

Mathematics - Grades 4-6

Session 1

Title: Relevant Mathematics in the Classroom Economy

Presenter(s): Kris Knutson – Windfields J.H.S.

Session Description: The purpose of this session is to introduce the financial literacy-based classroom economy. The classroom economy is used to teach skills such as mathematics, writing, and reading in a manner that is relevant to the real, everyday lives of students. Mathematics emerges naturally within the economy, as it is integrated into the fabric of class life. During the course of this session, participants will be introduced to the basic structure of the classroom economy and will be given strategies and tools for implementation.

Session 2

Title: Using Visual Models to Understand Mathematical Operations

Presenter(s): Rachel Hughes & Bart van Veghel – The Bishop Strachan School

Session Description: Can you calculate 37×65 in your head? This session will outline our work using mathematical models to promote student inquiry into operations. In grades 5 and 6, we have been using visual models to help represent computation with whole numbers and rational numbers. The essence of the work is to move away from rote “tricks” and algorithms to a more conceptual understanding of the mathematics, as well as becoming proficient in using mathematical language and representations to communicate student thinking.

Session 3

Title: “Marth”: The Arts in Math

Presenter(s): Brian Smith – Lexington P.S.

Session Description: Come explore the intersection of the arts (music, dance, visual arts) and mathematics. Students love seeing the messy and creative ways of exploring mathematical concepts by using the arts to demonstrate knowledge and understanding. Let’s build a love of mathematics by making explicit where it exists in what we love!

Mathematics - Grades 7-8

Session 1

Title: For the Love of Spatial Thinking

Presenter(s): Kevin Shonk – Baden P.S.

Session Description: In mathematics, we sometimes get bogged down with numbers and operations while the development of spatial thinking is squared away during a geometry unit. In this session, we will rekindle our love of spatial thinking as we explore some spatially themed games and problems, some of which remain unsolved in mathematics. We will venture into the movie “Good Will Hunting”, spend some quality time with rectangles and even investigate Brussels sprouts, all while lighting that spark that inspires us as mathematicians.

Session 2

Title: Four of a Kind: Exploring the Depths and Connections of Mathematics

Presenter(s): Allen O’Hara – University of Western Ontario

Session Description: When an average person is asked to describe mathematics, they will often mention counting and numbers, formulas and calculations. One of the most amazing things about mathematics is its ability to transcend the numbers and calculations and demonstrate a deep, abstract connection. In this session, we’ll look at four simple counting problems which, on the surface at least, look very, very different. However, if we venture away from calculating answers to the problems, and go searching for something a little deeper, we’ll find a common thread to each problem. We’ll transcend the numbers and glimpse the beauty of mathematics.

Session 3

Title: Coding, For the Love of Mathematics

Presenter(s): Richard Clausi – Elmira District S.S. (retired)

Session Description: Coding, a new player in the elementary school curriculum, offers teachers and students a new way to explore mathematics. This session is a light overview of entry-level programming (code.org, scratch and LOGO) as a way to engage and nurture mathematical thinking. This new tool for problem solving allows us to use simple programming to understand and apply “tough” concepts such as recursion, modularity and multi-tasking to ARDUINO programming and Mouse Mazes, calculating TT, Newton’s Method for Square Roots, Fractals and Mandelbrot Set. You will leave with inspiration and ideas that you can use to explore your own personal mathematical adventures.

Mathematics - Grades 9-12

Session 1

Title: Quadratics

Presenter(s): Shawn Godin – Cairine Wilson S.S.

Session Description: Quadratic functions are one of the first topics students are introduced to where some specific abstract mathematical tools are needed to analyze problems. In this session, we will discuss topics that involve quadratics that are known to students (the Pythagorean theorem), and some teachers (conic sections). We will also branch out to other topics in mathematics that involve quadratics: representing numbers as sums of squares; complex numbers, quaternions and octonions; Pell's equation; testing for primes; continued fractions; and complex fields. Many of these ideas will be tied together by examining *binary quadratic forms*, which are quadratic polynomials of two variables of the form $f(x, y) = ax^2 + bxy + cy^2$. We will discuss the algebraic structure of these forms, how they represent integers and how they tie in to other areas of mathematics.

Title: Triples

Presenter(s): David Robinson – Lakefield D.S.S. (retired)

Session Description: Participants will learn a very simple and easy way to do the following: (without knowing any of the traditional formulae that are customarily used)

- A. Determine the equation of a line given two points, say $(3, -7)$ and $(-8, 6)$.
- B. Use triples for the following: Given $\triangle ABC$ with $\cos A = 0.6$ and $\sin B = \frac{15}{17}$, determine the value of sine, cosine and tangent of $(A \pm B)$; sine, cosine and tangent of C ; $\sin 2A$, $\cos 2B$ and $\tan \frac{C}{2}$.
- C. Evaluate $\arctan \frac{1}{2} + \arctan 13$.

Prior to the presentation, participants are encouraged to try these using the traditional formulae so they will truly appreciate the simplicity of the techniques. More time is required to write down all of the above answers than to do the work!

Session 2

Title: Complex Numbers for Secondary Students

Presenter(s): Rich Dlin – TanenbaumCHAT

Session Description: Complex numbers are just too cool to be left out of high school! This session covers the complex number system using secondary school level mathematics, and shows how the beauty of complex numbers is definitely attainable for secondary school students. Whether you're involved in your school's enrichment program, or just plain awesome, this session will have something for you. Attendees will receive an electronic version of a file that can be used to bring the session back into your classroom or math club.

Title: Continued Fractions: Invisible Patterns

Presenter(s): Ramana Andra – Yorkdale Adult Learning Centre

Thomas Jackson – Danforth C.T.I.

Session Description: Continued fractions connects mathematics and computer science. Irrational numbers such as π , e and the golden ratio can be expressed using continued fractions in simple patterns invisible to the layman. A brief historical account that includes the work of Euler, Gauss and Ramanujan will be presented. A geometrical representation of rational numbers using rectangles and squares connects continued fractions with geometry. Using the power of modern computation technology and a few simple algorithms, continued fractions representations of rational numbers will be demonstrated. Further we will discuss the periodic nature of the continued fractions representations of radicals. A computation of $\sqrt[3]{3}$ using continued fractions will take us beyond the quadratic irrational numbers. We will make connections to convergent series and methods of approximation, keeping the content grounded for our intended audience with applications to contemporary topics like chaos theory and fractals. We will end by mentioning recent developments in this area of research. Our objective is to showcase the connections between arithmetic, geometry and computer science.

Session 3

Title: The Wonderland of Probabilities

Presenter(s): Alexandru Pintilie – Crescent School

Session Description: The theory of probabilities is the most intriguing branch of mathematics as it has the lowest ratio of tedium to “wow” and the highest ratio of surprise to predictability. Some of its results are not just surprising, they can even seem counterintuitive. We will discuss a number of examples using both mathematical common sense and actual calculations. Bring your sense of wonder. (Well-known examples such as the Birthday Problem and Monty Hall’s problem will be avoided in the hope that most of the material will be new and thought-provoking.)

Title: Creating a Provocative Context of Learning Mathematics with Rich Mathematics Topics

Presenter(s): Elena Corina Georgescu – Chaminade College School

Varvara Nika – Toronto Catholic District School Board

Session Description: Through exploration of advanced mathematics topics, such as number theory, real analysis, cryptography, graph theory, advanced counting techniques and problem solving strategies, we hope to make unexpected connections among different areas of mathematics and real life situations, to incite interest in teaching and learning and to increase the thrill and excitement in problem solving. In this session, teachers will be presented with rich problem-solving contexts which draw the learners into a world of discovery, of making connections and of constructing meaning. At the end of our presentation the participants will be equipped with some answers to the frequent questions: “Do I need this kind of mathematics? How do I use it in real life?”.

Computer Science

Session 1

Title: Creating Mathematical Art and Optical Illusions Using Trigonometric Functions

Presenter(s): Jason Schattman – Sir John A. Macdonald S.S.

Session Description: At first glance, the functions

$$y(t) = A \sin(B(t - C)) \text{ and } x(t) = A \cos(B(t - C))$$

don't seem very exciting. Sure, they can make cool spirals and Lissajou's pretzels, but these curves have been known since the 1700's. Are graphics based on trigonometric functions a dead science? In this session, we'll show that this is not at all true! Using the magic of programming, we can bring to life an entire universe of artistic animations and optical illusions that you'd never guess had anything to do with trigonometry, or even mathematics. We'll see how to make animated string-art, how to make "TV static" that's so mesmerizing you would actually prefer watching it over the show that got interrupted, how to simulate a Canadian flag fluttering in the breeze, and a few more surprises along the way.

Session 2

Title: Shhhh! Lessons from "Discrete" (get it?) Mathematics

Presenter(s): Kirsten Nelson – Carleton University

Session Description: Discrete mathematics is one of the younger branches of mathematics, with unsolved problems that are easy to understand, but hard to scale up. You might expect that modern computing power brings any problem within reach, but not in this area! Combinatorial designs tend to exhibit exponential explosion as their various parameters get larger. Smart algorithms and intelligent reasoning have to go hand-in-hand with programming. We'll look at some examples, such as covering arrays, projective planes, and the Ramsey numbers. For each problem, we'll examine the computer science techniques that have brought results within reach.

Session 3

Title: Introduction to Artificial Intelligence: Programming and Mathematics

Presenter(s): Michael Chan – Albert Campbell Collegiate Institute

Session Description: Since artificial intelligence (AI) technology is now a part of our everyday routines, it is beneficial for students to learn some basic AI programming techniques. These techniques are accessible and in this presentation, I will demonstrate some elementary connections between mathematics and computer programming and make use of these connections to perform the recognition of objects, colours, texts, and codes, as well as remote controls. During our discussion, there will also be the opportunity for participants to share their experiences. At the end of the session, the participants should have enough resources to implement basic AIs in their programming classes.

University of Waterloo Presenters

Session 1

Title: Mathematics and Brain Rhythms

Presenter(s): Sue Ann Campbell – University of Waterloo

Session Description: The human brain consists of billions of cells. The electrical activity of these cells underlies the many functions of the brain including memory, thinking, processing the input from our senses, and the control of movement. A fundamental property of this electrical activity is that it is rhythmic, periodically waxing and waning with a period that can vary with the brain state. In this session, we will look at how mathematics can be used understand the rhythmic electrical behaviour in the brain from the single cell to the large network level.

Session 2

Title: Adventures in Problem Solving

Presenter(s): Ian VanderBurgh – University of Waterloo

Session Description: In the course of solving problems, we sometimes encounter surprising results, unexpected connections, and simply beautiful problems. In this session, we will work through a handful of problems that highlight the joy of problem solving and will talk a bit about the process of creation of the CEMC's contests.

Session 3

Title: Sounds like Sine

Presenter(s): Eddie Dupont – University of Waterloo

Session Description: We often teach students about using sinusoids to model ferris wheels, temperature cycles, tides etc. While an excellent starting point, wouldn't it help to relate it to something "cool" like music and selfies?!? We will discuss how the basic sinusoid helped to usher in a media revolution.