BLUEBIRD MATH CIRCLE
Alliance of Indigenous Math Circles

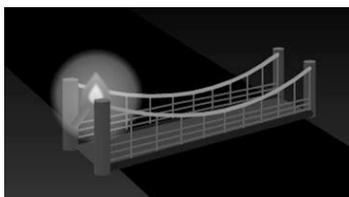## Issue 2 Recap

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

NEWSFLASH Join LIVE Bluebird Math Circle with friends and family.

Monday April 26, 5-6 PM MDT online.

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

Family Circle: Bridge and Torch Action/Adventure Stories

PROJECT—WRITE AN ACTION/ADVENTURE STORY There is an old math story about people crossing a rickety dark bridge with a single torch. You can find many versions under the name Bridge and Torch Puzzles. Now is your turn to tell stories and pose problems in your own way! Change characters, mathematical elements, or the setting of your story. Any little thing you change can cause big math and story implications.

STARTER STORY Person **A** takes 1 minute to cross a bridge, Person **B** takes 2 min, Person **C** takes 4 min, and Person **D** takes 8 min. It is dark, and they must carry a torch to cross. Two people can walk close together if one carries the torch, but the bridge will break if more than two people step on it. All four people must cross with just one torch, and take no more than 15 minutes to cross. Can they cross, or will they fail?

If you played with Flyer 2 at school or at home, Bluebird greets you! If you were among the students, parents, teachers, and math friends who gathered live on April 12, Bluebird thanks you for coming and exploring the mathematics of time together. And if you have not started yet, come on over, bring friends, and join the circle!

FROM SMALL GROUP DISCUSSIONS
Here are some of the notes that live circle participants shared after they worked on their storytelling projects. Bluebird thanks Beth Cammarata, Craig Young, Dawnlei Hunter Ben, Donna Fernandez, Rick Preston, and other teachers and parents for making this happen!

Key choice: How much context? The story and the number.
Do you prefer your math within a story with lively characters that you care about, in a world that you can love, and a situation that draws on your life experiences? Or do you prefer the precise and abstract feel of formal math, where a number is purely a number? Or a mix of the two?

Mathematicians grapple with that choice all the time. Formal mathematics comes with powers such as proof and precise predictions. Context-rich mathematics is grounded in vivid experiences, connected, and socially aware. We need both.

The Bluebird live circle had three working groups. They chose three different paths. One group created a story inspired by traditional Navajo characters and imagery, so rich that it literally began with the origins of the world. Another group's work was so mathematically formal that they even did away with letter-names of their characters. And the third group took the third way: minimalist world-building, but characters fleshed out enough to inspire neat structural changes in math. By their powers combined, the three groups worked out complementary ways to teach and learn. And all groups reported having a good time.

Ch'ał Háastiín (Frog Man) and Dził Dit Ł'ooí (Fuzzy Mountain). Photo by Dził Ditł'ooí School of Empowerment, Action and Perseverance - DEAP.

In the time of Giants: the big story
The story goes...
In the time of Giants, there was a holy person that lived on Dził Dit Ł'ooí (Fuzzy Mountain). There were Male and Female Giant Frogs that always went by the mountain. The Frogs would cause the ground to shake and cause change in the land every time they went by. Changes include erosions of the land, smashing of plants, trees, and people's homes, changing landscape where water runs, noise, and small earthquakes.

FROM SMALL GROUP DISCUSSIONS (continued)

One day the holy person was tired of this and decided to turn them to stone. To this day the frogs are still standing there, and suffered the effects of weatherization.

We can use this story in science to do weatherization lessons. The history of the story connects our students to the land, carrying on Navajo history of the land our students then gain respect for the land. Paper models from the circle:
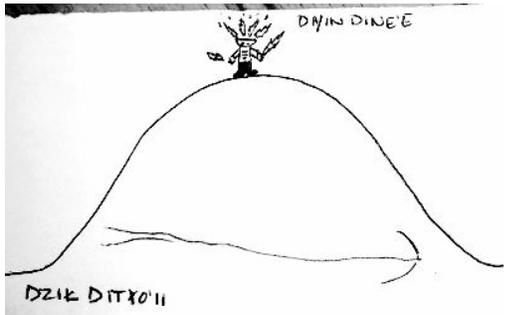

Listen to these words at **https://aimathcircles.org/bluebird/#frog** (click the button next to Issue 2 Recap to listen).
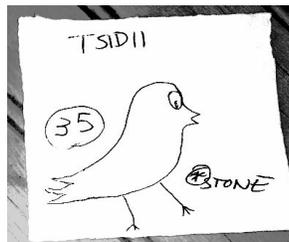
A scenario: It takes Frog Man 4 hops to pass the mountain, and it takes Frog Woman 8 hops.

A problem based on that scenario: Suppose that the holy person tolerates 200 hops total, and will turn the frogs into stone after any additional hop. What is the maximum number of times that both frogs can pass the mountain and not be turned into stone?

Could you think of any other problems that would go nicely with the *Holy Person and Frogs* story? Or invent your own story accompanied with a problem? Share your ideas with Bluebird, and they will appear in future recaps.
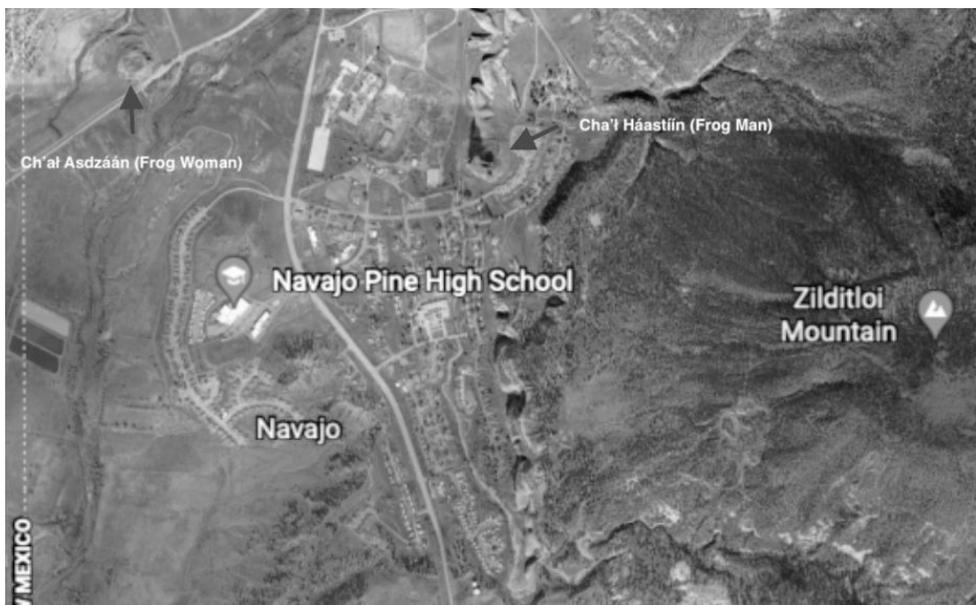

Note on subject areas and terms

Mathematicians group similar problems into classes, to better pose and solve them. *Holy Person and Frogs* problem above relates to a big class of problems called *optimization with constraint conditions*. People pose and solve optimization problems in *calculus*, *linear programming*, and *numerical analysis*. Bluebird is confident that you can make good progress with these problems with some thinking and maybe experimentation.

FROM SMALL GROUP DISCUSSIONS (continued)

Formal math: not even letters!

We came up with this scenario. I don't think we really got into naming our characters like everyone did. We dove right into the problem and started trying to figure out a solution. There were just 1, 2, 4, and 8. We took them across the river. One and Eight went across, and then Eight was left behind, and One came across, which was 9 minutes total. Then One and Four crossed, so we have a total of 13 minutes. Of course, One goes back, since it's this character who is the fastest. And that is 14 minutes on return trip. One goes back with the torch, gathers up number Two, and then they return and meet up with everyone. So in this instance, we have a total of 16 minutes. This was our first scenario; we did another one. See the picture below.
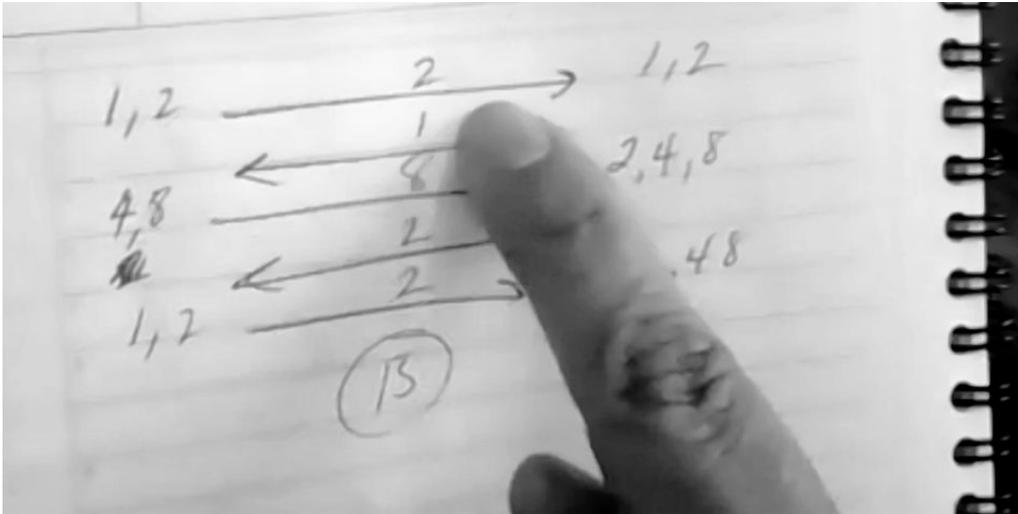
What if they can carry one another? A new math element!

In this group, character's features drove math problem-posing. A new math element (strong characters) came into the canon puzzle. World-building was minimal. This style of doing mathematics is between the two previous groups: some context, and some formal math.

Josue's characters:
Roger—a person who takes 4 minutes to cross the bridge
Morty—a robot that takes 3 minutes
Mike—a friendly monster that takes 2 minutes
Bob—a person who takes 1 minute

The four characters are running from a scary monster.
How long does it take the four people to cross the bridge?
Solution:

Bob & Mike cross first	2 minutes
Bob goes back with torch	1 minute
Bob & Roger cross, because Roger is scared of the dark	4 minutes
Bob goes back with torch	1 minute
Bob & Morty cross the bridge	3 minutes
	Total: 11 minutes
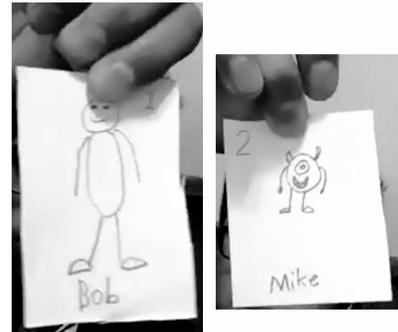
We then asked could it be done faster? Several ideas came up:
Get a car or scooter, call in a helicopter, Bob could carry Roger (which would take less than 4 minutes), but we ended up with Morty carrying Roger, because he is strong and can carry him in the same amount of time it would take him alone.

The group then collaborated on another story with 4 characters:
Abby—1 min
Bill—2 min
Carol—4 min
Dominic—8 min

FROM SMALL GROUP DISCUSSIONS (continued)

We liked the idea of carrying the slower ones, so we made Carol and Dominic children that Abby could carry easily.

Abby carries Dominic over the bridge. He slows her down a bit, takes	2 min
Abby goes back	1 min
Abby carries Carol	2 min
Abby goes back	1 min
Abby & Bill cross the bridge	2 min
	Total 8 min

A happy ending to the starter story

We used pieces of paper to model how characters move, and wrote down total crossing time. Here is one scenario where people do cross the bridge in 15 min.

- **A** and **B** cross together = 2 min
- **A** carries the torch back 2+1 = 3 min
- **C** and **D** cross together 3+8 = 11 min
- **B** carries the torch back 11+2=13 min
- **A** and **B** cross together 13+2=15 min **YAY! The end.**

Flyer 2 also had a puzzle called Wason Selection Task:
Cards can have numbers on the front (1 or 2) and colors on the back (red or yellow). You see four cards on the table: 1, 2, red, and yellow. A note says, "If a card on the table has 1 on one side, then it should be red on the other side." Is the note a lie? How many cards do you need to turn over to find out?

SOLUTION You need to turn the card with 1 over to see if it's red on the other side. If not, the note is a lie. You also need to turn the yellow card over. If it has 1 on the other side, the note is a lie. The note says nothing about 2, so you don't need to check that card. The red card is the trickiest. If the other side has 1, the note is not a lie. If the other side has 2, the note is also not a lie. So you can let the red card be. Answer: you only need to turn over two cards, 1 and yellow. You can search for Wason Selection Tasks to find more puzzles in this style.

Questions for Bluebird

Ask Bluebird

What is the Pythagorean Theory?
From Ye-Shiao T.

What does math modeling mean?
From Beth Cammarata

I want to know what mathematics has to do with the Navajo Hogan.
From Dawnlei Hunter Ben

Can I learn calculus here?
From Rivas T.

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

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