



PROMOTING CLASSROOM DISCOURSE THROUGH OPEN MIDDLE PROBLEMS

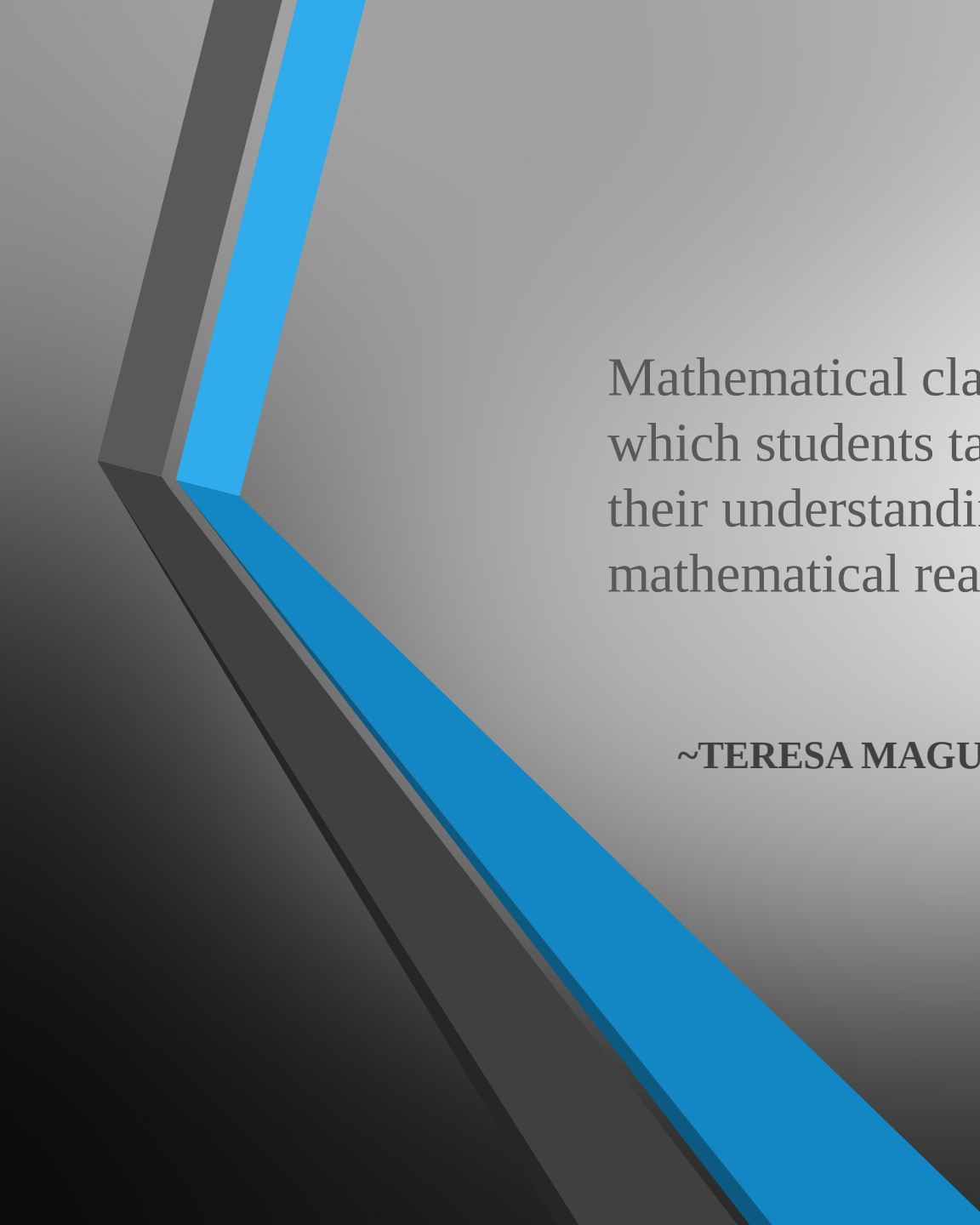
BRYAN ANDERSON

Session 172: 12:30 P.M.–1:00 P.M.

Henry B. Gonzalez Convention Center, 217B



*What does Mathematical Discourse
mean to you?*



DISCOURSE

Mathematical classroom discourse is about whole-class discussions in which students talk about mathematics in such a way that they reveal their understanding of concepts, students also learn to engage in mathematical reasoning and debate.

~TERESA MAGUIRE AND ALEX NEILL (2006)

*Mathematical discourse IS about reasoning,
developing understanding and explaining the
processes used to arrive at solutions.*



*How do we get students to
participate in Mathematical
Discourse?*



Although there are many possible ways to get students to “Talk Math”, the most influential factor I have found in my classroom is:

Changing the way you ask questions.



Consider the following problem:

Make up an addition problem where 2, 3 and 4 are used somewhere in the problem or answer.



Compare it to the following problem:

Make up an addition problem where 2, 3 and 4 are used somewhere in the problem ~~or~~ and answer.

How does that change student thinking?

ACTIVITY:

While you work on your problem(s) consider the following questions:

1. What would mathematical discourse sound like for your problem?
2. How does the problem(s) promote or impede discourse?
3. What changes would you make to the problem to promote discourse?

$$3. 17^5 =$$

$$8. 16^2 =$$

$$4. 12^2 =$$

$$9. 4^3 =$$

$$5. 13^1 =$$

$$10. 5^3 =$$

EXPONENTS

Directions: Fill in the boxes using the whole numbers 1 through 9 to make the biggest 3 digit number. Use each digit at most once.

$$\square^{\square} = \square\square\square$$

DISCUSS THE FOLLOWING:

1. What would mathematical discourse sound like for your problem?
2. How does the problem(s) promote or impede discourse?
3. What changes would you make to the problem to promote discourse?

HOW DOES THIS CHANGE STUDENT THINKING?

TARGET STANDARD:

CCSS 8th Grade 8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions For example: $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$

Which format would promote student discourse? What would that discourse sound like?



ABOUT

[Dan Meyer](#) introduced us to the idea of “open middle” problems during his presentation on “Video Games & Making Math More Like Things Students Like” by explaining what makes them unique:

- they have a “closed beginning” meaning that they all start with the same initial problem.
- they have a “closed end” meaning that they all end with the same answer.
- they have an “open middle” meaning that there are multiple ways to approach and ultimately solve the problem.

Open middle problems require a higher [depth of knowledge](#) than most problems that assess procedural and conceptual understanding. They support the [Common Core State Standards](#) and provide students with opportunities for discussing their thinking.

Some additional characteristics of open middle problems include:

- They often have multiple ways of solving them as opposed to a problem where you are told to solve it using a specific method. [Example](#)
- They may involve optimization such that it is easy to get an answer but more challenging to get the best or optimal answer. [Example](#)
- They may appear to be simple and procedural in nature but turn out to be more challenging and complex when you start to solve it. [Example](#)
- They are generally not as complex as a performance task which may require significant background context to complete. [Example](#)

We hope you enjoy these problems. Please be sure to [send us](#) any ideas for problems we can add.

[Nanette Johnson](#), [Robert Kaplinsky](#) and [Bryan Anderson](#)

HOW DOES OPEN MIDDLE DIFFER FROM WHAT IS TRADITIONALLY PRESENTED IN YOUR CURRICULUM?



Graham Fletcher ... 11 Dec 15, 10:23am
First things that come to mind...
low-entry and high-scalability,
accessible to all students,
multiple entry points and solution
paths



Audrey Mendivil @Audrey_Me... 5d
[@Anderson02B](#) [@openmiddle](#)
Opport. for deeper understanding
of the content, S discourse, &
"ah-hahs" that aren't always
possible with txtbk Qs

[View](#)



Fawn Nguyen ... 10 Dec 15, 2:57pm
Attributes of good problems
(aside from low entry, high exit: 1)
multiple strategies/solutions, 2)
simply stated, 3) non-routine



Norma Gordon @normabgordon 5d
[@Anderson02B](#) [@openmiddle](#) 2
"disrupt" answer getting; to
engage Ss MP1 + number sense-
making; to foster math discourse
too! #MTBoS

[View](#)



Susan Russo @Dsrussosusan 5d
[@Anderson02B](#) [@openmiddle](#) to
stretch thinking and make
connections. As warmups,
mid-chapter. As pieces of puzzle
days to reinforce!

[View](#)

HOW TO CREATE AN OPEN MIDDLE PROBLEM



TRAVEL In Exercises 44–48, use the following information.

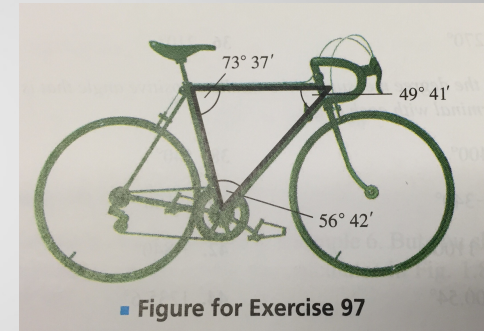
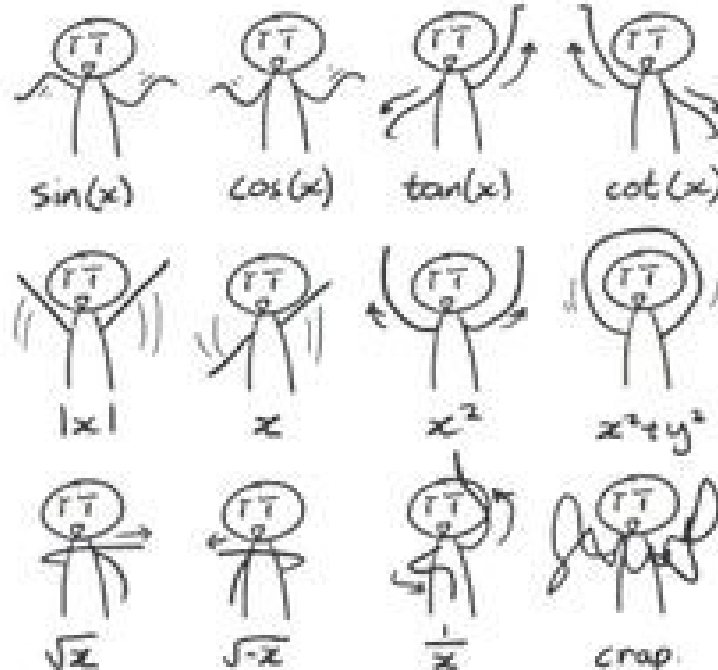
Your friend is traveling abroad and is sending you postcards with encoded messages. You must decipher what landmarks your friend has visited. Use the inverse of matrix D to decode each message. Each message represents a landmark in the country where your friend is traveling. Use the coding information on pages 225 and 226 to help you.

$$D = \begin{bmatrix} 2 & -3 \\ -1 & 2 \end{bmatrix}$$

44. $-1, 4, 30, -41, 39, -58, 22, -33, 31, -46, 23, -34, 1, 1$
 45. $21, -31, 22, -26, -9, 19, -20, 40, -3, 11, 20, -24, 10, -15$
 46. $39, -58, -2, 12, 0, 9, -19, 38, 13, -9, -16, 33, 10, -15$



Beautiful Dance Moves



87. **MULTI-STEP PROBLEM** To determine whether a Holstein heifer's height is normal, a veterinarian can use the cubic functions

$$L = 0.0007r^3 - 0.061r^2 + 2.02r + 30$$

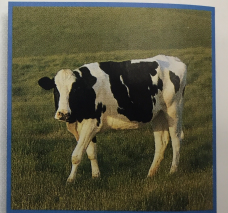
$$H = 0.001r^3 - 0.08r^2 + 2.3r + 31$$

where L is the minimum normal height (in inches), H is the maximum normal height (in inches), and r is the age (in months).

► Source: Journal of Dairy Science

- What is the normal height range for an 18-month-old Holstein heifer?
- Describe the end behavior of each function's graph.
- Graph the two height functions.

Writing Suppose a veterinarian examines a Holstein heifer that is 43 inches tall. About how old do you think the cow is? How did you get your answer?



A heifer is a young cow that has not yet had calves.

*Find a way to make it cool.
 (the Dan Meyer Effect)*

HOW TO CREATE AN OPEN MIDDLE PROBLEM (the real way)

1. Find a standard you want to address.
2. Look at how your students practice this standard, what do you want them to be able to do versus what they are actually practicing to do.
3. How can you change this problem to create deeper cognitive demand and promote classroom discourse?

STEPS TO CREATE AN OPEN MIDDLE PROBLEM

1. Find a standard you want to address.

CCSS.Math.Content.HSN.VM.C.8

Add, subtract, and multiply matrices of appropriate dimensions.

2. Look at how your students practice this standard, what do you want them to be able to do versus what they are actually practicing to do?

$$7) \begin{bmatrix} -5 \\ 6 \\ 0 \end{bmatrix} \cdot [3 \quad -1]$$

$$8) \begin{bmatrix} 3 & 2 & 5 \\ 2 & 3 & 1 \end{bmatrix} \cdot \begin{bmatrix} 4 & 5 & -5 \\ 5 & -1 & 6 \end{bmatrix}$$

3. How can you change this problem to create deeper cognitive demand and promote classroom discourse?

MY OPEN MIDDLE MATRIX PROBLEM

Directions: Using the digits 1-9, each only once, fill in the blanks to create the smallest possible value for a .

$$\begin{bmatrix} - & - & - \\ - & - & - \end{bmatrix} \begin{bmatrix} - \\ - \\ - \end{bmatrix} = \begin{bmatrix} a \\ b \end{bmatrix}$$

How would you change your numbers to create the smallest value for b ?

Create matrices such that a and b are of equal value (if you can't generate equal values, how close can they get?)



START CONVERTING ***YOUR PROBLEMS*** INTO
AN OPEN MIDDLE FORMAT

*Have your students try to convert their own problems as
well*

BRYAN ANDERSON
@ANDERSON02B

MathLab: banderson02.wordpress.com

