BLUEBIRD MATH CIRCLE
Alliance of Indigenous Math Circles

Issue 8 Recap

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Monday July 26, 5-6 PM MDT online.

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Introduction

This time we had a good mixture of students, teachers, parents/guardians, and math friends. All students came from two schools – Tuba City Boarding School, Tuba City, Arizona, and St. Paul Catholic High School, Bristol, Connectut. Bluebird is very happy to have had these students and their teachers! We also had people from Tsaile, Arizona; Santa Rosa and San Jose, California; Athens, Ohio; New York City, New York; Navajo and Santa Fe, New Mexico; and Burnaby BC, Canada. As usual, we started this meeting by listening to a bluebird song and thinking of whether we had any questions for Bluebird. Some people did! Those questions are listed at the end of this recap.

Next, our host of the day, Wesley Hamilton, told us about himself. Wesley recently graduated with a PhD in mathematics from University of North Carolina. And he is about to start a position at University of Utah. He said, "It means that I get to do more math and teach and work with students." When asked what kind of mathematics he was doing, he replied, "The short answer is data analysis. I like taking mathematical tools and seeing what they can tell us about data." This sounds fascinating! Especially to those people who attended the last meeting, where we talked about data representation, among other things.

Wesley briefly reminded us about most parts of Issue 8:

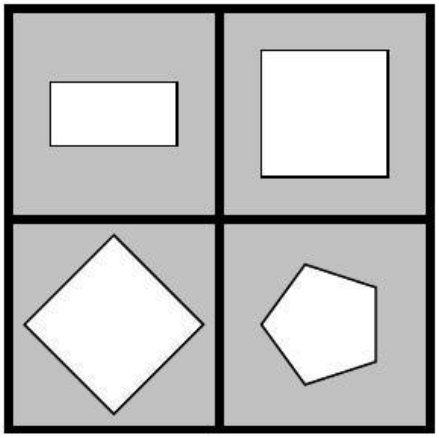
- An activity about finding differences between shapes, patterns, and then numbers, *How am I Different?*
- Family Fun Game, *No-Three-in-a-Row*
- Ask Bluebird – A question asked at a previous meeting, "What is π?" – has an answer in this issue.
- Fun Fact of the Fortnight is about playing cards and shuffling them. How random can you get cards? How many shuffles you need to do?

Read Issue 8 to learn the answers!

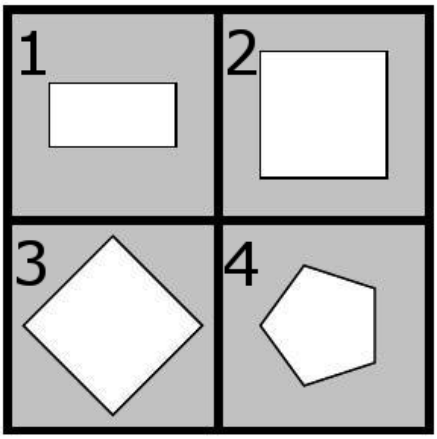
How am I different?

Now it was time to start looking at the first activity in earnest. And we did!

We looked at the following four shapes, and tried to find one thing for each shape which was different from the other three shapes:



Let's number the shapes 1 through 4 starting at the top left. This is what participants said:



Shape 1: It is the only rectangle which isn't a square.
Shape 2: It is the only one similar to its own frame. You can get this shape by simply shrinking its frame.
Shape 3: It's a square whose diagonals are parallel to the sides of the frame. Another observation is that its vertices are pointing to the midpoints of the frame. Yet another possible answer is that the vertices are pointing to the cardinal points – North, East, South, and West.
Shape 4: The only one with 5 sides.

Some of the participants pointed out that "the four shapes were of different sizes." This might be a starting point of a very interesting – and mathematically deep – discussion of what does one mean by 'the size' of a flat figure? What do you think?

Now we asked the same question – *How am I different?* – about the four drums in the following picture:

Again, we numbered them 1 through 4, starting at the top left one. This time, people found great many possible answers:
Shape 1:

- It is the only blue one.
- The only one with hands.
- It has animals depicted on both sides.
- It has a reflection (mirror) symmetry with respect to a vertical line.

Shape 2:

- It has a green band which separates the inner face from the outer pattern.
- The inner face has a mirror symmetry with respect to a vertical line, but the outer pattern doesn't.
- The outer pattern has a 4-fold rotational symmetry (see an explanation below).

Shape 3:

- Its primary color is red.
- The artistic elements are smaller. (More elaborate.)
- It's the only one which has details like leaves and plants.
- It has a 4-fold rotational symmetry.

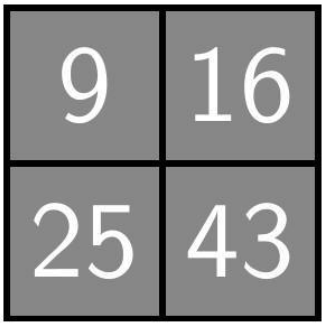
Shape 4:

- Its primary color is yellow.
- It has two big fishes (salmon?).
- It has a 2-fold rotational symmetry, but no reflection symmetries or 4-fold rotational symmetry.

Of course, there might be other answers. If you find any answer which isn't included, please tell us!

Note: A figure has a 4-fold rotational symmetry if rotation by an angle of $360/4 = 90$ degrees around its center does not change the figure. Likewise, a figure has a 2-fold symmetry if rotation by an angle of $360/2 = 180$ degrees around its center does not change the figure.

Next we went to the following table containing four numbers, and asked the same question:



Here's what participants noticed:

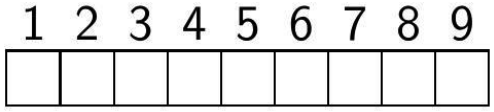
- 9 is the only 1-digit number.
- 16 is the only even number (and the only power of 2).
- 25 is the only number divisible by 5.
- 43 is the only prime number.

We didn't have time to look at the last diagram of this section of the flyer #8 – the table with numbers 17, 26, 44, and 65. Send us your answers about these numbers!

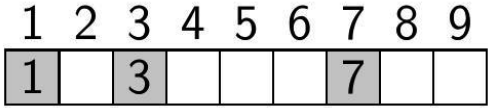
No-Three-in-a-Row

The last thing we did in the session was playing the No-Three-in-a-Row game. First, Wesley explained the rules:

1. To begin, write the numbers 1, 2, 3… over a set of boxes like this:

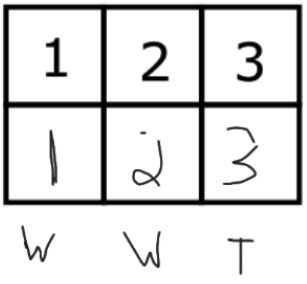


2. Players take turns in which they choose a number and write it in the box below. After three turns, we could be left with this:



3. A player loses the game when they enter a number that forms a sequence of three-in-a-row.

We played the game with a very small board having only 3 squares. It wasn't a very exciting game – no matter what the first player does, and regardless of the second player's move, the first player would lose by placing the third-in-a-row number on the board (make sure that you see it, too). Here is a screenshot where Wesley (W) and Tatiana (T) kept track of their moves. Wesley made the first (1) and the third (2) moves, and he lost.



But then we all went into breakout rooms where we had jamboard slides with boards of several sizes. You can make your own copy of our jamboard here:

https://jamboard.google.com/d/1KTuWl2_p3mJlM6V0pK9j9TsVQAi8baDVSdaEoaT3WvI/edit?usp=sharing Besides simply playing and enjoying the game, we wanted to find answers to several questions , such as:

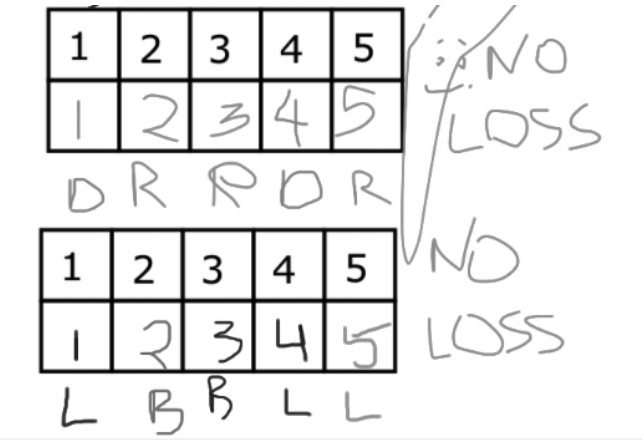
- What is the maximum number of moves?
- If you want to force your opponent to lose quickly, what is the smallest possible number of moves?
- In general, what can we say about playing on different board sizes?

Here is an observation people shared after coming back together:

> On the board of size 5, the first player has a winning strategy. For example, start by placing number 3 in the middle square. No matter what the second player does, you can place one of the end numbers – 1 or 5 – down at your next move. And this will force your opponent to produce three-in-a-row at their next move and thus lose.

It turned out that the rules of the game led some participants to variations in their interpretation.

Does "three-in-a-row" mean (1) three numbers placed by either of the players, or (2) three numbers all placed by the same player? We thought of (1) when sharing the rules. One of our breakout rooms used (2) – an unexpected development with potentially interesting mathematical consequences.. For example, if you look at the screenshot below you will see that when people used the second interpretation, two games on the board of size 5 resulted in a draw.



We didn't have time to play with other sizes, or answer questions posed above. Will you try? If you do, make sure to tell Bluebird about your experiences and discoveries.

Share your ideas with other Bluebird Math Circle participants at **https://aimathcircles.org/Bluebird**

New Questions for Bluebird

Is there a pattern in the Blue Bird feather compared to other birds? – from Anonymous

Why are bluebirds blue? – from Mark Saul

Why is it important to relate math and art? – from Lila A.

How many different sizes of infinity are there? – from Craig Young

BLUEBIRD SAYS—Curious questions. I will fly around and seek some answers. Watch this space in the next flyer!

Submit your math-related questions at **https://aimathcircles.org/Bluebird**