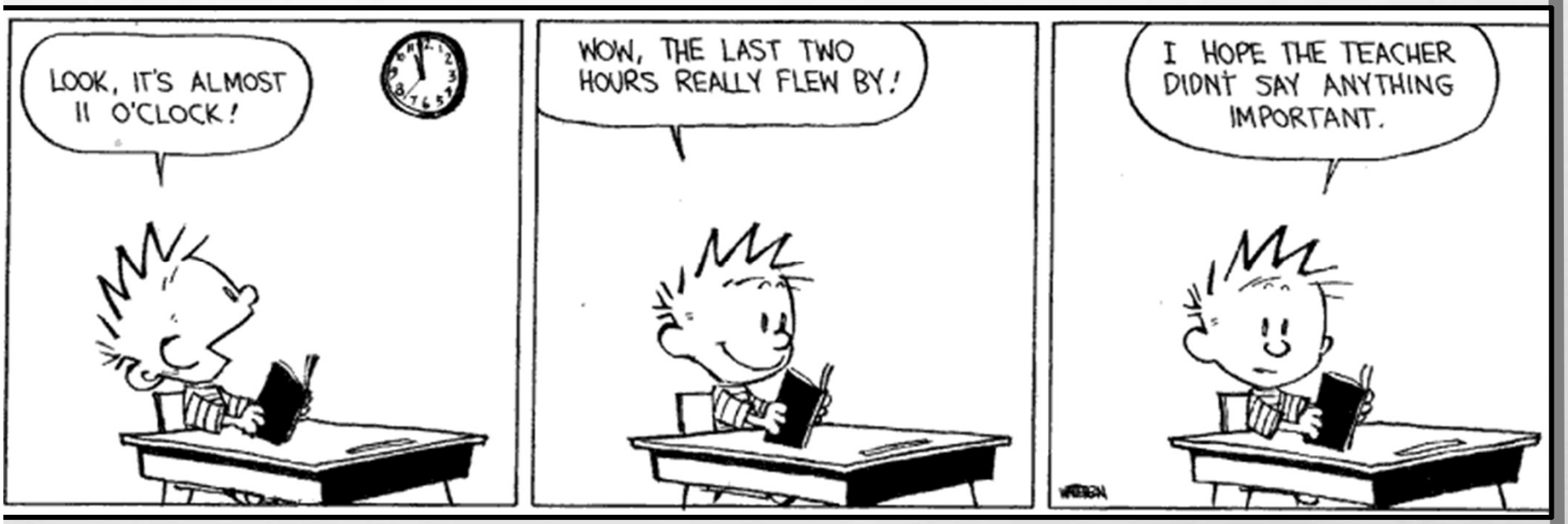
Best part of my day? My student commenting on how much he loves the signposts on display! Thank you @KyleneBeers

LIKES
8

5:47 PM - 3 Feb 2016

Kylene Beers liked my tweet!!!!!

LET'S PROCESS.



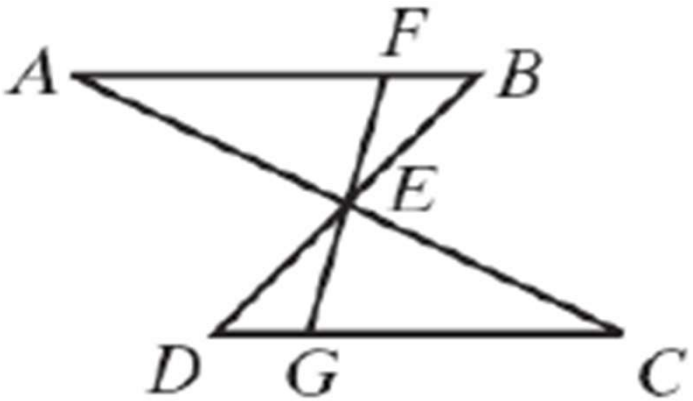
Scaffolding

Before

Question C:
Construct a Two-Column Proof:

Given: $\overline{AC}$ and $\overline{BD}$ bisect each other.

Prove: $\Delta AEF \cong \Delta CEG$



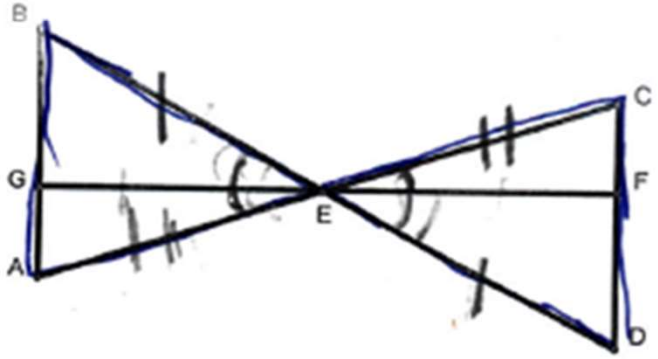
Student work before scaffolding

9) Two-Column Proof (17 points)

Given: $\overline{AEC}$, $\overline{BED}$, $\overline{GEF}$.

$\overline{BD}$ and $\overline{GF}$ bisect each other.

Prove: $\Delta DEC \cong \Delta BEA$



S	R
① $\overline{AEC}$, $\overline{BED}$, $\overline{GEF}$ $\overline{BD}$ and $\overline{GF}$ bisect each other	① Given
② $\angle BEA$ and $\angle CED$ are vertical angles	② Intersecting lines form vertical angles
③ $\angle BEA \cong \angle CED$	③ Vertical angles are $\cong$
④ E is mdpt of $\overline{AC}$ and $\overline{BD}$	④ Segment bisector forms mdpt
⑤ $\overline{AE} \cong \overline{EC}$ $\overline{BE} \cong \overline{ED}$	⑤ mdpt divides segment into two $\cong$ segments
⑥ $\Delta DEC \cong \Delta BEA$	⑥ SAS $\cong$ SAS

You were not given this

AC was not given as a bisector

This made the proof easier

Scaffolding

Question C:
Construct a Two-Column Proof:

Given: $\overline{AC}$ and $\overline{BD}$ bisect each other.

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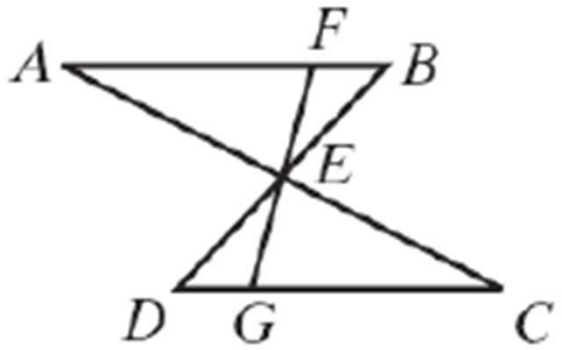


1) Before you begin the proof, consider the Prove statement. What theorems could be used to justify this statement? (Hint: There are five, list all)

2) Mark your model from the Given statement. Based upon these markings what pair of triangles contain your marks?

3) Is the pair of triangles you listed in (2) the same as the pair of triangles listed in your Prove statement?

4) If you answered yes, either talk to a partner or your teacher. If you answered no, what type of proof is this?

5) Can you easily prove the pair of triangles you listed in (2) congruent? If yes, state the method. If no, consider this hint. (Hint: Look for a pair of vertical angles).

6) List all of the pairs of congruent corresponding **parts** (sides and angles) for the triangles from (2).

7) List all the pairs of corresponding **parts** (sides and angles) for the triangles in the Prove statement.

8) Are there any corresponding parts that you wrote for (6) **AND** (7)? If yes, state them.

9) Examine your markings from your given statement and the corresponding parts you listed in (8). Is it now possible to prove the Prove statement? If yes, list the method.

10) Using all of your answers above you have formulated a plan for this proof. Complete the proof on the following page.

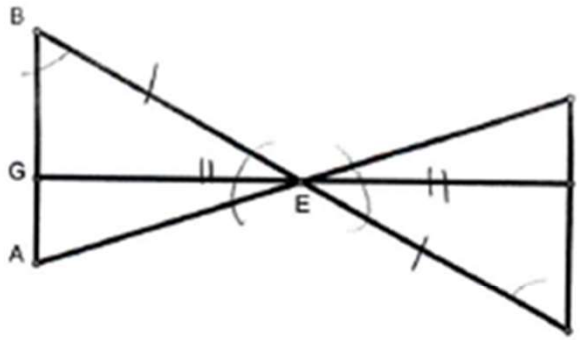
Student Work with Scaffolding

Question D:
Construct a Two-Column Proof

Given: $\overline{AEC}$, $\overline{BED}$, $\overline{GEF}$.

$\overline{BD}$ and $\overline{GF}$ bisect each other.

Prove: $\Delta DEC \cong \Delta BEA$



Statement	Reason
① BD and GF bisect each other	① Given
② E is the midpoint of BD and GF	② Bisections create midpoints
③ GE ≅ EF, BE = ED	③ Midpoints divide segment into 2 ≅ parts
④ ∠BEG & ∠DEF are vertical ∠'s	④ intersecting lines form vertical ∠'s
⑤ ∠BEG = ∠DEF	⑤ Vertical ∠'s are ≅
⑥ ΔBEG ≅ ΔDEF	⑥ SAS ≅ SAS
⑦ ∠B ≅ ∠D	⑦ Corr parts of ≅ Δ's are ≅
⑧ ∠BEA and ∠DEC are vertical ∠'s	⑧ intersecting lines form vertical ∠'s
⑨ ∠BEA ≅ ∠DEC	⑨ Vertical ∠'s are ≅
⑩ ΔDEC ≅ ΔBEA	⑪ ASA ≅ ASA

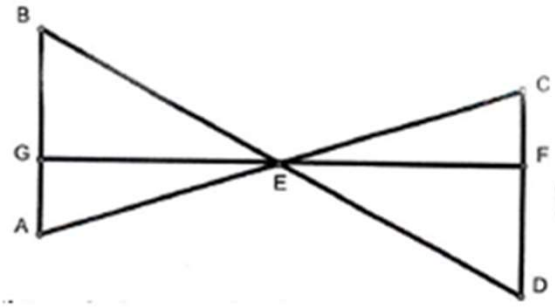
Student Work with Scaffolding

Question D:
Construct a Two-Column Proof

Given: $\overline{AEC}$, $\overline{BED}$, $\overline{GEF}$.

$\overline{BD}$ and $\overline{GF}$ bisect each othe

Prove: $\Delta DEC \cong \Delta BEA$



Part A:
On this side list questions that would lead someone through this proof. To help you with this think of the questions Ms. Pawlowski asks in class or write down the questions you are asking yourself in your head as you are going through this proof.
Part B:

1. What theorem can be used to justify the proof statement?
2. What triangles contain the sides listed in the given?
3. What type of proof is this?
4. Is the ~~same~~ pair of triangles listed in (2) the same triangles in the proof statement?
5. What methods can be used to solve this proof?

Post-It with a *Purpose*

- Post-it notes make it possible to mark students thinking when reading a problem.
- Post-it notes can flag a page and mark a line or question so readers can:
  - **find a part quickly**
  - **mark a confusing part to get clarification**
  - **hold thinking to share later**

Post-It with a *Purpose*

the numbers/variables in the ( ) dont match up... did I factor this wrong?

7) $z^3 - 9z^2 + 27z - 27 = 0$

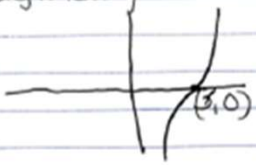
Polynomial Equation Degree 3

$z^2(z-9) + 27(z-1) = 0$

Not factorable

$X = 3$

Other two solutions are imaginary



when the eqn is not factorable, plug it into the calculator and look at the graph to see where the line crosses the x axis.

⑤ $|x^2 + x - 4| \leq 2$

SET EQUAL TO ZERO quadratic absolute value inequality

split into 2 equations, negate one answer, look at the inequality symbol to determine where to shade, pick test points, graph and shade on number line!

I forget what to do!!

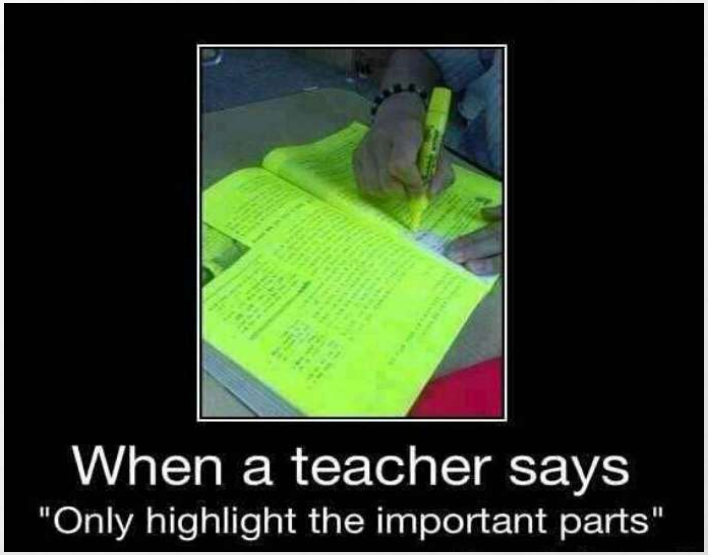
How do you graph? Should it be =0?

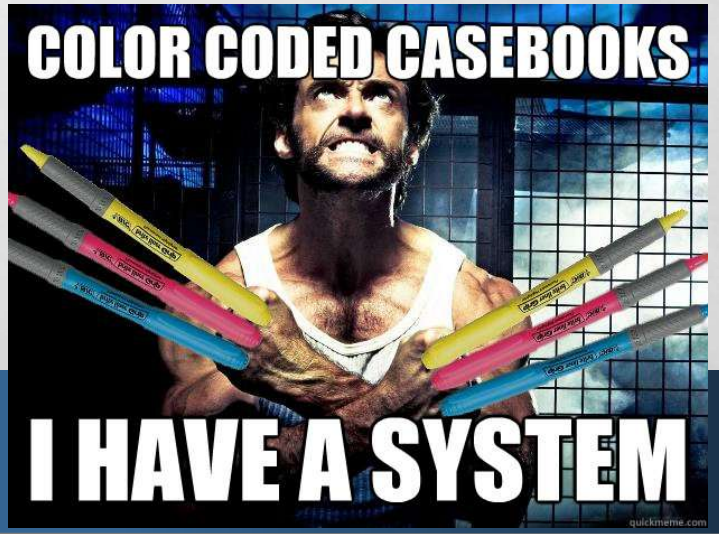
Annotate with a *Purpose*

- Annotating allows students to mark notes to hold onto their thinking.

- Annotations can flag a page and mark a line or question so readers can:
  - **Summarize important theorems**
  - **mark a confusing part to get clarification**
  - **hold thinking to share later**

NOT LIKE THIS, PLEASE!



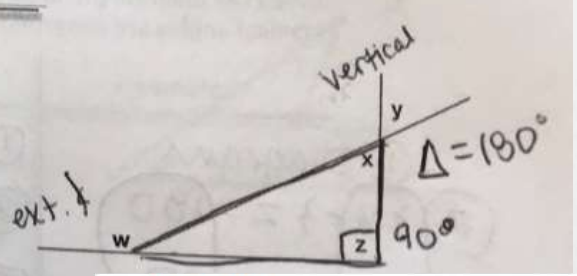


ANNOTATION STARTS AT HOME

PROPER ANNOTATION MUST BE MODELED AND EXPLICIT.

Given the diagram pictured to the right, prove that $\angle w = \angle y + \angle z$.

Statements	Reasons
1) Diagram	1) Given



1991 AB5

Symmetric wrt y axis

Let f be a function that is even and continuous on the closed interval $[-3, 3]$. The function f and its derivatives have the properties indicated in the table below.

x	0	$0 < x < 1$	1	$1 < x < 2$	2	$2 < x < 3$
$f(x)$	1	Positive	0	Negative	-1	Negative
$f'(x)$	Undefined	Negative	0	Negative	Undefined	Positive
$f''(x)$	Undefined	Positive	0	Negative	Undefined	Negative

$f'(x)=0$ & $f''(x)<0$

(a) Find the x-coordinate of each point at which f attains an absolute maximum value or an absolute minimum value. For each x-coordinate you give, state whether f attains an absolute maximum or an absolute minimum.

$f'(x)=0$
$f''(x)>0$

(b) Find the x-coordinate of each point of inflection on the graph of f. Justify your answer.

$f''(x)=0 \rightarrow$ Sign Change

WRITE AROUND CENTER

- A WAY TO HAVE STUDENTS COMMUNICATE THEIR IDEAS ***SILENTLY*** THROUGH WRITING.
- THIS ACTIVITY CAN BE USED TO INTRODUCE OR CLOSE A UNIT.
- TEACHERS ARE ABLE TO SEE HOW THE STUDENTS ARE THINKING ABOUT A TOPIC AND BE GIVEN A CHANCE TO CORRECT ANY MISCONCEPTIONS OR PRAISE ANY INTERESTING OBSERVATIONS.

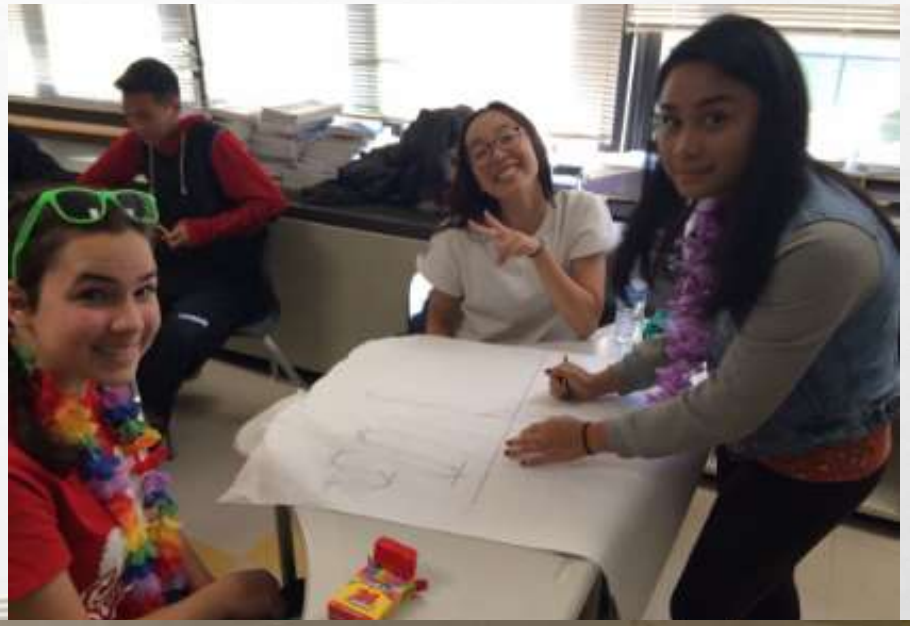
IN COMPLETE SILENCE, HAVE A "CONVERSATION" CENTERED ON QUESTION LISTED ON THE POSTER.

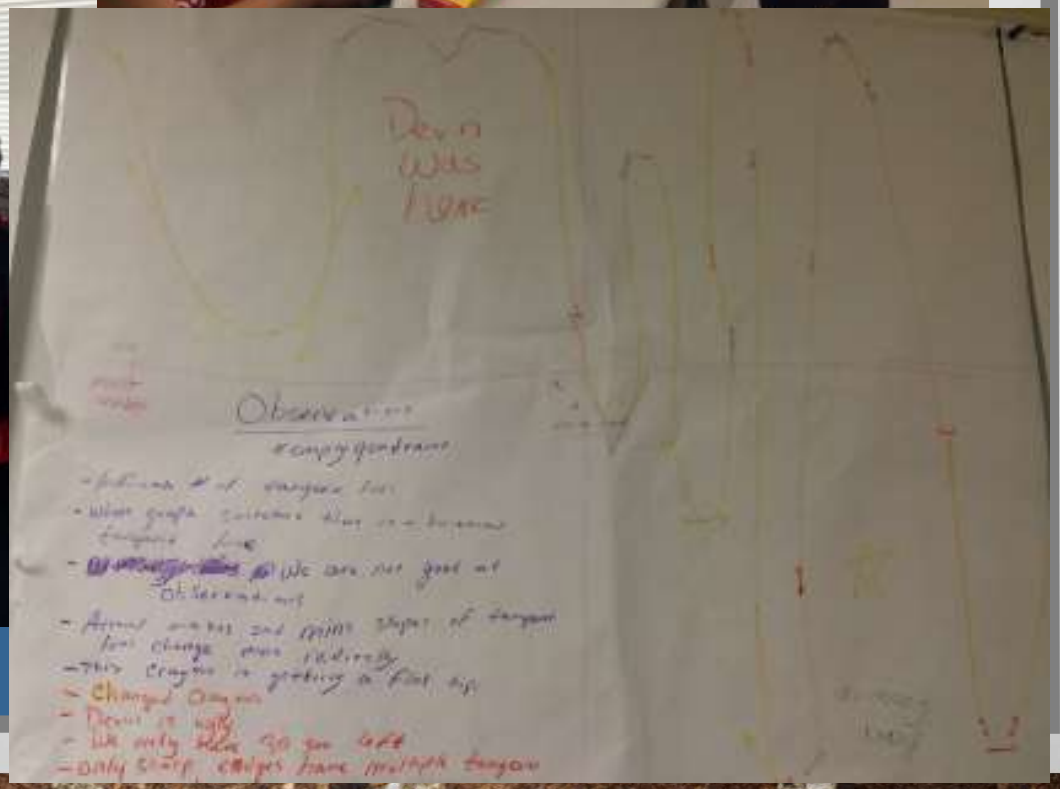
YOU MAY:

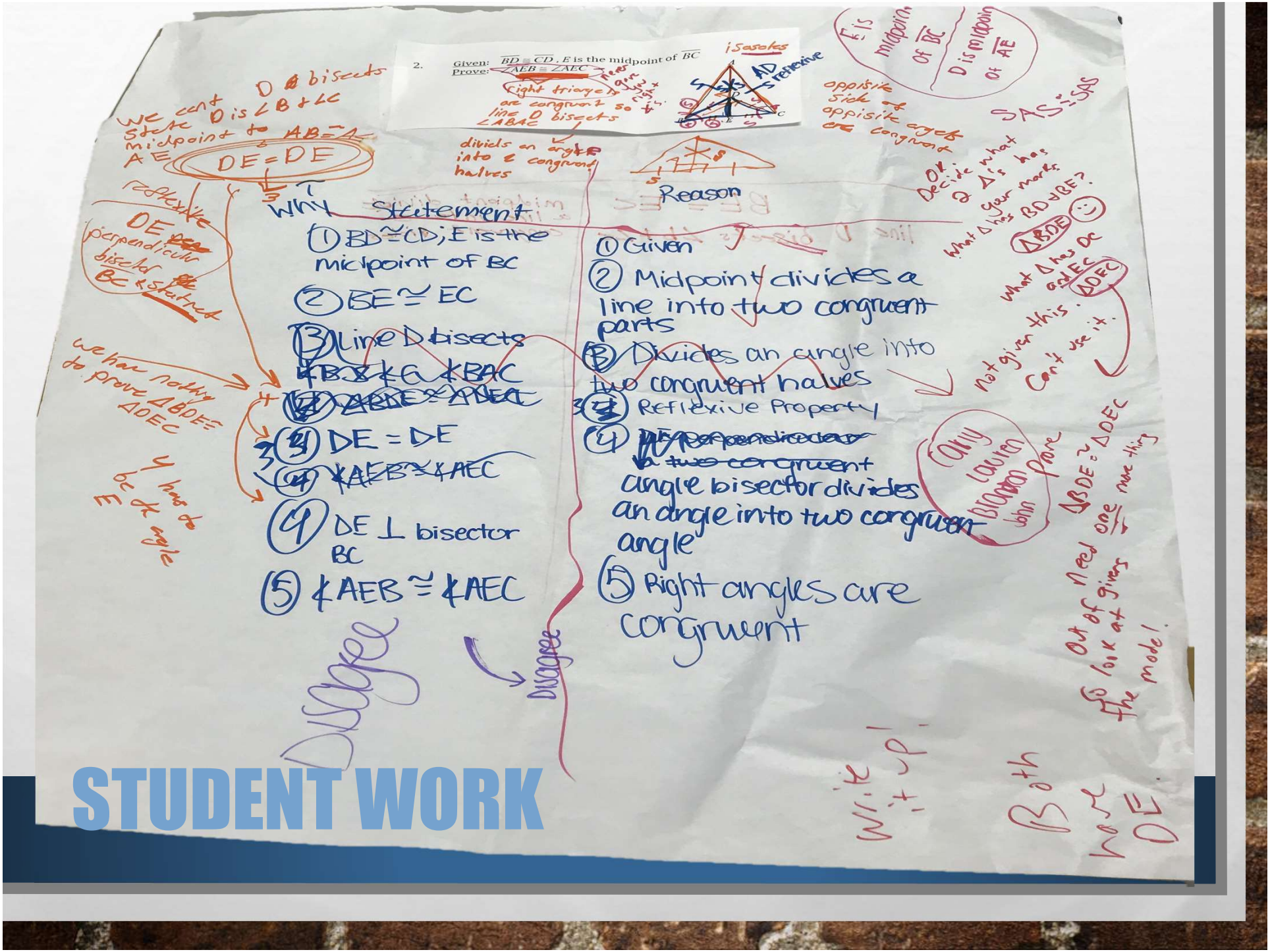
- ANSWER THE QUESTION
- JOT DOWN YOUR THOUGHTS AND IDEAS
- RESPOND TO YOUR GROUP MEMBERS
- BUILD OFF OTHERS IDEAS
- ASK GROUP MEMBERS QUESTIONS

Skill: **Synthesize Information**

WRITE AROUND CENTERS IN ACTION

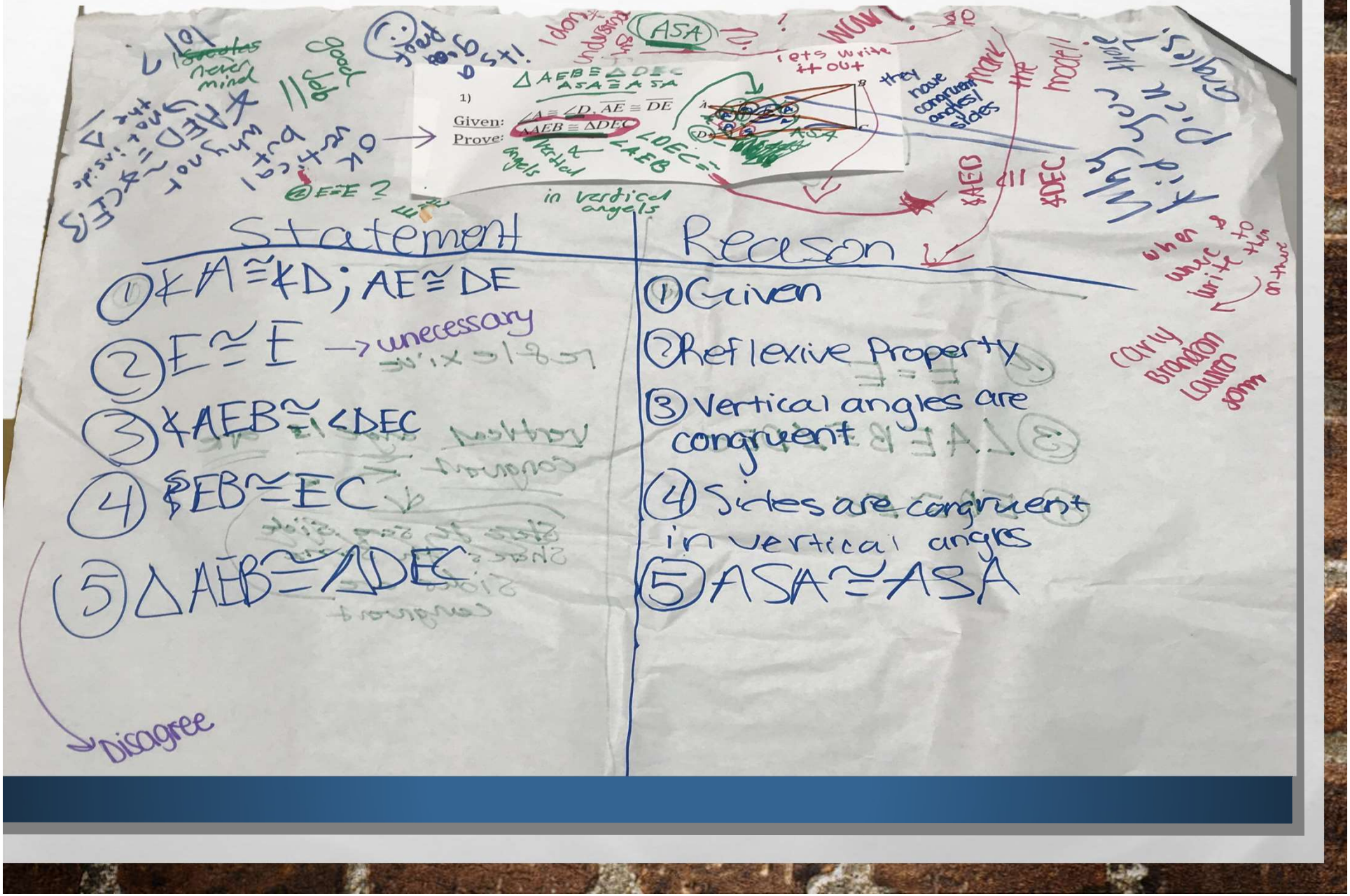


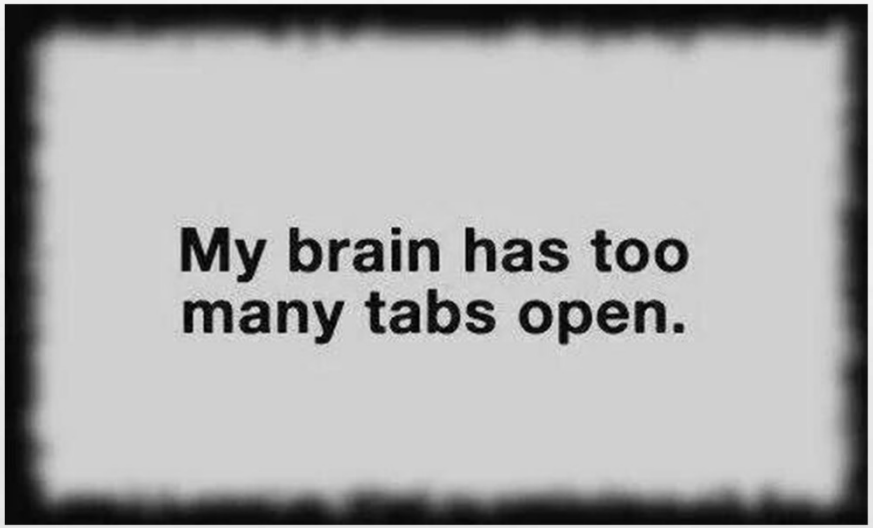




STUDENT WORK

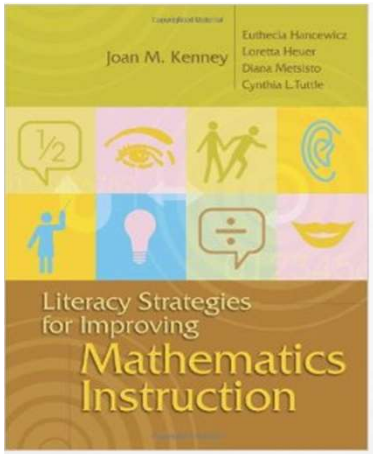
STUDENT WORK



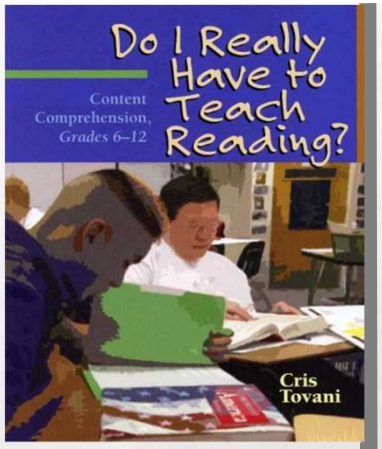


LET'S PROCESS OUR SILENT CONVERSATION.

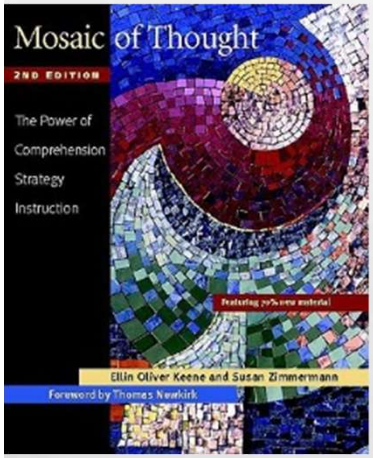
Texts

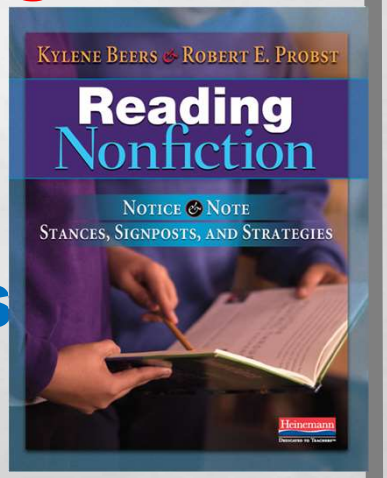


Comprehending Math
by Arthur Hyde



Why Do I Need to Teach Reading?
by Cris Tovani





Reading Nonfiction
by Kylene Beers & Bob Probs

Mosaic of Thought
by Ellin Keene & Susan Zimmerman

THANK YOU FOR JOINING ME TODAY!

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