Welcome to the February Issue of *CMS Notes*

Issue Contents

February 2022 : Vol. 54, No. 1

Javad Mashreghi (Laval)
CMS President

The midlife crisis knocks our doors around forties. Insufficient or lack of income, breakups, sickness, etc. are usually the main, hidden or transparent, roots of the crisis. The Canadian Mathematical Society, close to its eighties, has faced a crisis which considering the average lifetime of medium-sized societies could be branded as a midlife crisis for the CMS! We need to survive. Otherwise, in the giant wheel of history, the CMS fate would simply help the statistical data. More explicitly, the current crisis would count as another evidence for the 'middle-age' crisis of scientific societies. Let's count some of the problems. Completing this list and finding concrete solutions are to be thought.

At this strange era, all fingers are pointed toward the COVID virus family. After all, they are guilty of the great pandemic all over the globe! Hence, it is easy and straightforward to hold them accountable for our problems too. As a matter of fact, it is true and unfortunately inevitable that part of our revenues is missing and when we look carefully for the causes and dig profoundly, the true guilty is COVID. Indeed, we even expect worse to come. However, we need to be just and careful. The COVID virus is not responsible for all our problems and if we close our eyes and accuse this family of all the shortcomings, we are misleading ourselves and will not find a true solution for the middle-age crisis. A precise analysis of the financial structure of CMS, its odds and ends, future projections, etc. is inevitable. Incidentally, this is the right point to sincerely thank the federal government. In the past two years, the CMS has benefited from several aid packages offered by the government. Without these generous gestures, the CMS financial status would have been entirely different.

The next item on the list is our meetings. For a long time, the CMS has kept the tradition of having two annual meetings. The winter meeting, usually in major Canadian cities, and the summer meeting, in other parts of the country. As a rule of thumb, winter meetings have attracted more participants. Both gatherings have been essential for the CMS and the Canadian mathematicians, senior and junior. Currently, the meetings are affected by several intertwined phenomena, each one of them needs careful consideration.

The first one is again related to COVID. From the last summer, we started to practice the online meetings. However, since early 2020 there is a myriad of online meetings all over the globe. At the early stage, it was a new and attracting activity for all of us. But the more we continue to live with the virus, the more we are tired of online activities. Students do not show up that much in online courses. Virtual meetings are less populated than before. Our last online meeting was not an exception and it was less welcomed compared to the previous ones. Therefore, we are naturally worried in advance about the upcoming summer meeting.

On one hand, we do not know how long this special period of our life will continue. It is hard, and possibly unwise, to make any prediction. On the other hand, assuming we go back to normal and start having in-person meetings, despite what explained above it seems that there is a willingness to keep the virtual component alongside the main in-person stream. In both situations, either fully online or hybrid, the CMS has no financial benefit and such meetings, despite their importance and moral values, start to be a heavy burden on the CMS shoulders.

The interrelation between the CMS and the mathematical institutes is another delicate item that needs to be analysed and "re-defined". The emergence of mathematical research institutes from coast to coast with gradually increasing thematic programs, focus programs, weekly international conferences, high-level colloquiums, etc. spread uniformly all over the year, the importance and essence of summer and winter meetings of CMS have declined. This aspect of meetings is already observed and carefully address by the CMS prominent friend Dr. Juris Steprans in an article entitled "Are CMS meetings meeting their goals?" (*CMS Notes*, December 2018). I strongly believe that the institutes and the CMS need to collaborate and coordinate their activities.

The Institutes Committee is a newly suggested committee at CMS. As a Canadian entity, its goal is to represent the Canadian mathematical life at major international events such as the Joint Mathematics Meetings (JMM), International Congress of Mathematicians (ICM), European Congress of Mathematics (ECM), Mathematical Congress of the Americas (MCA), etc. Considering the above issue and that this committee is not even formed yet, the institute representatives may get together and discuss more broadly about the future of mathematical meetings in Canada, mutual collaborations, responsibilities, etc.

'Publication' is another seriously affected part of the CMS body. On one hand, the publisher drastically decreased the projected payments to the CMS. As usual, they blamed the COVID and pictured its implications that eventually led to a lower income for the publisher. Hence, it is immediately reflected in projected payments to clients, the CMS one of them. On the other hand, we are getting closer and closer to the open access era. In three years from now, all publications will be open access. This by itself is a very complicated problem with numerous twists. However, we feel the heat from now on. I strongly request my successors to take this problem seriously. If the CMS cannot find a remedy for its publication problems, I do not see how it would be possible to survive.

All CMS committees are running by volunteers. In the past 5 years that I have been with the Executive Committee, the Nominating Committee has had difficulty to fill the vacancies. Even worse, the Executive Director has faced shortcomings even for the Nominating Committee itself and had to fulfill some activities which were not officially her task. Lack of young faces and unwillingness of senior colleagues to get involved are major issues in other (even larger) mathematical societies. The CMS has a very rich administrative structure and thus we constantly need volunteers and devoted colleagues in all committees.

Finally, please let me emphasize that I just highlighted some major issues that the CMS is facing. This list is not comprehensive. I still have a couple of other items that were not mentioned above; just the most important ones were put on the table. For future, we need to take two actions. First, closely analyse the situation and detect all the existing problems. Second, to address them. The latter, despite been already partially treated, needs a thorough analysis and implementation. The CMS needs your help.

Robert Dawson (Saint-Mary's University)

Editor-in-Chief

This was the semester it was all meant to go back to normal. Hybrid teaching in the fall, everybody said. Then in the winter term it would be just like the old days. But, as we all know, along came Omicron, and things fell apart.

I know: you don't want to read an editorial about COVID. I don't want to write an editorial about COVID. So I won't. Instead let me tell you…

I was amused to hear how many people called the new variant "Omnicron" or "Omnicon" at first. It makes sense: until a couple months ago, it wasn't a name that most people heard much. Outside of fraternities and sororities (and the Christian use of "Alpha and Omega"), most people tend to hear Greek letters in a scientific context or not at all. And omicron doesn't get much use – mathematicians and physicists avoid it in formulae because it doesn't have a distinctive glyph. Astronomers use it, but as they use it for the fifteenth-brightest star in a constellation, it doesn't get much screen time there either.

Fortunately, we've never had enough tropical storms in one year for the meteorologist to announce a "Hurricane Omicron." The WMO has retired the Greek alphabet as a source of storm names anyhow. Some of the "Greek storms" of 2020 were severe enough that protocol called for those names to be retired – and they felt they couldn't retire single letters from it, so they went to a second alphabetical list list of given names.

Maybe that decision was premature. After all, Classical Greece retired letters on occasion. Where now are digamma (Ϝ) , stigma (Ϛ), koppa (ϟ), and sampi (ϡ)? Not just a rhetorical question: all four of them ended up with post-retirement jobs as Greek numerals. At various times digamma and stigma represented 6; koppa was 90; and sampi was 900. Many years later, mathematics also found a role for digamma: Ϝ(z) is the logarithmic derivative of $\Gamma(z)$, that is, $\Gamma'(z)/\Gamma(z)$. Just for good measure, the trigamma, tetragamma, etc. functions were defined; they are sometimes represented by "letters" that look rather like coatracks.

The use of $\sum$ and $\prod$ for sums and products is straightforward. But what of the $\coprod$ we use for coproducts? That seems to have a fair amount of history, starting off back in the 19th century when Peano introduced U and $\cap$ for union and intersection. Russell introduced "v" for "or" in 1908 (presumably from the Latin "vel".) He used a dot for "and" – underlining its formal resemblance to multiplication, but not its de Morgan duality with "or." Only in 1930 did Heyting introduce "$\bigwedge$" for "and", underscoring the similarity between than operation and set intersection. With the advent of category theory, of course, extending this to an inverted product symbol for disjoint union was almost obvious. But it seems as if there's a coincidence somewhere in the process. Peano surely didn't invent the $\cap$ symbol to resemble π.

I'm not quite sure what the moral of all this is. But it's better than one more story about COVID.

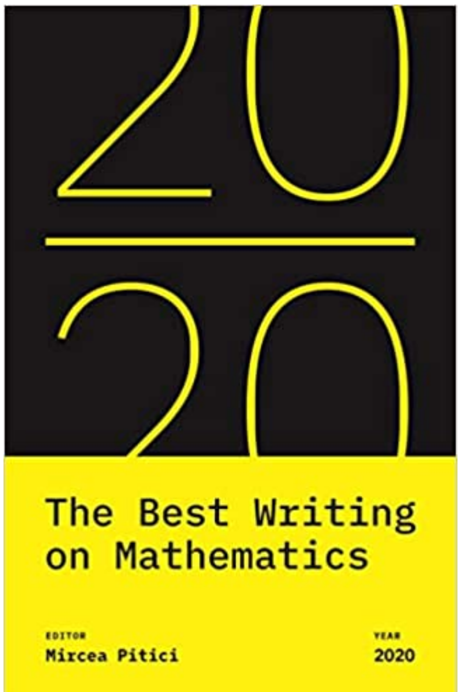
The Best Writing on Mathematics, 2020

Book Reviews
February 2022 (Vol. 54, No. 1)

Karl Dilcher (Dalhousie University)

Book Reviews bring interesting mathematical sciences and education publications drawn from across the entire spectrum of mathematics to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Karl Dilcher, *Dalhousie University (notes-reviews@cms.math.ca)*



The Best Writing on Mathematics, 2020

Edited by Mircea Pitici
Princeton University Press, 2020
ISBN: 978-0-691-20756-8

This is the eleventh volume in a remarkable series of annual anthologies. Earlier in this space I addressed some general features shared by all volumes. I will not repeat these remarks here; the interested reader will find it in the September 2019, issue. Instead, I will quote from the overview of this volume and add the titles of the individual articles.

"In a piece eerily reminding us of the current coronavirus health crisis, Steven Strogatz recounts the little-known contribution of differential equations to virology during the HIV crisis and makes the case for considering calculus among the heroes of modern life. [*Outsmarting a Virus with Math*].

"Peter Denning and Ted Lewis examine the genealogy, the progress, and the limitations of complexity theory—a set of principles developed by mathematicians and physicists who attempt to tame the uncertainty of social and natural processes. [*Uncertainty*].

"In yet another example of fusion between ideas from mathematics and physics, Bruce Boghosian describes how a series of simulations carried out to model the long-term outcome of economic interactions based on free-market exchanges inexorably leads to extreme inequality and to the oligarchical concentration of wealth. [*The Inescapable Casino*].

"Stan Wagon points out the harmonic-average intricacies, the practical paradoxes, and the policy implications that result from using the miles-per-gallon measure for the fuel economy of hybrid cars. [*Resolving the Fuel Economy Singularity*].

"Jørgen Veisdal details some of the comparative reasoning supposed to take place in majoritarian democracies—resulting in electoral strategies that lead candidates toward the center of the political spectrum. [*The Median Voter Theorem: Why Politicians Move to the Center*].

"In an autobiographical piece, John Baez narrates the convoluted professional path that took him, over many years, closer and closer to algebraic geometry—a branch of mathematics that offers insights into the relationship between the classical mechanics and quantum physics. [*The Math That Takes Newton into the Quantum World*].

"Erica Klarreich explains how Hao Huang used the combinatorics of cube nodes to give a succinct proof to a long-standing computer science conjecture that remained open for several decades, despite many repeated attempts to settle it. [*Decades-Old Computer Science Conjecture Solved in Two Pages*].

"A graph-based explanation, combined with a stereographic projection, also helped Richard Montgomery solve one of the questions posed by the dynamical system formed by three masses moving under the reciprocal influences of their gravitational pulls, also known as the three- body problem. [*The Three-Body Problem*].

"Chris King, who created valuable online resources freely available to everyone, describes the algebraic iterations that lead to families of fractal-like, visually stunning geometric configurations and stand at the confluence of multiple research areas in mathematics. [*The Intrigues and Delights of Kleinian and Quasi-Fuchsian Limit Sets*].

“In the next contribution to our volume, Jim Henle presents several paper-and-pencil games selected from the vast collection invented by Sid Sackson. [*Mathematical Treasures from Sid Sackson*].

“Dave Linkletter breaks the classic Rubik’s cube apart and, using the mechanics of the cube’s skeleton, counts for us the total number of possible configurations; then he reviews a collection of mathematical questions posed by the toy—some answered and some still open. [*The Amazing Math Inside the Rubik’s Cube*].

“Colin Adams introduces with examples, defines, and discusses several important properties of the hyperbolic 3-manifold, a geometric notion both common to our physical environment and difficult to understand in its full generality. [*What Is a Hyperbolic 3-Manifold?*]

“In a similar geometric vein, with yet more examples, physical models, and definitions, followed by applications, Boris Odehnal presents an overview of higher dimensional geometries. [*Higher Dimensional Geometries: What Are They Good For?*].

“With linguistic flourishes recalling Fermat’s cryptic style, James Propp traces the history of two apparently disconnected results in the theory of numbers—which, surprisingly, turned out to be strongly related—and tells us how an amateur mathematician used the parallelism to prove one of them. [*Who Mourns the Tenth Heegner Number?*].

“Patrick Honner works out in several different ways a simple multiplication example to compare the computational efforts required by the algorithms used in each case and to illustrate the significant benefits that result when the most efficient method is scaled up to multiply big numbers. [*On Your Mark, Get Set, Multiply*].

“Ben Orlin combines his drawing and teaching talents to prove that ignorance of widely known mathematics can be both hilariously ridiculous and academically rewarding! [*1994, The Year Calculus Was Born*].

“Donald Teets’s piece is entirely concerned with the young Karl Friedrich Gauss’s contribution to the history of the Christian calendar. [*Gauss’s Computation of the Easter Date*].

“Paul Thagard proposes five conjectures (and many more puzzling questions) on the working of mathematics in mind and society and formulates an eclectic metaphysics that affirms both realistic and fictional qualities for mathematics. [*Mathematical Knowledge and Reality*].

“Mark Colyvan asserts that explanation in mathematics—unlike explanation in sciences and in general—is neither causal nor deductive; instead, depending on the context, mathematical explanation provides either local insights that connect similar mathematical situations or global answers that arise from non-mathematical phenomena. [*The Ins and Outs of Mathematical Explanation*].

“Gerry Hahn, Necip Doganaksoy, and Bill Meeker call (as they have done over a long period of time) for improving statistical inquiry and analysis by using new tools—such as tolerance and prediction intervals, as well as a refined analysis of the role of sample size in experiments. [*Statistical Intervals, Not Statistical Significance*].”

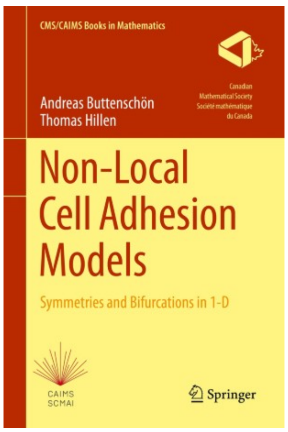
This volume ends, as usual, with a book list of other recently published notable writings. The next volume, The Best Writing on Mathematics, 2021, is due to appear in the Spring of 2022.

Prof. Karl Dilcher (Dalhousie University)

Book Reviews bring interesting mathematical sciences and education publications drawn from across the entire spectrum of mathematics to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Karl Dilcher, *Dalhousie University (notes-reviews@cms.math.ca)*

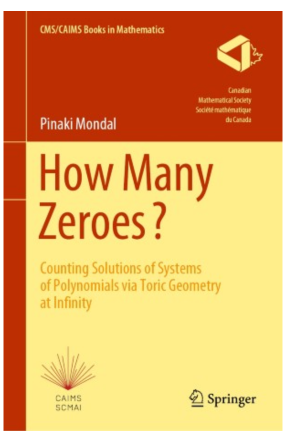
The two titles featured in this column are the first volumes in the new CMS/CAIMS book series, which succeeds the previous "CMS Books in Mathematics". Full reviews of both volumes will be published in due course; therefore, just the publisher's descriptions are given here.



Non-Local Cell Adhesion Models
Symmetries and Bifurcations in 1-D

by Andreas Buttenschön and Thomas Hillen
CMS/CAIMS Books in Mathematics, Springer, 2021
ISBN: 978-3-030-67110-5

Publisher's description: "This monograph considers the mathematical modeling of cellular adhesion, a key interaction force in cell biology. While deeply grounded in the biological application of cell adhesion and tissue formation, this monograph focuses on the mathematical analysis of non-local adhesion models. The novel aspect is the non-local term (an integral operator), which accounts for forces generated by long ranged cell interactions. The analysis of non-local models has started only recently, and it has become a vibrant area of applied mathematics. This monograph contributes a systematic analysis of steady states and their bifurcation structure, combining global bifurcation results pioneered by Rabinowitz, equivariant bifurcation theory, and the symmetries of the non-local term. These methods allow readers to analyze and understand cell adhesion on a deep level."



How Many Zeroes?
Counting Solutions of Systems of Polynomials via Toric Geometry at Infinity

by Pinaki Mondal
CMS/CAIMS Books in Mathematics, Springer, 2021
ISBN: 978-3-030-75173-9

Publisher's description: "This graduate textbook presents an approach through toric geometry to the problem of estimating the isolated solutions (counted with appropriate multiplicity) of n polynomial equations in n variables over an algebraically closed field K. The text collects and synthesizes a number of works on Bernstein's theorem of counting solutions of generic systems, ultimately presenting the theorem, commentary, and extensions in a comprehensive and coherent manner. It begins with Bernstein's original theorem expressing solutions of generic systems in terms of the mixed volume of their Newton polytopes, including complete proofs of its recent extension to affine space and some applications to open problems. The text also applies the developed techniques to derive and generalize Kushnirenko's results on Milnor numbers of hypersurface singularities, which has served as a precursor to the development of toric geometry. Ultimately, the book aims to present material in an elementary format, developing all necessary algebraic geometry to provide a truly accessible overview suitable to a second-year graduate students."

Leslie Shayer (UBC Okanagan)

Education Notes bring mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, issues, and noteworthy news items. Comments, suggestions, and submissions are welcome.

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One of the greatest and controllable influences on math success is math anxiety – a field of study which surfaced over 50 years ago when researchers identified individuals who were "emotionally disturbed in the presence of mathematics" (Dreger & Aiken, 1967, p. 344). Researchers in the field, primarily with psychology or education backgrounds determined that:

1. Math anxiety affects math performance: the greater the anxiety, the lower the score in the math-related course, leading to greater math anxiety and then an even lower score (Hembree, 1990; Ma, 1999; Namkung et al., 2019, Sonnert et al., 2020). Phew! I feel dizzy.
2. Math anxiety leads to math avoidance: students with math anxiety deny themselves a future in math-related fields, such as science, technology, engineering, and mathematics (STEM, Ashcraft, 2002; Hembree, 1990; Mighton, 2020; Namkung et al., 2019; Perry, 2004; Tobias, 1993). Perhaps, more importantly, these students shun mathematics in everyday life, limiting themselves, since math IS everywhere.

Math anxiety has no prejudice – it affects students of all social classes, ethnicities, races, sexes, and genders. There are many causes of math anxiety – from stressful timed tests, to instructor behaviours, to the attitudes of parents/teachers/family/community members, to previous poor math performance, to low competency levels, to socio-economic status. However, today, dear CMS *Education Notes* reader, let us focus on positives and appreciate things that might help.

I posited in my Master's thesis (Shayer, 2020) that math anxiety can be decreased for all students via the incorporation of contemplative practices while taking math courses. Contemplative practices include exercises based on reflection or introspection, which offer a variety of techniques, such as breath awareness, meditation, and visualization.

Now before getting into greater details, let us just begin by taking a deep breath. *In… Out…* You feel better already, right? In fact, Brunyé et al. (2013) determined that focused breathing minimized math anxiety, but did not totally undo its effects when test writing. Truth be told, they only investigated one exercise of focused breathing and suggested further work, over a longer period of time. Perhaps then, greater and sustained effects may emerge (as demonstrated with stress and anxiety in learning by Shapiro et al., 2011).

According to Bellinger et al. (2015), who examined the relationship between math anxiety and mindfulness levels, the more mindful the individual, the less math anxious they were in high stakes testing environments – timed tests, final exams, or any evaluation worth a lot of marks or could decide entrance to careers. Furthermore, Ashcraft and Kirk (2001) considered the drop in working memory – the memory which is used to break problems down into steps or to remember studied procedures – that math-anxious students suffer when test writing, depleting valuable resources to recall methods or to process steps toward a solution. Bellinger et al. (2015) shared that "individuals who received mindfulness training, and extensively practiced, did not show this drop in working memory" (p. 124), leading to their higher performance. Notice the expression "extensively practiced". Evidence demonstrates that regular practice is important for continued benefits (Hyland, 2016; Shapiro et al., 2011).

To support students taking mandatory first-year, university transfer math courses, I devised a program (further detailed in Shayer, 2020), entitled *Mindful Math*, which incorporated evidence-based practices emanating from Mindfulness-Based Stress Reduction (MBSR, a program created by Kabat-Zinn, 1994, the father of the secular mindfulness movement) and smartEducation (an MBSR-style program for pre-service and in-service teachers) curricula. This out-of-class support did not offer tutoring. Instead, the six 45-minute length sessions featured various contemplative practices. The Mindful Math sessions offered a means to observe the impact of contemplative practices on the perceived anxiety of students enrolled in these first-year mandatory math courses. The first three sessions occurred on a weekly basis, whereas the last three were offered biweekly to allow participants time to develop their own practice.

The three most popular (and helpful according to the participants) were:

1. The Pause Practice (involving focused breathing)
2. The 5-4-3-2-1 Practice
3. The Math Class Visualization

The first practice, the Pause Practice, involved taking three intentional deep breaths, focusing on the inhale and the exhale of each (see Figure 1).

Then, participants were invited to ponder their thoughts, sensations, and feelings. The practice ended with three more deep breaths.

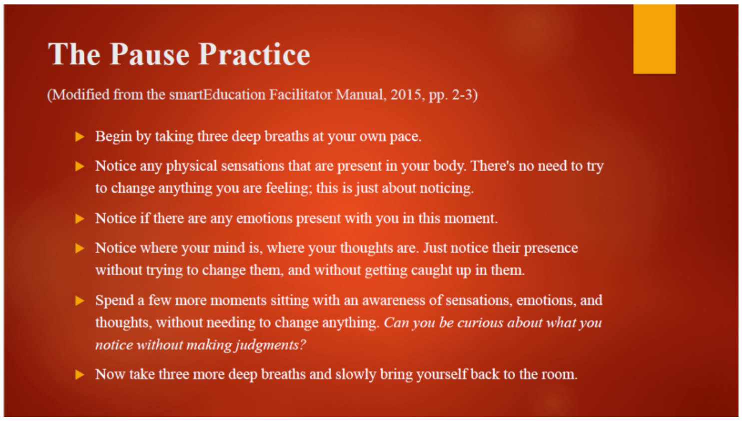

Figure 1. The Pause Practice

Side Note: See the excerpt from the field notes from Session 1 (Figure 2), when the Pause Practice involving focused breathing was first introduced. This description in the excerpt was the first presentation of Number-Induced Math Anxiety, when mere numbers make people feel anxious or react physiologically, as predicted by Namkung et al. (2019). Other such episodes occurred during that first session. In consequence, I steered cleared of counting and of saying “one”, “two”. Instead, “in” and “out” were used.

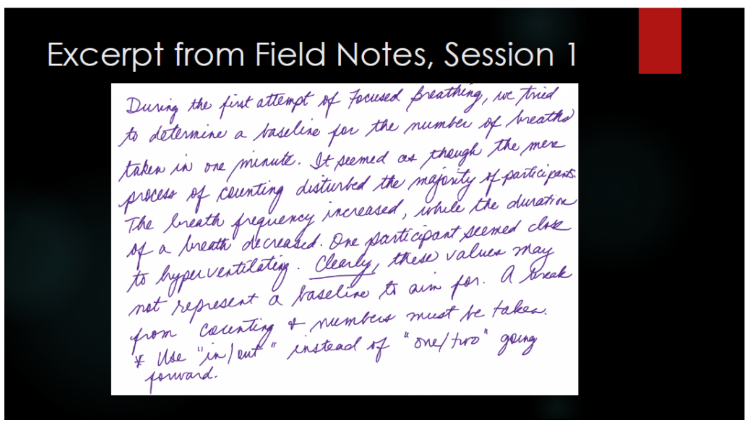

Figure 2. Excerpt from Field Notes, Mindful Math Session 1

I delayed the introduction of the 5-4-3-2-1 Practice due to the presence of numbers; however, by the fourth session, the participants’ willingness to engage with it was noticeable. In the end, the 5-4-3-2-1 Practice is an excellent grounding exercise. It quickly became a participant favourite as it is easy to do anywhere and does not require a large time commitment (see Figure 3, 5-4-3-2-1 Practice). As always, you can start and finish with three deep breaths.

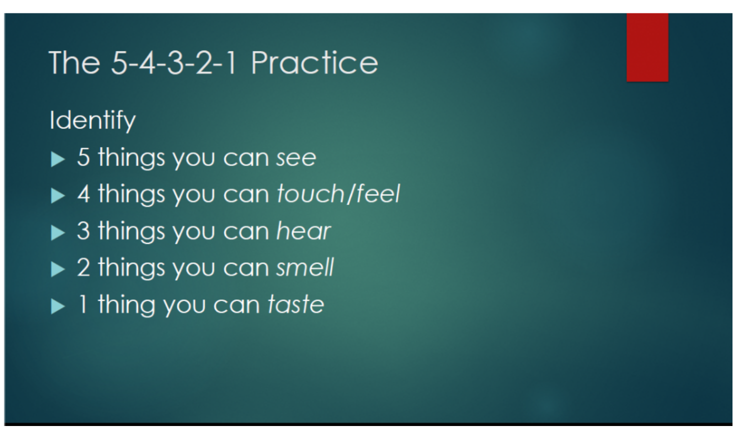

Figure 3. The 5-4-3-2-1 Practice

Finally, one participant felt more at ease in the class after practising visualizations. In consequence, they were more apt to ask questions when they did not understand or ask the instructor for help. The Math Class Visualization was a guided visualization beginning and ending with three deep breaths. It involved the description of a regular student classroom, along with its sights, smells, and sounds. At every instance where anxiety would start to increase (such as when the instructor entered, discussed a difficult topic, or mentioned an upcoming test, or when fellow students would discuss the ease or difficulty of the homework), I would remind the participants that they had done all that they could, that they had done all their homework and that they could manage. Extra deep breaths were had. Positive, yet realistic outcomes were visualized – passing a test, understanding a concept (eventually), problems becoming more manageable with practice, feeling more comfortable asking questions in class or during office hours. As it is a longer practice, please consult Shayer (2020) for the step-by-step visualization.

The case study results also demonstrated that with regular practice over the span of nine weeks, participants were able to manage their math anxiety, all while demonstrating better control of their emotional reactions to math.

I believe that math anxiety is a "chicken or the egg scenario". We can easily get hung up in discussions relating to how math anxiety starts or the best age to squash it. However, those discussions do not lead to solutions. It is never too late to affect change. No matter which grade you teach, whether you have children or adult learners, it is worth a try. Plus, math anxiety is interconnected with many things, from job opportunities, to self confidence, to happiness in life.

Hence, if contemplative practices CAN decrease self-perceived math anxiety, then many ripples can occur, including decreases in math avoidance and increases in math performance. As Tobias (1993) wrote, decreasing math anxiety increases math self-confidence and greater confidence in life in general. Why not give our students the ability to have greater confidence in their lives and in themselves?

Update: I am continuing to work with these ideas now in my Ph.D., incorporating the practices into the classroom itself. Interested readers are encouraged to contact me with questions or comments.

Leslie has been an educator all her life, whether it be as a piano teacher, gymnastics coach, or math instructor. She obtained her master's in applied math in 1998, which led her to the post-secondary classroom experiences. For over twenty years, she has seen students struggle with the very subject that she loves. Leslie returned to graduate school in 2018 to not only complete an M.A. in education, but is currently working on her Ph.D. at UBC Okanagan under the supervision of Dr. Karen Ragoonaden. Her research investigates how contemplative pedagogy may be used to improve the learning of mathematics by decreasing math anxiety.

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William Playfair's Statistical Graphs

David Bellhouse (Western University)

CSHPM Notes bring scholarly work on the history and philosophy of mathematics to the broader mathematics community. Authors are members of the Canadian Society for History and Philosophy of Mathematics (CSHPM). Comments and suggestions are welcome; they may be directed to either of the column's co-editors:

Amy Ackerberg-Hastings, *Independent Scholar (aackerbe@verizon.net)*
Hardy Grant, *York University [retired] (hardygrant@yahoo.com)*

William Playfair (1759–1823) was a man of contradictions. On one hand, he was known as a good statistician and economist. He pioneered the use of statistical graphs and made substantial contributions to the first posthumous edition of Adam Smith's *Wealth of Nations* [12]. He was also one of the first to formulate a theory of how wealthy nations decline and fall [8]. On the other hand, he participated in criminal activity that resulted in his spending a few months in jail. When pressed for money, he engaged in a variety of scams to make ends meet. A lawyer representing one of Playfair's intended victims called him "a daring worthless fellow." (See, for example, [13].)

Playfair's dual nature carried over to his greatest statistical accomplishment, his graphs. On the positive side, graphs provide an easy way to digest complex information. On the negative side, graphs can be an intentional font of misinformation, a convincing depiction of alternate facts. Even when their creators do not intend to be misleading, graphs are only as good as the data going into them. Makers might not know they are using a bad data set, or they may be too lazy to obtain good data. Playfair's graphs exhibited all of these positive and negative characteristics.

Most of his constructions were motivated by his attempts to illustrate economic issues in a simple and understandable way. For example, he invented the bar chart to illustrate the size of imports and exports of various trading partners with Scotland. He is best known among statisticians for two types of specialized graphs: (1) his unique time-series charts related to English trade and its surplus or deficit; and (2) displays of multivariate data that compared a number of statistics for several European countries. Playfair also invented the now ubiquitous pie chart to illustrate the relative sizes of various states and territories of the United States. Here I will present three of Playfair's innovative graphs and comment on what motivated them, as well as their good and bad features. A full account will be given in my forthcoming book, *The Flawed Genius of William Playfair: The Story of the Father of Statistical Graphics*, to be published by University of Toronto Press.

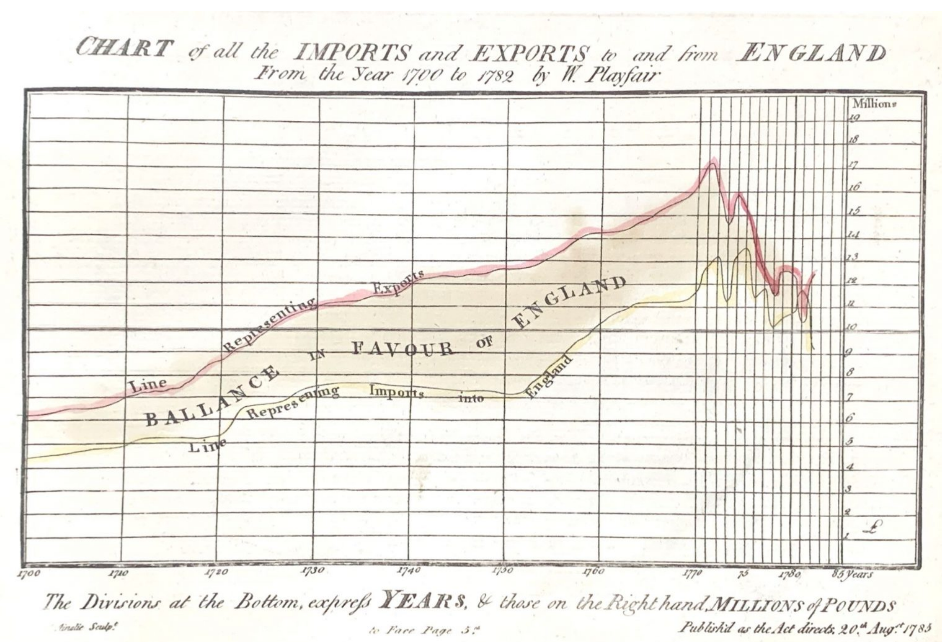

Figure 1. Total Exports and Imports for England 1700–1783.
Image courtesy of Stephen M. Stigler, Chicago.

One of Playfair's early innovations was his use of comparative time-series plots. Several of these graphs appear in his 1786 *Commercial and Political Atlas* [6]. The graph in Figure 1 shows the total amount of exports from England and the total amount of imports, all valued in pounds sterling. The coloured area between the lines shows the trade surplus or deficit. Why this was important had to do with the gold standard. Bank of England pound notes were then backed by gold. Gold was flowing out of England in order to pay for wars in Europe and then America and then Europe again. Gold flowed into England because of the trade surplus. As can be seen in the graph, the surplus had shrunk over time, so that by the end of the American Revolution trade was in a deficit position. Playfair saw this as a problem to be addressed.

Playfair's graphs stand out when compared to others of his day because he used elements that have now become standard. For example, Playfair pioneered the use of colour in his graphs, when colour was rarely used in the printing process. Also, in Figure 1 the plot is framed with the title placed outside the frame. Room is left inside the frame for labels and axis values. Grid lines have been added for ease in reading the chart. All of these elements provide a pleasing appearance. A thorough discussion of Playfair's use of graphical elements can be found in [3].

A feature that particularly stands out for me in the graph in Figure 1 is the way the volatility in the data changes near the end of the series. Further, the gridlines are placed closer together during the period when there is more volatility. This raises a question: Did Playfair smooth his data in some way? In order to answer this question, it is necessary to get at the original data. Playfair gives the data only by decade. In some late-18th-century and early-19th-century publications [4; 15], I found yearly data from 1697 for imports and exports drawn from the Custom House records. I took the yearly data and smoothed the years 1700 through 1770 using a modern technique called LOESS, while the years 1771 through 1782 were left unsmoothed. The result is shown in Figure 2. I have also inserted Playfair's data into the graph to show how closely my smoothed data come to his. While my smoothing does not exactly replicate Playfair's, it comes fairly close. Of course, he did not have this technology. My conjecture is that Playfair used a draftsman's spline to smooth his data. This spline is made of flexible wood which can be bent into curved shapes that are held in place by weights.

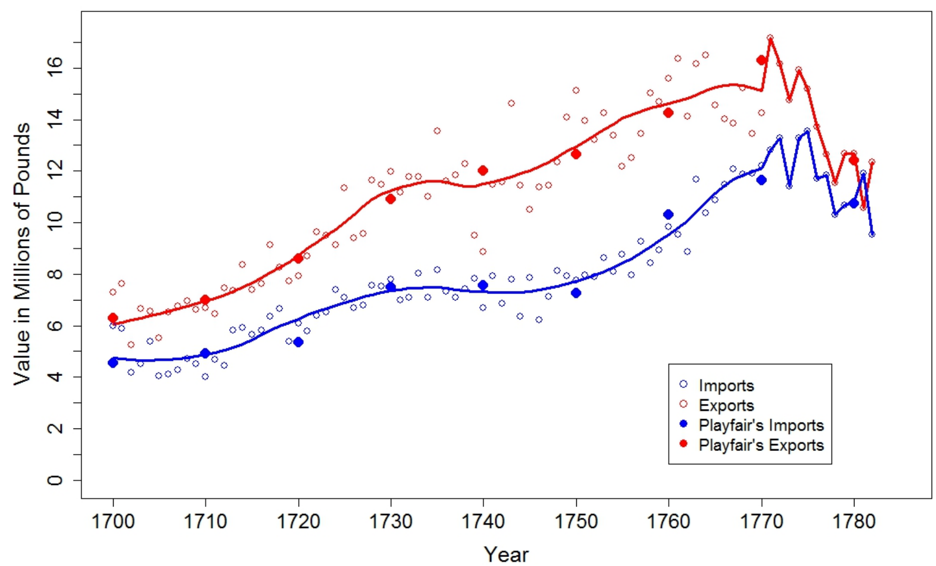

Figure 2. Total Exports and Imports for England 1700–1783, Original and Smoothed Data. Graph drawn using the R software by the author.

Ten years prior to the creation of Playfair's graph, Adam Smith in his *Wealth of Nations* [11] questioned the accuracy of the value of the goods in the Custom House records. This reminds us of the adage that a graph is only as good as the data going into it. If we make a reasonable assumption that the bias in the Custom House records is constant over time and between exports and imports, then Playfair's graph provides a good look at the trends over time, particularly the trend in the trade surplus.

It often happens that peace following war is accompanied by an economic depression. Such was the case in Britain at the end of the Napoleonic Wars in 1815. Some of the hardest hit were factory workers in the cotton mills in the north of England. As a result, there were calls to repeal the corn laws. These were tariffs imposed on the import of grain in order to support the income of the landowners, the upper class of English society. Since the French Revolution, Playfair had supported these landowners as the natural ruling class. He was afraid of the democracy that he had seen evolve in France. Thus he argued against repealing the corn laws and claimed that wages were rising with the price of bread.

Playfair supported his questionable claim with the graph in Figure 3, taken from [9]. Here he has smoothed the data by calculating 25-year averages for the price of a quantity of wheat in shillings. He then calculates the number of days' wages it would take a "good mechanic" to purchase this wheat, as shown by the green bars in the graph. The price of the wheat is given by dotted lines in each of the bars. When the dotted line for price is higher than the days' wages, he colours the difference as a red bar on top of a green one. The vertical axis in the graph stands for both the number of days' wages and the price of wheat in shillings. As can be seen from this graph, although the cost of wheat in shillings was generally increasing over the time period, the number of days' wages required to buy that wheat is decreasing. Consequently, Playfair would say, any criticism of the corn laws vanishes.

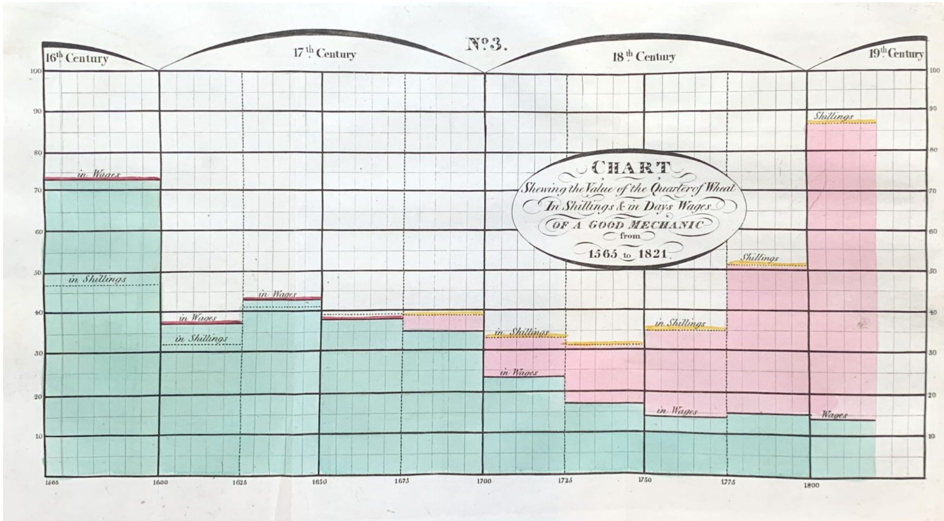

Figure 3. Cost of Wheat in Shillings and the Number of Days' Wages to Purchase the Wheat. Image courtesy of Stephen M. Stigler, Chicago.

The graph is pure propaganda designed to support the landowners. What Playfair meant by the phrase "good mechanic" was "artisan" or "skilled craftsman". Generally, wages for this group had in fact been rising. In that sense, the graph was accurate. But this group was quite different from the factory workers, whom Playfair had completely ignored. Their wages were on the decline and causing them hardship since the cost of bread, the workers' main food source, was rising substantially with the cost of wheat. This situation caused general unrest among the working class, making the government fearful of a revolution such as had occurred in France.

As mentioned earlier, Playfair invented the pie chart. An anticipation appears in his 1801 *Statistical Breviary* [7]. In terms of an actual pie chart, Playfair was not fully aware of what he had done at that point. His fully-fledged pie chart, which appeared in 1805 in his *Statistical Account of the United States of America* [10], is shown in Figure 4. In this book, Playfair claimed to have newly invented the pie chart. The graph shows the fractions of the whole taken up by various states and territories of the United States in 1805. One can easily see, compared to the existing states, the relative sizes of the Louisiana Purchase, the recently-acquired western territories and parts of Florida. However, if you look closely, Playfair made some errors. For instance, he mixed up New York and New Jersey. Further, the data he used were questionable. I compared the areas of various states given in the graph to a map of the United States from about 1805 [1]. The areas don't match up. Sitting in England with little money and possibly in prison, Playfair did not have the resources to obtain a U.S. gazetteer. Instead, he relied on a book, *Éléments de statistique* [2], that had been sent to him by its author, Denis-François Donnant. In addition to a translation into French of *Statistical Breviary*, the book contains a large amount of material on the United States. For each state, Donnant gives the length and breadth of the state. What Playfair did was to multiply the two measurements together to get a state's area, ignoring the fact that the states were not rectangular.

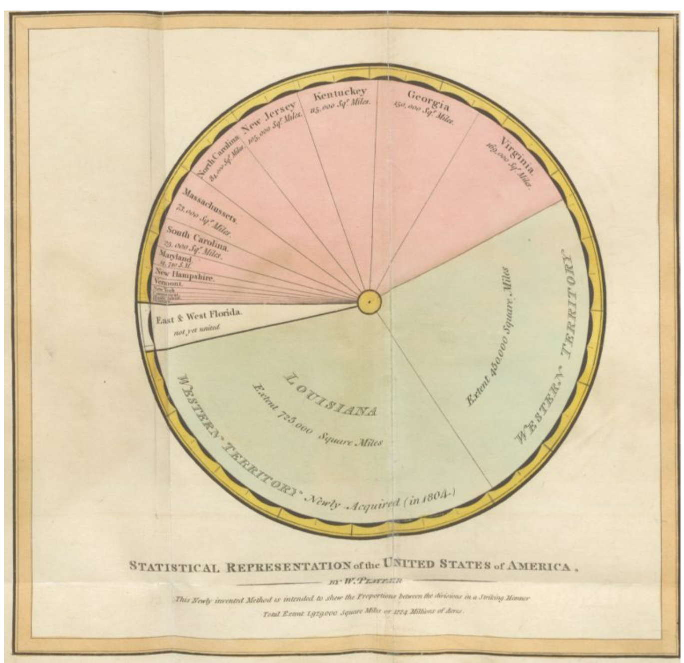

Figure 4. The Relative Sizes of the States and Territories of the United States.
Image courtesy of the British Library.

The pie chart is widely used and misused today. Its severest critic is Edward Tufte [14], one of the modern pioneers of data visualization. He wrote, "The only thing worse than a pie chart is several of them." In qualified support of pie charts, the eminent pedagogue of statistics David S. Moore suggests that they can be used to emphasize a group's relation to the whole [5]. Such is the case with Playfair's pie chart.

These are only three examples chosen from the dozens of graphs that Playfair produced during his lifetime, but they give a fair representation of the work he did. Over the past two hundred years, Playfair's work has sometimes been neglected or forgotten, corresponding to the ebb and flow of interest in statistical graphics. With the advent of new methods of data visualization via computers, interest in Playfair's work has picked up substantially. Reflecting this trend, in 2010 a copy of his *Commercial and Political Atlas* sold at Christie's auction house for $43,750 USD. Despite some of the shortcomings that I have mentioned, he laid a solid foundation for good graphical procedures.

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[2] Donnant, D. F., and W. Playfair. (1802) *Éléments de statistique: Où l'on démontre, d'aprés entièrement neuf, les ressources de chaque royaume, état et république de l'Europe: suivis d'un état sommaire des principales puissances et colonies de l'Indostan*. Paris: Chez Batilliot et chez Genets.

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[8] Playfair, W. (1805) *An Inquiry into the Permanent Causes of the Decline and Fall of Powerful and Wealthy Nations: Illustrated by Four Engraved Charts*. London: Greenland and Norris.

[9] Playfair, W. (1821) *A Letter on Our Agricultural Distresses, their Causes and Remedies: Accompanied with Tables and Copper-plate Charts, Shewing and Comparing the Prices of Wheat, Bread, and Labour, from 1565 to 1821. Addressed to the Lords and Commons*. London: William Sams.

[10] Playfair, W., and D. F. Donnant. (1805) *Statistical Account of the United States of America*. London: Greenland and Norris.

[11] Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: Strahan and Cadell.

[12] Smith, A., and W. Playfair. (1805) *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: Cadell and Davies.

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About the necessity of collecting data to improve EDI in mathematics

Habiba Kadiri (University of Lethbridge)

MOSAIC, Mathematics, Outreach, Society, Accessibility, and Inclusiveness Column is directed by the CMS EDI committee and touches upon issues concerning equity, diversity, and inclusion in mathematics. Comments, suggestions and submissions are welcome.

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In this article we hope to explain why the CMS needs to collect data about the status of diversity across the mathematical community at large.

What is the role of the CMS-EDI committee?

One of the first duties for the Executive Committee is "to take appropriate action to ensure diversity throughout the Society". The CMS EDI committee was created in Summer 2020 to support the Executive Committee in this effort. Since then, it has organized discussions and scientific sessions during each semi-annual meeting, and it has also created a new column, MOSAIC, in the CMS Notes. These initiatives open long awaited spaces for mathematicians to express themselves and share their experiences as members of underrepresented groups. They also provide a space for EDI champions to share their wisdom in building a more inclusive community.

The specific mandate of the CMS-EDI committee includes "to ensure that conferences are accessible and welcoming to all groups", "to monitor the position and interests of women in mathematics, those with disabilities, LGBTQ+ communities as well as other underrepresented groups in Canada and in the Society", and "to recommend actions to the Board of Directors which will assure equitable treatment of these groups in the mathematical community." [1]

Some initiatives have already been undertaken using the experiences of other research communities; for instance, to help session organizers of the CMS meetings select a more diverse panel of speakers, the committee has advised replacing the invitation system with an open call one. We hope this system will be in place by Summer 2022. To determine if this initiative is effective would require some quantitative measures.

Collecting data to take appropriate action to ensure diversity throughout the CMS

As of today, the CMS does not collect or at least share any aggregated data about its meeting participants. More generally, there is a lack of data at all levels of CMS activities. Understanding if and where problems exist and identifying practical solutions require data about the circumstances of the mathematical community. In this article, we would like to highlight various reasons why collecting data is essential to fulfill the CMS mandate and to support the mathematical community:

1. We can measure our position relative to the national (funding agency) mandate;
2. We can measure the extent to which the CMS meets its own mandate;
3. We can identify biases in how the CMS characterizes excellence, and specifically how it recognizes the outstanding contributions of its membership and community;
4. We can start to assess whether the mathematical spaces we support are welcoming and safe for all participants.

One of the first tools that the EDI-Committee is building to start understanding some of these questions is a **nation-wide survey.**

1. **We need data to measure our position relative to that of the national (funding agency) mandate.**

During the November 2017 Gender Summit in Montreal, Dr. Mona Nemer, Chief Science Advisor of Canada, stated that "increasing the number and impact of women and other members of underrepresented groups in STEM requires the concerted efforts of our entire society—including governments, scientific organizations, research granting agencies, and educational institutions".
Dr. Nemer also added that "using the same thinking and approaches—including criteria, metrics, policies and procedures for hiring and recognition at all levels—will not lead to change."[2]

NSERC's need to initiate change arose, in part, from a 2006 Settlement Agreement with the Canadian Human Rights Commission. The settlement addressed a complaint concerning the underrepresentation of individuals from four designated protected groups in the Canada Research Chairs (CRC) Program. The four groups were comprised of (women, Indigenous peoples, persons with disabilities and members of visible minorities). With successive addendums until 2019[3], the Federal Court has required the government to implement targets and to use data to set and enforce said targets. The CRC program is required to achieve the following representation rates by 2029[4]:

Women	Visible Minorities	People with Disabilities	Indigenous
50.9%	22%	7.5%	4.9%

The program now has public accountability and transparency requirements as well as penalties in the event of non-compliance[5]. As of October 2021, the Representation of members of the above four designated groups among the NSERC's CRC[6] was:

Women	Visible Minorities	People with Disabilities	Indigenous
30.2%	26.2%	5.3%	0.8%

Completing the self-identification questionnaire is mandatory; however, all questions provide an option to select "I prefer not to answer". Understanding why collecting this data is important and how it informs EDI initiatives is clearly communicated by NSERC[7][8]. In 2018, a relatively low rate of 5.7% "I prefer not to answer" shows that applicants understand and are willing to provide self-identification information[9]. Since then, the CRCC self-identification questionnaire was revised in 2020 as the 2019 Addendum required revisions to collect data regarding LGBTQ2+ communities. Considering the fundamental partnership between granting agencies and mathematicians, one expects the CMS to have a vested interest in upholding these commitments. While it is in a privileged position to monitor the status of underrepresented groups in mathematics, the CMS does not yet appear to collect any data. Thus, it is difficult to have an accurate picture of the situation. In the meantime, with information readily available, such as participant lists, one can make estimates concerning women as it is a category one can identify with a marginal error.

2. **We need data to measure the extent to which the CMS meets its own mandate.**

Over the last thirty years, the majority of the Canadian population has been female[10]. Over 40% of graduates in mathematics and related studies are women at both the Bachelor and Master level. This rate drops to about 30% at the PhD level (2019 Stats Canada[11] and 2021 NSF[12] reports). We are giving here a first account of the participation of women in the various CMS activities during the past year. These numbers are not official ones and should not be referred to as they have been compiled based only on the information found on the CMS websites.

CMS Boards	**Women**
Board of governors [13]	37%
Editorial boards [14] Canadian Journal of Mathematics Canadian Mathematical Bulletin Crux Mathematicorum	 24% 25% 47%
CMS Winter meeting 2021 [15]	
Participants	32%
Speakers	35%
Organizers of a scientific session	49%

While these participation numbers align with the rate of PhD's in mathematics, a closer study of the participation numbers at the last CMS meeting reveals some discrepancies in the representation of women depending on the scientific sessions. For example, none of the 8 education, EDI, and Indigenization themed sessions had less than a 20% female speaker rate, and only one had below 30%. On the other hand, among the other 24 scientific sessions, there were 2 below 10%, 8 below 20%, and 12 below 30%. In the context of an online conference, these numbers can be considered disappointing as the pool of potential speakers is less restricted by geography, financial means, or logistics, such as parental duties. More systematic data collection would allow us to clarify the situation and better assess the need for specific policies in the organizer handbook.

3. We require data to identify biases in how the CMS characterizes excellence.

The following table summarizes data collected from the CRCC report[16].

	Women	Visible Minorities	People with Disabilities	Indigenous
Canada Graduate Scholarships–Master's	62%	20.1%	4.4%	2.3%
NSERC Postgraduate Scholarships	41.6%	27.8%	3.4%	1.8%
NSERC Postdoctoral Fellowships	42.4%	41.6%	-	-
NSERC Discovery Grants	23.9%	23.0%	1.4%	0.6%
Canada Research Chairs	38.6%	21.4%	5.5%	3.2%

Note that the CGSM and the CRC's numbers are for the Tri-Agencies.

In addition, a rapid assessment of the Chairholders database[17] indicates that roughly 21% of CRC's in mathematics are held by women.

The following table presents the frequency of some Canadian awards for women in mathematics since their inception, and its evolution over the past 10 years. The numbers below are not official ones and should not be referred to as they have been compiled based only on the information found on the CMS Awards website[18].

Awards	Women (since beginning)	Women (since 2012)
Fellowship of the CMS [19] (since 2018)	11.8%	11.8%
David Borwein Distinguished Career Award [20] (since 2006)	0%	0%
Graham Wright Award for Distinguished Service [21] (since 1995)	10.3%	20%
Adrien Pouliot Award [22] (since 1995)	14.3%	20%
Excellence in Teaching Award [23] (since 2004)	16.7%	20%
Coxeter James Prize [24] (since 1978)	4.5%	0%
Jeffery-Williams Prize [25] (since 1968)	1.9%	0%
CMS Blair Spearman Doctoral Prize [26] (since 1997)	7.7%	0%
G. de B. Robinson Award [27] (since 1995)	15.4%	27.3%
CRM-Fields/CRM-Fields-PIMS Prize [28] (since 1995)	7.4%	10%

The CMS fellowship was created in 2018 to acknowledge "contributions to the profession and to the Canadian mathematical community" and "to support the advancement of mathematicians to leadership positions within their own organisations and the broader society". We note a significant discrepancy between the rate of women recognized via this fellowship and the rate of women contributing to the CMS board of governors or to the organization of sessions at the CMS meetings.

We note that during the past 10 years, the rate of awards recognizing excellence in mathematics has not increased in half the awards or prizes, namely the David Borwein Distinguished Career Award, the Coxeter James Prize, the Jeffery-Williams Prize, and the CMS Blair Spearman Doctoral Prize. In addition, none of them has been awarded to a woman in the past 10 years.

Even though 30% of math PhD graduates and 42.4% of NSERC PDF recipients are women (among whom a positive proportion of mathematicians), none of them was recognized with a Blair Spearman Doctoral Prize.

In the end, all the numbers are below 21% which is roughly the proportion of women CRCs in mathematics.

The table does not show the Krieger-Nelson prize which has specifically targeted female mathematicians since 1995. We note that this award does not seem to have leveraged the profile of its recipients the way other CMS prizes do have: many recipients have received several awards while only one Krieger-Nelson prize recipient received another Canadian award.

Finally, we note that the CMS does not have any other form of celebration for the contributions to mathematics from other underrepresented groups in the discipline.[29] There is also no explicit mention of contributions to EDI taken into consideration in the selection of the recipients.

As universities and NSERC have made commitments to rectify biases against underrepresented groups, we are left wondering how they reconcile with using the CMS accolades in the evaluation or promotion process.

The following table looks at the representation of women among the ICM speakers[30] affiliated with Canada, in comparison to those affiliated with France and the United States of America. The choice of these two countries is justified by being Fields Medallist leaders together with Canada's main research partner countries.

Country	**Women (from beginning)**	**Women (since 2010)**
Canada (since 1912)	1/46 = 2.18%	1/12 = 8.32%
France (since 1897)	33/387 = 9.04%	14/55 = 25.45%
United States (since 1900)	50/727 = 6.88%	17/106 = 16.04%

Canadian representation at the ICM has been subject to gender imbalance, far more than have France and the USA. We note one Canadian female speaker at the ICM since 1912. This number can grow to 3 by allowing consideration of dual citizenships.

The next International Congress of Mathematicians will take place this summer in Saint Petersburg, Russia. Because of Russia's list of human rights abuses (political prisoners include a student mathematician, repression of opponents, including students and faculty, discrimination of LGBT people, etc), mathematicians around the world have called for a boycott[31] of the event. At the very least, the CMS will need to publicly acknowledge these valid concerns raised by the mathematical community about the situation in Russia in relation to ICM 2022.

4. **We need data to assess whether mathematical spaces are welcoming, and safe for all participants.**

According to a 2019 Statistics Canada survey on students' experiences of discrimination based on gender, gender identity or sexual orientation at post-secondary schools[32], 20% of women students experienced discrimination, versus 13% of their male colleagues. Discrimination was also more common for LGBTQ+ students who reported twice the rate of heterosexual students, at 31% versus 15%.

There is testimonial evidence that math students and math conference participants have upsetting or distressing experiences. However, there is limited quantitative data available in the context of the CMS formalized. In November 2018, the CMS officialised its Code of Conduct[33] and included it in the registration process for its meetings as of December 2021. It is however not clear whether the code has any real substance, as the number of incidents is not recorded. Data about STEM more generally indicates a need for action. To understand if any initiative to make math spaces more welcoming and more safe can be effective, we will need to collect data specific to our community.

Conclusion

There is limited information regarding the status of underrepresented groups in the Canadian mathematical community. The current information gathered shows clear disparity between the rate of participation and the rate of recognition for women in mathematics. We can only assume a similar phenomenon is happening for other equity seeking groups. Only the regular collection of self-identification data will allow us to monitor the diversity of participants and to design new measures that achieve greater equity, diversity, and inclusion. Currently, our Society seems behind common practices that our funding agencies, our universities, and our international partners have already put in place to partially compensate biases against underrepresented groups.

This year, the CMS is launching an inaugural EDI survey to get an overview of the diversity of Canadian mathematicians and to understand the experience of underrepresented groups in mathematical spaces. The relevance of this survey depends on a large buy-in, so we hope you will participate and will encourage all of your mathematical contacts to do so as well.

Notes

[1] CMS Terms of Reference Standing Committees and Editorial Boards.
https://www2.cms.math.ca/Docs/Terms/terms2020-07.pdf

[2] Speech of Dr. Mona Nemer, Chief Science Advisor of Canada, at the Gender Summit, Montréal, Québec (November 7, 2017).
https://www.ic.gc.ca/eic/site/063.nsf/eng/h_97755.html

[3] 2019 Addendum to the 2006 Canadian Human Rights Settlement Agreement.
https://www.chairs-chaires.gc.ca/program-programme/equity-equite/2019_addendum-eng.aspx

[4] Table 10, Canada Research Chairs Program Statistics.
https://www.chairs-chaires.gc.ca/about_us-a_notre_sujet/statistics-statistiques-eng.aspx

[5] Canada Research Chairs Administration Guide
https://www.chairs-chaires.gc.ca/program-programme/admin_guide-eng.aspx#consequences

[6] Table 4, Canada Research Chairs Program Statistics:
https://www.chairs-chaires.gc.ca/about_us-a_notre_sujet/statistics-statistiques-eng.aspx

[7] Self-identification data collection in support of EDI.
https://www.ic.gc.ca/eic/site/063.nsf/eng/h_97615.html

[8] NSERC Framework on Equity, Diversity and Inclusion.
https://www.nserc-crsng.gc.ca/NSERC-CRSNG/EDI-EDI/framework_cadre-de-reference_eng.asp

[9] Canada Research Coordinating Committee 2018-19 Progress Report: Strengthening Canadian Research.
https://www.canada.ca/en/research-coordinating-committee/services/publications/progress-reports/2018-2019/annex-1-self-identification-data-collection.html

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https://www150.statcan.gc.ca/n1/pub/89-503-x/2010001/article/11475-eng.htm#a2
[11] Persistence and Representation of Women in STEM programs – Stats Canada.
https://www150.statcan.gc.ca/n1/pub/75-006-x/2019001/article/00006-eng.html

[12] Women, Minorities, and Persons with Disabilities in Science and Engineering – NSF report:
https://ncses.nsf.gov/pubs/nsf21321/report/field-of-degree-women#mathematics-and-statistics

[13] https://cms.math.ca/about-the-cms/governance/

[14] https://cms.math.ca/publications/

[15] https://winter21.cms.math.ca/

[16] Canada Research Coordinating Committee 2020-2021 progress report.
https://www.canada.ca/en/research-coordinating-committee/services/publications/progress-reports/2020-2021.html

[17] NSERC's Awards Database
https://www.nserc-crsng.gc.ca/ase-oro/index_eng.asp

[18] https://cms.math.ca/awards/

[19] "For excellent contributions to mathematical research, teaching, or exposition; as well as having distinguished themselves in service to Canada's mathematical community."

[20] "To recognize individuals who have made exceptional, broad, and continued contributions to Canadian mathematics."

[21] "To recognize individuals who have made sustained and significant contributions to the Canadian mathematical community and, in particular, to the Canadian Mathematical Society."

[22] "To recognize individuals or teams of individuals who have made significant and sustained contributions to mathematics education in Canada."

[23] "To recognize sustained and distinguished contributions in teaching at the post-secondary undergraduate level at a Canadian institution."

[24] "To recognize young mathematicians who have made outstanding contributions to mathematical research."

[25] "To recognize mathematicians who have made outstanding contributions to mathematical research."

[26] "To recognize outstanding performance by a doctoral student who graduated from a Canadian university in the preceding year."

[27] "To recognize the publication of excellent papers in the CJM and CMB and to encourage the submission of the highest quality papers to these journals."
We count the number of articles (co)-authored.

[28] http://www.fields.utoronto.ca/honours-and-fellowships/crm-fields-pims-prize

[29] Elbert Frank Cox was the first African American to receive a PhD in mathematics co-supervised by Lloyd Williams, co-founder of the CMS.
https://cms.math.ca/about-the-cms/inclusive-mathematics/

[30] Plenary and Invited Speakers of the International Congress of Mathematicians (ICM)
https://zenodo.org/record/1976747#.YdlyfyxlBpQ
Speakers with multiple known citizenships are not counted.

[31] Boycott ICM 2022 in Russia.

http://www.icm2022boycott.org/

[32] Students' experiences of discrimination based on gender, gender identity or sexual orientation at postsecondary schools in the Canadian provinces, 2019:
https://www150.statcan.gc.ca/n1/pub/85-005-x/2020001/article/00001-eng.htm

[33] CMS Code of Conduct:
https://cms.math.ca/wp-content/uploads/2020/02/CMS-Code-of-Conduct-Jan-2019.pdf

Nominations of individuals or teams of individuals who have made significant and sustained contributions to mathematics education in Canada are solicited. Such contributions are to be interpreted in the broadest possible sense and might include: community outreach programs, the development of a new program in either an academic or industrial setting, publicizing mathematics so as to make mathematics accessible to the general public, developing mathematics displays, establishing and supporting mathematics conferences and competitions for students, etc.

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity or sexual orientation.

Nominations must be received by the CMS Office **no later than April 30, 2022**.

Please submit your nomination electronically, preferably in PDF format, to apaward@cms.math.ca.

Nomination requirements

- Include contact information for both nominee and nominator.
- Describe the nominated individual's or team's sustained contributions to mathematics education. This description should provide some indication of the time period over which these activities have been undertaken and some evidence of the success of these contributions. This information must not exceed four pages.
- Two letters of support from individuals other than the nominator should be included with the nomination.
- Curricula vitae should not be submitted since the information from them relevant to contributions to mathematics education should be included in the nomination form and the other documents mentioned above.
- If nomination was made in the previous year, please indicate this.
- Members of the CMS Education Committee will not be considered for the award during their tenure on the committee.

Renewals

Individuals who made a nomination last year can renew this nomination by simply indicating their wish to do so by the deadline date. In this case, only updating materials need be provided as the original has been retained.

2021 Adrien Pouliot Award Recipient

Joseph Khoury
University of Ottawa

Dr. Khoury is the most recent recipient of the award. Please read the Media Release. For a list of past recipients and to read their citations, please visit the official Adrien Pouliot Award page.

In 1995, the Society established this award to recognize individuals who have made sustained and significant contributions to the Canadian mathematical community and, in particular, to the Canadian Mathematical Society. The award was renamed in 2008, in recognition of Graham Wright's 30 years of service to the Society as the Executive Director and Secretary.

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity or sexual orientation.

Nominations should include a reasonably detailed rationale including three support letters and be submitted **by March 31, 2022**.

All documentation should be submitted electronically, preferably in PDF format, by the appropriate deadline, to gwaward@cms.math.ca.

Renewals

Individuals who made a nomination last year can renew this nomination by simply indicating their wish to do so by the deadline date. In this case, only updating materials need be provided as the original has been retained.

2021 Graham Wright Award for Distinguished Service Recipient

Kseniya Garaschuk
University of the Fraser Valley

Dr. Garaschuk is the most recent recipient of the award. Please read the Media Release. For a list of past recipients and to read their citations, please visit the official Graham Wright Award page.

Jessica Wallace (CMS)

Events and meetings organizer

Happy New Year to all! 600 mathematicians were welcomed to the online platform for the 2021 CMS Winter Meeting from December 2-7. This was the fourth online meeting the CMS has hosted. Participants attended over 30 scientific sessions; four plenary lectures; two prize lectures and one public lecture over the course of the meeting. The plenary lecturers were Richard Hoshino (Northeastern University); Doina Precup (McGilll University); Rediet Abebe (University of California Berkeley and Dimitris Koukoulopoulos (University of Montreal)

CMS continued to offer three-hour mini courses, which took place on Thursday, December 2. There were three mini courses offered, which included: a free course for an Introduction to Programming in Maple; and two courses: an introduction to self-similarity and an introduction of modelling for infectious diseases with vaccination

At the end of Thursday, CMS hosted a Public Lecture featuring Caroline Colijn (Simon Fraser University) who gave a talk titled: Mathematics and the pandemic: from populations to individuals

The official conference opened on Friday afternoon with an opening and welcome given by CMS President, Javad Mashreghi.

The CMS Student Committee (STUDC) hosted a student social giving students a chance to network and interact in a non-academic setting in a relaxed atmosphere buoyed by icebreaker activities. Mathematically themed games were also played.

The meeting also included a panel discussion on Tuesday, December 7, which was organized by Nicholas Fillion and Martiza Branker. The panel discussion was focused on some snapshots of Women in Mathematical History.

During the 2021 Winter Meeting, attendees were able to network with peers and like-minded individuals on the online community boards and in our networking sessions.

The customary awards banquet was not possible,, but the CMS recognized our 2021 prize winners during the opening remarks and prize winners also prepared a lecture. Those recipients include: Joseph Khoury (University of Ottawa) recipient of the Adrien-Pouliot Prize, Luke Postle (University of Waterloo) recipient of the Coxeter-James Prize who gave a lecture on On Hadwiger's Conjecture, Christopher Liaw (University of Toronto) recipient of the CMS Blair Spearman Doctoral Prize who gave a lecture on Optimal anytime regret with two experts, and Kseniya Garashuk (University of the Fraser Valley) recipient of the Graham Wright Award.

The AARMS – CMS Student Poster Awards were also presented during the online event. The winners were AARMS Prize: Benoit Corsini (McGill University) with Local minimum spanning tree optimization; CMS Student Committee Prize: Tian Wang (University of Illinois Chicago) with On the Effective Version of Serre's Open Image Theorem; and CMS President's Prize: Gavin Orok (Waterloo University) with Patterns in Higher-Dimensional Electron Domain Geometries

Putting on such a meeting requires much dedication and hard work and would not be possible without the efforts of the Scientific Organizing Committee, the Scientific Directors, the Session Organizers, and the CMS staff. The Scientific Directors, Nils Bruin (Simon Fraser University), and Nilima Nigam (Simon Fraser University) worked tirelessly on a large scientific program. Their dedication and flexibility helped to make this 2021 Winter Meeting one to remember.

The CMS would like to acknowledge financial support from MITACS, PIMS, FIELDS, CRM, AARMS, and MapleSoft.

2021 CMS Competitions Report

Jessica Wallace (CMS)
Events and Meetings Organizer

Happy New Year! 2021 was quite the year for CMS! Due to the pandemic, CMS had to make a few difficult decisions to make in regards to the competitions. Our national teams continued to compete online for the European Girls Mathematical Olympiad (EGMO) and International Mathematical Olympiad (IMO). We had another great year with the Canadian Open Mathematical Competition (COMC), and Canadian Mathematical Gray Jay Competition (CMGC), which aims at younger students wishing to compete in a fall math competition.

European Girls' Mathematical Olympiad

European Girls' Mathematical Olympiad was slated to take place in Kutaisi, Georgia from April 9 to 15, but quickly pivoted to a virtual competition again. Mariya Sardarli (Leader) and Elnaz Hessami Pilehrood (Deputy Leader) trained our 2021 team: Alison Tsypin, Jennifer Wang, Yifan Tang, and Kaylee Ji. Anna Krokhine (observer with Deputy) also supported the training process

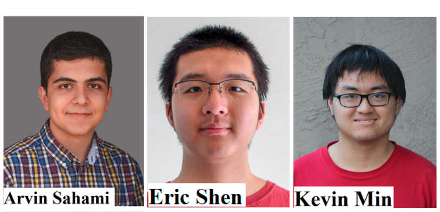
What a momentous occasion it was! Kaylee Ji became the first Canadian female student to win a gold medal at EGMO. Executive Director of CMS, Termeh Kousha was excited to hear the news. "This is a great victory for the Canadian community, for girls in math and STEM, and for the CMS."

Dorette Pronk who has been heavily involved with EGMO's Canadian Team for many years was so pleased with the results :

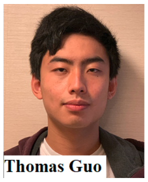
> *I am greatly impressed by the hard work put in by the team leaders, the students and all the trainers who contributed their time and skills. Although the competition is written by each student individually, the training and preparation is truly team work. I am very pleased with the first gold medal for Canada's EGMO team, and I look forward to seeing what each of these girls will do as she continues to pursue her dreams and explores her talents. I hope that they have all experienced that they are a valued member of the Canadian and world-wide math community!*

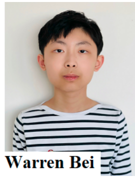
See the EGMO media release for additional information.

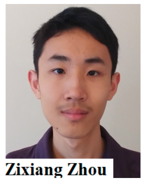
International Mathematical Olympiad



The IMO was scheduled to take place in St. Petersburg, Russian Federation, but eventually was decided to be held virtually. The team members this year were Eric Shen, Thomas Guo, Zixiang (Peter) Zhou, Kevin Min, Arvin Sahami and Warren Bei. The IMO regulations determined that all students write from an IMO testing location. The University of Waterloo graciously allowed CMS and the IMO team to use their facilities to write the competition. This year's team was coached by leaders and previous IMO medal winners, Alex Song (Citadel LLC) and Dani Spivak (University of Toronto).







The opening ceremony for the IMO took place online on July 18th and the contest was held from July 19th to 20th at each country's writing centres. Due to COVID restrictions, some CMS friends, including Robert Garbary, helped to invigilate the competition. Big congrats to Eric Shen, Thomas Guo and Zixiang Zhou who took home gold; Kevin Min, Arvin Sahami and Warren Bei who took home silver!!

The Co-Chair of IMO committee, James Rickards was very pleased with the results: "The 2021 IMO was a great success for Canada. We received 3 gold medals for only the third time, and added 3 silver medals to the haul. The 5th place result matches the 2012 team for highest country ranking."

See the IMO media release and IMO report for more information.

Canadian Open Mathematics Challenge

This year, the CMS formed new partnerships with Asian Math Alliance (AMA): Singapore; Magic Square: Hong Kong, Macau; MathsRFun: Australia, New Zealand; and Transitions Lab Preparatory School: India. The organizers were delighted to take part in a Canadian competition, and the students were just as elated, as some had never competed internationally.

As the pandemic is still going on, it proved to be another difficult year for teachers across the country. The schools who did participate had the opportunity to administer the COMC exam in-person. Those who were unable to participate with their school, had the opportunity to register with university writing centres, which included online and some in-person. Overall, there were 5197 exams purchased, which included those schools who received it digitally, and 275 who wrote online. Marking is completed for COMC and we look forward to announcing the results soon.

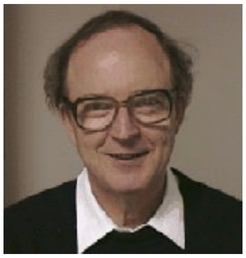
Canadian Mathematical Gray Jay Competition

The new Canadian Mathematical Gray Jay Competition was aimed at students in grades 5-8 but any student was welcome to compete. CMS formed a Gray Jay Committee with mathematicians from across Canada to create an exam with 15 multiple-choice questions. Overall, Gray Jay had 2793 exams purchased across Canada and internationally. 1970 of those were online and 823 print exams.

Girls Initiative and Closing the Gap

CMS would like to give a big thank you to the Royal Bank of Canada, who supported and funded the Girls Initiative. The Girls Initiative purpose is to encourage girls to confidently register and take part in mathematical competitions. We were able to provide a limited number of free registrations to girls wishing to participate in COMC and Gray Jay. We saw an increase in girl participation because of the Girls Initiative.

John Grant McLoughlin (University of New Brunswick)



Bruce had a profound influence, not only on me, but on many of the people he came in contact with. He will be missed.

We only met in person a handful of times and he always made me feel like a friend and a valued colleague.

Bruce was always kind to me, and he challenged me to do more. I think I'll consider my mathematical career a success if I can measure my positive influence in a fraction of Bruce's positive influence.

I always found him to be calm, and to have a calming presence. I can't recall him being upset, perhaps sometimes slightly exasperated or a bit frustrated with some problem or other, but somehow he always seemed to see them in perspective. I don't know this, but I suspect he asked himself if he would even remember the problem after some time had passed, and decided that he would not, and therefore it was really not that important. It also helped that he had a good sense of humour.

His joy of life and of mathematics clearly shines through whenever one encounters him.

Bruce L.R. Shawyer (12 May 1937 – 21 November 2021) passed peacefully at St. Luke's Homes, St. John's, after a sudden illness. The above quotes from contributors to this piece speak to the person. An effort is made here to offer a tribute to Bruce Shawyer through broadening awareness of his contributions to the mathematical community while offering a wider lens for viewing his life as a mathematician and beyond. Many of the voices appearing in this piece are those of long-time colleagues at Memorial University of Newfoundland (MUN).

As a child in Kirkcaldy, Scotland, during WWII, he discovered a love for Mars Bars, provided by his grandfather, a naval blacksmith who had access to chocolate rations. He was the first in his family to attend university. At the University of St. Andrews, his mentor David Borwein encouraged his interest in mathematics, and Bruce received his PhD in 1963. He taught at the University of Nottingham from 1962-1966, where he met his beloved wife Jo. In 1966 they moved to Canada for a six month visit that extended 55 years. Bruce taught at the University of Western Ontario (1966-1985) and Memorial University (1985-2002) prior to being named a Professor Emeritus of Mathematics at MUN in 2004.

Bruce Watson had an unusual take on Bruce Shawyer's experience in Canada, as reflected in his words here:

> *Bruce moved to St. John's in 1985 to take up the position of head of the Department of Mathematics and Statistics at Memorial University. But I had known him since the 1966-67 academic year. Soon after arriving from the UK as a new faculty member at Western University, Bruce was assigned to teach the complex half of the third-year honours course Real and Complex Analysis. I was an undergraduate student in that class. Two years later I became a graduate student of David Borwein. Bruce had also been a student of David's at St. Andrew's in Scotland. Hence, we were interested in the same sorts of problems.*
>
> *After I was hired by Memorial, Bruce visited the university. He and his wife, Jo, liked the city and university and he later applied for the headship position. During his time at Memorial, besides allowing me to bounce my ideas off him, we collaborated on two books. The first was an Oxford publication entitled Borel's Methods of Summability: Theory and Applications. Bruce's early research work had been on problems in Borel's methods. The other book was volume XI in the CMS's ATOM series called Problems for Junior Mathematics Leagues.*
>
> *Bruce's contributions to mathematics education in Newfoundland and Labrador were extensive. He started the very successful Senior High Math League in St. John's area high schools and later, via the internet, it was expanded to other interested schools in the province. He encouraged me to extend the math league idea to the junior high level when I was acting head in 2000-01. This led to the ATOM book.*

Years earlier in 1987, Bruce Shawyer and Rita Janes established the Newfoundland and Labrador Teachers' Association (NLTA) Senior Math League in St. John's. This league brought together various schools in a common setting, such as a host school or the MUN campus, usually four times annually. The league extended beyond the overpass to regional gatherings across Newfoundland and Labrador. Bruce was a regular attendee at the St. John's games for many years along with Peter Booth as representatives of the math department. Volumes III, VI, and VIII of the ATOM series are *Problems from Mathematics Leagues I, II and III* respectively. These publications along with *Shaking Hands in Corner Brook* offer collections of math league problems prepared by Bruce Shawyer, Peter Booth, and John Grant McLoughlin.

The building of relationship with students and colleagues was significant. David Pike adds, "When I was a junior member of my department, Bruce's mentorship and advice were always welcome and sage. He was particularly fond of working with undergraduate students and helping to provide them with opportunities, including the annual invitational to his splendid backyard garden."

Bruce was a mentor who touched the lives of many people. Neil and Rebecca McKay are among the math league participants who have gone on to pursue academic careers in mathematics. "Dr. Shawyer largely contributed to both of us ending up in mathematics." As a participant in the *Women in Science and Engineering (WISE)* program, Bruce showed Rebecca the beauty of mathematics (and LaTeX!). Neil states, "Bruce's biggest impact was through the NLTA Senior Math League. The Math League introduced me to collaborative mathematics and to sharing mathematics in a room full of strangers, which I now do professionally." One of the noticeable hallmarks of the league was the high level of participation by women, as supported by the collaborative model with teams of four at tables doing mathematics. The fact that the league continues to flourish 35 years after its inception speaks to the legacy of Bruce's efforts in building a community for mathematical problem solving.

Bruce served as Editor-in-Chief for *Crux Mathematicorum*. Shawn Godin comments on his own experience upon joining Crux to edit the *Mathematical Mayhem* section: "I was intimidated. I had enjoyed *Crux* for years, and was proud when I was able to solve a problem or two from an issue, but I didn't feel qualified to work on it. Bruce was a wonderful mentor, he taught me LaTeX, gave me praise for some of my work and gave me feedback that allowed me to grow without feeling that I was out of place." Later this year a special issue of *Crux* will be dedicated to Bruce Shawyer. The call for contributions is forthcoming in the next month.

Exemplary mentorship was an aspect of his leadership that showed in other ways, as expressed here by Eddy Campbell.

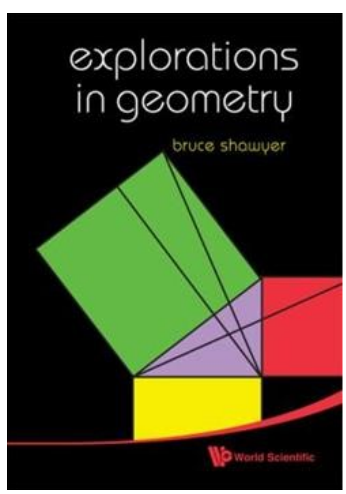
> *In my experience, he was balanced and fair in his work as an administrator. A good citizen, without whom no department, faculty or university can run well or aspire to be great. He cared about teaching—this was really obvious in his work for the CMS—and this, too, is essential for any university, and Memorial benefitted a great deal from his passion for teaching, part of why I use the word balanced. Of course, he understood the importance and value of research, this showed in his work as Head in the hires that he oversaw. Service teaching is the bread and butter of mathematics departments everywhere, it helps if our leaders show that they care and work hard to support it. He also helped nurture undergraduates with his life-long commitment to problem-solving and Crux.*

Bruce Shawyer's contributions to mathematics have been recognized throughout his career. These honours include recognition as a Fellow of the Alexander von Humboldt Foundation. The CMS named him the recipient of the Adrien Pouliot Award in 1996 for his contributions to mathematical education. Recently in 2019 he was named a Fellow of the CMS.

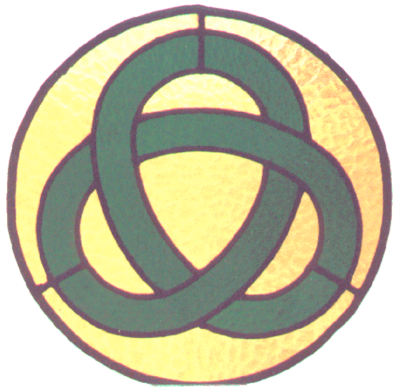
Bruce was a mathematician. His research was in the analytic theory of divergent series. In communications with Jo Shawyer, she wrote:

> *The bottom line is that Bruce enjoyed mathematics every day of his life. And he enjoyed sharing it with others, and demonstrating its excitement to even the most reluctant students. He was particularly fond of geometry and a little sad that it did not have a more prominent place in the curriculum in the years which he taught.*

His publication of a book entitled *explorations of geometry* illustrates his appreciation through a blend of theory and about 200 problems encompassing topics such as basic Euclidean geometry, concurrency and collinearity, constructions, and conic sections. Detailed solutions to problems cover almost 150 pages, thus, making up half of the book. In the preface, Bruce mentions the value of the material to students at secondary school and undergraduate levels with an interest in math competitions. He writes "I have been involved in helping in such events for many years, and still find it such an enjoyable occasion when students are having enjoyment solving mathematical problems." Bruce played an active role in coaching with the *International Mathematical Olympiad* (IMO) and most notably played a critical role in organizing and bringing the IMO to Canada in 1995.



The interests of Bruce Shawyer extended well beyond mathematics. Bruce played the piano his whole life and composed many Scottish and English country dance works. His favorite times in recent years were playing with his bandmates at St. Luke's. His father taught him gardening, and Bruce loved spending time outdoors and hosting garden parties. He also built beautiful things with wood and stained glass.



Bruce actually composed musical pieces for each of my two daughters when they were young in St. John's. Bruce and Jo were such kind people to our family especially when settling into St. John's. Bruce was a mentor as well as being the editor who brought me on board with *Crux* initially to coordinate the book reviews and subsequently to participate with *Mayhem* problem selection and so on. Bruce was also the Chair who vetted me to teach MUN's first year math courses in Labrador Community College in the early 1990's. The opportunity to collaborate with him on books and math leagues added to our professional connections, and visits to his home and the wonderful gardens were always a delight.

An amusing memory concerning Bruce occurred in 1998 in his absence. Bruce and Jo commonly went to the UK in May. Imagine the surprise when a person arrived in the department looking for Bruce having travelled from the UK. This person had come for the CMS Meeting in St. John's. We had to break the news that the Shawyers were in the UK and that he was a year early for the meeting. People really went out of their way to visit Bruce!

Bruce's spirit of hospitality and kindness was further reflected through opening a family home to immigrant families needing a place to stay, to Polish defectors during the Cold war, to Miranda Leather whom he loved like a daughter, and to numerous others who were always welcome at holiday meals. Bruce is loved by his sister Elma MacIntyre (Bill), his wife Jo, his children Janet Rowe (Glen), Andrew Shawyer (Molly), Anna Shawyer, Susanne Shawyer (Tony), granddaughter Amanda Shawyer and Miranda Leather (Chris).

In closing, the words shared by Edgar Goodaire offer further insight into why many of us feel fortunate to have had our journeys cross paths with Bruce Shawyer.

> *I think often of the early days. It is important to note that Bruce was the first Memorial Head of Mathematics/Statistics who was not a native Newfoundlander and natural friend of those who worked for him. There is no doubt that some were skeptical, even anxious, but these feelings did not last for long. I have never met a couple who defined "social" as did Jo and Bruce Shawyer. Almost immediately, they began hosting dinners. I'll bet there was not a member of the department who hadn't been invited over to the house. I was fortunate to have been there on many occasions. The children were chefs and waiters. For some reason, I was usually the designated wine server! Boy, what a great guy. Great person, friend, colleague, leader, citizen.*

Acknowledgments:
Contributions from Peter Booth, Eddy Campbell, Robert Dawson, Shawn Godin, Edgar Goodaire, Neil McKay, Rebecca McKay, David Pike, Jo Shawyer and Bruce Watson are respectfully appreciated.

The editors welcome articles, letters and announcements. Indicate the section chosen for your article, and send it to *CMS Notes* at the appropriate email address indicated above.

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