

Teacher Lesson Design

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With appreciation for participating teachers,
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Think about your math lessons

1. Which of these descriptors would you predict students pick after a typical lesson?
2. Which would you want them to pick?
3. What would need to change?

Funny	Fine	Amazing	Just OK
Fascinating	Suspenseful	Enjoyable	Satisfying
Boring	Fun	Frustrating	Dull
Surprising	Thought-provoking	Intriguing	Not special

Session Overview



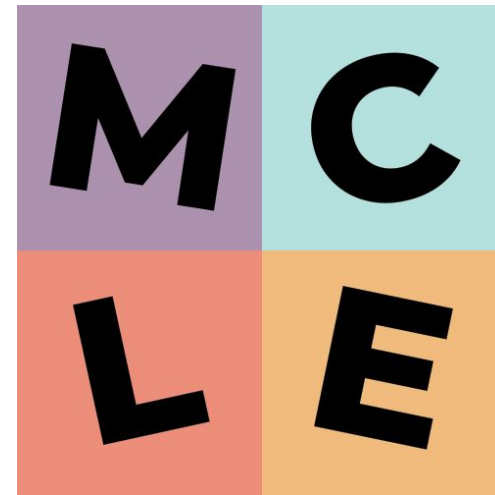
1. Share an overall design approach for mathematics lessons that we used to raise student curiosity and engagement
2. We will participate in one of the lessons (from Algebra 2) in groups
3. We will analyze the lesson for how it works
4. Discussion

Mathematically Captivating Learning Experiences

6 High School Mathematics Teachers

3 Different High Schools:

- 1 charter
- 1 comprehensive public urban
- 1 comprehensive public suburban



Design approach



Interpreted the unfolding mathematics as a **story**.

Typically, stories need to:

- be about something
- make some sense although you need to suspend “reality”
- offer some reason for the reader to want to keep reading (e.g., suspense, curiosity)
- allow anticipation of what will happen

What is a Math Story?



It's an ordered sequence of connected events (e.g., "acts") that temporally links a beginning to its ending. This framing focuses on the collective interactions between the parts rather than any specific part.



What is a Math Story?



But it is **NOT** only “story problems” nor is it stories about mathematics.

It’s focused on how the mathematical ideas come to be recognized and understood.



What is their impact?

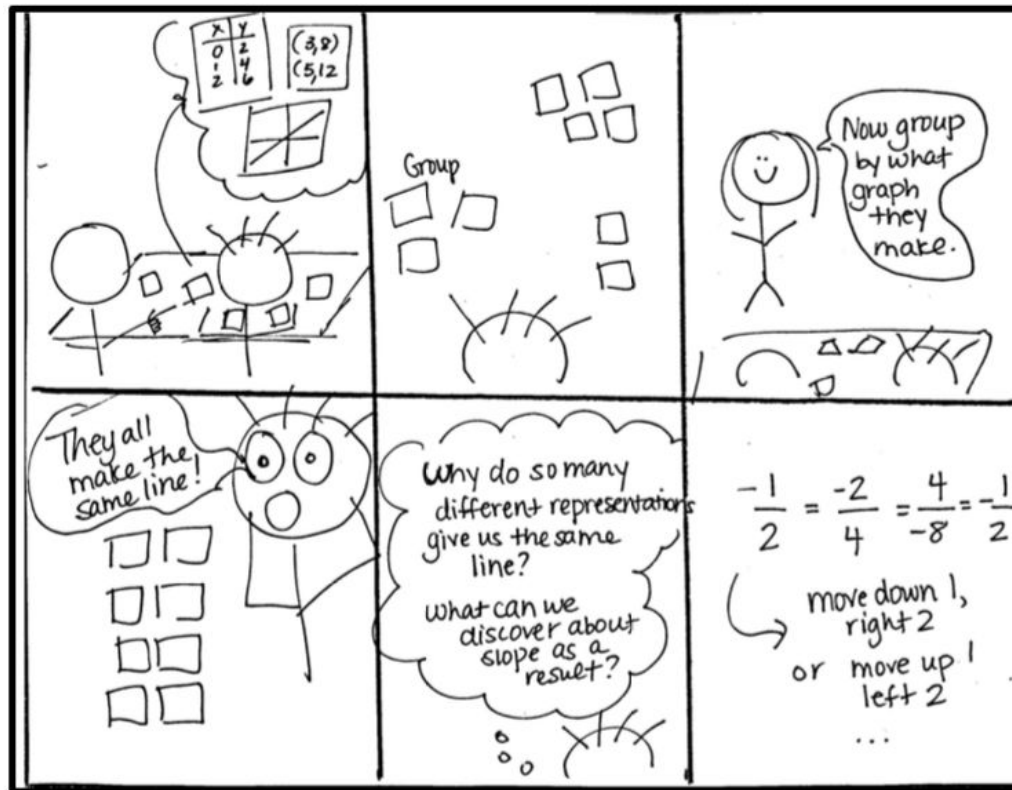
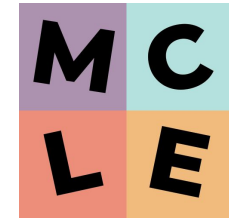


Stories create opportunities for readers to become engaged with the story.

The way a mathematical story moves an individual is its **mathematical plot**.



Designing a Mathematical Story



Enact and Survey

Theory

POTENTIAL AESTHETIC RXNS TO MATH LESSONS

- satisfaction → success, closure
- playfulness → curious, interested
- amusement/funny → tension for response
- confusion → excitement
- awe → happiness
- surprise → dislike/disgust/curiosity
- frustration → annoyance
- pride → confidence
- boredom → focus/attention
- misbehavior → anxious / fear
- outrage / anger / relief

Plan for Aesthetic

Whole class: Ask students to predict cards that they believe are connected. In this discussion, students present their reasoning and make and investigate with other students' groups. Through this discussion, students realize that every card represents the same function! Could it be that all of the cards are connected to the same function?

In small groups: Students determine that pairs or small groups of cards represent the same function.

In small groups: Students verify that all the remaining cards in fact do represent the same function.

Whole class: Present final connections discovered. Opportunity to discuss how to recognize the y-intercept and the slope in many different representations of a linear function.

Hook → Building Action → Understanding Action → Resolution

MCLE Design Process

Lesson Materials

x	y
0	6
1	5
2	4
3	3

The line that passes through the points (4, 4) and (0, 1)

Start at (0, 6). Move left 4 and up 2.

Start at (4, 4). Move down 3 and right 6.

$y = -\frac{1}{2}x + 6$

Storyboard Sequence

equations could be helpful

probably going to group by representation

? each group responsible for making a group for making a group for making a group

Now groups (groups by what groups they choose)

Why do we have 1? How else can we group them?

Can have to differentiate which one does not belong?

$y = -\frac{1}{2}x + 3$

more down 1, right 2 or move up 1 left 2

Number System Puzzlers

Work with a partner on the tasks designed by the teacher to experience the mathematical story. **Assume you are a student in Algebra 2.**

1. Find two numbers that satisfy each description. If it is not possible to find a solution, write *not possible*.
 - a. Find two numbers that have a product of -20 and a sum of 8 .
 - b. Find two numbers that have a product of 4 and a sum of 8.5 .
 - c. Find two numbers that have a product of 1 and a sum of 4 .
 - d. Find two numbers that have a product of $\frac{3}{16}$ and a sum of 1 .
 - e. Find two numbers that have a product of -2 and a sum of 0 .
-

Reflection

What do you think Algebra 2 students would think this lesson is about?

Number System Puzzlers

Work with a partner on the tasks designed by the teacher to experience the mathematical story.

2. Given the equation $x^2+7x+10=0$:

a. Solve this equation.

b. How can you connect the sum and product of the solutions with the equation?

Reflection

What do you think Algebra 2 students would think this lesson is about? **Has it changed?**

Where do you predict this lesson is heading? Why?

Number System Puzzlers

Work with a partner on the tasks designed by the teacher to experience the mathematical story.

3. Suppose a quadratic equation has solutions 6 and -4. Find the equation (in standard form) that has those solutions.
-

Reflection

What new ideas do you have about
the design of this lesson (so far)?

Number System Puzzlers

Work with a partner on the tasks designed by the teacher to experience the mathematical story.

4. Use the equation $x^2 - 4x + 1 = 0$:
 - a. Based on the equation, what is the sum and the product of the solutions?
 - b. Solve the equation. Simplify your answers as much as possible.
 - c. Show that the solutions do in fact have the product and sum that you predicted in part (a).
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Workspace

4. Use the equation $x^2 - 4x + 1 = 0$:
- c. Show that the solutions do in fact have the product and sum that you predicted in part (a).



Reflection

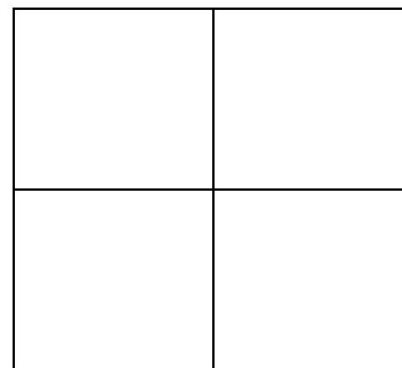
Do any of your previous ideas about this lesson (like it's purpose, what it's doing) need to be revisited?

If so, what is causing you to rethink?

Number System Puzzlers

Work with a partner on the tasks designed by the teacher to experience the mathematical story.

5. Use the equation $x^2 - 6x + 10 = 0$:
- Based on the equation, what is the sum and the product of the solutions?
 - Find two numbers that have the right product and sum. An expansion box may support your work.



Workspace

$$x^2 - 6x + 10 = 0$$

Sum:

Product:



Number System Puzzlers

Work with a partner on the tasks designed by the teacher to experience the mathematical story.

5. Use the equation $x^2 - 6x + 10 = 0$:
 - c. What number system do your solutions belong to?
 - d. Now, solve the original equation $x^2 - 6x + 10 = 0$. Can you confirm your answer to (b)?
-

Turn and Talk

What do you notice and wonder about the design of this lesson?

1

Number Puzzles

- Integers with product of -20 and sum of 8
- Rational numbers w/ product of 4, sum of 8.5
- Numbers in any system w/ product of 1 and sum of 4
- Rational numbers with product of $\frac{3}{16}$ and sum of 1.
- Irrational numbers with product of -2 and sum of 0

2

Given $x^2 + 7x + 10 = 0$ Quadratic Equation

- Solve this equation.
- How can you connect the sum and product of the solutions with the equation?

3

Working Backwards Given Solutions 6 and -4

Find the quadratic equation.

4

Given $x^2 - 4x + 1 = 0$

- Based on equation, what is the sum and product of the solutions?
- Solve the equation.
- Show that the solutions have product and sum predicted in (a).

5

Given $x^2 - 6x + 10 = 0$

- Based on equation, what is the sum and product of the solutions?
- Find two numbers with given product and sum.
- Which number system?
- Solve the equation. Can you confirm your answer to (b)?

Turn and Talk

How does what this lesson seems like it is about change?

1

Number Puzzles

- Integers with product of -20 and sum of 8
- Rational numbers w/ product of 4, sum of 8.5
- Numbers in any system w/ product of 1 and sum of 4
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Given $x^2 + 7x + 10 = 0$ Quadratic Equation

- Solve this equation.
- How can you connect the sum and product of the solutions with the equation?

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Working Backwards Given Solutions 6 and -4

Find the quadratic equation.

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Given $x^2 - 4x + 1 = 0$

- Based on equation, what is the sum and product of the solutions?
- Solve the equation.
- Show that the solutions have product and sum predicted in (a).

5

Given $x^2 - 6x + 10 = 0$

- Based on equation, what is the sum and product of the solutions?
- Find two numbers with given product and sum.
- Which number system?
- Solve the equation. Can you confirm your answer to (b)?

Student Reactions - of 15 who took the survey

9 *thought provoking*

5 *surprising*

3 *intriguing*

3 *fascinating*

“It is much different than before because we were always told that it was an error is there is a negative square root”

Thank you!

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