math circles

Annual Report 2021—2022

Content:

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

As another school year winds down, 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, introducing students to mathematics in a fun and engaging way; and hosting monthly interactive presentations at Dalhousie and online, 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.

The fall began with a shift back to normal operations for the program, with the return of in-person visits to school. This was a pleasant change from the fully online format of the previous year. We shifted again back to online-online class visits when the Omicron variant surged, but we made the best of the situation by arranging a number of virtual class visits. Our hard work from the previous year on adapting the presentations to go virtual paid off, and we did 28 virtual class visits since January. Near the end of March, we were able to resume in-person visits again.

This year Tom Potter continued as program director of Math Circles. Tom is currently pursuing a Ph.D. in mathematics at Dalhousie. Dr. David Iron was our faculty advisor again this year, and helped by giving Tom feedback and support throughout the year. In the fall semester our core team of presenters and content developers consisted of Scott Wesley, Mozhgan Saiedi, Heesung Yang, and Jonathan Tot, who are all PhD students at Dalhousie, in math or computer science. In the winter and spring, we recruited a number of new presenters to round out our availability. These included Cali Park, Bian Xiaoning, Arvin Vaziry, Louis Bu, Joey Latta, Dr. Asmita Sodhi, and Carmen Graves, all students in our department, except for Dr. Sodhi who graduated a couple years ago and has been a long-time contributor to Math Cir-

cles. Cali and Louis are recent graduates of the undergraduate programs in Stats and Math, respectively, and dedicated many hours to Math Circles.

This year, we have reached nearly 700 students through 28 virtual class visits, and over 3800 students through 43 in-person school visits! While most of our visits have been within the greater HRM, we also did visits to Wolfville, Brookfield, Valley, Pentz, and Newcombville.

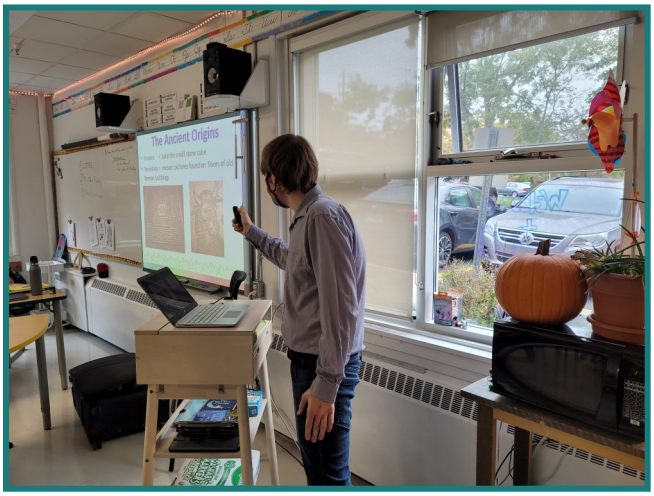
Our Monthly events this year have attracted a mix of participants from students, parents, and teachers. We decided to host a number of these events in a hybrid format, meaning that students could attend in person, or online. These events were given by presenters from our team, enthusiastic graduate students, department alumni, and post-doctoral researchers in our department. Over 160 students attended these events over the course of the year. Our presenters so far this year were Dr. Asmita Sodhi, Jonathan Tot, Tom Potter, Scott Wesley, Dr. Frank Fu, Dr. Danielle Cox, and Dr. Karyn McLellan, Fred Gluck, and Dr. Hector Baños Cervantes. See our website to learn more about these excellent presentations. We are very grateful to our volunteers for giving these fun workshops.

This year, we are also helping with a Summer Camp this July, organized by Dr. Nauzer Kalyaniwalla and the Black Educators Association. This will be our first time helping with this summer camp. Other summer plans include giving our presentation on Tessellations for two groups of in-service teachers, for an education course Dr. Asmita Sodhi is teaching later this summer. Next year, we plan to give a PD workshop for teachers at a private school in Bedford, which will give us an opportunity to share our approach to creating engaging math activities, and give us an opportunity to learn from and brainstorm with teachers. We were also invited to be on a committee, along with with Drs. Danielle Cox and Karyn McLellan, for planning a math outreach activity at the library next year, for the Bridges 2023 conference, an international math & art conference.

We are in the process of creating some new presentations on more advanced topics, namely topology and probability. Future goals include resuming longer trips, hopefully to Cape Breton, Yarmouth, and other counties. We are also seeking more French-speaking presenters and have so far tentatively secured one part-time bilingual presenter for next year.

We created a new facebook page this year. We also made minor visual improvements to the website that support the high resolutions of modern displays, to keep our website looking fresh.

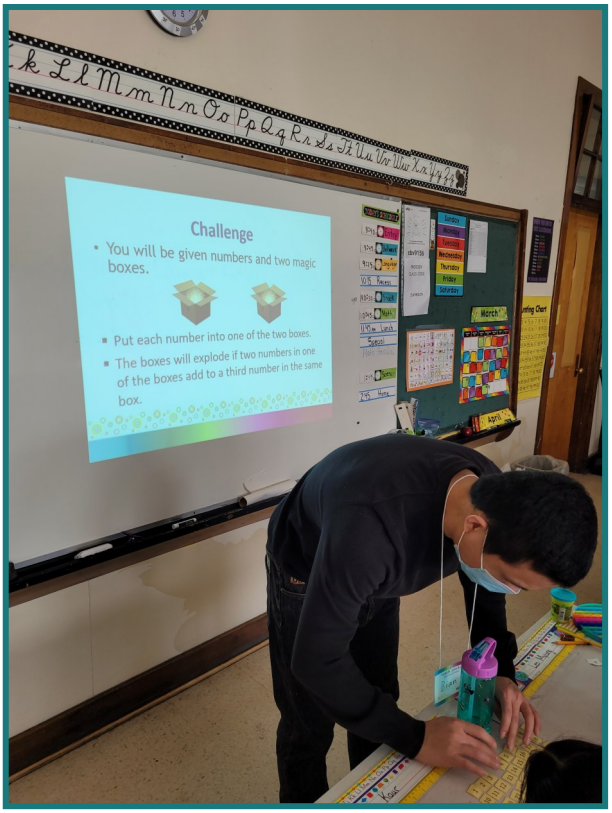
This year, Math circles celebrates its eighth year of funding with Eastlink. Thank you, Eastlink, you've made our success possible!



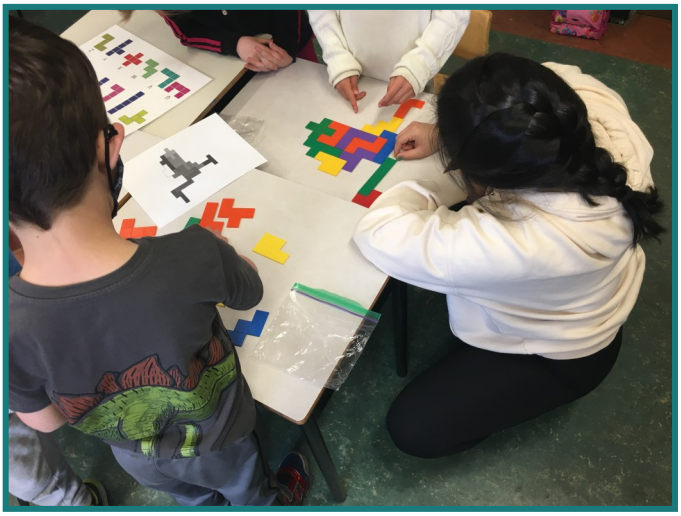
"Awesome topic, kept students engaged and enthusiastic! Presenters were great at helping students." —Kelley Hadfield, Gr 5/6, Michael Wallace Elementary

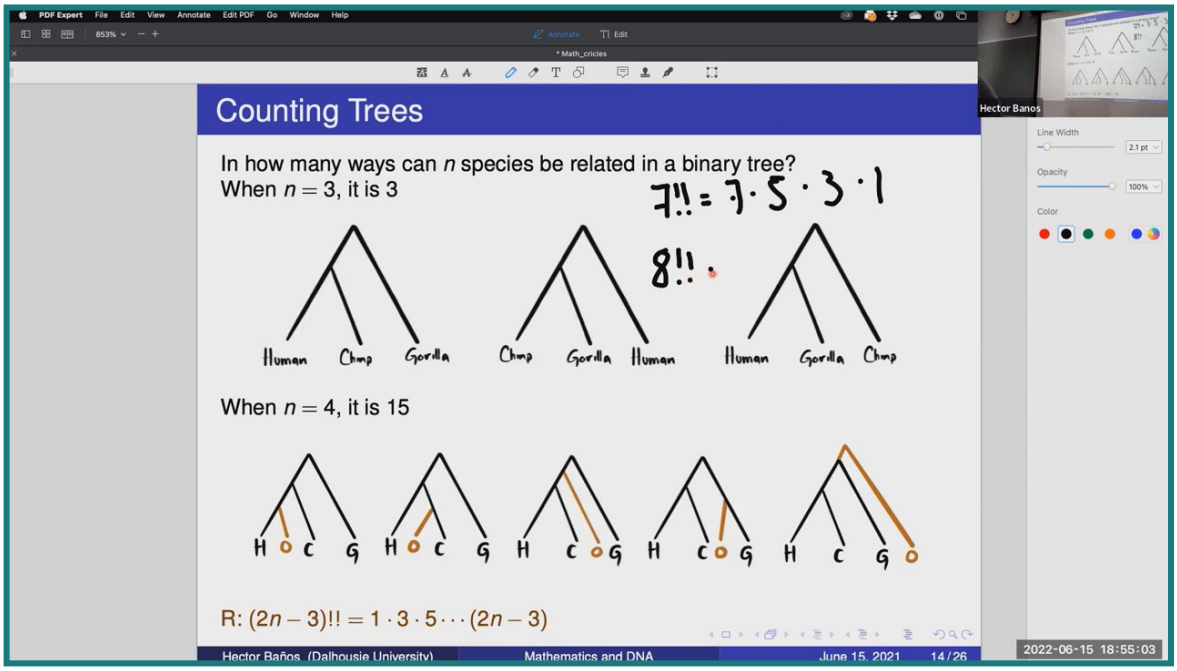
And thanks again to everyone who helped make this year a great success!

Keep up to date with our events at www.nsmathcircles.ca, via our Twitter account **@NSMathCircles,** or via Facebook **@NSMathCircles1**



"There were materials for everyone so everyone was problem solving. The presenters took the time to show genuine interest, and giving encouragement. Presenters were excellent at engaging with students in a confident, positive way." —Matt Arsenault, Redcliff Middle School





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*† (Complete revision)

* These presentations have been adapted for virtual class visits.

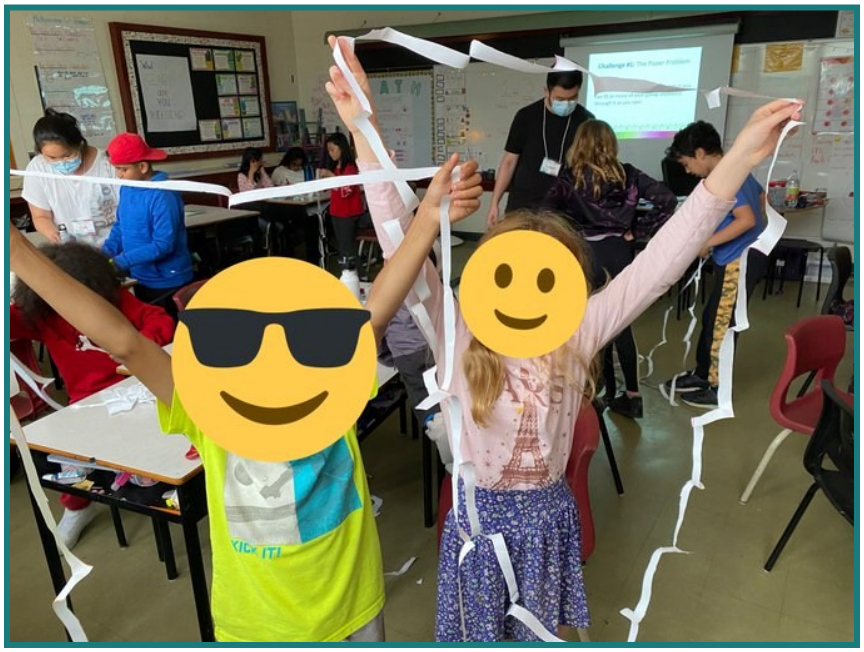
† These presentations have undergone revisions and improvements this year.

Junior High Schools

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

Senior High Schools

- Bothersome Brainteasers*† (added notes)
- 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
- 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 second 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.

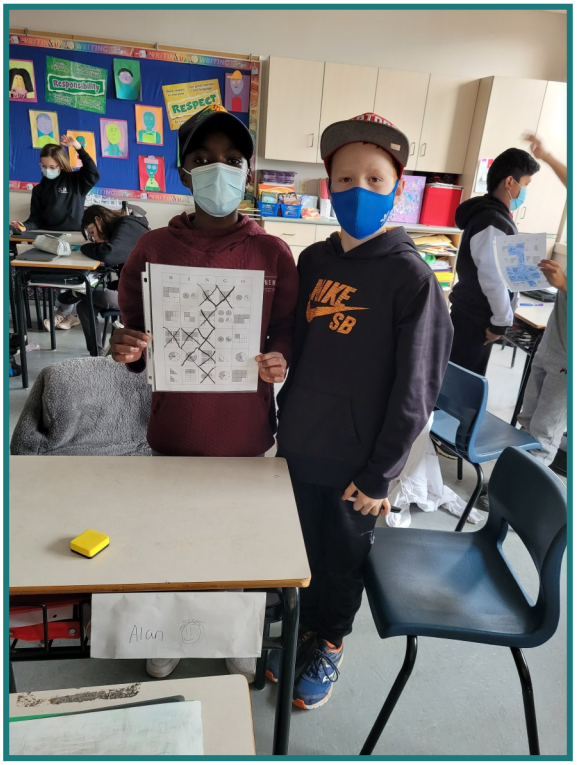
This year, Dr. David Iron was our faculty advisor.

Presenters and Content Developers

The presenter/content developer positions are filled by 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 Mozhgan Saeidi, Heesung Yang , Scott Wesley, Arvin Vaziry, Bian Xiaoning, Cali Park, Louis Bu, and Joey Latta.

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 Carmen Graves and Dr. Asmita Sodhi. Carmen is an undergraduate student in our department, and Dr. Sodhi is a former Assistant Director for our program, and regular presenter at our events. We also wish to thank Joyce Jiao for her help with decluttering files and papers in the office, and maintaining/organizing materials!



"It is wonderful to see students so hyperfocused on problem-solving. Thank you for sharing your passion with youth." —Kora Lee Gallant, Madeline Symonds Middle School

Monthly Events

This year we hosted 10 evening events, 6 of which were offered in a hybrid format, with approximately 160 students in total in attendance.

September 22nd Presenter: Dr. Asmita Sodhi (Dalhousie)

Topic: How to Count Votes

This sounds like it should be easy—we just ask people who or what they want to vote for, count the votes, and see which option has the most… right? This is one way of counting votes, but this way can leave a lot of people unsatisfied with the winner. There are lots of other ways of voting and counting votes, some of which we'll see in this talk. We'll explore some voting systems, voting paradoxes, and also have a little election of our own!

October 27th Presenter: Jonathan Tot (Dalhousie)

Topic: Mr. Collatz's Marvellous Mathematical Machine

We will present the infamous Collatz Conjecture, an unsolved mathematical problem that has perplexed some of the brightest mathematicians in recent decades. Paul Erdos said "Mathematics may not be ready for such problems." But fear not! The problem is very simple to state; at the core only basic arithmetic on whole numbers is needed, so that the problem could likely be understood by keen grade-schoolers. But the unfolding of the problem leads to very deep questions about the nature of numbers, as well as mesmerizing visuals and endless fun! It all starts with Dr. Collatz's peculiar mathematical operation.

"Very engaged w/ the kids, started easy and gradually got more challenging. This way students could be comfortable." — Autaum Marshall Gr 2/3, Brookfield Elementary

November 24th Presenter: Tom Potter (Dalhousie)

Topic: Tessellations and Symmetry

Tessellations are important mathematical objects of intrinsic and immediate beauty. We discuss the basics of tessellations of the plane, count the basic types, and play a fun game to illustrate the difficulties involved in trying to name them. We also see some more unusual tessellations, known as *aperiodic tilings*, and wrap up by looking at instances of tessellations in design, art, and nature. You will need a pencil, paper, and eraser (colours optional).

December 8th Presenter: Tom Potter (Dalhousie)

Topic: Awesome Algebra and Devious Divisibility

Algebra is one of the oldest expressions of mathematics, dating back to the ancient Babylonians, and developed as a subject in its own right by mathematicians like Diophantus and Al-Khwarizmi. Algebra can be considered as the study of mathematical symbols and rules for manipulating these symbols, and this is often understood in the context of equations.

In this presentation we explore some fun number tricks and use algebra to illuminate the mathematics behind these tricks. We also do some number theory, particularly some interesting tricks to determine when a number is divisible by various familiar small numbers. We also get a brief glimpse of *modular arithmetic*, which will illustrate how algebra can be used to answer questions about numbers. Bring pencil and paper!

January 26th Presenter: Scott Wesley (Dalhousie)

Topic: Similar Shapes and Topological Magic

Shapes are all around us. In school, we learn to tell apart different shapes based on their geometric properties. However, we spend little time thinking about the properties that shapes have in common. For example, a circle and a square are not very different if we are allowed to bend the sides! This is known as a topological property, rather than a geometric property. In this monthly event, we will learn about topological properties and how they can be used to solve puzzles. We will also witness some topological magic, such as how to turn a donut into a coffee cup and how to turn a ball inside-out!

February 23rd Presenter: Dr. Asmita Sodhi (Dalhousie)

Topic: Alice's Adventures in Numberland

Charles Lutwidge Dodgson, better known as Lewis Carroll, was an Oxford mathematician and the author of Alice's Adventures in Wonderland. This children's classic is full of the riddles, rhymes, and nonsense that Dodgson loved so much, but also more math (and more sense!) than you may have realized when you first encountered this story. Together we'll take a trip with Alice down the rabbit hole and through Wonderland, discovering some of the mathematics hidden there along the way.

March 30th Presenter: Dr. Frank Fu (Dalhousie)

Topic: Fun with Cryptography

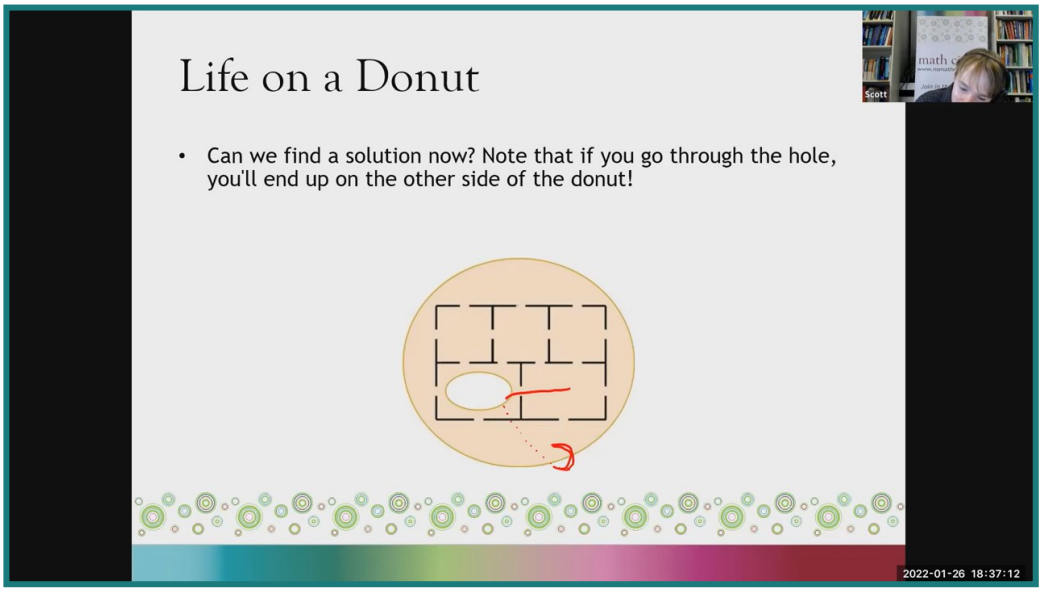
How do we communicate through the internet without being eavesdropped? How can we login to a remote computer without using a password? How does the remote computer know it is really me? In this talk, we will learn a few cryptographic concepts and encryption methods. Hopefully, by the end of the talk, we gain some insights into how modern cryptography is safegarding the digital world.

April 27th Presenters: Drs. Danielle Cox and Karyn McLellan (MSVU)

Topic: Fibonacci & The Golden Ratio

In this talk students discover the relationship between the Golden Ratio and Fibonacci numbers. We also learn why the Golden Ratio is found throughout nature and listen to Fibonacci number inspired music.

"Math Circles is always successful & meaningful in my classroom. I love that students are encouraged to think outside the box! Love that you talked about the importance of proving why a problem can't be solved too." — Steven Ross, Madeline Symonds Middle School

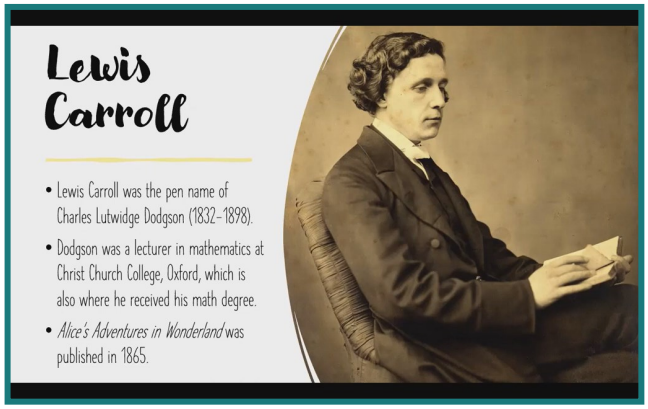


May 25th Presenter: Fred Gluck (Julia Robinson Mathematics Festival)

Topic: Buried treasure or hoax? You decide!

A little more than 200 years ago, a man named Thomas Jefferson Beale left Virginia to seek his fortune out west. Sometime later he returned and left information in a box with an innkeeper. Years later, when the box was opened, three documents with numbers that appeared to be encryptions were found. Eventually someone decoded one of the codes, which proclaimed that thousands of pounds of gold, silver, and precious gems, are buried somewhere in Virginia. The decoded note stated that directions to the buried treasure are contained in one of the other notes. However, despite the many attempts to decode both of the other documents, no one has succeeded. Some think it's all an elaborate hoax. Some are certain the treasure exists. Come to this session to hear more of the details of the story, examine the codes, and decide for yourself. Will you dismiss it all as a hoax, or are you ready to pick up your shovel and start digging?

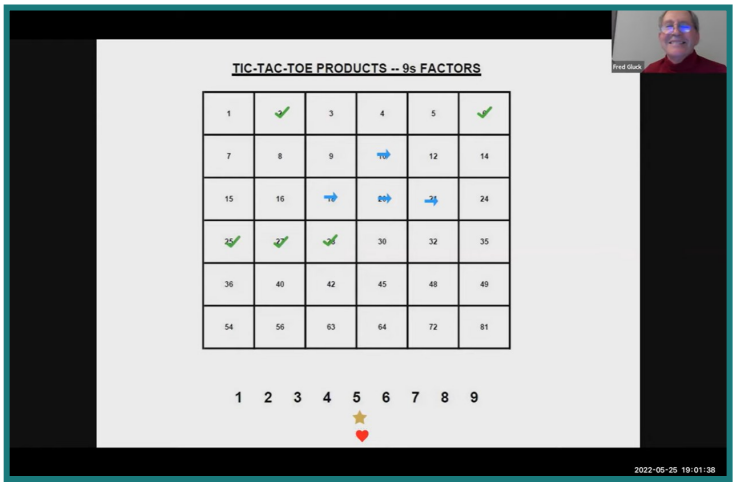
The foundation of encryption is all about prime numbers and divisibility. This session will explore some simple methods for determining divisibility — some tips, tricks, and techniques. Many of the techniques can be done easily mentally. For others, paper and pencil help. So bring those simple supplies. No need for calculators! The arithmetic will not be taxing. Besides, you probably can use the mental math practice, right?



June 15th Presenter: Dr. Hector Baños Cervantes (Dalhousie)

Topic: Mathematics and DNA

DNA is found in every cell of every living thing. It carries all of the instructions for an organism to build, maintain and repair itself. DNA molecules allow this information to be passed from one generation to the next. In this interactive seminar, we will explore some of the mathematics used to model some problems relating to DNA and some of its applications. We briefly discuss topics from how DNA is used to uncover the evolutionary relationships between species to how DNA could be used to store music, videos, and other files.



"Thank you for providing such great enrichment for students in math. Our students benefit from the content of each seminar and also the interesting ways of thinking about problem solving."

—Taya Shields, Junior School Director, King's-Edgehill School.

School and Program Events and Activities

Week-long trips

We regret that this year it was not feasible to do week-long trips, due to staffing challenges and lack of drivers. We plan to do a longer trip next year, however. Our director, Tom, is in the process of taking driving lessons, and it looks like we will have more people on the team next year who can drive and be away from school for several consecutive days.

Materials' Development

We made a strong effort again this year to improve the quality of our presentations, along with our PowerPoint slides for these. Updating presentations is an ongoing activity: when we do our workshops with students, we see the things hinder comprehensions and enjoyment of learning, and find ways to improve in these areas. Sometimes it's having a certain manipulative to assist understanding, or changing the way something is worded, changing the emphasis or the way that we work through an activity, or adding something for students who need an extra challenge. In some cases we replace activities completely with more engaging and successful activities. In tandem with these improvements, we try to write and add to presenter notes, which provide an explanation of the activities along with best presentation practices. This year, we made major revisions to Tessellations and the Junior High Fractions activities, and added to our Nasty Numbers presentation. There are more topics we are thinking of including in future years, and we are currently working on presentations dealing with Probability and Topology. We also have many ideas for improving our current presentation bank.

Training and Professional Development

This year, we revised and improved our guide for doing virtual class visits, and found ways to present more effectively online. We also made steps toward improving our in-person presentations, such as having portable amplifiers for soft-spoken presenters. We spent dozens of hours having group and one-on-one training sessions and discussions, which led to fruitful insights to carry forward.

Other Activities

As mentioned in our Overview, we have plans to get involved in number of collaborations this summer and next year, such as the Summer Camp with the Computer Science Department and the Black Educators Association in July.

> "Is this presentation two hours long? 'Cuz I'm having a blast!"
> —Grade 7 student at Rocky Lake Jr High

This year we were able to reach schools in 4 different centres for education (school boards):

Halifax Regional Centre for Education (HRCE)

Madeline Symonds Middle School (2 visits), Park West School (6 visits), Ridgecliff School (2 visits), École Rockingham School, Sir Charles Tupper Elementary, Rocky Lake Junior High (4 visits), Grovesner-Wentworth Park Elementary, Prospect Road Elementary, Michael Wallace Elementary, St. Stephen's Elementary, Sunnyside Elementary (2 visits), Kingswood Elementary, Fairview Heights Elementary School (2 visits), Eastern Passage Education Centre, Central Spryfield Elementary

Annapolis Valley Regional Centre for Education (AVRCE)

Wolfville School

Chignecto-Central Regional Centre for Education (CCRCE)

Redcliff Middle School (4 visits), Brookfield Elementary (2 visits)

South Shore Regional Centre for Education (SSRCE)

Newcombville Elementary School, Pentz Elementary School

Private Schools/Groups

Armbrae Academy (2 visits)

"Can I record this, because this is amazing!"—

Gr 8 Student at Rocky Lake Jr High

"Please tell our teacher that this is the kind of math we need to do!" —Gr 5 student at Park West School

2022-2023 Program Goals

We will continue our strong presence in schools during 2021-2022. Future goals include:

- Doing one or two longer trips to more distant parts of the province
- Increasing interest in our monthly events, by expanding our network of principals and administrators who can help promote them directly to the students
- Taking part in the Math Teachers Association conference in October
- Continuing to maintain and expand partnerships with other outreach programs
- Updating our templates for PowerPoint Slides, and carrying recent changes over to French versions
- Adding presentations on Probability and Topology
- Completely updating our Fractals presentation
- Refreshing our High School presentations, and promoting those more
- Continuing to tweak and perfect our Elementary and Junior High repertoire, adding presenter notes for as many as possible

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