math circles

Annual Report 2022—2023

Content:

Overview	2
Presentations	6
Staff	7
Monthly Events	8
School and Program Visits/Events	13
Future Goals	14

Mission Statement

Nova Scotia Math Circles is dedicated to enriching the experiences of Nova Scotia students in all areas of mathematics.

Our program vision is to foster enthusiasm for math through interactive, creative, and meaningful presentations.

Many thanks to our sponsors!

eastlink

DALHOUSIE UNIVERSITY

Nova Scotia Math Circles is a mathematics outreach program run out of Dalhousie University and funded by Eastlink. Our activities are two-fold: We host monthly events at Dalhousie to enrich local students and visit schools all across the province for hands-on activities with the entire class.

Overview

It has been another year of successful outreach activities for NS Math Circles. The activities of NS Math Circles are twofold: travelling to schools around the province to do interactive math workshops—doing mathematics and in way that promotes engagement and builds confidence—and hosting monthly interactive presentations aimed at the junior to senior high level, which are free to attend. Thanks to the ongoing funding from Eastlink, we were able to continue to offer excellent educational opportunities across Nova Scotia.

This year Tom Potter continued as program director of Math Circles, and Dr. David Iron continued as faculty advisor. A number of presenters and content developers from last year continued to work with Math Circles this year; these include: Arvin Vaziry, Cali Park, Carmen Graves, Dario Brooks, Joey Latta, Joyce Jiao, Louis Bu, Scott Wesley, and Xiaoning Bian. We also recruited a large number of presenters in order to keep up with the growing demand for Math Circles presentations; these include Anaam Choudhury, Baorui Jia, Daniel Teixeira, Dulguun Norjinbat, Fangda Cui, Iresha Madduwe Hewalage, Neil Kelley, Razy Shafiee, Shapour Heidarkhani, Thiago de Holleben, Usman Shehu, and Vivienne Kwan.

The fall started off very busy for NS Math Circles. In October we began school visits and monthly events and attended the Math Teachers Association Conference at CP Allen High in Bedford. There, we gave presentations to groups of teachers from around the province to promote our program. We also had a table for conference attendees to sample our activities and learn about our work.

In November we did a special presentation at Dalhousie for a group of students from Duc d'Anville Elementary, organized together with Phillip Jackson, an African Nova Scotian Student Support Worker. Dario Brooks gave a presentation for this, which was very well-received. Together with Mr. Jackson, we organized another presentation in Janu-

ary for Clayton Park Jr High students of African Ancestry. We plan to have both groups back again next year.

We also visited Yarmouth in November and did four days of presentations there. This was the first multi-day trip that Math Circles has done since 2019. We completed another multi-day trip to Antigonish and Cape Breton in May.

In February, we did two special evening presentations, one with a group of Embers and another with a group of Sparks. The presenters were Carmen Graves and Vivienne Kwan, and the topic was Pentominoes. In addition, Math Circles participated in the first Mount Family STEAM Day, at MSVU, in February. This involved fun math activities on a Saturday morning at the Mount: families could drop in, participate in some fun math challenges, and learn about our program. We had a great time and it was a great opportunity to promote our work. We look forward to doing it again.

In March we hosted the 2023 Canadian Math Kangaroo Contest at Dalhousie. Dalhousie was the only Kangaroo contest site in Nova Scotia, with 111 registrants. Tom Potter and Dr. Dorette Pronk were the site coordinators, who also had help from several members of the Math Circles team. This year, we had three students in Nova Scotia place in the top three in Canada for their grade: Maria Mihai (Grade 12, 1st place), Sagar Sawnani (Gr 10, 2nd place), and Eunwoo Kim (Gr 2, 3rd place). Maria and Sagar have attended Math Circles events throughout the years. We are having an awards ceremony next week to celebrate all those who placed in this contest, regionally and nationally.

In March we also did 6 breakout sessions for grades 6-12 at the South Shore Science Fair in Bridgewater.

The Dal Discovery Days resumed in April, for the first time since before the pandemic, and NS Math Circles provided the activities for the Math Department. Over two days we hosted three large groups and one small group in the Learning Centre. We did activities such as cutting Mobius Strips, Fold and Cut Theorem, Tangrams, Cryptography, and Card Tricks, and included a refreshment break for each group. We also hosted a homeschool group at Dalhousie in April, which was very well-received.

As of the first week of June, we have done 107 school visits, for a total of 427 classes, in addition to the special outreach presentations mentioned above. We have visited schools all over the HRM, as well as in Antigonish, Canning, Inverness, Lantz, Liverpool, Milford, Oyster Pond, Port Hawkesbury, Valley, and Yarmouth. We also have visits planned to Berwick, East and West Hants, Truro, and Wolfville later this month. Moreover, we did two online class visits this year: one for a school in Halifax, and one for a school in London, Ontario. The latter group was very excited about our visit and wants

"Students love challenging math, especially when they can figure it out themselves! It teaches them they are capable of complex problem solving!" Jenny Goodyear, Elizabeth Sutherland School, Gr 5/6

to do another.

Our Monthly events this year have attracted a mix of participants from students, parents, and teachers. We've continued to host these events in a blended format, meaning that students can attend in person or online. These events were given by presenters from our team, enthusiastic graduate students, department alumni, and post-doctoral researchers in our department. Over 240 students joined us this year. We had pizza and pop for those who attended in person. Our presenters so far this year were Tom Potter, Cali Park, Sarah Meng Li, Dr. Hector Baños Cervantes, Dr. Dongho Lee, Erick Lee, Dr. Danielle Cox, and Dr. Karyn McLellan. See our website to learn more about these excellent presentations. We are very grateful to our volunteers for giving these workshops.

"Math was introduced as useful beyond equations and textbooks. They began with an amazing yet attainable magic trick which the students cannot wait to reproduce. Then the game of clue was also interactive, useful and amusing!" —Jennifer Moore, Rocky Lake Jr High, Gr 7

Math Circles is also working toward doing more for under-served groups in mathematics. We have been very fortunate to collaborate with Phillip Jackson to give special presentations with role model presenters for groups of African Nova Scotian students. We are also working toward collaborating more with Imhotep's Legacy Academy, with the goal of doing a joint monthly presentation in the fall.

In addition, our director has worked with Dr. Dorette Pronk to initiate a pilot project working with Indigenous students at Ridgecliff Middle School. With this project, we are trying to help Indigenous students to achieve their mathematics goals in a supportive environment. The administration and support staff at Ridgecliff school have been very eager and supportive in this endeavor. NS Math Circles has provided presenters, materials, and snacks to help with this initiative. We hope that some of the Math Circles activities will help the students to engage with math and see it as fun, while boosting their confidence. We ultimately hope to learn about and explore ways to teach math in a way that's relevant and personally meaningful to students, by connecting it with examples that relate to their interests.

Last year, we gave a presentation for the summer camp organized by Nauzer Kalyaniwalla in the department of computer science, and the Black Educators Association. This was a successful experience, and the students were engaged, so we are looking forward to doing it again this year!

Thanks to everyone who helped make this year a great success, including presenters, teachers, and math consultants and support workers in the community. We would also like to thank the office staff in the Math and Stats Department: Anna Marie Davis, Susan Enta, and Mark Monk, for all their time and support, especially Susan for help with all pay-related work. Thank you to Dr. David Iron for overseeing all contracts and expenses. And thank you to Dr. Dorette Pronk for being interested and involved in the program's success and for collaborating on diversity work.

This year, Math Circles celebrates its ninth year of funding with Eastlink. We are extremely grateful to Eastlink for their generous support, which makes our program possible!

Keep up to date with our events at www.nsmathcircles.ca. We are also on Twitter (@NSMathCircles) and Facebook (NSMathCircles1).

List of Presentations

Elementary Schools

- Candy Game *
- Dots and Boxes*
- Exploding Buckets*
- Exploring Mathematics*
- Jury Duty*†
- Fun with Fractions*†
- Mathemagic*
- Pascal's Triangle*
- Pentominoes†
- Problem Solving*
- Tessellations*

* These presentations have been adapted for virtual class visits.

† These presentations have undergone revisions and improvements this year.

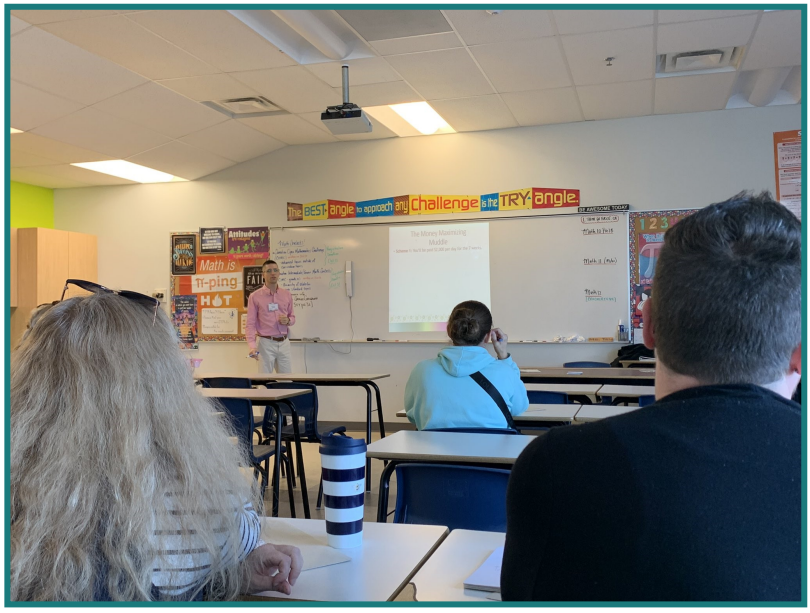
†† New

Junior High Schools

- Bothersome Brainteasers*
- Candy Game*
- Classical Cryptography
- Dots and Boxes*
- Eulerian Circuits
- Fibonacci & the Golden Ratio†
- Fractions Fun†
- Graph Colouring
- Jury Duty*†
- Mathemagic*
- Nasty Number Tricks and Devious Divisibility
- Pascal's Triangle*
- Prime Numbers
- Probability (Work in progress)††
- Problem Solving*
- Tessellations*
- Toads and Frogs*
- Tower of Hanoi

Senior High Schools

- Bothersome Brainteasers*
- Classical Cryptography
- Eulerian Circuits
- Fibonacci & the Golden Ratio†
- Fractals
- Graph Colouring
- Infinity
- Logic and Reasoning
- Million Dollar Hat Problem
- Master Your Cards
- Modern Cryptography
- Nasty Number Tricks and Devious Divisibility†
- Nim
- Numeral Systems
- Pascal's Triangle*†
- Permutations & Combinations
- Pi
- Prime Numbers
- Probability (Work in progress)††
- Toads and Frogs*
- Tower of Hanoi



NS Math Circles Staff

Program Director

The Program Director is responsible for the day-to-day running of Math Circles. The Director oversees the overall program direction and the school trips, online class visits, local, online, and other events. They are also responsible for the social media and newsletter.

This year, the Program Director was Tom Potter, a Ph.D. candidate in the department. This is Tom's third year in this position, after being a presenter and content developer for NS Math Circles for two years previously.

Faculty Advisor

The faculty advisor is the liaison between Math Circles and the Mathematics & Statistics Department. This person also provides continuity as they usually stay in this position for several years. They advise the Director and any Assistant Directors on any issues that might arise.

This year, Dr. David Iron was our faculty advisor.

Presenters and Content Developers

The presenter/content developer positions are filled by undergraduate and graduate students who commit to working with Math Circles throughout the year for a significant number of hours. They staff many of our school/class visits and develop and update presentations. Our presenter/content developers this year were Anaam Choudhury, Arvin Vaziry, Baorui Jia, Bian Xiaoning, Carmen Graves, Daniel Teixeira, Iresha Hewelage, Joey Latta, Neil Kelley, Razy Shafiee, Scott Wesley, Shapour Heidarkhani, Usman Shehu, and Vivienne Kwan.

Casual Presenters and Content Developers

The casual presenters/developers are undergraduates and graduate students, and postdoctoral fellows at Dalhousie that will occasionally go out on school trips or help develop/improve materials. This year, our casual presenters were Cali Park, Dario Brooks, Dulguun Norjinbat, Fangda Cui, Joyce Jiao, Louis Bu, and Thiago de Holleben.

"All three presenters not only engaged students academically, but spoke to students about them. Showed interest in their lives. (Relationship building was evident.)"—G MacNeil, Gr 7, Redcliff Middle School

Monthly Events

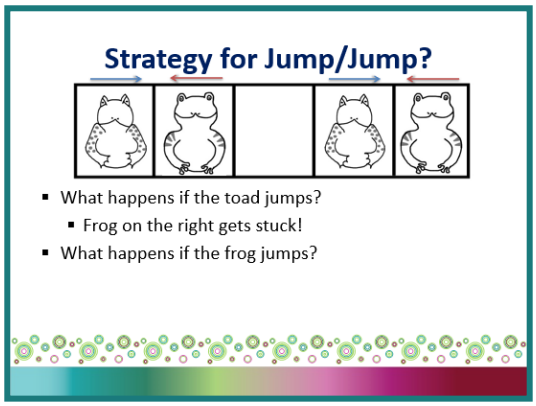
This year we hosted 8 evening events, all of which were offered in a hybrid format, with approximately 245 students in total in attendance.

October 26th

Presenter: Tom Potter (Dalhousie)

Topic: Toads and Frogs

Toads & Frogs is a game that is easy to play and fun to explore. We will find the number of moves needed to solve the game, and discover more about number patterns within the game.



November 30th

Presenters: Cali Park (University of Alberta) and Tom Potter (Dalhousie)

Topic: Exploring Probability—Part 1

Probability underlies many aspects of our day-to-day life. In this talk, we explore what probability is and how it appears in daily occurrences. We define probability, sample space, and mutually exclusive events, and show how to determine the probability of a basic outcome. We briefly discuss the axioms of probability. Then we'll play Probability Dice-Bingo and discuss the likelihood of a given Dice-Bingo card winning. Lastly, we explore normal distributions and probability in the game Plinko from the popular gameshow *The Price is Right*.

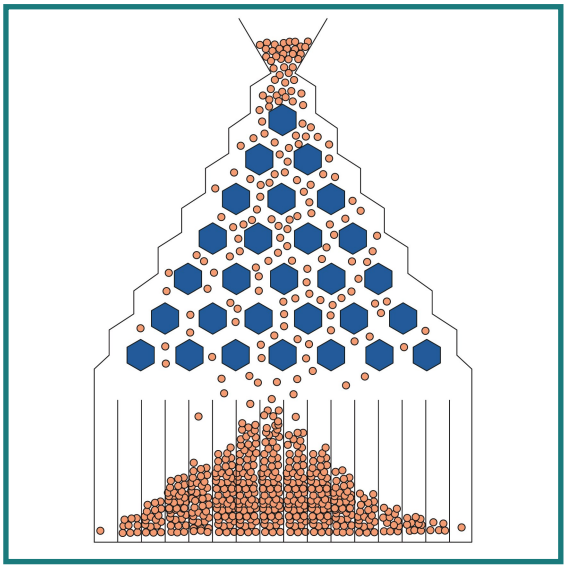
December 14th

Presenters: Cali Park (University of Alberta) and Tom Potter (Dalhousie)

Topic: Exploring Probability—Part 2

In this presentation, we continue to explore probability through several fun activities. We will finish our exploration of the binomial distribution in Plinko from last time. We will explore a Monte Carlo method for approximating pi, known as the Buffon needle problem. We will also do a die-rolling activity to demonstrate the nature of randomness. Lastly, if time permits, we will explore some veridical paradoxes (results that seem absurd or untrue yet can be shown to be true) that involve probability.

> "Students didn't want it to end"—Stephanie Fawson, Beaverbank Monarch Elementary School



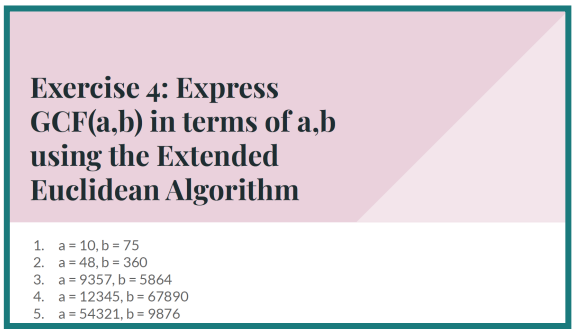
January 25th

Presenter: Sarah Meng Li (University of Waterloo)

Topic: A beginner's guide to algorithms: demystifying the RSA cryptosystem

An algorithm is a series of step-by-step instructions to carry out a task or solve a problem. For example, a cake recipe is an algorithm for baking. At school, you have learned algorithms such as the procedures for adding, subtracting, multiplying, and dividing numbers. What are other usages of algorithms in real life?

For instance, RSA (Rivest-Shamir-Adleman) is a public-key cryptosystem that is widely used for secure data transmission in email and other digital transactions. In this workshop, we will demystify the RSA cryptosystem by first introducing you to two beautiful yet fundamental algorithms that were proposed over two thousand years ago: the Euclidean algorithm and the extended Euclidean algorithm. Then we will walk you through the procedure of RSA, after which you could perform encryption and decryption of information safely against some malicious cyber attacks.

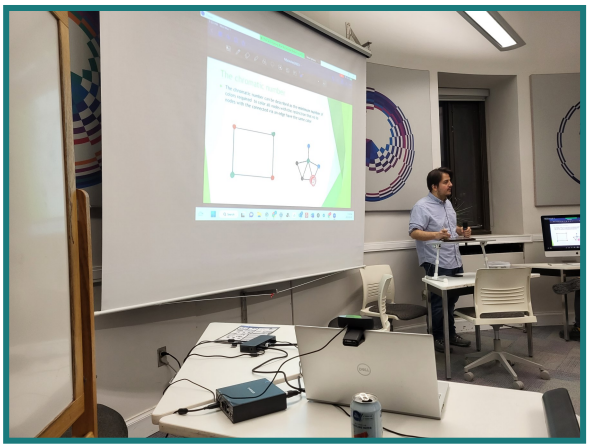


March 1st

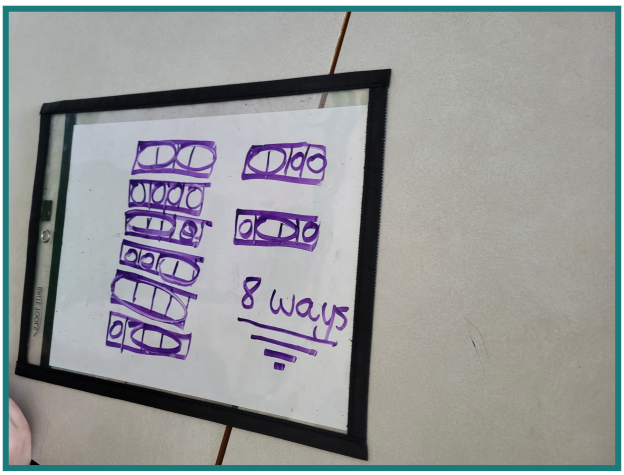
Presenter: Dr. Hector Baños Cervantes (Dalhousie)

Topic: What is Graph Theory, and what makes it so interesting?

Graph Theory is not just a fun area of mathematics, it is also applied everywhere in real life. This includes applications in biology, linguistics, physics, helping solve crimes, improving air traffic, and many others. Graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. In this presentation, we will learn the basics of graph theory as well as some of its fascinating problems.



"I loved the open-ended, problem-solving questions. The students were very engaged. After Neil and Joey left a student said "they just made math really, really, really fun" (And the others agreed.)"—Joanna Scully, St. Catherine's Elementary, Gr 2



April 26th Presenter: Erick Lee (HRCE)

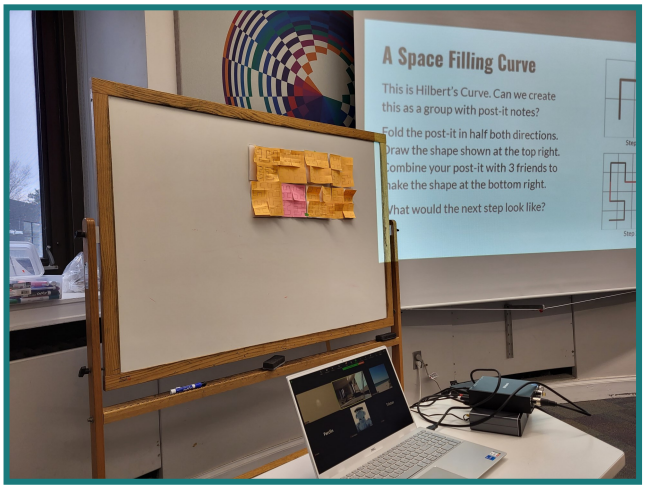
Topic: Thinking Recursively with Art and Games

Recursion can be found in art, mathematics, games and even computer programming. What is recursion? Join us to find out. We'll explore the concept of recursion while making art with paper and scissors as well as playing a recursive game. We'll also talk about the famous Fibonacci Sequence and how it can be modeled with mathematics.

March 29th Presenter: Dr. Dongho Lee (Dalhousie)

Topic: Definability and Games

In this workshop, we will be looking into a question in Finite Model theory regarding definability. Model theory is a branch of mathematical logic which studies the relationship between the formal theories and their models. Finite Model Theory concerns, in particular, the models of the finite universe and it has nice relationships with database and complexity theory. In the first part of the presentation, we will be introduced to an example of (first-order) theory and its (relational) model. We will then ask what (Boolean) properties of models can be defined as a formula in first-order logic. In the second part, Ehrenfeucht-Fraïssé Game will be introduced and we will see how Ehrenfeucht-Fraïssé theorem helps us show that some properties are not definable in first-order logic.



May 24th Presenters: Drs. Danielle Cox and Karyn McLellan (MSVU)

Topic: Combinatorics and Art

We will explore the mathematical art inspired by a mistakenly placed stone tile on a house in London, England. We will play with a set of tiles to create various patterns and learn about their geometric properties. This is joint work with Eva Knoll at UQUAM.

"My brain is on fire today!"—Student at March 1 Monthly event

"This was the most fun math class of my life"—Gr. 7 Student at Madeline Symonds Middle School

"It didn't feel like math. We were solving puzzles."—Gr. 6 Student at Rocky Lake Elementary School

This year we were able to reach schools in 6 different centres for education (school boards):

Halifax Regional Centre for Education (HRCE)

Madeline Symonds Middle School (6 visits), Park West School (7 visits), Ridgecliff Middle School (4 visits), École Rockingham School, Rocky Lake Junior High (10 visits), Rocky Lake Elementary (3 visits), Grovesner-Wentworth Park Elementary (3 visits), Prospect Road Elementary, Sunnyside Elementary, Kingswood Elementary, Fairview Heights Elementary School (4 visits), Brookhouse Elementary School (2 visits), Five Bridges Jr High (3 visits), Harry Hamilton Elementary, Sackville High School, Bel Ayr Elementary (2 visits), Elizabeth Sutherland School (2 visits), Springvale Elementary School (2 visits), Smokey Drive Elementary School, Maple Ridge Elementary (3 visits), Duc d'Anville Elementary School, Chebucto Heights Elementary School, Sycamore Lane Elementary School, LeMarchant St. Thomas Elementary School (3 visits), Ash Lee Jefferson Elementary (2 visits), Humber Park Elementary (2 visits), St. Margaret's Bay Elementary, St. Catherine's Elementary, Cunard Jr. High, Kingswood Elementary, Holland Road School, Colonel John Stuart Elementary, Hawthorn Elementary School, Oyster Pond Academy, Alderney Elementary School. Planned: Gorsebrook Academy, Astral Drive Elementary (2 visits)

Annapolis Valley Regional Centre for Education (AVRCE)

Kings County Academy, Glooscap Elementary (2 visits)

Chignecto-Central Regional Centre for Education (CCRCE)

Redcliff Middle School (4 visits), Riverside Education Centre (2 visits). Planned: Hants East Rural High (2 visits), West Hants Middle School, Berwick District School

South Shore Regional Centre for Education (SSRCE)

Dr. John C. Wickwire Academy (4 visits)

Tri-County Regional Centre for Education (TCRCE)

Maple Grove Education Centre (4 visits)

Straight Regional Centre for Education (SRCE)

St. Andrew's Consolidated School, Inverness Centre for Education Academy (2 visits), Tamarac Education Centre (2 visits)

Private Schools/Groups

Halifax Grammar School (3 visits), East Coast Varsity (1 visit), Halifax Independent School (2 visits), Shambala School

"I don't want to do a puzzle that's easy. I want to do one that is really hard that I can figure out"—Breah, Gr 4, Beaverbank Monarch Elementary School

"I don't even like math, and this was the most fun I had in math"—Gr 4/5 student at Harry Hamilton Elementary

School and Program Events and Activities

Week-long trips

We did two week-long trips this year, for the first time since before the Covid-19 pandemic. Our first attempt at a trip this year was thwarted by tropical storm Fiona, but we rescheduled for May. We also did a week-long trip to Yarmouth, visiting all the classes at Maple Grove Education Centre. We felt that these visits were invaluable, and the appreciation of students and teachers was evident.

Materials' Development

We made a strong effort again this year to improve the quality of our presentations, along with our PowerPoint slides for these. We are constantly working to improve our repertoire or activities, based on feedback from teachers, students, and presenters. This year, we developed presentations on Probability, one suitable for younger grades, and one suitable for high school. These still require some testing, but are near completion. We also made major revisions to our Fibonacci and the Golden Ratio presentation. We also hope to include a presentation introducing Topology next year. We are also working to update the image and logos on all our existing presentations.

Other Activities

As mentioned in our Overview, we have lots going on this year, which we hope to continue! Highlights include: the afterschool program with the Indigenous students at Ridgcliff Middle School, the special online visit to Woodland Heights Elementary in Ontario, special presentations at Dal for groups of African Nova Scotian students organized with Mr. Phillip Jackson, MTA conference, the Mount STEAM day, a visit from a large group of home-schooled students, the South Shore Science Fair, the week-long trips to Yarmouth and the Straight Region, Dal Discovery Days, and visits to groups of Embers and Sparks.

Training and Professional Development

This year, we begin developing a repository of videos on the Math Circles community page on the Dalhousie Brightspace system. These videos will be accessible to future generations of Math Circles presenters. So far, we have created about 20 videos. These give the opportunity for more thorough training and onboarding of new presenters.

> "My brain is exploding"— Student at South Shore Science Fair

2023-2024 Program Goals

We will continue our strong presence in schools during 2023-2024. Future goals include:

- Visiting parts of rural Nova Scotia that we haven't recently visited.
- Continuing to maintain and expand mathematics outreach to under-served communities.
- Doing a joint event with Imhotep's Legacy Academy, and potentially doing a joint school visit.
- Adding a presentation on Topology, and trying out our Probability presentation in schools.
- Completely updating our Fractals presentation
- Refreshing our High School presentations.
- Continuing to tweak and perfect our Elementary and Junior High repertoire.

NS Math Circles

Department of Mathematics & Statistics
6316 Coburg Road
PO Box 15000
Halifax, NS B3H 4R2

www.nsmathcircles.ca

Office: 902-494-7036
Cell: 902-401-4075
Email: mathcircles@dal.ca