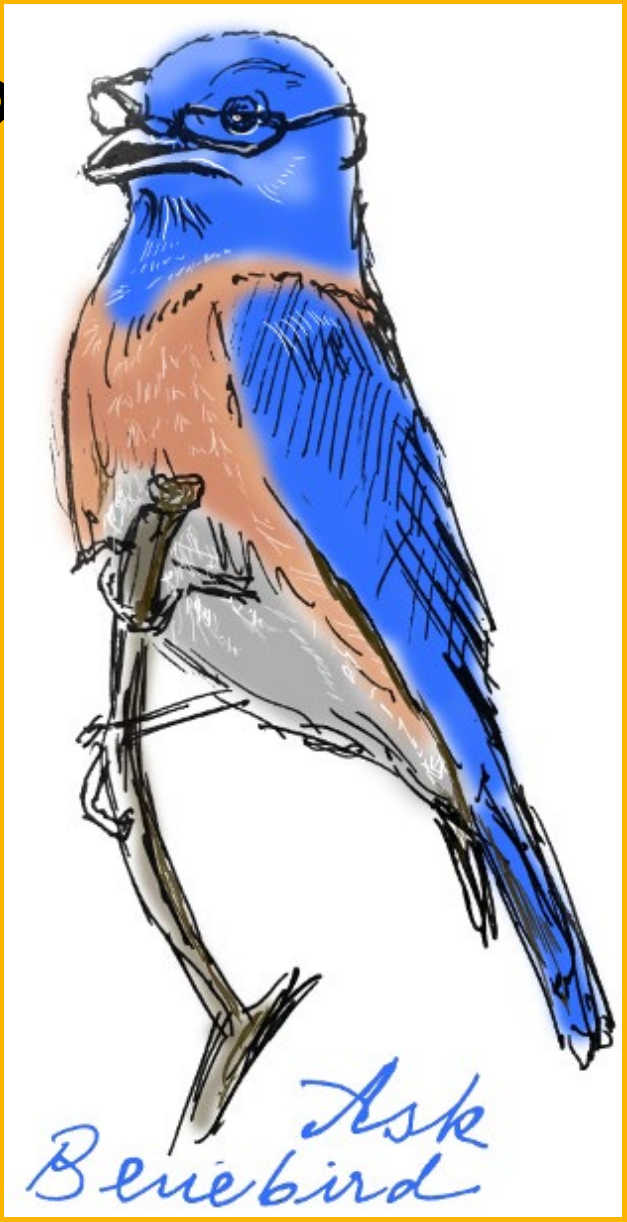
Bluebird Math Circle

A Virtual Math Communit

What is the Bluebird Math Circle?



- It is a special program of the Alliance of Indigenous Math Circles (AIMC)

Alliance of Indigenous Math Circles

Mission

The mission of the Alliance of Indigenous Math Circles (AIMC) is to create mathematical opportunities for Indigenous students and to build community among math teachers of Indigenous students while respecting Indigenous culture.

Vision

Our vision is to increase by an order of magnitude the number of Indigenous students who choose to pursue post-secondary STEM degrees.

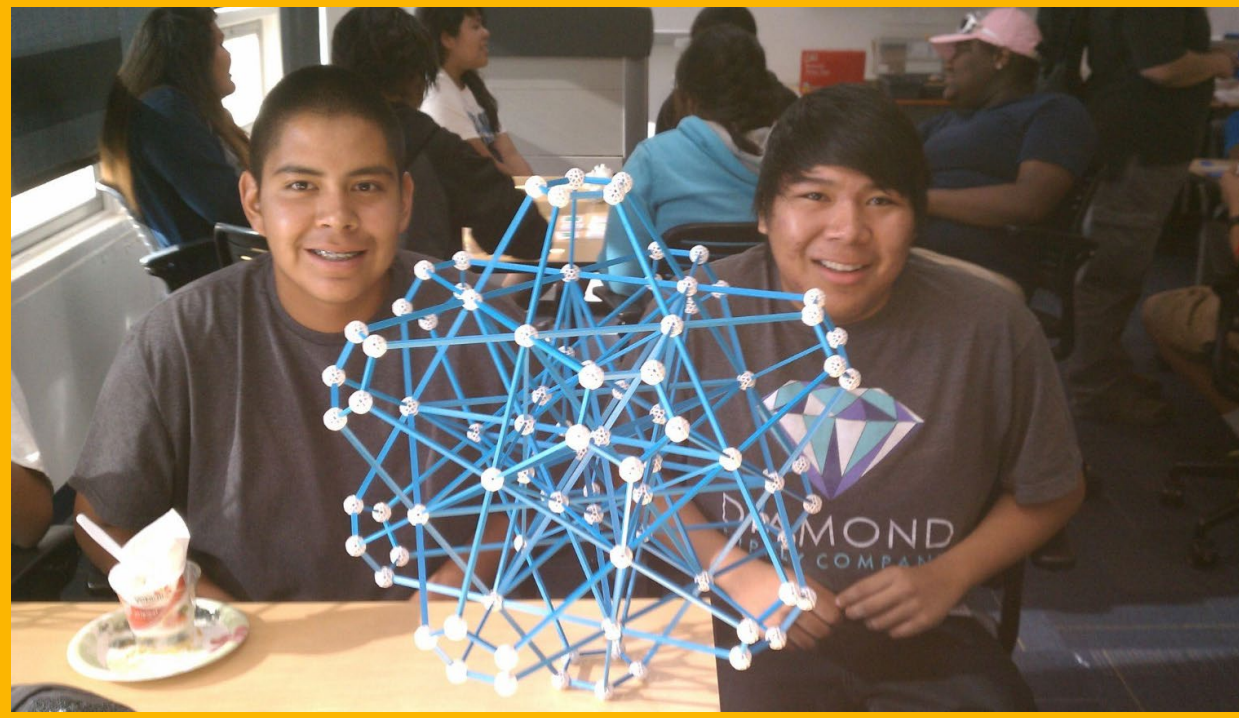
Systemic barriers to indigenous students' success:

Indigenous people are underrepresented in STEM disciplines and especially in mathematics.

Mathematics, like music and poetry, is the birthright of every human, and mathematical talent is spread uniformly among all people. Thus, underrepresentation suggests that Indigenous students' talents remain unrealized because of reasons beyond their control, and not because of a lack of capacity or interest. Moreover, indigenous people will bring their unique view point and thus will enhance and expand the professions.

Systemic barriers to indigenous students' success:

School mathematics hides mathematics' role as a cornerstone of human civilization, leading to student disinterest in the subject.



Besides opening many doors to STEM and other professions, mathematics is the best tool for developing logical thinking and training analytical abilities. Not studying math deprives students of an excellent opportunity to build their “mental muscles”.

Systemic barriers to indigenous students' success:

Schools serving large percentages of indigenous students face high turnover among math teachers, making it difficult for students to build the kinds of connections with role models that sustain students' interests in pursuing mathematics.

Building a community of math teachers' who have a network of connections to peers and mathematicians around the country provides professional and emotional support. Decreasing teacher turnover has a high return on investment and supports student persistence.

AIMC addresses these pro

Math Circles partners with indigenous communities to uplift the beauty and power of mathematics

Network of professional mathematicians facilitates math circle demonstrations, math festivals, teacher workshops

Respected teacher-leaders from indigenous-serving schools and organizations serve as regional coordinators

AIMC Directors

Regional Coordinator

SUDESMANAGOMA

AIMC links indigenous community

AMERICAN INDIAN SCIENCE AND ENGINEERING SOCIETY

to the mathematical community

- Mathematical Association of America (MAA)
- American Mathematical Society (AMS)
- American Indian Science and Engineering Society (AISES)

AIMC by the numbers annually (pre-pandemic)

500+

K-12 students served through Math Circles educational approach

80+

K-12 teachers served through Math Circle workshops in schools that served Native American students.

1

7th - 12th grade FREE 6-day summer math camp for indigenous students at Navajo Preparatory School

4

Math Circles teacher professional development in Santa Fe, Oklahoma, Tuba City & Las Vegas (NM)

27

Mathematician presentations to schools in the Navajo Nation, Hopi and other locations.

And then the pandemic started…

We couldn’t go to the communities we’
serving in person.
Instead, we started an online program:

Bluebird Math Circle

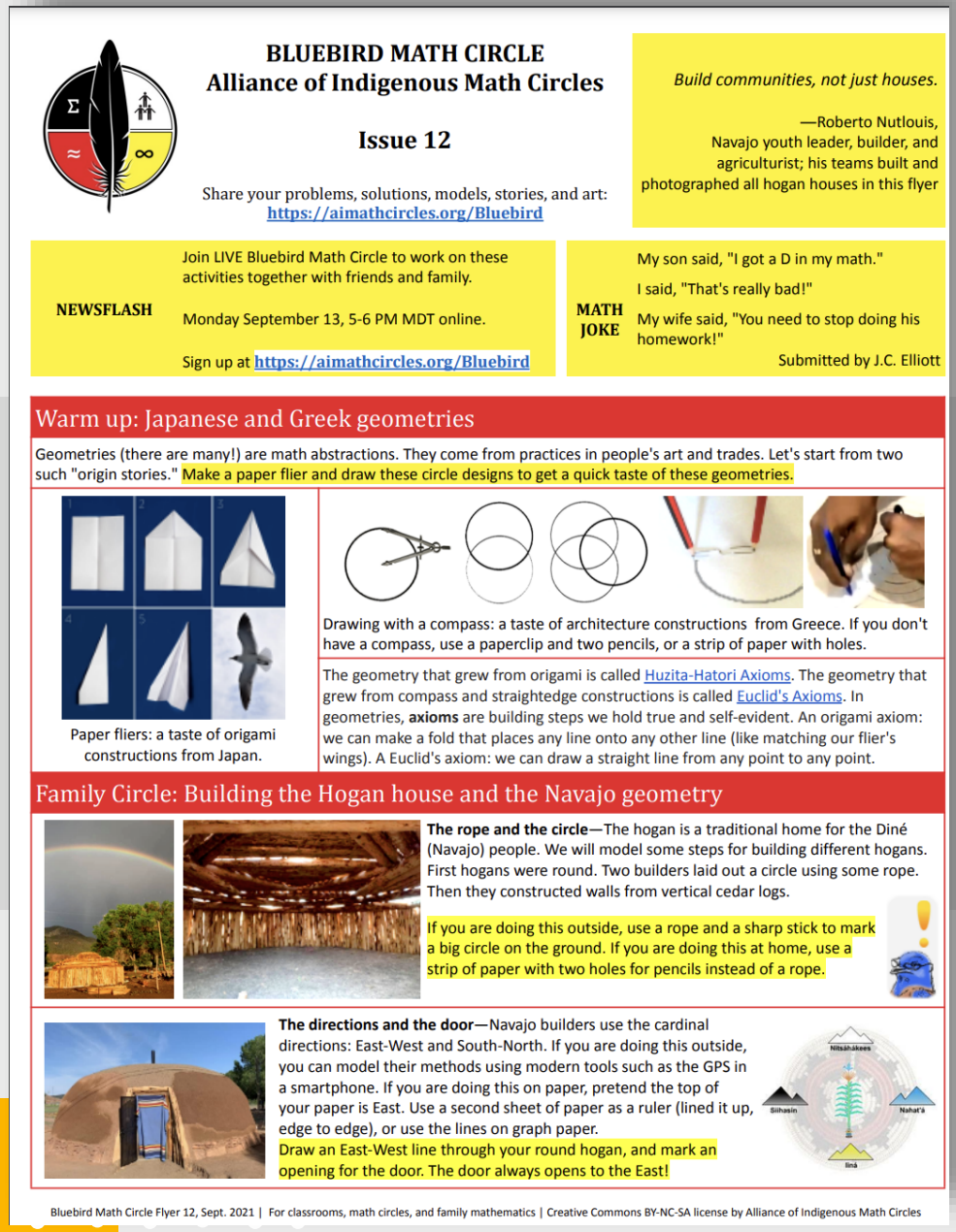
Bluebird Math Cir

Virtual Math Community

Launched in March 2021 it is a supportive community of teachers, students and their families – everyone who cares or is curious about mathematics, education and indigenous young people's futures.

Look us up at https://aimathcircles.org

Bluebird Math Ci



BLUEBIRD MATH CIRCLE
Alliance of Indigenous Math Circles

Issue 12

Share your problems, solutions, models, stories, and art:
https://aimathcircles.org/Bluebird

Build communities, not just houses.

—Roberto Nutlouis,
Navajo youth leader, builder, and agriculturist; his teams built and photographed all hogan houses in this flyer

NEWSFLASH

Join LIVE Bluebird Math Circle to work on these activities together with friends and family.

Monday September 13, 5-6 PM MDT online.

Sign up at https://aimathcircles.org/Bluebird

MATH JOKE

My son said, "I got a D in my math."

I said, "That's really bad!"

My wife said, "You need to stop doing his homework!"

Submitted by J.C. Elliott

Warm up: Japanese and Greek geometries

Geometries (there are many!) are math abstractions. They come from practices in people's art and trades. Let's start from two such "origin stories." Make a paper flier and draw these circle designs to get a quick taste of these geometries.

Paper fliers: a taste of origami constructions from Japan.

Drawing with a compass: a taste of architecture constructions from Greece. If you don't have a compass, use a paperclip and two pencils, or a strip of paper with holes.

The geometry that grew from origami is called Huzita-Hatori Axioms. The geometry that grew from compass and straightedge constructions is called Euclid's Axioms. In geometries, **axioms** are building steps we hold true and self-evident. An origami axiom: we can make a fold that places any line onto any other line (like matching our flier's wings). A Euclid's axiom: we can draw a straight line from any point to any point.

Family Circle: Building the Hogan house and the Navajo geometry

The rope and the circle—The hogan is a traditional home for the Diné (Navajo) people. We will model some steps for building different hogans. First hogans were round. Two builders laid out a circle using some rope. Then they constructed walls from vertical cedar logs.

If you are doing this outside, use a rope and a sharp stick to mark a big circle on the ground. If you are doing this at home, use a strip of paper with two holes for pencils instead of a rope.

The directions and the door—Navajo builders use the cardinal directions: East-West and South-North. If you are doing this outside, you can model their methods using modern tools such as the GPS in a smartphone. If you are doing this on paper, pretend the top of your paper is East. Use a second sheet of paper as a ruler (lined it up, edge to edge), or use the lines on graph paper.
Draw an East-West line through your round hogan, and mark an opening for the door. The door always opens to the East!

Every other Wednesday

Bluebird Math Circle flyer released with fun and engaging math activities that are accessible to everyone. People are encouraged to play with the activities in class and at home.

https://aimathcircles.org/bluebird/

Following Monday

A live online circle meeting is held to discuss and solve the activities.

Every 2-page issue of the newsletter ha a certain structure:

BLUEBIRD MATH CIRCLE
Alliance of Indigenous Math Circles

Issue 21: Making Things Equal

Share your problems, solutions, models, stories, and art: https://aimathcircles.org/Bluebird

From my experience, no one expects you to be perfect on the first try and there is honor in knowing where you're lacking. Take the time to better yourself - to not give up.

—Alexis Keeling, Cherokee Nation, Industrial and Systems Engineer

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MATH PUZZLE

How many numbers do you see here?

Warm up: Cut It Up Equally

Split the figure on the grid into two equal parts (so that you can place one part on top of the other one and they completely coincide). You can move the pieces any way you want – slide, turn them around or flip them. Artwork: Coyote (Zuni fetish).

Family Circle: Making Shares or Numbers Equal

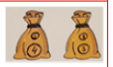
Problem 1: Once upon a time on a faraway planet there was an island nation called Bluebird Nest. When the people of Bluebird Nest wanted to appoint the leader, they asked candidates to demonstrate their cleverness, generosity, and fairness. Each candidate was given 100 coins, each coin of different value: 1 blue dollar, 2 blue dollars, 3 blue dollars, etc, all the way to 100 blue dollars, and they were told to distribute the money among people. Whoever distributes the money among the largest number of people in such a way that every person gets the same total value becomes the leader. Could you help?

Artwork: *The Money Changer and His Wife* by Quentin Matsys (oil on panel painting, 1514).

Here is an example: If we have three coins of 1, 2, and 3 blue dollars, we can split them evenly between two sacks as shown.

Can we split the coins between more than 2 sacks?

If we have coins of 1, 2, 3, 4 blue dollars, we can split them evenly between two sacks.



Can we split the coins between more than 2 sacks?

What if there were 101 coins (of 1 blue dollar, 2 blue dollars , 3 blue dollars, ..., 100 blue dollars, 101 blue dollars)? What if there were 2020 coins?

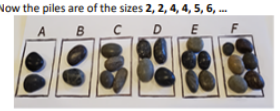
Problem 2: Make the piles equal. The game starts with N piles of stones. The first pile has just 1 stone, the second pile has 2 stones, the third pile has 3 stones, etc. A move consists of adding 1 stone to each of any two piles of our choice (see the example).

If we are allowed to make any number of moves, can we end up with all piles having the same number of stones?

EXAMPLE for a move: We start with the piles of size **1, 2, 3, 4, 5, 6, ...**

Move: Add 1 stone to the piles A and C.

Now the piles are of the sizes **2, 2, 4, 4, 5, 6, ...**



Try to answer the same question if (a) N = 11; (b) N = 12; (c) N = 13; (d) N = 14. Did you notice any patterns?

Ask Bluebird

QUESTION—*What is the smallest perfect number?* – from Chris K.
BLUEBIRD SAYS—A perfect number is one that is equal to the sum of all its divisors including 1 but excluding itself. Let's look at the following table:

Number	All its divisors	The sum of all the divisors excluding the number itself
2	1, 2	1
3	1, 3	1
4	1, 2, 4	3 (=1+2)
5	1, 5	1
6	1, 2, 3, 6	6 (=1+2+3)

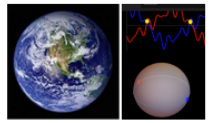
(Can you see why the table starts with number 2 instead of 1?)

From the table we see that the smallest perfect number is 6. Try to find the next perfect number, it won't take long. Many interesting facts are known about perfect numbers. Bluebird's favorite ones are the following two:

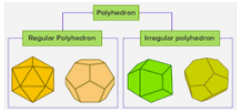
1. Nobody knows whether or not there exist odd perfect numbers; this may be the oldest open problem in mathematics.
2. It was the study of perfect numbers that led Pierre de Fermat (a 17th century French mathematician) to discovery of the result (so-called Fermat's Little Theorem) which has recently become totally indispensable in a very applied area of mathematics – cryptography – used everyday in all our electronic devices (telephones, computers, etc.)

FUN FACT OF THE FORTNIGHT

1. At any given moment on the earth's surface, there exist two antipodal points (on exactly opposite sides of the earth) with equal temperatures and barometric pressures.



2. In geometry, a *polyhedron* (plural *polyhedra*) is a three-dimensional shape with flat polygonal faces, straight edges and sharp corners (or vertices). We are well familiar with many polyhedra such as cubes, pyramids, rectangular boxes. Polyhedra occur in nature as crystals; jewelers shape up stones as intricate polyhedra. We can imagine (or construct) polyhedra of many, many different forms (try it!). But it is a fact that every polyhedron must have at least two faces with the same number of vertices. If you want to see why this is so, write to Bluebird and we'll talk about this fact.



A quote and a Math Puzzle (or a Math J

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A warm-up activity:

Warm up: Cut It Up Equally

Split the figure on the grid into two equal parts (so that you can place one part on top of the other one and they completely coincide). You can move the pieces any way you want – slide, turn them around or flip them. Artwork: Coyote (Zuni fetish).

Main activity (usually consisting of one or two challeng

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Bluebird's answer to a question posed at a past meeti

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Last but not least part of the newsletter: Fun Fact of the Fortnight:

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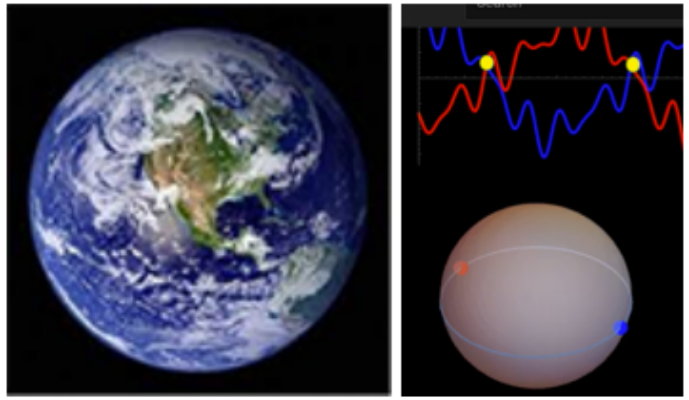

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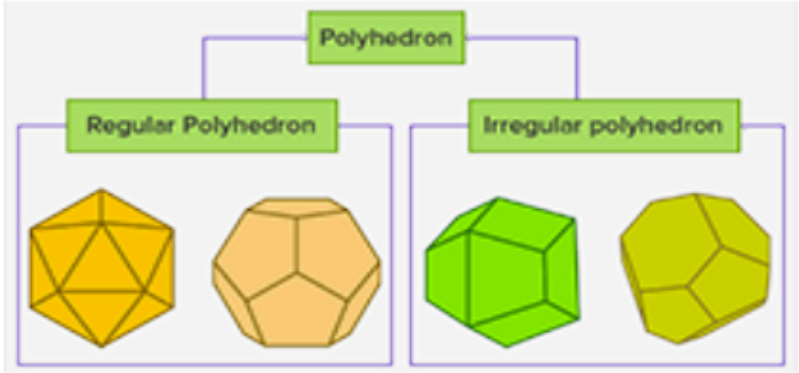

After the meeting, we publish a recap where Circle members and friends share the ideas they developed in the meeting, ask questions, and suggest future topics.

BLUEBIRD MATH CIRCLE
Alliance of Indigenous Math Circles

Issue 14 Recap

Share your problems, solutions, models, stories, and art: https://aimathcircles.org/Bluebird

NEWSFLASH Join LIVE Bluebird Math Circle with friends and family.

November 1, 5-6 PM MDT online.

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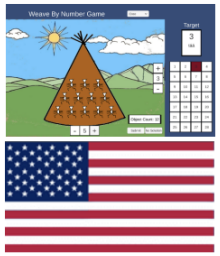
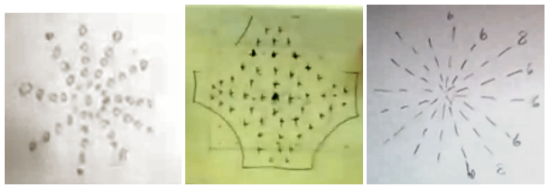
Family Circle: Polygonal Numbers

The Bluebird MC meeting on October 18 was very special. It was led by a teacher/student team. Donna Fernandez and her students from Navajo Prep School—Yilnazbah W. and Watson W.—led the participants through an introductory part to a computer game *Weave-by-Numbers* which they have recently created.

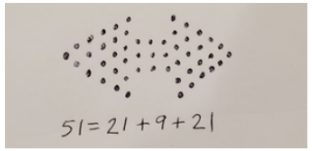


Donna says, "I was so pleased to see new and old faces at Bluebird Math Circles. The Bluebird Math Circles opened with an engaging problem on redesigning the stars on the flag. The challenge was to add one more star to the 50 stars on the current flag. Attendees came up with various drawings to keep symmetry or redesign the flag. I was impressed with Aliana T. who worked for a while and then showed a circular design. Other participants talked about setting stars in the middle first and then using the remaining stars to fill in the quadrants."

Here are designs for a 51-star flag by Aliana T., Yilnazbah W., and Beth Cammarata:



It's possible to use figurate numbers for a pleasing design with 51 stars:

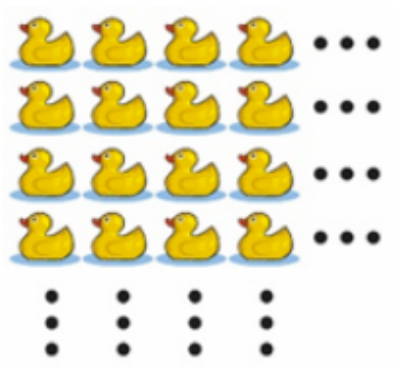


Here we used two triangular and one square number.

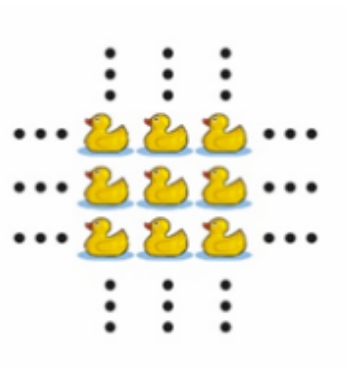
Moreover, 51 is the 6th pentagonal number (see Bluebird Flyer Issue 14), so the stars can be placed as the dots are there. Also, 51 is the 5th *centered pentagonal* number. A centered pentagonal number is a *centered figurate* number that represents a pentagon with a dot in the center and all other dots surrounding the center in successive pentagonal layers.

The next two slides contain an excerpt fro

Recap 17 Sizes of Infinity



Problem 1

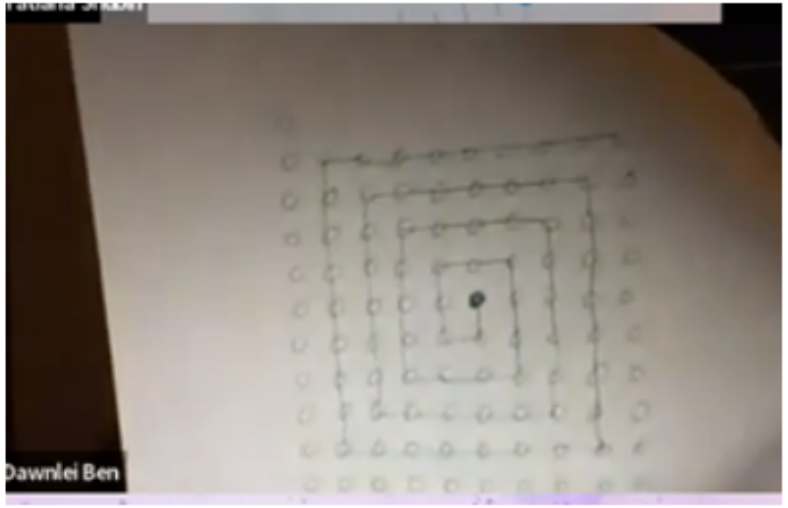


Problem 2

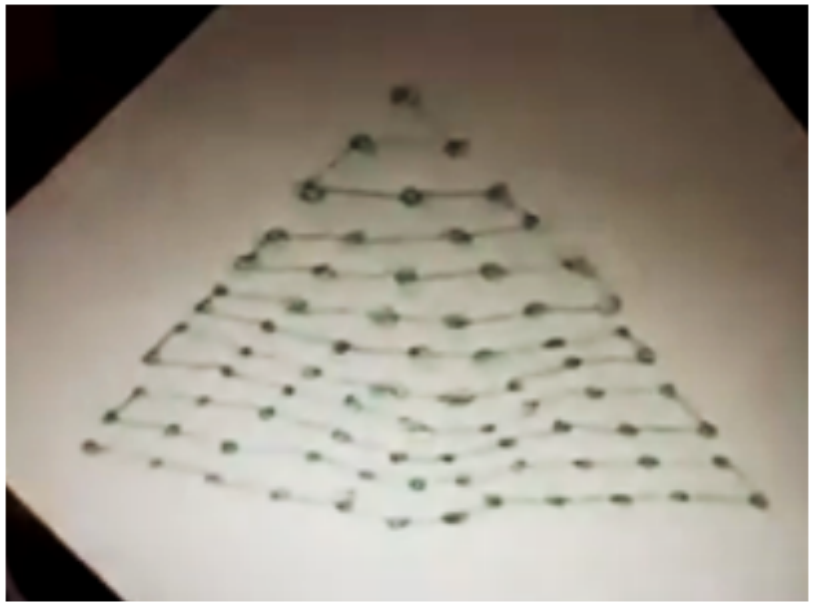
In each problem, we need to decide how to distribute tickets with numbers 1, 2, 3, 4, and so on among all the ducks. We want to make sure that every duck, no matter where it is in a row or how far down a column, eventually gets a ticket with a counting number on it.

After about 20 minutes we all came back together again and talked about our discoveries.

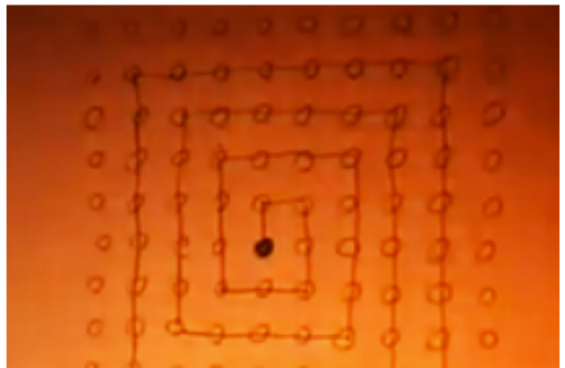
People from one room reported, “We are so happy to report that in our room we have solved both problems.” To explain, Dawnlei Ben showed the following two pictures:



Then she went on to tell us more about her solutions: “This one had a starting point. So that's where we started, and I just zigzagged back and forth and thought of a Christmas tree. That’s the perfect way to put lights on a tree mathematically. Yeah, that’s how all our trees should look now:



"I put up my tree yesterday, so it started making me do that. And then when you put the star on the top you see the ornaments and the lights from the top view and then your cords wrap around it. That gave me the idea of just looking from the top of the tree down here:



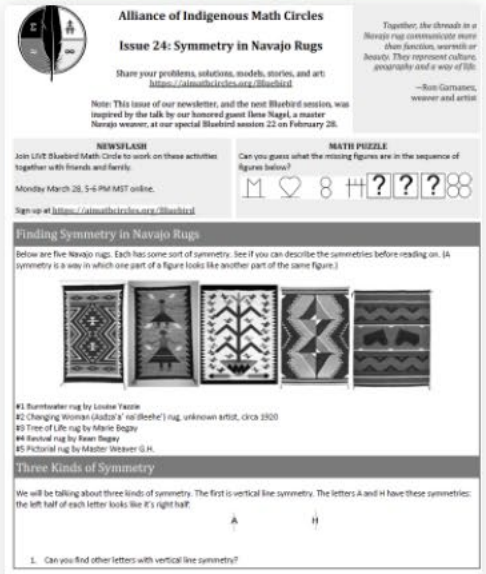
All our newsletter issues and recaps can be found at our

Bluebird Math Circle | For Teachers | Newsletters Archive

Issue 25—Traci Sorell reads Classified—full color PDF

Issue 25—Traci Sorell reads Classified—grayscale PDF

Issue 24—Symmetry in Navajo Rugs—full color PDF



Issue 24—Symmetry in Navajo Rugs—black and white PDF

Also, our website has a special tab for teachers:

Bluebird Math Circle | For Teachers | Newsletters Archive

For Teachers

Dear Teacher,
The Alliance of Indigenous Math Circles appreciates your involvement with the Bluebird Math Circle. We offer you a certificate granting 3 PD hours when you:

- participate in a live Bluebird MC meeting,
- use the materials after the meeting with a group of people: students, or parents, or neighbors, or other teachers,

You are welcome to receive these certificates multiple times—as many times as you come to Bluebird MC meetings and implement the materials as described above.


ALLIANCE

Certificate of Completion
THIS ACKNOWLEDGES THAT
<Your Name>
Has completed 3 hours of professional development through participation in the Bluebird Math Circle meeting on <date>, implementing the mathematical material in a subsequent community meeting, and reporting the results to the AIMC team.

<Signature> Amanda Serenevy, AIMC Director

<Signature> Bob Klein, AIMC Director

Teacher interview

Alicia Gonzales, Pojoaque Valley Middle School, Santa Fe, NM

Download the interview

"The main reason that I love to teach math is because I was never good at math when I was a student. I always was the student that thought, "I'm so bad at this, and I'll never get it." Then, when I was offered the opportunity to get my math teaching degree, I had

Come to our live meetings. Register at

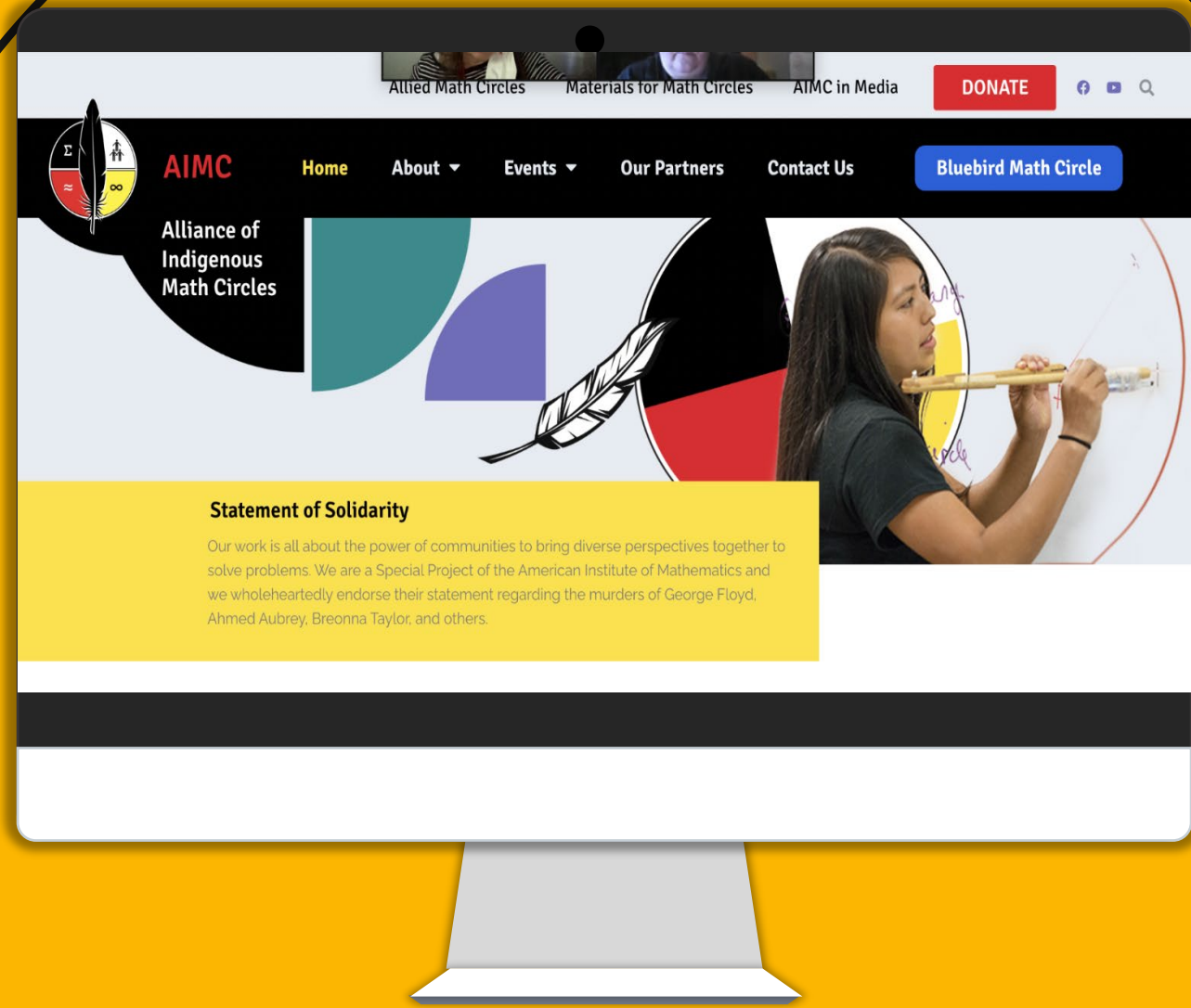
https://aimathcircles.org/bluebird/

We would like you to spread the word about AIMC and Bluebird Math Circle. We encourage you to bring Native American students, teachers and families to join us for engaging math.

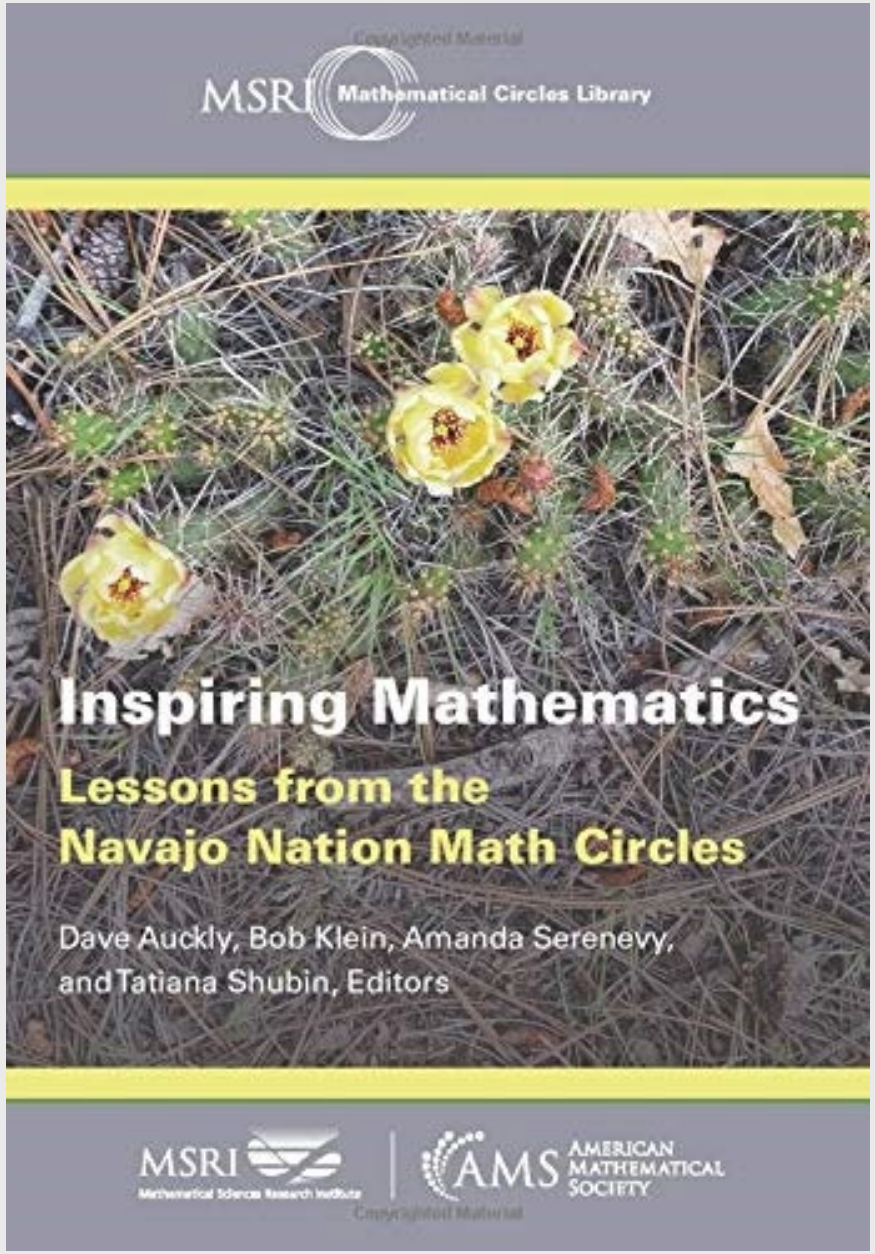
We welcome you to join our community as participants or leaders.

Join AIMC!

We want to partner with you. Please fill out our Contact Us online form at our website: www.aimathcircles.org



Book featuring activities used in Math Circles at Navajo Nation.



THANK YOU!

Contact us at:

www.aimathcircles.org