Submission of Articles

The *Ontario Mathematics Gazette* (*OMG*) is looking for news items, articles, and good ideas that are useful to mathematics teachers and mathematics teacher education. We are seeking submissions, preferably from mathematics teachers K–12 and other mathematics education professionals, that describe innovative and creative approaches to mathematics teaching.

Please keep in mind the following criteria when making submissions to the *OMG*:

- The ideas/activities must be of interest to the readership.
- The ideas/activities must be fresh and innovative.
- The mathematics content must be appropriate for the readership.
- The mathematics content must be accurate.
- The article must be well written and easily understood.
- The article and its ideas must be free of sexual, ethnic, racial, or other bias.
- The article must not have been previously published, nor should it be out for review by other publications.
- The article must be original.

Articles must be word-processed in MS Word, double-spaced with wide margins, not exceeding 10 numbered pages of text, and prepared according to the *Publication Manual of the American Psychological Association, Sixth Edition*. Figures and diagrams should be drawn by computer, if possible, or drawn in black ink in camera-ready form. Embedded images must also be submitted separately in jpeg or tif format. Proof of the photographer's permission is required, and for **photos of students** under the age of 18, the written permission of a **parent or guardian is required**.

You must submit **one complete copy** of your article, embedded with any tables, figures, and captioned photographs or graphics, to the Editor, Stewart Craven, along with **separate files for each of the text, graphics, and/or photographs**. Please e-mail all files to Stewart Craven at **numeratecitizen@mac.com**.

Your name should not appear anywhere in your article, including websites, so that your article can be sent out for blind review. Your name, full mailing address, and e-mail address must be included on a separate sheet. Upon review, you will be notified as to whether your article has been accepted for publication (as is, or pending minor or major revisions) or rejected.

The Editor reserves the right to edit manuscripts prior to publication. Once an article is published, it becomes the property of OAME.

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▲ About the *Ontario Mathematics Gazette*

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Submission of Advertisements

Advertisements for publication in the *Ontario Mathematics Gazette* should be sent to **Robert Sherk** at the above address. Courier is recommended to avoid possible delays. Deadlines for advertisements are January 23 for the March issue, April 1 for the June issue, July 1 for the September issue, and October 1 for the December issue.

Full page advertisements are to be on 8.5" by 11" paper with a minimum of 0.5" margins and single sided. Each advertisement should be camera-ready and colour advertisements should have no bleeds.

Advertising Rates

Advertising Rates are available by telephoning, e-mailing, or writing to the Advertising Manager.

▲ Editor's Message

STEWART CRAVEN, EDITOR



As of June 30th, I will be passing on the editorship of the *Ontario Mathematics Gazette* to Marian Small. With support and encouragement similar to that which I have received over the last two years, she will undoubtedly be very successful. I wish her the very best.

I would like to thank Sue and Dave Hessey, the Executive Directors of OAME; Robert Sherk and the OAME Publications Committee; all columnists and contributors of special features and articles; my associate editors, Anna Dutfield, Shirley Dalrymple, and Tom Steinke; my design and layout expert, Penny Clemens; my article reviewers; and my copy editor and proofreader for ensuring the successful publication of the last eight issues.

My retirement from the *Gazette* will coincide with my retirement from the Toronto District School Board. It seems that a number of endeavours that I have been engaged in are drawing to a close: my role on the steering committee for the Mathematics Education Forum at the Fields Institute; the annual Mathematics Camp—a 22-year tradition that is no longer funded by the Board; my work with OAME going back almost 25 years; and most important, my place inside a classroom, learning with my students.

This next step into retirement will be a big one. I wonder if I can still contribute and how I might do that. Will it be through volunteering at a local community centre to help students with their mathematics? Will it be through writing a book about why learning and doing mathematics is fundamental to being human? Will it be through seeking out the "epiphanies" that led people to become engaged in the world of mathematics, or through supporting teacher education in remote places in Canada or elsewhere in the world? In time, I will find the answer.

What I do hope is that I actively maintain the hundreds of friendships that I have garnered over the past 25 years. I will not disappear. Lastly, I have much to be thankful for—primarily, my health and a family that steadfastly continues to love me and stand by my side. Thank you one and all for being part of my fantastic journey. ▲

▲ President's Message

DAVID ZIMMER, PRESIDENT



Since I began teaching in 1973, I have had the pleasure of meeting with mathematics teachers from every region of Canada. Most of my career as a classroom teacher took place in what is now known as the Peel District School Board. However, my adventures in mathematics publishing led me to the Maritime Provinces and Newfoundland, Quebec, and the West, with occasional side trips to the U.S. and Bhutan.

From my perspective, we have a unique community of math education thinkers and doers in Ontario who share a vision of what effective learning experiences for students ought to look like. From the folks at the Ministry of Education and the Literacy and Numeracy Secretariat to the Ontario Mathematics Coordinators Association and the math coaches and leaders in individual boards of education and schools, we find active and committed members of OAME.

Our membership represents a broad spectrum of interests. OAME is a grassroots organization for math teachers of primary through senior secondary grades and increasingly, from the college and university communities. OAME represents teachers in public, separate, and independent schools.

As an organization, OAME provides resources and activities designed to directly support teachers and students. The *Gazette* and *Abacus* provide ideas that teachers can use right away in their classrooms as well as broader discussions of important issues related to mathematics learning. OAME attracts an average of 1200+ conference goers to our annual conferences, and we intentionally locate them around the province to ensure equity of access. Our Mathematics Leadership Conference attracted over 150 participants in 2010, while the OAME-organized Ontario Mathematics Olympics involves students from virtually all regions of the province in regional play-downs and provincial finals. Our local affiliates also provide district-oriented workshops and activities.

For many years, OAME has provided the environment and opportunity for the kind of collegial collaboration and unrestricted talk that has fostered the development of critical mathematics education leaders and thinkers. More often than not, OAME members have been the nodes from which entire support networks for critical change and the improvement of classroom practices have sprouted. You will find OAME members leading provincial and regional math coaching initiatives; organizing and facilitating provincial institutes and study groups; forming the core of committees that develop and review curriculum; and reaching out to parent communities and post-secondary institutions.

I am proud of my long association with OAME, and I am excited about beginning my term as President. With curriculum revision scheduled to begin in 2012, we have a lot of thinking and doing in our future, and I know that OAME will make a profound contribution to the process. ▲

ABACUS: A COMPILATION OF VOLUME 46



$10 PLUS SHIPPING AND HANDLING

This resource for teachers includes the concepts of addition, subtraction, multiplication, and division of whole numbers and decimals, alternative algorithms, mental math strategies, manipulatives, and links to literature. It will be useful for exploring these aspects of teaching and learning personally or with a team of teachers. Includes one two-coloured bead string.

Order by mail, fax or online:

OAME

or Order online www.oame.on.ca

Do not send cash or cheque. You will be invoiced with shipping and handling costs added.

▲ What's the Problem? Rectangles and Triangles

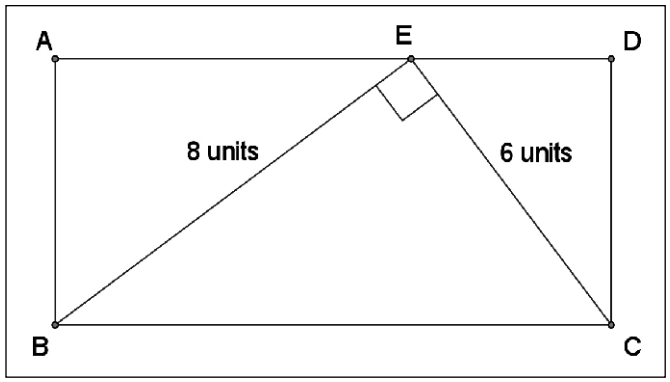
SHAWN GODIN



Shawn is the head of Mathematics, Business and Technology at Cairine Wilson S.S. in Orleans, ON. The web page for this column is ***whats-the-problem.wikispaces.com****.*

Welcome back, problem solvers! Last issue, I left you with the following problem:

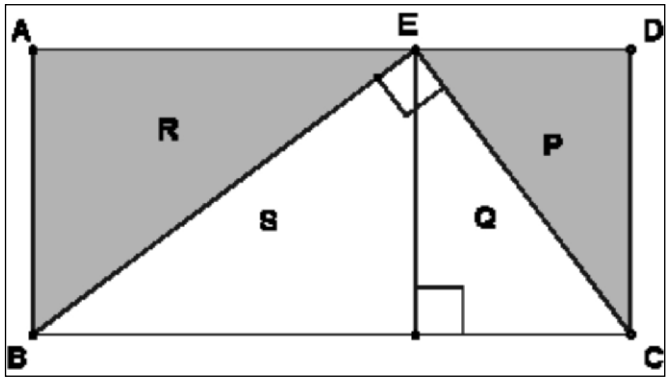
Determine the area of the rectangle ABCD.



This problem appears in the Perimeter, Area, and Volume package from the Continuum and Connections collection for TIP4RM. This, as well as many other great math resources, can be obtained from the Ministry's *Leading Math Success* website, **www.edu.gov.on.ca/eng/studentsuccess/lms**. You can access the TIPS4RM material directly at **www.edu.gov.on.ca/eng/studentsuccess/lms/library.html#TIPS**.

This was one of the first exercises I gave my Grade 9 academic students this semester, and I was impressed by the number of techniques they used to solve the problem. Many of them recognized that a triangle that shares its base and height with a rectangle has half the area, but the original problem asked for multiple solutions.

We can get our answer by throwing the pencil away and dealing directly with the paper. Either paper folding, or a couple of strategic cuts with a pair of scissors, reveals that the part of the rectangle outside of the triangle exactly matches the part that is inside the triangle. That is, triangles labelled P and Q are congruent (although that language doesn't have to be used), as are triangles R and S.



A similar "low tech" solution uses scale drawings. Since the diagram is in the correct proportions but is not the correct size, many of my students used the diagram and rulers to figure out "how long 1 cm was." Using that information, they determined the lengths of the sides of the rectangle and thus, its area.

Others reached into their mathematical toolbox and pulled out a familiar tool—the Pythagorean theorem. Using it, they determined that the length of the base of the rectangle would have to be

$c^2 = 8^2 + 6^2$

$c^2 = 64 + 36$

$c^2 = 100$

$\therefore c = 10$

Now, returning to the triangle, they see that , but also that

And now they have the width of the rectangle and can calculate the area directly.

A beautiful thing about a question like this is that it lends itself nicely to all kinds of "What if?" questions. What if we had another right triangle? What if the triangle had not been right angled? Seeing that some of the techniques will still work while others won't is important. Most important is the relationship between the area of the rectangle and the triangle. At the start, many students could rhyme this relationship off, but by the end of the exercise, a few more understood this relationship and why it must be true.

An interesting sidebar: One group of my students

stated that since we are dealing with right triangles with EB = 8 and EC = 6, the Pythagorean theorem gives BC = 10. Thus, they stated, . They then used the Pythagorean theorem again to get AB (or CD). When I asked how they knew it was true, they said, "It just is," and showed that it worked for other examples.

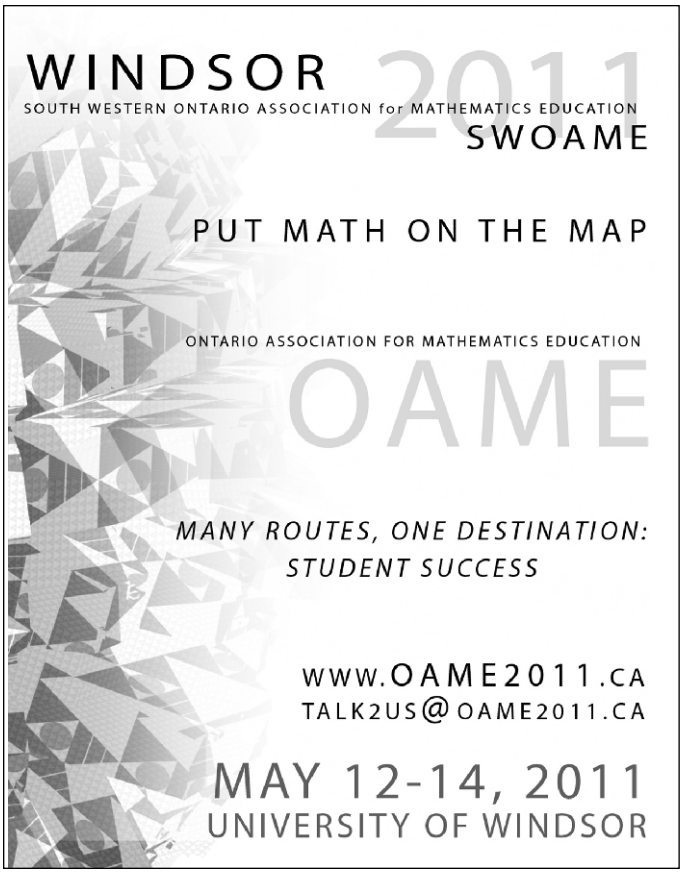
As an extra challenge, have your students show that the relationship discovered above is true in general.

Now, for your homework!

An unmarked ruler is known to be exactly 6 cm in length. It is possible to exactly measure all integer lengths from 1 cm to 6 cm, using only 2 marks, as shown in the diagram at 1 cm and 4 cm, since 2 = 6 – 4, 3 = 4 – 1, and 5 = 6 – 1.

Suppose that an unmarked ruler is known to be exactly 30 cm in length. Find a way of placing 9 or fewer marks on the ruler to be able to exactly measure all integer lengths from 1 cm to 30 cm.

Until next time, happy problem solving!



▲ Data Rocks – A Social Justice Data Fair and an Example of Using Mathematics to Investigate an Issue

YVES SAINT-PIERRE, STATISTICS CANADA
WITH MATERIAL FROM MICHELLE MUNK



Yves Saint-Pierre has worked at Statistics Canada in many capacities since 1990: questionnaire design, data editing and imputation, analysis, and publication. He has been sharing his knowledge with schools since 2002.

I recently attended a workshop at OAME with Michelle Munk, who has organized Social Justice Data Fairs with her students at The Linden School. She writes:

This is the second year of the Social Justice Data Fair at Linden School. It is an opportunity for students to apply their learning in math to understanding social and environmental issues that they are concerned about. As the Ontario Curriculum documents say: "...connecting mathematical ideas to real-world situations through learning activities can enhance students' appreciation of the role of mathematics in human affairs, in areas including health, science, and the environment. Recognizing the importance of mathematics in such areas helps motivate students to learn and also provides a foundation for informed citizenship."

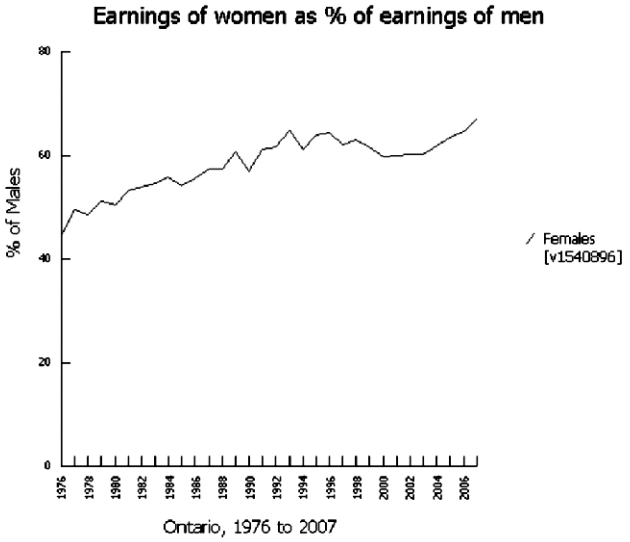
It is an opportunity for students to recognize the larger importance and usefulness of the math they learn in class. For me, the highlight of my math teaching is to walk around the gym and hear the students passionately interpreting their findings and analysis, their graphs, to their classmates and larger community. I hope that they will continue to consider math as a useful tool for understanding and addressing social issues.

Recently, I was also invited to present the StatCan page entitled "Investigating Social Justice Issues" to an Applied Math class at a UNESCO school. The principal was very interested, stating that "especially for applied math… it is difficult to find activities!"

A Case Study: The Wages of Men and Women

There are many issues and data sets to investigate on the page entitled "Investigating Social Justice Issues." (You'll find it by going to **www.statcan.gc.ca/learning resources > Students**.)

One issue that comes to the public's attention from time to time is that of the ratio of women's wages to men's wages. There are numerous ways to investigate this with data from Statistics Canada, and I have put several of them on our web page. The easiest way is to simply take the average earnings of women as a ratio of the average wages of men. I start with CANSIM table 202-0101 (easy to find on the Social Justice page). In Ontario in 2007—the most recent year for which we have data—this ratio is 67.2%. The CANSIM table shows the trend of that ratio between 1976 and 2007:



Source: Statistics Canada, CANSIM table 202-0101. Extracted from E-STAT on April 14, 2010.

I notice that there is another variable in this table: the average earnings of full-year, full-time workers. Hmmm. I wonder why that is? Critical thinking at every step! Perhaps the proportion of women who work full-year, full-time is not the same as that of men? Of course, if someone is working part-time, or only part of the year, their earnings would be lower. We could investigate the prevalence of various schedules among men and women, or we could take it right out of the picture and compare like with like! Well then... In 2007 in Ontario, the ratio of earnings of women to men among those who work full-year, full-time is... 72.9%. Better than the general picture, so varying schedules was a factor that explained *some* of the gap. As was the case above, this ratio has similarly gone up by about 20 percentage points over the 30-year period.

So, if differences in work schedules account for 10 percentage points of the difference in income, I wonder if we can find factors that could account for the rest of the difference, or at least some of it.

We should certainly compare men and women in the same age groups (which, to some degree, would account for years of experience in the workplace), with the same level of education and, if possible, working in the same occupations!

The following table allows us to take some of those factors into consideration.

Here are wages of men and women who worked full-year, full-time. I've selected only a few from the list of 720 occupations detailed.

WAGES OF MEN AND WOMEN WORKING FULL-YEAR, FULL-TIME IN SELECTED OCCUPATIONS, 2005

OCCUPATION	MALE	FEMALE	RATIO
Mathematicians, statisticians, and actuaries	$ 99,606.00	$ 74,144.00	74%
Optometrists	$ 89,543.00	$ 77,592.00	87%
Lawyers and Quebec notaries	$ 161,942.00	$ 106,671.00	66%
Secondary school teachers	$ 60,964.00	$ 55,121.00	90%
Cooks	$ 23,307.00	$ 21,145.00	91%
Light-duty cleaners	$ 28,646.00	$ 21,460.00	75%

Source: Statistics Canada, 2006 Census of Population, Statistics Canada catalogue no. 97-563-XCB2006062

There are other tables that look at level of schooling, age, gender, and status of immigration, or again at occupation, age group, and gender. I will leave it up to you and your students to examine those tables!

Don't hesitate to write or call with comments or questions. We've just released video tutorials on using our *Census at School* project with Tinker Plots, Fathom, and Excel, and we would appreciate your comments. We are also looking at creating more online tutorials. Would you like to see video tutorials about other topics besides *Census at School*? If so, which ones? Let me know! ▲

▲ Call for Manuscripts

The *Ontario Mathematics Gazette* is inviting manuscripts for all grade levels.

Instructions for submission of manuscripts are found on page 1 of any *OMG*.

Contact the Editor for further details.

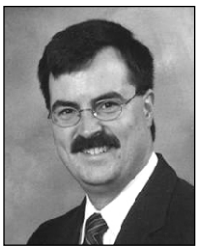
▲ Web 2.0 – Finding the Tools That Will Shape Us

Greg Clarke

Ross Isenegger



Greg Clarke is the Secondary Programme Coordinator for the Simcoe Muskoka CDSB as well as the OAME webmaster. Currently, he is on assignment with the Ministry of Education (CLIPS and GAINS projects). Check out CLIPS at ***oame.on.ca/CLIPS****.*



Ross Isenegger is the Numeracy Coordinator with the Near North DSB. For the past few years, he has been working on the Ministry of Education's CLIPS project. His blog can be found at ***mathfest.blogspot.com****.*

One of the features of the Web 2.0 world is the proliferation of web-based productivity tools. A clear leader in this field is Google, who is working to make all the usual computer tasks occur in the web browser. Many of these new web-based tools are free (often described as "beta") or marketed as part of a "freenium" scheme, where basic functionality is free, but more advanced capabilities are not. The Web 2.0 in Education wiki (**web2educationuk.wetpaint.com**) lists hundreds of free tools, organized under the following categories: Mindmaps, Website Builders, Presentations/Slideshows, Timeline Makers, Comics and Cartoons, Diagrams/Drawing Tools, Webtrail/Web Tours, Photo Fun, Surveys/Polls, Discussion/Debate Tools, Multimedia Scrapbooks, Graphs/Charts/Databases, Mapping Tools, Music Tools, Electronic Books/Writing Tools, Flyer/Brochure Maker, Word Processor/Note Taking Tools, Read Write Think, Thinking Tools, Whiteboards/Collaborative/Communication Tools, Shared Browsing, Iceberg, Avatars, Web 2.0 Research Project, Quizzes, Games & Revision Tools, Video Tools/Screencasting, Streaming Media, Visual Search Engines, Assessment Tools, Learning Support Tools, and Internet Research/Page Clipping Tools. Jane Hart writes a blog entitled "Jane's Pick of the Day" that features a Web 2.0 tool or news about such tools and how they can be used in Education (**janeknight.typepad.com**). See the Centre for Learning and Performance Technologies Learning Tools Zone (**www.c4lpt.co.uk/Directory**) for another comprehensive list of Web 2.0 tools. All that we can hope to do in this article is to whet your appetite by describing a few of these tools.

Our last column gave an introduction to Google Docs (**www.docs.google.com/**) and how to get started, using this online application. The three types of documents most commonly created are word-processing documents, spreadsheets, and presentations. As of this month, a new type of document is available! You can now create a drawing in Google Docs and share it. Another feature that Google Docs has is the ability to create an online form, which can be shared and tabulated, creating not just a document, but a whole survey process from start to finish. You create the initial form (or questionnaire) in a word-processing-like editor and then share it through e-mail or by sending people the URL; finally, results are summarized automatically for you in your Google account, either with graphs or on a Google spreadsheet. For some ideas on how to use Google Docs online forms with your class, check out the blog entry by Jean-Louis Bontron at **jeanbont.wordpress.com/2009/01/20/why-i-like-google-docs-so-much/**.

As you can see, Google Docs is evolving and continuing to add functionality, with more features being added regularly. Here is a sampling of some more advanced features that you may find useful:

- When editing a text document, you can now insert an equation using an Equation Editor (similar in functionality to the standard one found in most office suites). You can also insert a Google Drawing into a Google document (or spreadsheet or presentation). Tables can also be created from the Insert menu; just complete the pop-up box with the details about the size and look of the table, and Google will create it for you.
- Google spreadsheets are very flexible and are a great way to organize information for a team. You can add as many pages to the spreadsheet as necessary, and you can create a form to directly update a specific cell in the spreadsheet. If you have numeric data in the spreadsheet, choose Insert -> Gadget to display it in a more interesting format.
- Google presentations can be created using tools

similar to traditional office-suite presentation packages, including the ability to embed Google drawings. When viewing the Google presentation, if the other collaborators and/or participants are online at the same time, they can be taken through the presentation in sync with the presenter. Also, a chat/discussion pod can be used to assist during the presentation, allowing participants to ask questions or suggest alternative ideas. There is also support for PowerPoint users, allowing them to load or save presentations in that format and/or to save the entire presentation as a PDF file.

- The new Google Drawings come with a number of predefined shapes in the gallery and a set of powerful tools to create and edit your own drawing components. You can copy an entire drawing (or just a portion of it) to the web clipboard, then paste it into any other Google Doc. The web clipboard is tied to your online login, so you can even copy on one computer, login later on a different computer, and then paste from the web clipboard!
- All Google Docs allow you to share with others and collaborate in real time. Depending on the type of document, there are some restrictions on how to access the information simultaneously. For example, in a spreadsheet, each collaborator must be editing a different cell, whereas in a presentation, only one person can edit a textbox at one time. In a Google document, if two people are changing the same piece of text, one of the changes will be committed to the online version, and a notification will pop up on the other person's screen, indicating the conflict. You can see how much more efficient it is to collaborate on a single document in real time and avoid the hassle of e-mailing back and forth the latest version of a file.
- Alternatively, if you just want to share your version of the document, spreadsheet, presentation, or drawing with the world, you can publish it as a web page. This will allow anyone with the URL to view the document, but not make changes to it. (Hence, the viewer does not need to have a Google account). For example, this entire column was created using a Google document, and has been published as a web page with the URL **www.docs.google.com/View?id=d668mvt_7czmsjgcf**. If you visit this web page, you will get the same text you are currently reading, with active links to all the references.
- Finally, another new feature of Google Docs is the ability to upload *any file type* to your online storage area. Google Docs may not be able to edit them, but it gives you a place to store your files in the "cloud," where they can be accessible from any Internet-connected machine and shared with whomever you have given the appropriate permission.
- The presentation component of Google Docs allows you to create slide-based presentations in a fairly traditional way. There are lots of interesting thoughts about how to create more compelling presentations, some of which are bookmarked at **www.delicious.com/rossisen/presentation**. A great starting point is Garr Reynolds' "Presentation Zen" blog (**presentationzen.com**). One of the most valuable sites on the web is **ted.com**, where truly fascinating people give remarkable presentations, often about 20 minutes long, on all kinds of compelling subjects.

A truly fresh look at what a presentation tool can be is offered by **www.prezi.com**. Watch their "Prezi in 3 minutes" video (**prezi.com/learn/getting-started/**), and then have a look at some examples, like Maria H. Andersen's "Playing to Learn Math" (**prezi.com/r2lbb3lfomg5/playing-to-learn-math/**) to get a sense of the possibilities. Even the unconventional user interface, which uses three concentric circles to position, scale, and rotate elements, is diabolically simple. As Marshall McLuhan wrote, "We shape our tools and afterwards, our tools shape us."

Educators have been using concept-mapping software like Inspiration™ and SMART Ideas™ with students to help them understand procedures, concepts, and relationships. Web 2.0 tools that do similar things include **bubbl.us**, **mindomo.com**, and **mindmeister.com**. On these sites, users share their mind maps, which provide exemplars for students and launching points for inquiry. Maria H. Andersen, of "Teaching College Math" blogging fame, has a set of examples at **teachingcollegemath.com/?p=1248**. Her "Using the Internet to Spice Up Your Math Class" mindomo can be used as a self-paced, self-directed workshop for math teachers; it links to all kinds of interesting sites. Incidentally, Maria is a big proponent of Wolfram Alpha and has written about its potential impact on mathematics teaching (see **teachingcollegemath.com/?page_id=1730**).

Traditionally, image editing is one of the most intensive applications to run on a computer. You might be surprised to learn that there are image-editing tools that will run directly in a web browser. One the most interesting is **aviary.com**. Aviary is a flock of

applications including an Image Editor, Phoenix; a visual Effects Editor, Peacock; an image markup tool, Falcon; a Color Editor, Toucan; a Vector Editor, Raven; a screen-capture tool, Talon; and even an audio editor, Myna. Videos are available to introduce each tool and are very helpful. In true Web 2.0 fashion, you can share your work and collaborate with other users. The developers have ambitious plans to include desktop publishing, painting, 3-D modelling, font creation, video editing, and music-generation applications.



Image by Aviary.com. Printed with permission.

One of our favourite Web 2.0 finds was Etherpad, which allowed for real-time, character-by-character collaborative text editing. Imagine an entire class simultaneously creating a review document! Apparently, we weren't the only ones who were impressed. Google acquired the team and has them working on Google Wave, Google's new collaboration platform. Fortunately, the group has posted its code for others to use and advance. One site that uses the Etherpad engine is **meetingwords.com**. All members of a group can work on a text document at the same time. Each contributor's work is coloured differently, and the results can be saved locally. Also available is a Time Slider, which allows you to see how the document has evolved over time. There is also a chat pod, which allows group members to discuss issues, instead of fighting over the cursor and having BackSpace and Delete wars!

There is a cornucopia of online calculators, including basic, scientific, and graphing calculators, as well as Computer Algebra Systems (CAS). Our favourite is the CLIPS calculator, available all the time from the right side of the CLIPS wrapper, or directly from **oame.on.ca/clips/calculator.html**. Click the drop-down menu at the top of the calculator to switch between basic, scientific, graphing, and conversion modes. You can also download the calculator as a .swf for offline use, for use on your own website, or for embedding in a SMART Notebook™ file or gallery. A wiki page devoted to online calculators, plotting utilities, and business calculators can be found at **mathfest.wikispaces.com/Online+Calculators**.

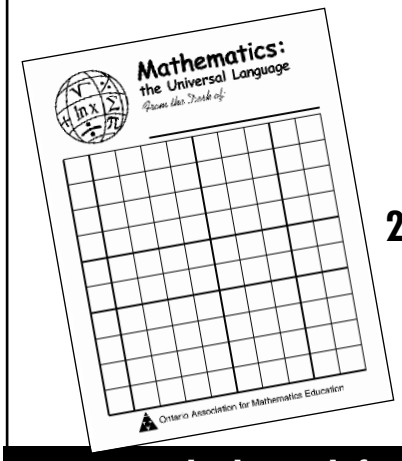
A growing number of math educators are producing screencasts, podcasts, or videos of various mathematical concepts. Some favourites include **youtube.com/user/rodgjohn**, **youtube.com/user/rodcastmath**, and **youtube.com/user/Papapodcasts**. These can then be embedded into blogs and wikis for students. Each of these channels supports an RSS feed so that you can be notified via your Google Reader of any new content.

And we haven't even mentioned some very fun and expressive Web 2.0 tools like Voki, Kerpoof, Yack Pack, Animoto, Glogster, Ning, Twitter, DimDim, SurveyMonkey, or Voicethread! There is a whole world of interesting, powerful, and increasingly mobile tools for you to discover.

This brings us to the end of our Introduction to Web 2.0. We hope that you have found an entry point into the community of creative educators who are blogging, constructing wikis and podcasts, and tweeting about how they are harnessing these tools to engage and motivate learners.

See you online! ▲

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▲ Technology Corner — Upgrade Your TI Technology

MARY BOURASSA



Mary has been teaching mathematics and computer science for the past 15 years. Currently at West Carleton Secondary School in Ottawa, she is a strong advocate of the appropriate use of technology in the classroom. She has presented workshops internationally, has been involved in authoring high school mathematics textbooks, is a past Vice-President of OAME, and is Past-President of COMA. An award-winning teacher, Mary continually strives to learn new and better ways of helping students learn and love mathematics.

TI recently released new operating systems for their TI-Nspire™, TI-Nspire CAS™, and TI-84 Plus™ graphing technology. What follows are highlights of the new features. Please go to **www.education.ti.com** to download the latest OS and full documentation.

One of the most notable improvements of TI-84 Plus (Version 2.53) is MathPrint. Often referred to as "pretty print," this allows you to see mathematical expressions, especially fractions, the way you would write them. A few examples are shown in figures 1–3.



Figure 1

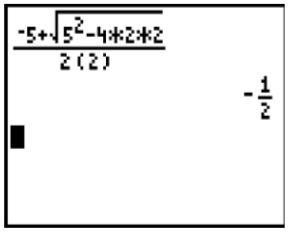


Figure 2

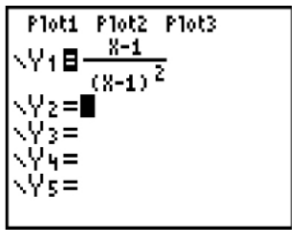


Figure 3

Access "MathPrint" mode through the second screen in the MODE menu. (See Figures 4 and 5.) You will notice other options have been added to the MODE menu, including the ability to turn diagnostics off and on. When set to ON, the r and r^2 values will be displayed when regressions are performed. Previously, this command was available only through the catalogue.



Figure 4

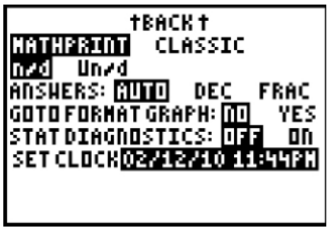


Figure 5

You can scroll up through the History on the home page and copy previous calculations to a new line.

You can now output fractions in improper or mixed form. (More on this shortly.) Fractions are also supported when working with tables and lists.

There are shortcuts to access fraction, function, matrix, and y-variable menus (see Figures 6–10). Use ALPHA-F1 to ALPHA-F4 respectively, to gain quick access to these commands from any screen that has an input area.

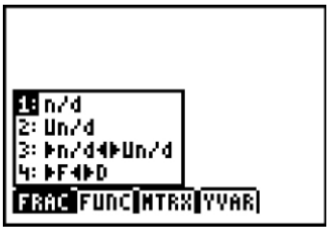


Figure 6



Figure 7

1. n/d – Fraction template
2. Un/d – Mixed Number template
3. >n/d< >Un/d – Improper Fraction to Mixed Number
4. >F< >D – Fraction to Decimal toggle

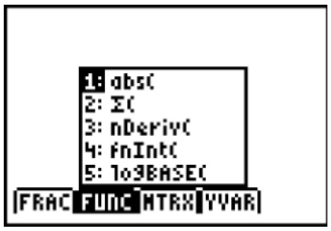


Figure 8

1. Absolute Value template
2. Summation template (new!)
3. Numerical Derivative
4. Numerical Integration
5. Log Base *n* (new!)

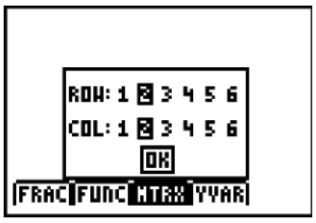


Figure 9

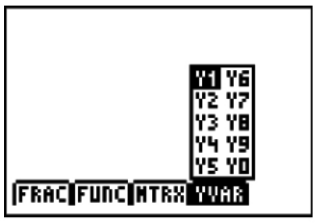


Figure 10

You can change the increment of *x*-values in a table by pressing "+" in the TABLE view (see Figures 11–13).

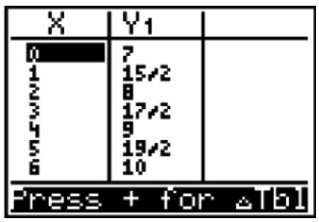


Figure 11

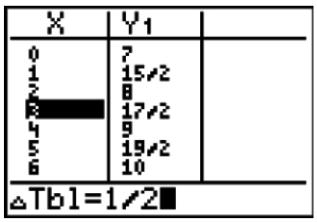


Figure 12

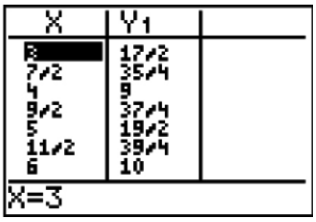


Figure 13

There are new ZOOM features (see Figure 14), as well as a ΔX setting in WINDOW (see Figure 15), a new random feature (see Figure 16), and a new remainder feature (see Figure 17).



Figure 14

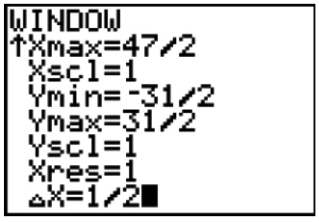


Figure 15

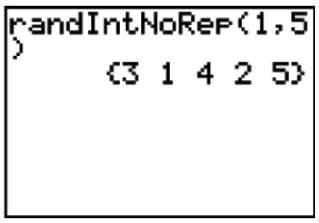


Figure 16

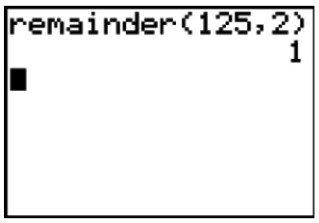


Figure 17

And don't forget to upgrade the OS on your copy of TI-SmartView, too!



Figure 18

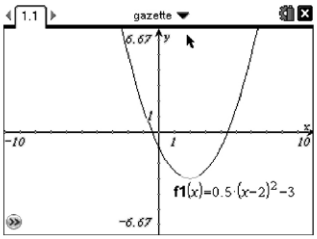
Version 2.0 of TI-Nspire/TI-Nspire CAS represents a big change. There is now a touchpad! This means that navigating is much easier, and there are now many more clickable areas. For example, you can now move between pages, using the touchpad.

The keypad has a new layout; the CAS device appears as shown in Figure 18. The entire keypad is also removable (as was always the case for TI-Nspire).

- The alpha keys are now on the bottom portion of the device.
- The centre of the clickpad is a touchpad, just like on a laptop.
- The Home screen has been redesigned. This is what you will see each time you turn the handheld on, so students will all have a common starting point. All document management is in the right-hand column.
- A scratchpad has been added for quick calculations or graphs that you don't want as part of your document (although you can save the scratchpad to your document).
- The same types of pages exist, but graphs and geometry applications have been separated so that you have the appropriate settings for whichever one you need to use.
- There is quick access to settings from the Home screen.
- Trig functionality has been grouped under the Trig key.
- The settings/close document icons have been added to the top right of each screen:

A lot of new functionality has been added. Here are some of the highlights:

- You can now group and ungroup pages (Page Layout > Group). Grouping two consecutive pages is shown in Figures 19–21.



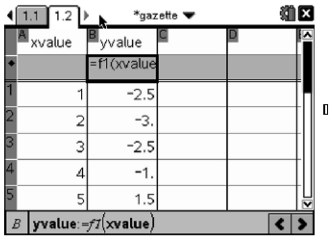


Figure 19 *Figure 20*

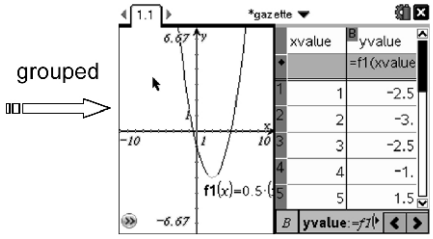
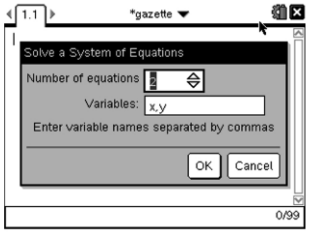


Figure 21

- Solving a system of equations is now a command in the Algebra menu of a Calculator page (see Figures 22–23).



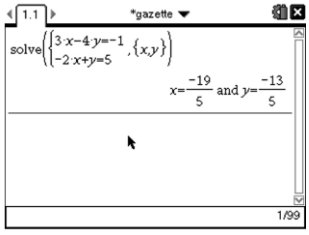


Figure 22 *Figure 23*

- There is an Analyze Graph menu available from a Graph page, which helps find the location of key points (see Figure 24).

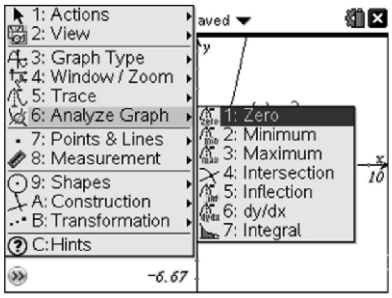


Figure 24

- You can now enter a Math Box on a Notes page. It will be dynamically linked to other Math Boxes in Notes and in any other applications in which the function was referenced.
- You can request input from the user when writing programs using the "Text," "Request," and RequestStr" commands.
- Multiple box plots can be plotted in one Data & Statistics application, based on data in different lists and/or columns in Lists & Spreadsheets.

The TI-Nspire computer software has many new features. The layout has been changed, as shown in Figure 25. Notice the tabs and panels. This is shown in Handheld mode at 150%, and you can zoom to 200%. You can have multiple files open at the same time. The left panel has a built-in explorer for the easy transfer of files between the handheld and a computer. With the Teacher Edition of the software, you can also have the TI-SmartView emulator in the left panel. Notice also that the icons more clearly show what they are representing.

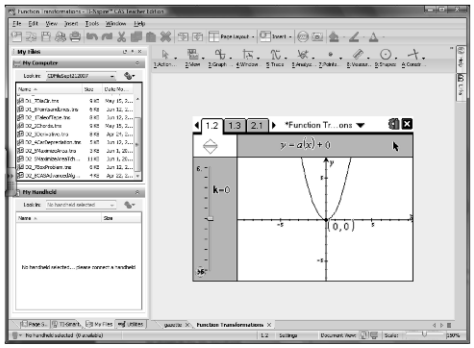
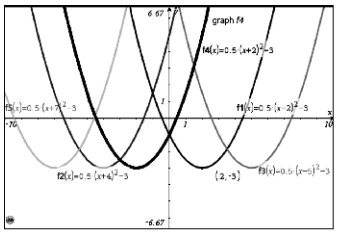


Figure 25

Colour has been added to Graphs, Geometry, Data & Statistics, and Lists & Spreadsheets pages (see Figures 26–27).



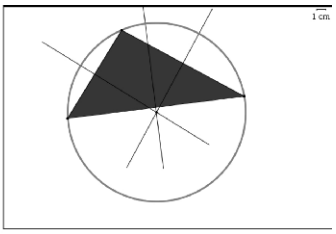


Figure 26 *Figure 27*

You can now pin objects on a Geometry page so that the user cannot move them. You can also group objects on Graphs and Geometry pages. The Teacher Edition of the software also allows you to make documents "Read Only."

In closing, I wanted to mention that there are Google Groups for TI-84 users (**www.groups.google.com/group/ti84plus/**) and for TI-Nspire users (**www.groups.google.com.au/group/tinspire**). Enjoy exploring all the new features! ▲

▲ OAME/NCTM Report June 2010

LAURIE MOHER



Laurie is an Instructional Coach Facilitator for Literacy and Numeracy (JK–8) with the Kawartha Pine Ridge DSB. She has served on the Board of Directors of OAME for 12 years.

What's New at NCTM?

NCTM recently released its 72nd yearbook entitled *Mathematics Curriculum: Issues, Trends, and Future Directions*. The contents of this yearbook have been divided into the following sections:

I. Curriculum Matters: Looking Back, Looking Forward

II. The Intended Curriculum

III. The Written Curriculum; Curriculum Development; Selection of Textbooks

IV. The Implemented Curriculum

V. Impact of Curriculum Materials on Students' and Teachers' Learning

The full table of contents, which outlines the individual chapters organized under the above headings, can be viewed through the online store. NCTM's 72nd yearbook, or individual chapters from the yearbook, can be purchased from this site.

April was Mathematics Awareness Month. To celebrate this, NCTM compiled a variety of online resources around the theme, "Mathematics and Sports." In this section, activities organized under the categories of High School, Middle School, and Elementary School can be found.

Early Learning is an exciting topic in Ontario right now as the Ministry of Education and boards across the province are about to embark on all-day learning for Kindergarten students in 580 sites this Fall. Anyone interested in Early Learning might want to take a look at

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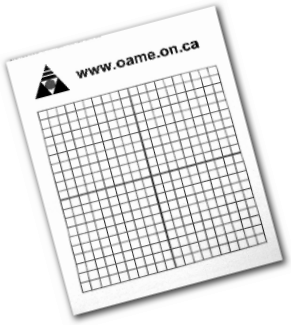
Hank Kepner's February President's Message entitled "A Missed Opportunity: Mathematics in Early Childhood." In this message, Kepner highlights the National Research Council (NRC) report, *Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity*, which was recently released. The report is available for purchase at **www.nap.edu/catalog.php?record_id=12519#description**.

Current information about full-day Early Learning in Ontario is available at **www.cal2.edu.gov.on.ca**, and the draft curriculum for all-day Kindergarten is available at **www.edu.gov.on.ca /eng/curriculum/elementary/kindergarten.html**.

If you enjoyed *Good Questions: Great Ways to Differentiate Math Instruction* by Marian Small, you might want to take a look at *More Good Questions: Great Ways to Differentiate Secondary Mathematics Instruction* by Marian Small and Amy Lin. This book will be available for sale at the NCTM Annual Meeting in California and through the NCTM online bookstore in May.

This month's NCTM Illuminations site features a story in which Wan Chow from Bishop Strachan School in Toronto shares her ideas for lesson warm-ups. If you visit this site, you can sign up to receive NCTM's *Bright Ideas*—a monthly e-newsletter that features practical strategies such as the ones shared by Wan Chow. Be sure to check it out, and then share the news with others! ▲

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▲ Locating Primes On A Table



BONNIE H. LITWILLER AND DAVID R. DUNCAN
PROFESSORS OF MATHEMATICS
UNIVERSITY OF NORTHERN IOWA

The location and properties of prime numbers have interested mathematicians and students of mathematics for thousands of years. Interesting patterns can be discovered by anyone willing to search for them. Verification of these patterns often requires nothing more than methods of beginning algebra. For instance, suppose that the positive integers are listed in array form, as in Table 1 (primes are circled):

TABLE 1

1	②	③	4	⑤	6
⑦	8	9	10	⑪	12
⑬	14	15	16	⑰	18
⑲	20	21	22	㉓	24
25	26	27	28	㉙	30
㉛	32	33	34	35	36
㊲	38	39	40	㊶	42
㊸	44	45	46	㊼	48
49	50	51	52	㊸	54
55	56	57	58	㊾	60
㊶	62	63	64	65	66
㊼	68	69	70	㊶	72
㊸	74	75	76	77	78
㊾	80	81	82	㊸	84
85	86	87	88	㊾	90
91	92	93	94	95	96
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A curious pattern is apparent; except for the numbers 2 and 3, all the primes lie in two (vertical) columns, either the first or the fifth. These two questions readily emerge:

1. Does this pattern continue if the table is extended?

2. If so, why does it hold?

Let us initially investigate this question by adding additional rows of larger numbers to Table 1. If this is

done, we note that while not all of the entries in the first and fifth columns are primes, all of the primes in the added rows lie in these two columns.

The verification of this pattern is surprisingly easy. In Table 1, the numbers of any specific row can be written as:

6k + 1, 6k + 2, 6k + 3, 6k + 4, 6k + 5, and 6k + 6 for some non-negative integer k. For the first row, k = 0; in succeeding rows, k = 1, 2, 3, …. .

Using the distributive property, the general row may be rewritten as: 6k + 1, 2(3k + 1), 3(2k + 1), 2(3k + 2), 6k + 5, and 6(k + 1). After the first row, $k \geq 1$; thus, 3k + 1, 2k + 1, 3k + 2, and k + 1 are all ≥ 2. Consequently, in columns 2, 3, 4, and 6, only composite numbers appear after Row 1, since each of these columns' entries are the product of at least two factors larger than one. In other words, beginning with Row 2, all the primes must be of the form 6k + 1 or 6k + 5, appearing in columns 1 or 5.

Of course, not all entries in columns 1 and 5 are prime; for instance 6(4) + 1 = 25 = 5(5), and 6(10) + 5 = 65 = 13(5). And although these entries are not all prime, beginning with Row 2, these two columns contain every prime.

The preceding observation on the distribution of primes has two interesting consequences.

Consequence 1: Square any prime. If the prime is of the form 6k + 1, its square $(6k+1)^2 = 36k^2 + 12k + 1 = 12(3k^2 + k) + 1$. If the prime is of the form 6k + 5, its square $(6K + 5)^2 = 36k^2 + 60k + 25 = 36k^2 + 60k + (24 + 1) = 12(3k^2 + 5k + 2) + 1$.

Thus, if any prime other than 2 or 3 is squared, the result is one more than a multiple of 12. For example:

$5^2 = 2 \bullet 12 + 1$

$7^2 = 4 \bullet 12 + 1$

$11^2 = 10 \bullet 12 + 1$

$13^2 = 14 \bullet 12 + 1$

$17^2 = 24 \bullet 12 + 1$

. .

. .

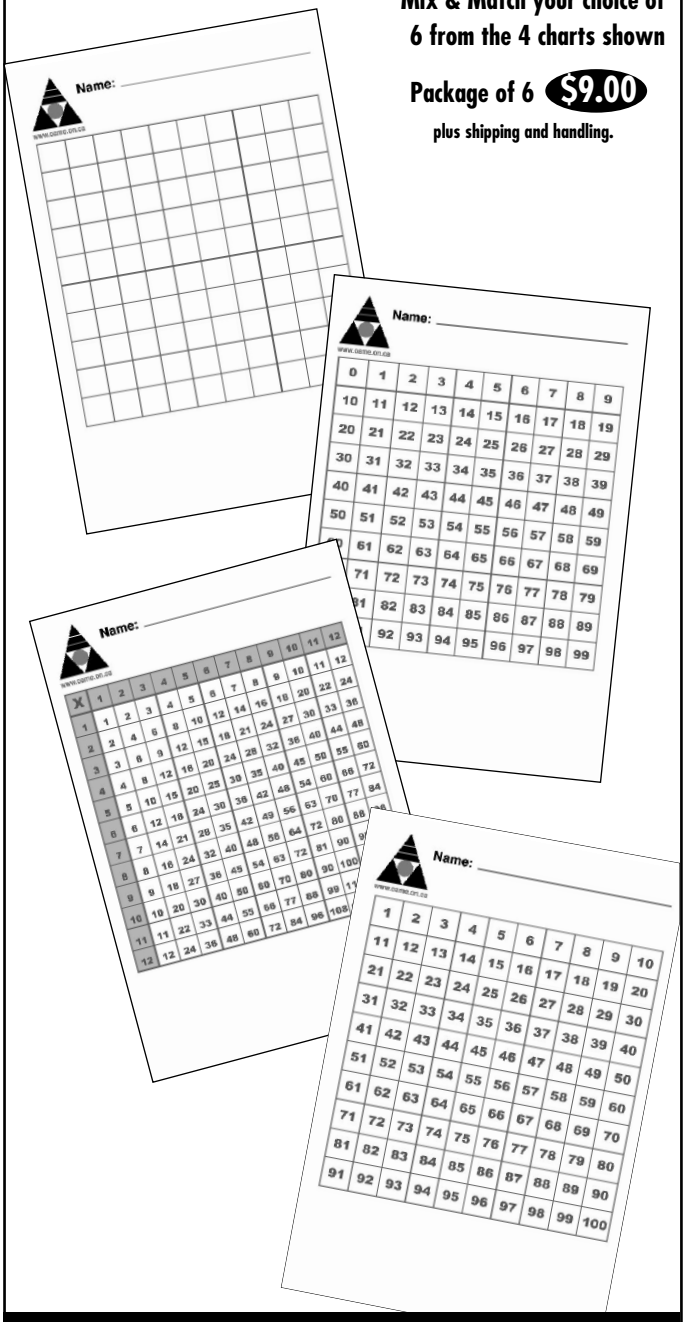
. .

The readers and their students are encouraged to investigate primes further to determine other patterns. ▲

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▲ Game: The Mathemagician!

Instructions

Ask your students to (individually) think of a number, and tell them that through the magic of mathematics, you will be able to guess their number. Lead them through the following series of calculations: ***Add 5 to your number. Multiply by 2. Subtract the original number. Add 4, and tell me what you have.*** Select a student. After the selected student tells you his or her answer, subtract 14 from it to guess the number. After you have correctly guessed a few numbers (and elicited a few *oohs* and *ahs*), ask the students if they can figure out the pattern. Then work out how algebra can be used to explain the trick. Next, have students design their own number tricks, which they can present to the class, along with a mathematical representation.

The Mathematics

Let x be the number. The trick is written as $2(x + 5) - x + 4$, which simplifies to the expression $x + 14$. Thus, if a student gives you the answer 25, for example, solve the simple equation $25 = x + 14$ to get $x = 11$.

Extension

Senior-level students could investigate questions such as the following:

- *Can you square the secret number as part of your trick? What about cubing it?*
- *What other operations can be used (sine, factorial, etc.)?*
- *Can you start with **two** secret numbers? How would you have to adapt the trick?*

This lesson can also be used to emphasize BEDMAS for younger students. For example, ask: *What is the difference between the rules* "Add 5. Multiply by 2." *and* "Multiply by 2. Add 5"? *How do we use brackets to show this difference when we write out the trick?*

Curriculum Connections

Following the oral instructions, allow students to practise their mental math skills. Proving the trick involves simplifying polynomial expressions and solving equations. These topics appear in Grades 7 and 8 Patterning and Algebra and in Grade 9 Number Sense and Algebra (Applied and Academic) in the Ontario curriculum. ▲

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▲ Game: Crossing Toronto Harbour

Materials

Two students are given one map of Toronto Harbour (see below), ten boats each (small cubes, paper, etc.), and 2 dice.

Set-Up

Each student places his or her boats in the student's docks, which are numbered 1 through 12. The student may place as many boats as he or she likes in each dock.

Instructions

On a turn, the student will roll the dice. If the sum of the dice equals the number of a dock in which a boat has been placed, the student may move his or her boat to the other side of the harbour. If there are multiple boats in the dock, the student moves only one. If there is no boat in the dock, the student does not make a move. The dice are passed back and forth until one player has moved all of his or her boats to the other side of the harbour. This player wins the game.

The Mathematics

Students will quickly realize that it is impossible to move a boat from the first dock, difficult to move a boat from docks 2, 3, 4, 10, 11, and 12, and easier to move a boat from docks 5, 6, 7, 8, and 9. This can be proven by calculating the probability of obtaining each sum. Rolling a 7 is the most common event, with a probability of . The probability that your students will want to repeat this game, using a new strategy, is high!

Extension

Play the game with 3 dice and 18 docks, or 4 dice and 24 docks. Ask students how their strategy would change in each case.

Curriculum Connections

Grade 7 Data Management and Probability, Grade 11 College, Grade 12 Data Management, or as a fun game for any grade!

Game Board

	1	2	3	4	5	6	7	8	9	10	11	12
Player One's Docks												
TORONTO HARBOUR												
Player Two's Docks												
	1	2	3	4	5	6	7	8	9	10	11	12

▲ Leadership Conference 2010

BEVERLY FARAHANI

The OAME 2010 Leadership Conference, "Instructional Decision Making," was held February 18–20 at the Holiday Inn, Toronto International Airport. Approximately 170 people attended. A generous donation by Union Gas helped sponsor the conference and was very much appreciated by OAME.

The conference began with a keynote address by Dr. Marian Small, who shared a number of online math lessons with us. We were encouraged to talk in small groups about the intention of each lesson and how it might impact a student's perception of what mathematics is all about. (A video of the keynote address and the accompanying PowerPoint slides can be found in the Members Only section of the OAME website, under Files and Links.) Following the keynote address, a reception was held, which gave participants an opportunity to network with others while watching the Olympics.

After breakfast on Friday, attendees participated in one of three workshops addressing Elementary, Intermediate, or Secondary issues. Dr. Marian Small led the Elementary session. Her goal was to help teachers see how their decisions affect their students' beliefs about math and how, in turn, those beliefs affect the students' ultimate success. The other two sessions were each led by a team that included a classroom teacher and a coordinator. The Intermediate team, led by Jacqueline Hill and Fareen Kanji, focused on a "toolkit" of resources designed to help teachers produce quality lessons. The Secondary team of Shirley Dalrymple and Shelley Yearley focused on doing and discussing mathematics in a way that enabled delegates to identify their instructional and leadership strengths.

The Publishers'/Suppliers' Lunch was excellent. Participants were given some time to tour the displays, after which door prizes, donated by the publishers and suppliers, were awarded. The sessions continued after lunch.

A buffet dinner followed the afternoon sessions. Ron Lancaster spoke about Mozart's Dice Game and other beautiful connections between probability and music, art, drama, literature, and poetry. It is amazing that Mozart, among others, created a series of pages from which one bar on each page was chosen at random to form a piece of music that actually sounds as though it had been created intentionally! The evening ended with another reception. Participants watched the Olympics or made a "Slide-Together" geometric paper construction.

Following a buffet breakfast on Saturday morning, participants headed off to their final workshop session. Most participants felt that the networking opportunity and sharing of ideas offered by this conference was extremely worthwhile.

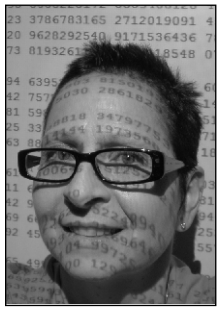
Plan now to attend the next Leadership Conference at the Holiday Inn, March 3–5, 2011. Look for the flyer with your September 2010 *Gazette*! ▲



▲ OAME 2010 Awards

GLYNNIS FLEMING
OAME AWARDS CHAIR

OAME Award for Exceptional and Creative Teaching in Elementary Mathematics



Maria Casasola is an artsy mathematician! Having begun her academic career with a Bachelor and Masters degree in Fine Art, Maria gravitated toward mathematics education and has since made both excellent and innovative contributions. Maria has led learning groups for the Lakehead District School Board, has co-chaired regional Math Olympics, and has been a member of the executive for her local OAME chapter, NWOAME, for over a decade.

One of her referees wrote, "Maria is one of the very finest elementary mathematics teachers in Northwestern Ontario. She willingly and generously shares her wonderful resources. She continually inspires colleagues with her insight, enthusiasm, energy, wit, and good humour." A former pre-service colleague penned, "Maria has opened my eyes to the endless creative possibilities that exist for teachers… Her creative genius should be as much of an inspiration to the teaching profession at large as it is to her students, who will undoubtedly remember her for the rest of their lives."

OAME is thrilled to honour Maria with the *OAME Award for Exceptional and Creative Teaching in Elementary Mathematics*!

Award for Exceptional and Collaborative Mathematics Teaching in Secondary Mathematics



Cheryl Costigan effectively integrates the use of manipulatives and technology into her teaching, with the goal of improving students' understanding of mathematical concepts. Cheryl's innovation and creativity has also had an impact on the whole school community, and she has worked effectively with parent groups to initiate a website and ongoing after-school support for her students. Cheryl has also collaborated with mathematics and special education colleagues, resulting in significantly improved student achievement at St. Elizabeth Catholic High School.

Cheryl's knowledge of technology as it relates to mathematics has led her to become a partner with the Ministry of Education in creating TIPS lessons and SMART Board™ toolkits, designed to differentiate learning and assessment opportunities for students and teachers around the province. Integrating these ideas into her presentations, Cheryl has contributed to the professional development of other teachers within the York Catholic District School Board through in-services and collaborative inquiry. In addition, Cheryl has led sessions at OAME conferences and has co-organized Mathematics PA days within her school board.

It is truly a pleasure to honour Cheryl with the *OAME Award for Exceptional and Collaborative Mathematics Teaching in Secondary Mathematics*.

Award for Leadership in Mathematics Education



"Trish knows and understands the need to build strong, trusting relationships with teachers and students alike in order to create a learning environment for them which empowers them to succeed." This quotation from one of Trish's nominees sums up the way Trish leads in mathematics education in the Simcoe County District School Board and around the province. Having worked as a classroom teacher, an itinerant resource teacher, a consultant, and for the Ministry, Trish knows and has supported mathematics education at every level.

One of Trish's greatest strengths has been her ability to facilitate collaborative inquiry as a professional learning model in mathematics at all levels of instruction. Another of her strengths has been her skill in promoting professional learning province-wide through the highly effective use of technology. These strengths, along with her boundless energy for sharing strategies, creating supports, and nurturing leadership make her a vital advisor to the Ministry of Education regarding its next steps.

It is an honour to wholeheartedly congratulate **Trish Steele** as the winner of the 2010 *OAME Award for Leadership in Mathematics Education*.



OAME Life Membership

Kathy Kubota-Zarivnij is no stranger to OAME! Since beginning her teaching career at what is now the Toronto Catholic District School Board, Kathy has been a strong advocate for teaching and learning, with mathematics being her passion. Beginning with being a Math Olympics coach and school mathematics representative, Kathy brought her creative flair and strategic organizational abilities to life; it is no wonder she was promoted to Vice-Principal to see in the new millennium. Concurrently, she worked with EQAO, the Ministry of Education, Curriculum Services Canada, the Ontario College of Teachers, and York University.

Promoted to Principal of Program – Mathematics Coordinator for the Toronto Catholic District School Board, Kathy then expanded her sphere of influence in the provincial math community! On the OAME executive for five years, including a term as President, Kathy worked tirelessly to lead OAME and the province into a collaborative inquiry model for professional learning. Through interactive professional learning sessions at OAME leadership and annual conferences, Kathy introduced Ontario to a completely different approach to teaching and learning mathematics. Based on her doctoral work, and patterned after Japanese professional learning of mathematics, Kathy introduced us to Ontario Bansho, an instructional strategy that is changing the face of instruction in mathematics in this province. Her work on the *Growing Up Mathematically* project continues to give teachers and administrators a window into what it means to teach through problem solving. Her work as a main contributor and editor of the *Abacus*, OAME's elementary mathematics journal, continues to guide teachers as they develop their knowledge of mathematics for teaching.

Following her move to the Literacy and Numeracy Secretariat (LNS) in 2005, Kathy and her colleague, MaryLou Kestell, were the lone voices of mathematics at the LNS. Collaborative Inquiry for Learning – Mathematics (CIL–M), a professional learning model that engages teachers in learning about teaching mathematics by teaching mathematics in collaborative learning groups, incorporates not only Ontario Bansho, but also the very best of the professional learning literature in its processes. One of the key components of CIL–M is that it takes place in actual classrooms with students; the learning is dependent upon what the students do, and is constructivist for both adults and students.

Kathy has worked with pre-service teachers, in-service teachers, resource teachers, consultants and coordinators, principals, supervisory officers, university professors, Student Achievement Officers, directors, and most importantly, with students. There is no level of education at which she has not worked. Her intensity, wit, and strong ability to communicate help her relate to everyone.

It is our honour and privilege to recognize Kathy's contribution to OAME over the last ten years and to thank her for her outstanding leadership in mathematics education by awarding her an *OAME Life Membership*.

Kenneth D. Fryer Award for Exceptional and Collaborative Mathematics Teaching

The mathematics teaching staff of **Saint Joan of Arc Catholic High School** in Maple, Ontario has been chosen as this year's award winner. "Their persistence, determination, and collaboration have contributed to our school's overall success," wrote one of the school's nominators. They have worked strategically to target lessons that have students conceptualize ideas and make connections. As they infused technology into their rich instructional practices, members of the Mathematics Department found that their students attained academic results that were noteworthy.



Not being satisfied with keeping their work within their own building, this collaborative team also worked "diligently, fostering relationships with the intermediate teachers from their seven feeder schools." Using the information they gleaned from this partnership as assessment for learning about their efforts to teach

through problem solving, the Mathematics Department was even better able to meet the needs of the students. This professional collegiality has since become a model within the York Catholic District School Board.

OAME is delighted to honour Saint Joan of Arc Catholic High School with the *Kenneth D. Fryer Award*.

Elementary School Staff Award for Exceptional and Collaborative Mathematics Teaching

"The entire **St. David** staff works together to foster teamwork and collegiality as it endeavours to share effective practices shared in professional learning communities…," wrote one of the nominators of this award. The St. David staff has been engaged in collaborative inquiry through action research focused on student achievement in mathematics. Actively engaged in assessment for learning strategies, the staff has engaged in ongoing professional learning and collaboration, having a notable connection to Special Education.



Although highly focused on students and their developing mathematical reasoning, the collaboration at St. David has also had an impact on the community: "Students within the school and parents know and will tell you that St. David is a school focused on mathematics education." Indeed, the school has developed a reputation within the Hamilton-Wentworth Catholic District School Board for its excellence in mathematics education.

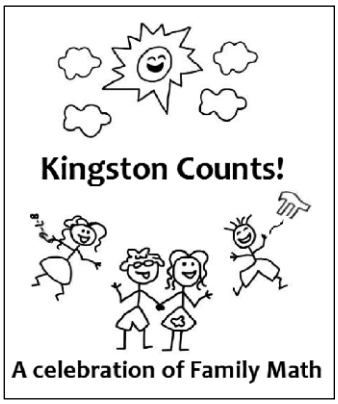
OAME offers congratulations as it honours St. David Catholic Elementary School with the *Elementary School Staff Award for Exceptional and Collaborative Mathematics Teaching*. ▲

▲ Hey, It's Elementary – *Kingston Counts!*

LYNDA COLGAN



Lynda is celebrating her 32nd year as an educator. She has taught at all levels—elementary, secondary, and post-secondary—and has mentored fellow teachers and more recently, teacher candidates and graduate students. Her first teaching award, The Marshall McLuhan Distinguished Teacher Award, was given in recognition of her "Learning Partner Initiative," in which elementary children attended professional development sessions with their classroom teacher to learn about innovative uses of technology in mathematics.

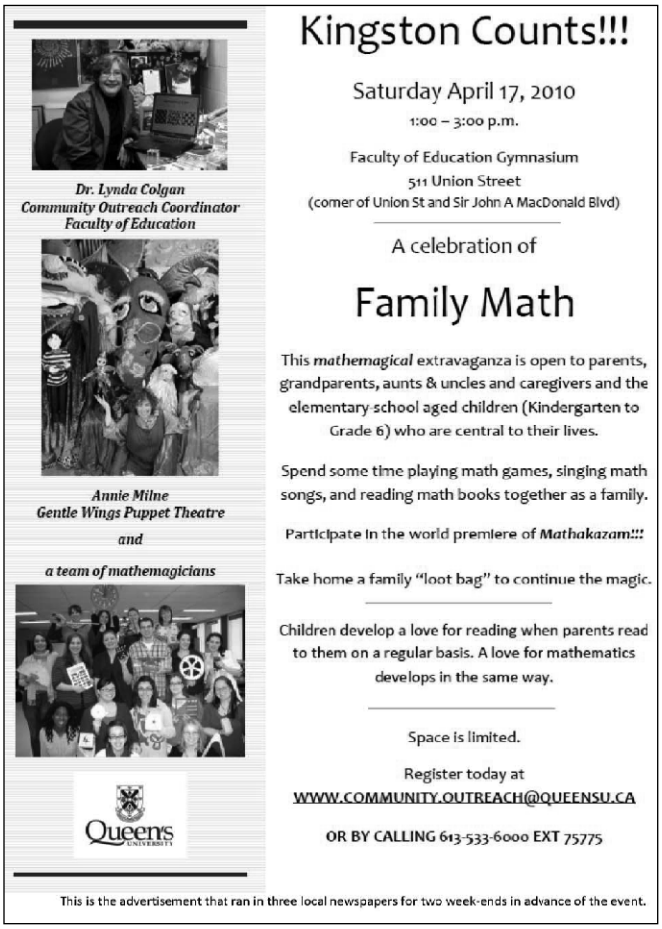


Exciting things are taking shape at the Faculty of Education at Queen's University. Through a generous donation from the Imperial Oil Foundation, a new Community Outreach Centre has been established, and I am fortunate to have been appointed Coordinator of this exciting new facility. In this column, I will tell you about our mission, the event that recently launched the centre (*Kingston Counts!*), and some of our upcoming projects and partnerships.

The goal of the Community Outreach Centre is to improve the outcomes for students who are "at risk" in literacy, math, and science and technology education. The mandate of the Community Outreach Centre is to make a positive impact by carefully planning and implementing activities and research that allows for the participation of all families, including those from lower socio-economic backgrounds, minority groups, and those of at-risk students (at either end of the achievement continuum). We want to engage parents, teachers, community agencies, and volunteer associations who contribute to the education of children, both inside and outside of the classroom, and we want to help caregivers—all of whom play an important role in

one way or another—learn how to support the development of positive attitudes toward literacy, mathematics, and science and technology, and support formal and informal learning that may have a positive impact on student achievement in these domains.

To introduce the Community Outreach Centre to our colleagues, peers, and neighbours, I started by inviting members of the local community to a mathematics party (called *Kingston Counts!*) at the Faculty of Education on Saturday, April 17, 2010. Invitations were sent to the presidents of every school council from Picton to Brockville and to every principal and vice-principal for each school in the same large catchment area. Also invited were math consultants, superintendents, and Directors of Education, as well as representatives from the Boys and Girls Club, Kingston Literacy, and many other community agencies. Ads were run in three local newspapers inviting the public to attend, and the event was promoted by two local radio stations and our local CTV television station.



This is the advertisement that ran in three local newspapers for two week-ends in advance of the event.

Once the announcement was made, the task of coordinating the event began in earnest. One of the unique aspects of the B.Ed. program at the Faculty of Education at Queen's is that all teacher candidates must complete a three-week Alternative Practicum, during which teacher candidates work in an educational context that is not classroom based. This often sees teacher candidates mentored by educators from theatre groups or museum activity directors, online course developers, or sustainability centre directors. I was fortunate to have an amazing team of 16 Primary/Junior "mathemagicians" elect to work at the Community Outreach Centre with the goal of implementing *Kingston Counts!* These particular teacher candidates were interested in learning about Family Math and community partnerships and were excited about participating in a unique and practical opportunity to learn.



My amazing team of mathemagicians! Back row, from left to right: Ashley Joy, Jenny Goncalves, Sarah Burrows, and Hillary Gale. Next row: Katharine McWhirter, Erin Insley, Adam Swanson, Kaitlyn Kuipers, and Ashley Morrison. Third Row: Marguerita Drayton, Aideen Maguire, Stephanie Vecchiarelli, Kristen Parker, and Jennifer Graham. Front row: Sonia Barreiros and Jennifer van Essen.

After a few days, the team was divided into two subgroups. The first small group opted to work with Annie Milne of the Upper Canada Academy of the Arts to develop an original puppet show called ***Mathakazam!*** Annie is a legend in and around Kingston because of her work with the Purple Dragon Puppet Theatre Troupe and is a world-famous puppeteer who has worked with children and adults to create and perform plays at the Canadian Museum of Civilization, the H'art Studio (for adults with special needs), Camp Trillium (for children with cancer), the Providence Manor Alzheimer Unit, and

the Faculty of Education (with concurrent sign language).

Under Annie's tutelage, teacher candidates Sonia, Stephanie, Aideen, Sarah, Jennifer, and Erin collaborated on a script, designed and built more than ten 2-D and 3-D puppets (including one that was over 7 feet tall), created props, choreographed a math dance, and learned an original math song (written just for the event by Trevor Strong).



Annie Milne and some of her original puppets.

The team's play is about **Math**ew and **Math**ilda—two children who are a little embarrassed by their mother's love of all things mathematical. In fact, the other children at school often tease them about being mathy. The play opens with Mathew and Mathilda, who really, really, really want to be in the school talent show, but are disappointed to learn that the other kids don't think that math is a talent and therefore will not let them take part. As luck would have it, during the planning stages for the talent show, BIG PROBLEMS happen, and much to everyone's surprise, it is Mathew and Mathilda who come to the rescue and save the day. In the end, it's a great day for math. *Mathakazam!*

While the puppet team worked on its part of the *Kingston Counts!* program, the remaining members of the team set up shop in the elementary mathematics classroom at McArthur Hall to plan the other aspects of the event: registration packages, activity centres, snacks, "loot bags," evaluation forms, and signage.



*Sarah Burrows working on her original puppet, **Math**ilda, at the Upper Canada Academy of the Performing Arts.*



*Erin Insley with **Math**ew during the early stages of his creation for the play.*

While the puppeteers were stitching, dancing, singing, and engineering their way to success, the "nuts and bolts" team was busy in the library; on the computer; and with glue guns, construction paper, and milk cartons, getting everything ready for the families who had indicated that they would attend.

The first task was to create the "Welcome Stations" that families would encounter as they arrived. Second, Activity Centres were developed to reflect the age of the children who were coming: Early Primary, Late Primary/Early Junior, and Late Junior/Intermediate. Third, interactive placemats were designed for children

to use at snack time. Finally, a take-home booklet was developed. Many of the materials were developed in French to complement the English-language resources.



From left to right, Ashley Joy, Katharine McWhirter, Hilary Gale, Jenny Goncalves and Kristen Parker.

In all, the McArthur team (with the help of volunteers from the B.Ed. program and local secondary schools) developed and implemented 24 stations. A skeleton was constructed from wood so that children could find out how many of their family members it would take to fill one cubic metre. Instructions were written so that families could determine which members were perfect squares, tall rectangles, or far-reaching rectangles. Instructions were developed so that families could be successful in making origami puffer fish and sonobe cubes; investigating anamorphic art; computing with Napier's Bones; creating tangram flags; outsmarting milk carton computers; and learning how to use a sorobon and unlock the secrets of codes and ciphers. A "Passport to Math Success" was designed so that families could accumulate stickers for each station visited.

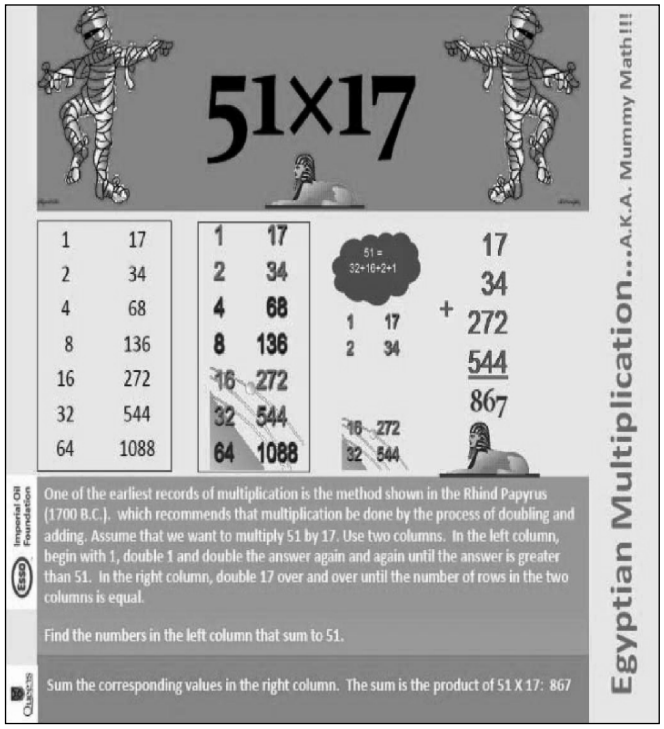


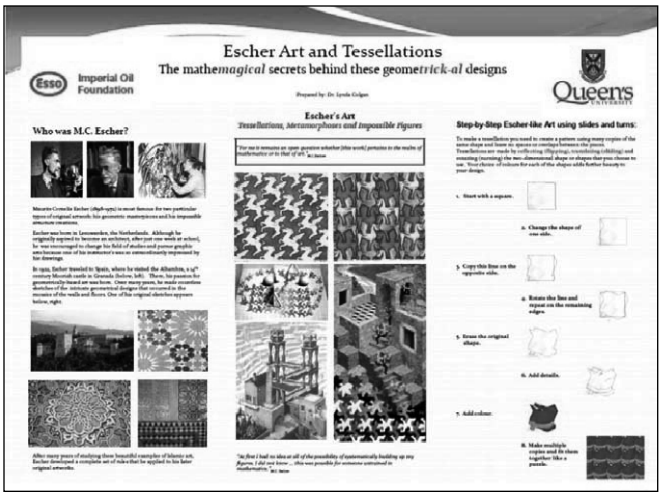
Clockwise beginning at the lower left: Hilary Gale, Jennifer Graham, Ashley Morrison, Kaitlyn Kuipers and Adam Swanson.

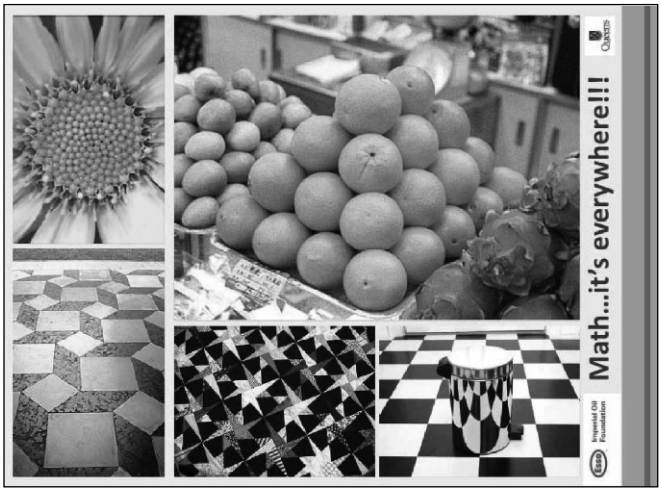


Local teacher, Toni Thornton and her son Tobias investigate the base-10 number system with a giant sorobon.

The McArthur team produced a 123-page booklet called *Making Math Magic at Home* (provided free of charge to each family) and developed ten interactive placemats for three age groups (in French and English). They also prepared 150 take-home packages (each of which included a handcrafted sorobon) and designed a poster walk so that families could explore math in the world around them (each poster was 4 by 6 feet and in full colour) as they munched on their popcorn snack at break time. Three of these posters (*Egyptian Multiplication, Escher Art and Tessellations,* and *Math... It's Everywhere!*) are shown here.







The good news is that the entire team of teacher candidates—puppeteers and Activity Centre team alike—did an extraordinary job, and *Kingston Counts!* was a wonderful success. Over 115 families attended, for a total of about 250 people of all ages, from babies in strollers to great-grandmothers. The great news is twofold. First, the Ontario mathematics community now has available to it an amazing cadre of young, knowledgeable, creative, and hard-working early-career teachers who believe in the power of mathematics community outreach because they have seen its extraordinary impact first-hand. Second, all of the resources from *Kingston Counts!* are available free of charge to you through our website at **www.community.outreach.educ.queensu.ca/**. There you can watch Mathakazam as a webcast; download the original song from the play as an mp3 file; see a slide show of the *Kingston Counts!* process and the actual event; download both the English and French placemats (designed for 11" x 17" paper) to use at home, in your school lunchroom, or in your classroom during indoor recess; or download the resource booklet. If you are in the greater Kingston area, the news is better still. All of the resources developed for *Kingston Counts!* are available on loan to help local schools and community centres organize and run their own version of the event. Over the summer, more activity centres will be added to the loan library. By September, you will be able to preview our 2011 *Family Math* calendar and order copies to sell as fundraisers in your local schools.

The Community Outreach Centre is continuing to seek ways of making a positive impact through partnerships with local museums, agencies, and organizations. I am hoping to build in as many opportunities as possible for B.Ed. candidates and recent B.Ed. graduates to be engaged in innovative and purposeful projects that will help children and their families see that math is doable, enjoyable, and relevant. As mathematics educators, we know all too well that math is commonly seen as the "bad guy." When many people hear words like "geometry," "algebra," or "stellated dodecahedron," they say out loud for all the world to hear: "I just don't have the math gene. Make it go away!"

Through events like *Kingston Counts!*, the Community Outreach Centre at Queen's University hopes to do some dragon taming of its own by making math seem as wise, wondrous, and warmly enveloping as Annie's legendary purple dragons. Please wish us well and join us whenever you can. Please know, too, that you are always welcome to visit, either in person or online. ▲



▲ Optimization Through Modelling: Revisiting the Popcorn Box Activity

WALTER WHITELEY
AMI MAMOLO



Ami Mamolo is a Postdoctoral Fellow in Mathematics Education at York University. Specializing in university students' learning and understanding of mathematics, she is currently involved in a research program to (re)design the teaching of large first-year mathematics.



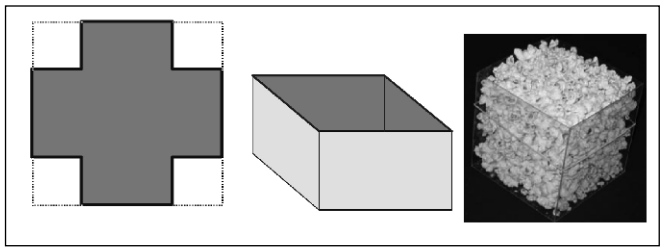
Walter Whiteley is Professor of Mathematics at York University. He works in applied geometry (with engineers, biochemists, computer scientists) and works on geometry education at all levels (K–20) with a variety of collaborators.

During the last round of curriculum revisions, there was some discussion about exploring rate of change and optimization prior to students taking calculus. While there were concerns about effective ways to explore these big ideas without calculus, we offer evidence that it can be done. Over the last four years, a group has been developing investigatory activities that address optimization and rate of change in a geometric way. Our experiences with these activities not only confirm that there is a place for these investigations prior to calculus, but also convince us that it should be done to open up some "big ideas" that might otherwise be overshadowed as students grapple with the techniques of calculus.

The Investigation

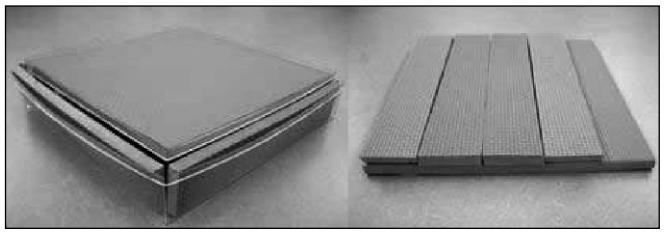
This problem is adapted from the Popcorn Box activity that can be found in OAME's *Growing Up Mathematically* materials for Grade 9, and in two versions for Grade 12:

> *An open-topped box (a popcorn box) is created from an 11"x11" piece of cardboard by cutting squares out of the four corners and folding up the sides. The student is asked to create the box of maximum volume from the piece of cardboard.*

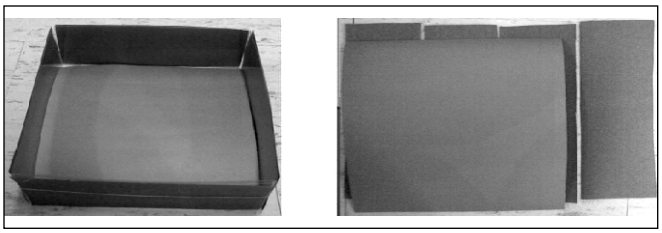


We have designed materials for a hands-on investigation of changes in volume, which also help foster key connections to important ideas of change and optimization. A detailed discussion of the materials and their implementation can be found in Whiteley and Mamolo (2010). In addition, worksheets and complementary activities in Geometer's Sketchpad (Jaciew, 1989) are available on the wiki site on Optimizing with Geometric Reasoning (see References).

In brief, the investigation uses pairs of plastic boxes cut out from rigid plastic sheets that are held together with rubber bands, as in the above illustration. The pairs of boxes differ by 1 cm in the size of the cut. Volume comparisons and rate of change explorations are done through the use of foam "fills." Pieces of foam are placed in the gaps along the sides between the boxes and on the top of the "inside box" to illustrate physically how the volumes are changing.



The materials afford a direct method to identify whether the volume gained in one box is larger or smaller than the volume lost in the other. In the diagram above, the volume gained (red foam) is larger than the volume lost (purple foam) for this pair of boxes. This exploration—as with those involving other pairs of boxes—offers the basis to conjecture what the box of maximum volume might be. However, there are limitations due to the size of the cuts made to the sheet of plastic and the corresponding thickness of the foam fills. These can be addressed by working with smaller changes in the square cuts—say, the thickness of cardboard—as illustrated below.



Big Ideas:

Important ideas that come up during this investigation include the following:

a. The exploration promotes reasoning about changing volumes under constraints, focusing on the changes in volume (volume lost and volume gained).

b. Changes in volume are connected to changes in surface areas (a big idea appearing in other situations that is illustrated when using thin materials such as cardboard).

c. When the volume lost is smaller than the volume gained, we know that the outer box is smaller than the inner box, and therefore is not the maximum.

d. The idea that when the change in surface area from one box to another is non-zero, we are not at the maximum, and thus, the optimum can occur only when the comparative change is zero.

e. Working with physical materials invites using thinner materials and taking the limit physically to estimate the volumes lost and gained.

f. To attain an optimum, the area of the four sides must match the area of the base, and, as illustrated in the figure, the squares that are cut out of the corners must have a length that is 1/6 of the length of the original side.

Extensions

There are a number of extensions and "What if?" problems available, as well as geometric techniques that can help investigate them. Here are some examples:

1. What if the paper is not square? The reasoning about volume lost and volume gained carries over, as does the identification with volume changes and corresponding surface areas.
2. What if we use a different shape (e.g., a triangle or a hexagon)? The reasoning connecting surface areas with changes in volume carries over completely. More surprisingly, the basic ratio of the cut also carries over (with one shift in focus), as illustrated in the sketch on the wiki site.
3. The plane analog for areas in the plane, the "fence on the river," has analogous reasoning, where change in area is identified with parts of the perimeter, and the optimum occurs when the perimeter where area is lost equals the perimeter where area is gained (see the GSP sketch on the wiki site). However, our experience is that the 3-D investigation makes more sense to the participants, and should be done first.
4. If a box is constructed by tilting the sides out a little (as happens in the theatre), one can apply related qualitative reasoning comparing loss and gain to determine that the volume is increasing, without any trig calculations and without determining the exact optimum tilt.

Does it Work?

The investigation has been used in settings ranging from math camp for students about to start Grade 9, to Grade 12 classes and classes for pre-service teachers and other mathematics majors, to professional development activities and graduate courses with teachers. It takes time, but we can confidently say that the activity engages students, prompts important questions and puzzles, and can, with enough time, bring participants to reasoning they can generalize and understanding that builds strong networks of connections for rate of change and optimization. For further information regarding this activity, including student reactions, strategies for implementation, and an in-depth discussion of the benefits and challenges of this approach, please refer to Whiteley and Mamolo (2010). As we continue to develop and refine this activity, its materials, and guiding instructional prompts, updates will be made on the wiki cited below.

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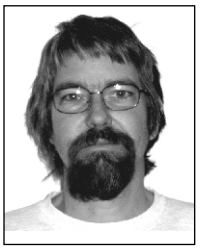
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▲ Learning Mathematics Through Card Games

TIM SIBBALD



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KEYWORDS

Teaching

Line of best fit

Exponential distribution

Card games

SUMMARY

Card games are used as a source of statistical data that is well suited to modelling line of best fit and exponential distributions. The content is suited to secondary school learners.

Card games are intrinsically interesting to students and are thus an ideal avenue for exploring certain concepts within the mathematics curriculum. Students who play cards of their own volition find it a beneficial social outlet and a pleasant way to maintain social ties beyond graduation. In the classroom, the social tone allows students to talk about the mathematics they are studying; I have found this quite beneficial to weaker students, who find that the relaxed atmosphere provides them with an opportunity to seek the peer support they need.

While I have not encountered any cultural or religious objections, there have been concerns raised historically about the connection between playing cards and gambling, as well as the relationship between tarot cards and the occult (See International Playing Card Society at **www.i-p-c-s.org/history.html** or World of Playing Cards at **www.wopc.co.uk/history/page_6.html**). I chose to use games of skill that are not used for gambling to mitigate this concern; however, card playing could provide an opportunity for an objective discussion about the personal risks of gambling.

Identifying variables is an expectation included in the Ontario Grade 9 curriculum. It can be addressed by manipulating a deck of cards or the rules of a game to explore the consequences. Compare the playing time of "Go Fish!" with the requirement that you can put down only four of a kind instead of pairs. What happens in "Crazy Eights" if you alter the number of crazy cards? Timing games can lead to trends that can be modelled, using lines, and then used to judge different game designs.

In Grades 11 and 12, card games fit several needs. For Data Management (MDM4U) and College and Apprenticeship Mathematics (MAP4C), they fit with the statistical content and the development of statistics for a purpose. Finally, the cost of gambling is a real concern that could be addressed in Mathematics of Personal Finance (MBF3C) and Mathematics for Everyday Life (MEL3E).

The remainder of this article develops some of the math concepts around three games: Klondike, War, and Crazy Eights Countdown. These games provide a rich opportunity because they combine social elements and mathematical discussions within the classroom. A level of interdependence is generated, and students have been observed extending their engagement beyond the classroom door.

Klondike

There are many solitaire games, but "Klondike" is perhaps the best known. It is also a very convenient game for analysis because it is included with Microsoft Windows and is available on many personal computers. Those who are not familiar with the game can find a description of it at **www.solitairecentral.com/rules/Klondike.html**.

SCORING KLONDIKE

Windows uses the following scoring system:

- Each card moved to the play area, +5
- Each play card flipped face up, +5
- Card moved to ace piles, +10
- Flipping the deck more than three times, –20 for each flip
- Bringing a card back from the ace pile to the play area, –15
- Every ten seconds of time, –2
- Windows includes a bonus of approximately 3 000 if you win; however, this is ignored in my analysis because I couldn't be sure that the time taken affected the bonus.

In the following analysis, I have chosen to draw three cards at a time ("draw three") and have used both the timing and scoring values provided by the Windows version of the game. This version of the game allows one to make lateral shifts (e.g., a red four can be moved from one black five to another black five). It also allows cards to be moved from the ace stacks back into the play area for a small scoring penalty. (I was only recently made aware of this feature. Trust an 8-year-old to teach me such a detail!)

In 65 games, there were three wins. We were able to gather this statistic easily by amalgamating each student's results after playing two or three games. My approximate rate of winning is about 5%, and my approximate rate of losing is about 95%. However, the word "approximate" raises the question of how many samples are needed. In a class of 25, would having each person play four games generate a better class set of statistics? The three winning games took 188, 217, and 269 seconds, respectively. This suggests that winning is rare and takes about three to five minutes of game time. The shortest game in this set of data was 24 seconds, and the longest took 275 seconds, making a range of 251 seconds. This is a considerable range and highlights an unpredictable component of the game.

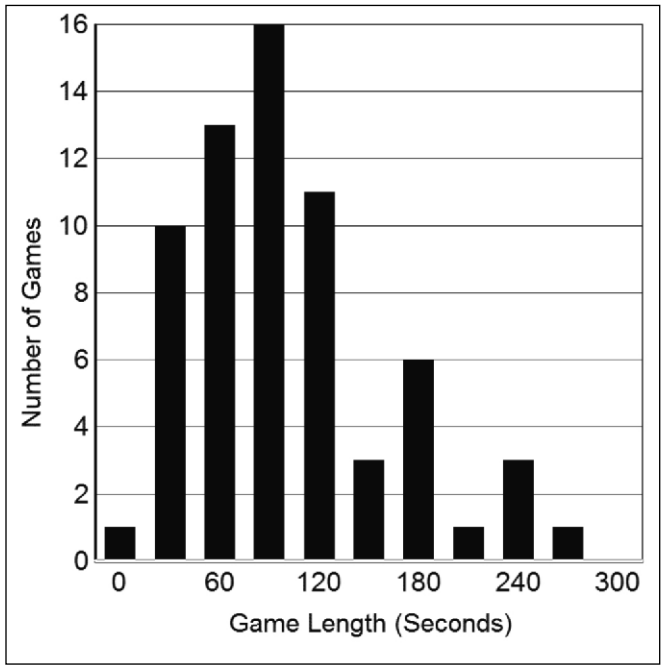


Figure 1: Game Duration

A histogram of game lengths (see Figure 1) provides a good graphical format for viewing the various attributes of the game, such as the central tendency reflected by the mean, median, and mode. The graph shows the existence of games that took longer and the asymmetry in the times that arose because of these longer games.

The mean, median, and mode in this data set were 116 seconds, 107 seconds, and 79 seconds, respectively. The mean is larger than the median due to the existence of longer times. For Ontario Grade 12 courses, this can be explained by the skewness of the game durations, which was 0.8 seconds (implying an asymmetry with longer games above the mean).

The same analysis can be provided for the scores. The range was 0 to 618 points, giving a full range of 618 points. The mean, median, and mode were 150, 135, and 19 points, respectively. Yes, the mode is 19! This particular score occurred twice, more than any other value of the score! Compare this with the histogram of the scores (see Figure 2), and you will quickly realize that the mode can bring about some discussion in your classroom! The game score histogram has a mode of 90 points or, one might argue, is bimodal, with a second value of 150 seconds. This turns the mode into a point of discussion, and you could have students argue the merits of each answer (19, 90, and bimodal with 90 and 150) in small groups before writing an opinion as a "communication" task.

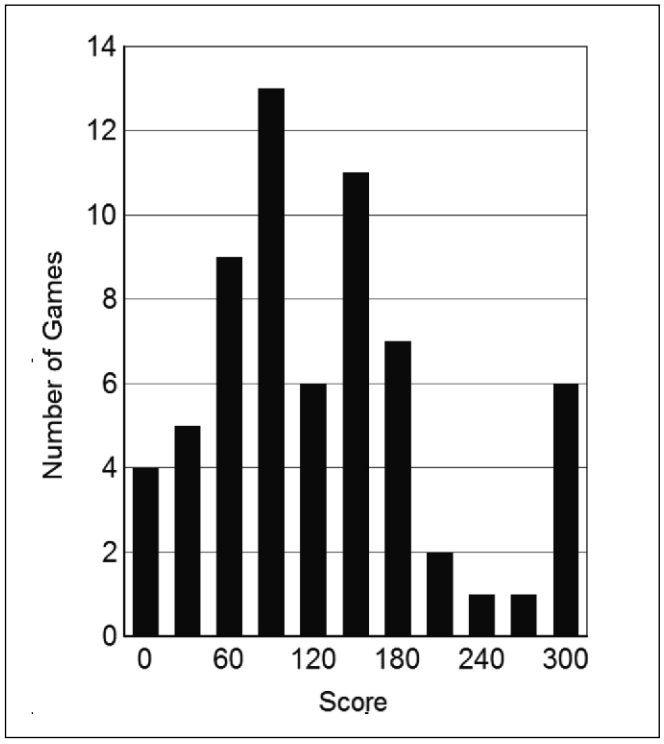


Figure 2: Game Scores

Do students expect that more points are scored in longer games? Will they hypothesize a positive

correlation? Does this conflict with views of randomness arising from shuffling, or is it consistent with views of probability? These questions can prompt a discussion highlighting that statistics consolidate the complex rules into some relatively simple and valid observations. A scatter plot illustrates the possibility of a link between score and time and provides a great opportunity to discuss dependent and independent variables. Does the player ("I," as in Independent) decide the score or the length of the game?

The scatter plot of scores versus play time is shown in Figure 3. The single game with a score in excess of 600 arose naturally and is cause to discuss outliers. Can it be removed? How does one justify the removal? Perhaps it reflects poor sampling when the time is larger than 200, and perhaps all the points with times larger than 200 should be removed. This hypothesis could be tested by gathering more samples!

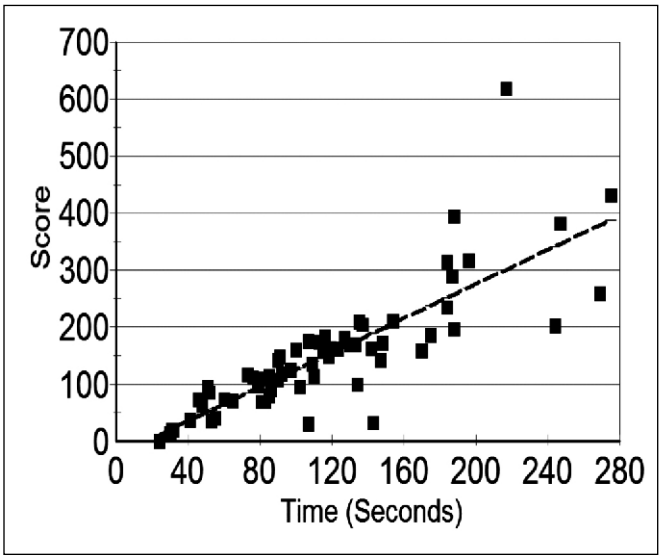


Figure 3: Solitaire Scores

The line that I have added to the scatter plot is the line of best fit. The value of R^2 is 0.68, which means that 68% of the variation in the score is explained by variations in the time. The line is approximately $y = 1.5t - 25$. This can be used for a variety of questions pertaining to scatter plots:

1. If a person were to play for exactly two minutes, what would you expect his or her score to be?
2. Use the equation to predict the score for a game lasting 350 seconds.
3. How long might a game in which the score is 200 last?
4. If one game were to take 50 seconds longer than another, how much larger do you think the score would be? Note that this could be done graphically or by using the slope value.
5. Write a paragraph describing how well the "line of best fit" models the data for short, medium, and longer times.

War

Klondike provides a useful way to examine descriptive statistics and correlation. The game of War is different because it provides an opportunity to examine the conceptual design of the game, which is the basis for developing strategies.

The game of War has relatively simple rules (see below), but can be quite lengthy. Students who try to perform a statistical examination of outcomes will realize that they simply cannot generate sufficient results in a realistic time. How, then, can they simplify the game to produce results that would be similar to those of the full game?

WAR

In the game of War, the deck is dealt out between two players. On each turn, the players turn one card over. The player having the higher card adds both cards to the bottom of his or her pile. If the cards match, then both players play three cards face down and turn over the next card. Comparison of the last cards determines the winner of the original pair, the six face-down cards, and the two final turned cards. In the rare event that the final cards match, a new set of three hidden cards and a turned card is added.

Using a graphic organizer to lay out the rules and potential variants is a good way to promote discussion and thinking about the consequences of each component of the game. (A sample organizer is provided in Figure 4.) Arranging group discussions to examine the ideas will lead to a debate about various aspects of the game. Students can then be challenged to develop experiments to test their ideas. These experiments do not need the full set of rules for the game and can therefore be developed in a fashion that facilitates realistic exploration of features of the game.

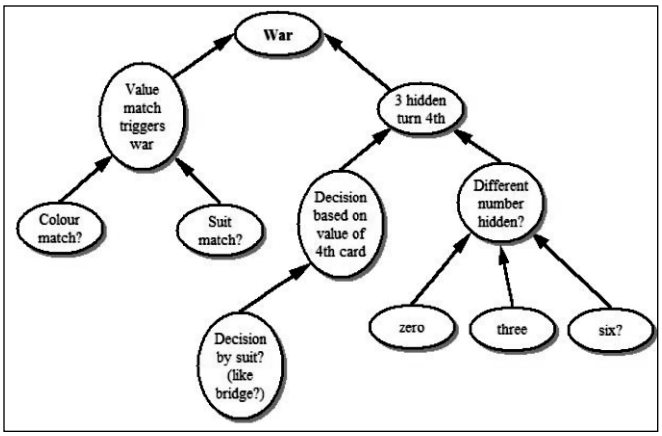


Figure 4: Components of the Game

War can be played with no hidden cards so that a war is decided by turning the next card; alternatively, a reduction of the deck to only aces, twos, and threes significantly reduces the play time. Similarly, the game can be played using four, five, or six different card values. All of these games can generate the required statistics in a timely fashion in the classroom. This makes it feasible for groups to achieve sufficient measurements to investigate the statistics of the game. Having students report results on the chalkboard allows "pooling," or the bringing together of different people's data to facilitate comparisons.

GAME LENGTH STATISTICS

Number of Different Card Values	Mean (plays)	Standard Deviation (plays)
2	7.13	4.01
3	14.65	9.10
4	24.82	17.30
5	38.26	31.13
6	61.82	47.69

The above table shows the length of games, based on different numbers of distinct card values. A value of three, for example, means that only aces, twos, and threes were used to play the game. No hidden cards were used to further simplify the game. The length of a game was determined by counting the number of plays (e.g., a card comparison was one play and a comparison that included a war was also counted as one play).

The results are exponential and provide an opportunity to use graphing technology to determine the relationship. Specifically, the models, using x to represent the number of card values, are:

$mean = 2.75(1.69)^x$

$sd = 1.32(1.85)^x$

EFFECT OF HIDDEN CARDS IN WARS

Number of Hidden Cards	Mean (plays)	Standard Deviation (plays)
0	25.03	17.35
1	15.20	9.47
2	8.61	5.25
3	7.42	5.75
4	6.88	3.55

The standard deviation may, for teaching purposes, simply be used as an extension or enrichment for those students who model the mean rapidly.

When $x = 13$, as it would be for a full deck, the values of the mean and standard deviation are larger than experience suggests, indicating that the hidden cards (during a war) significantly reduce the game length. Having students ask "How much?" leads naturally to the next step.

What is the effect of hidden cards in a war? Try it! I used games of four card values (ace, 2, 3, and 4) with different numbers of hidden cards to obtain the data provided in the table.

The hidden cards illustrate exponential decay. Again, exponential modelling can be used:

$mean = 21.4(0.72)^x$

$sd = 14.8(0.69)^x$

This analysis of War demonstrates that the game is a balance between the exponential game length due to the number of distinct cards and an exponential reduction due to the number of hidden cards in each war. In the case of the mean, the derived models can be used to draw conclusions about the regular game of War.

Crazy Eights Countdown

Crazy Eights is the most popular card game at my school. Student surveys routinely come back showing that Crazy Eights is the best known and most played game at the school. Those not familiar with it can find a good definition at **www. en.wikipedia.org/wiki/Crazy_Eights**. In the "countdown" version, one starts playing Crazy Eights, and upon completion, the player picks up seven cards and starts playing Crazy Sevens. This pattern follows until someone completes Crazy Ones. Note that for Crazy Sevens, the seven is used to change the suit, and the eight no longer has a special meaning.

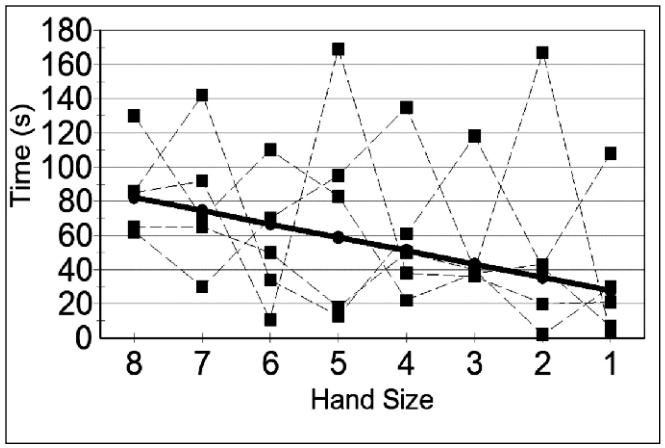


Figure 5: Crazy Eights Countdown Times

Two of my students played this game and measured the time it took for each "crazy" value. A scatter plot of the times was constructed and is reproduced in Figure 5. My initial reaction was to correct them about the way they had plotted the *x*-axis because their values are in descending order, which the students rightly argued is the order in which hands of that size are played in the game.

The times shown in the scatter plot, to the dismay of my students, appeared to show no particular pattern. However, this provided an opportunity to discuss the most representative time for each hand size. This also provided a practical context for discussing the mean and median, where the latter is less susceptible to effects due to rare, but unusually large, values. Since a player could be plagued with picking up cards, large numbers of cards could occur naturally and bias the mean. Therefore, the median time for each hand size was plotted and observed to be close to linear. A linear regression, performed using a graphing calculator, provided the solid line on the scatter plot.

The equation of the line of best fit is: $y = 7.8x + 19.9$ $r = .85$

What this equation does not show is the perplexity of reconciling the reversed order of values on the *x*-axis and of having a positive slope. There was considerable concern, by students and teacher, about making sure that clarity was maintained in a reasonable way. This was an interesting component of communication that evolved naturally from the mathematics!

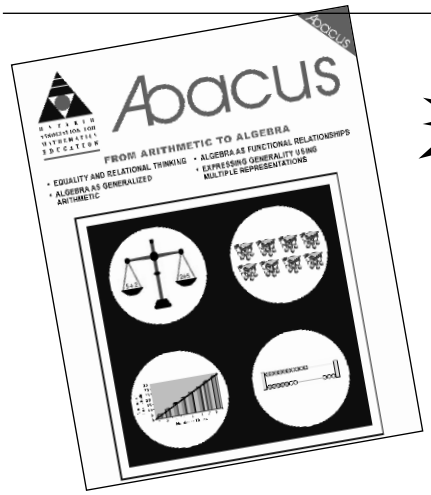
This equation estimates the median time and provides an opportunity to interpret what information the median provides. The key idea is that long games do occur, but the median indicates a likely game length.

Closing Thoughts

The use of card games in the classroom creates a relaxed environment, and students are often heard discussing the statistics between hands. The discussions typically start with statements that assume one will win. Using the statistics generated, the point is made that games can be designed. The design develops mathematical thinking and gives a pragmatic context for discussing interpretations generated by the statistics.

It is intriguing that there is such a variety of curriculum links. This suggests that card games could easily be used as an educational change of pace now and again in most courses. Card games also facilitate the use of technology and provide a social context for learning. In this way, card games add a richness to the learning environment that is often difficult to achieve. ▲

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▲ Facilitating Students' Learning Through Historical Approaches to Multiplication, from the Babylonians and Egyptians to Fibonacci and Descartes

VERA SARINA



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As mathematics teachers, what do we need to know about our subject besides the "standard" mathematical knowledge? In another words, what kinds of supplementary mathematical knowledge will help ensure our students' success? I found my answer in the history of mathematics.

The idea of incorporating history into mathematics education has received considerable attention and has been discussed for decades. Educators who actively use the history of mathematics in their teaching practices are enthusiastic about this approach. Researchers (Fauvell & Van Maanen, 1991; Liu, 2003) give many reasons for including history in the mathematics curriculum. Among the most common reasons are that history helps develop a positive attitude toward learning, that using history in mathematics instruction can contribute to students' understanding of concepts, and that mathematics history provides an excellent source of interesting problems that help sharpen problem-solving skills. In my own teaching practices, I have observed that a historical approach motivates student interest; provides memory cues for math concepts; builds connections between and among different strands and concepts by showing the origins of concepts; develops critical-thinking skills; demonstrates the interrelation of math and the real world, thus making math relevant and human; dispels many conceptual misunderstandings; promotes diversity, multiculturalism, and unity; and gives glimpses of world history. I have also noticed that my personal interest in the history of mathematics has rewarded me with a better understanding of the subject and of the difficulties students encounter with certain concepts. For me, the history of mathematics has become an endless source of alternative teaching strategies, interesting problems, and fascinating stories about mathematicians from around the globe.

The history of mathematics is a wide subject, and not all the facts, details, and intricacies of it may be interesting and relevant to practising teachers. It will not function as a teaching tool unless it is retold with a clear understanding of how, and for what purpose, historical materials might be used in mathematics classrooms (Wilson and Chauvot, 2000). This article is my attempt to show, using one particular math concept, how the history of mathematics can supplement the "standard" knowledge we present to our students. The article comprises a very brief introduction to the history of multiplication.

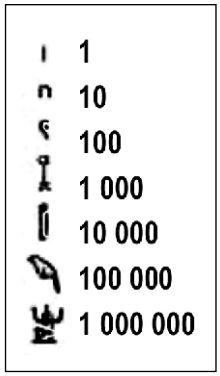
Multiplication Methods

A considerable part of mathematics history reflects attempts to facilitate computational tasks. Humanity came up with many multiplication methods before the invention of computing machines. We will consider only five of these methods:

- Egyptian multiplication (3000 BC–0 AD)
- Babylonian multiplication (2000–600 BC)
- Lattice multiplication (India, 200 BC–400 AD; Fibonacci, 1202)
- Logarithms (Napier, 1614)
- Analytic Geometry (Descartes, 1637)

Please note that to avoid unnecessary complexity and to highlight the essence of the methods described, only modern notation will be used in the examples.

Egyptian Multiplication



The Egyptian multiplication method was based on doubling and adding, in the same way that a binary computer works. This method was used in many rural communities in Ethiopia and the Middle East up until the twentieth century. Ancient Egyptians used an additive numeral system. Any number in such a system can be represented by the combination of symbols, where each symbol has its own value, independent of its position. The value of a number is equal to the sum of the values of all the symbols. This system made multiplication almost impossible, but ancient Egyptians

overcame this obstacle by inventing a multiplication method that could be performed without multiplication!

Let's see how they might multiply 21 and 36:

21 x 36	
1	36
2	72
4	144
8	288
16	576

Write down 21 x 36. Draw a line, setting up a small chart. Start with 1 in the left column and 36 in the right. Doubling both numbers, you will get 2 and 72. Proceed with doubling the numbers in both columns until you have enough numbers in the left column to make a sum of 21. The numbers are 1, 4, and 16 (1 + 4 + 16 = 21). Add the corresponding numbers from the right column (36 + 144 + 576 = 756) and you get 21 x 36, which is 756!

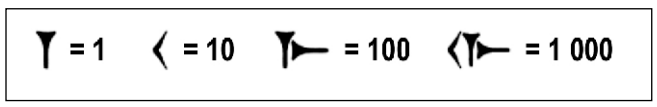
Why does this method work? It works because it implicitly uses the distributive law:

21 x 36 = 36 x (1 + 4 + 16) = 36 x 1 + 36 x 4 + 36 x 16

Good students in the junior grades might enjoy trying this method of multiplication, and some students in higher grades might be interested in explaining why this method works. This method also emphasizes that multiplication is just a shortcut for addition, a concept that sometimes remains a mystery, even for senior students.

Babylonian Multiplication

The Babylonian number system was based on the same idea of place value as the Indo-Arabic system we now use. However, the base of the Babylonian system was 60, as opposed to our 10. Babylonian documents were written on clay tablets by means of a sharp reed stylus. Babylonian multiplication tables were numerous, and many of them were times tables of one of 40 principal numbers (numbers that contain no prime factor but 2, 3, and 5, with the exception of 7; e.g., 2, 3, 5, 6, 7, 10, 16, 20, 24, 48, 75, 144) by 1, 2, 3… 20, 30, 40, and 50.



How might Babylonians multiply 24 (a principal number) and 37? Babylonians would write 37 as 30 + 7 and use the distributive law: 24 x (30 + 7) = 24 x 30 + 24 x 7. Then they would look up the answers for 24 x 30 and 24 x 7 in the multiplication table for 24 and add them up: 720 + 168 = 888. If they had to multiply a number for which they didn't have a multiplication table (non-principal number), they would write it as a sum of principal numbers (e.g., 26 = 20 + 6) and, once again, use distributive property and addition to find the product.

The Babylonian method might be a topic for exploration in Grades 4 and/or 5. "By the end of Grade 4, students will identify, through investigation, and use the distributive property of multiplication over addition to facilitate computation with whole numbers." (OCM 2005, p. 73) or "By the end of Grade 5, students will multiply two-digit whole numbers by two-digit whole numbers, using estimation, student-generated algorithms, and standard algorithms" (OCM 2005, p. 79).

How can our students use this method? To demonstrate, let's multiply 23 and 37. First, decompose 23 into 10 and 10 and 3. Then multiply 37 by 10 and again 37 by 10. You get 370 and 370. Then you have to multiply 37 by 3. Decompose 37 into 10, 10, 10, and 7. Multiply 3 by these numbers. You get 30, 30, 30, and 21. Add all the results and you have the answer 23 x 37, which is 851. In the regular notation, the process will look cumbersome, but clear:

$$\begin{aligned} 23 \times 37 &= \\ (10 + 10 + 3) \times 37 &= \\ 370 + 370 + 3 \times 37 &= \\ 370 + 370 + 3 \times (10 + 10 + 10 + 7) &= \\ 370 + 370 + 30 + 30 + 30 + 21 &= 851 \end{aligned}$$

Lattice Multiplication

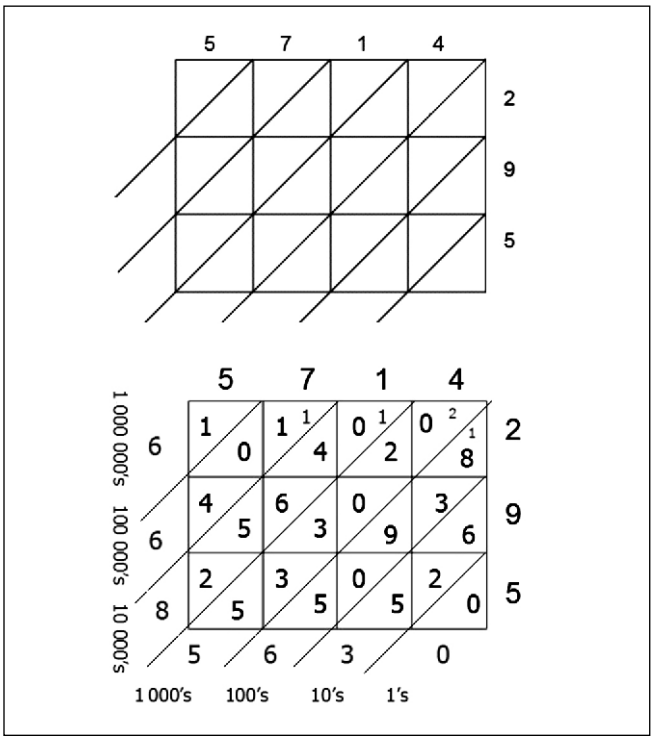
During the Renaissance, Europe—with its booming trade, money circulation, and navigation—desperately needed fast computational techniques. For many European mathematicians, that need was a driving force for their mathematical endeavours. Fibonacci, who is known mainly for his discovery of Fibonacci sequences, introduced the Western world to lattice multiplication in 1202 in his book *Liber Abaci*. Lattice multiplication is a method of multiplying large numbers, using a grid. It was invented by the mathematicians of ancient India, and along with Indian numerals, which we now call Arabic numbers, was brought to Europe by Arabs.

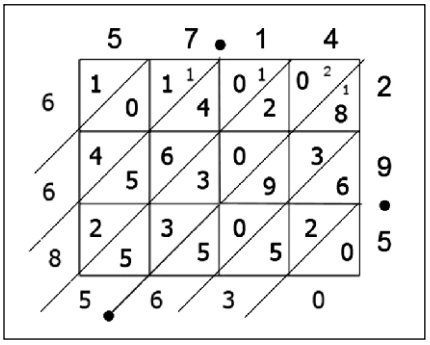
Let's multiply 5714 and 295, using lattice multiplication:

- First, draw a grid 4 by 3 and write 5714 and 295 on the top and right of the grid.
- Draw diagonals through all the squares.

- Multiply the digits at the head of each row and column, and fill in each square of the grid with the product.
- Add the numbers in the grid along the diagonals, starting from the lower right corner. Carry any tens into the top of the next diagonal.

The number outside the grid is the answer: 5714 x 295 = 6 685 630

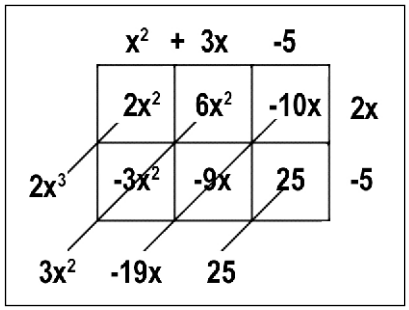




Lattice multiplication works beautifully while multiplying decimal fractions. Suppose that instead of the above problem, we want to multiply 57.14 by 29.5. We would proceed as before, but draw lines from the decimal points down and to the left until they meet, then follow the diagonal to the left or bottom of the grid. The point where this diagonal emerges from the grid is the position of the decimal point in the answer. Or just add up the number of decimal places in the factors and count accordingly the position of the decimal point in the product.

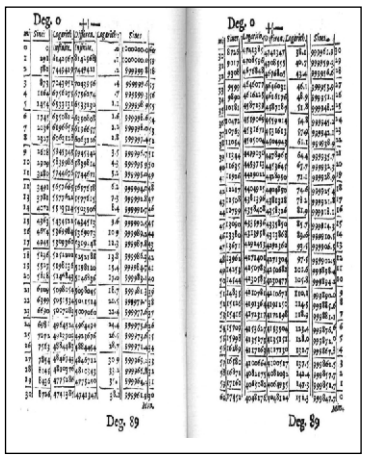
In Grades 6 and 7, lattice multiplication can be a valuable tool for addressing curriculum expectations that involve multiplying whole numbers by decimals and multi-digit numbers. "By the end of Grade 6, students will solve problems involving the multiplication and division of whole numbers (four-digit by two-digit), using a variety of tools and strategies" (OCM 2005, p. 88) or "By the end of Grade 7, students will solve problems involving the multiplication and division of decimal numbers to thousandths by one-digit whole numbers, using a variety of tools and strategies" (OCM 2005, p. 99).

Lattice multiplication, besides being an enjoyable and easy way to multiply long numbers, gives an organized display of the partial products. Adding along the diagonals accounts for place value (which is especially meaningful while students work with decimals) and thus reveals the mystery behind the obligatory aligning of least significant digits when doing long multiplication.



Lattice multiplication also extends beautifully to the multiplication of polynomials (Grade 10). It provides an explicit way to keep track of the distributive property: each term-by-term product gets its own cell. If the terms of the factors are placed according to the same order (descending or ascending powers of the variable) and missing terms get blank space, then like terms of the product are found along the diagonals of the grid. The final product is found by adding up the cells diagonally.

Logarithms



As the centuries passed, Europeans kept looking for better and faster methods of computation. In 1614, the Scottish mathematician John Napier invented logarithms. It took him 20 years to complete the first log tables. What was Napier's purpose for inventing this system? He developed it as a shortcut for multiplication to save astronomers time and to limit the "slippery errors" of calculations! Napier's logarithms had a base roughly equal to 1/e, but we will

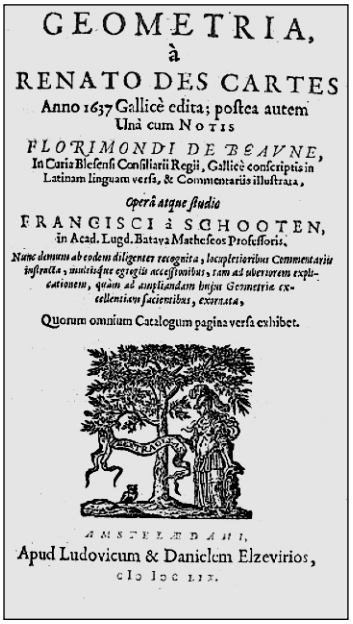
look at his method using base-ten logs that were introduced by the Englishman Henry Briggs some dozen years later. To demonstrate, let's multiply 67.8 by 938, with the help of logarithms. The logarithmic method of multiplication is based on one of the exponent rules: When you multiply powers with the same base, you just add their exponents. According to this rule, $10^a \times 10^b = 10^{a+b}$. Our first step is to find log 67.8 and log 938. Only 20 years ago, we would have used the log table, and we would have had to do some additional steps, writing 67.8 and 938 in scientific notation. But these days, we'll use a calculator: log 67.8 = 1.83123 and log 938 =. 2.9722. Thus, we can write our numbers as powers of ten and use the exponent law:

$$67.8 \times 938 = 10^{1.83123} \times 10^{2.9722} = 10^{1.83123 + 2.9722}$$
$$= 10^{4.80343} \approx 63\,596$$

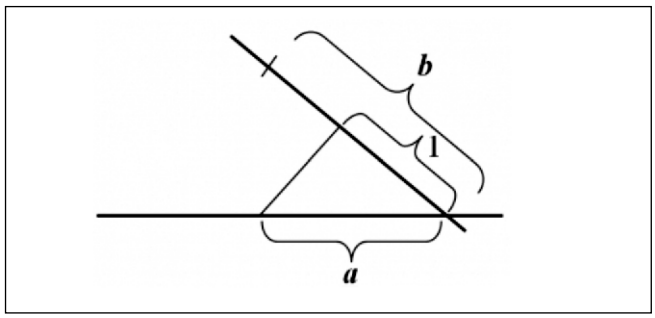
WORK BACKWARDS: Find the antilogarithm or inverse logarithm of 4.80343 (which is actually calculating 104.80343) by pressing SHIFT and LOG on a scientific calculator. It is approximately 63 596, so 67.8 x 938 is approximately 63 596!

This historical excursion into the real purpose of inventing logarithms as a multiplication device will give Grade 12 students a deeper understanding of logarithms and will show why logs are still so important in modern science. It also demonstrates strong connections between logarithm rules and exponent rules, and creates a bridge between intermediate and senior mathematics courses.

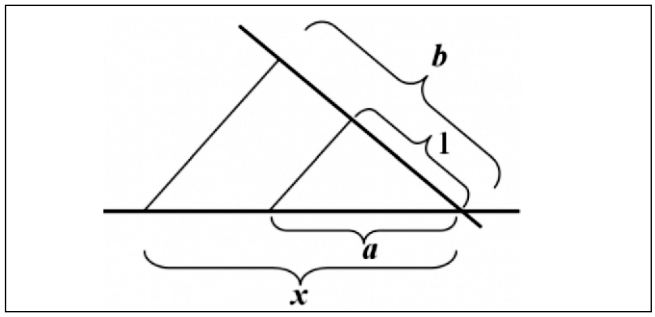
Analytic Geometry


GEOMETRIA,
à
RENATO DES CARTES
Anno 1637 Gallicè edita; postea autem
Unà cum NOTIS
FLORIMONDI DE BEAVNE,
In Curia Blesensi Consiliarii Regii, Gallicè conscriptis in
Latinam linguam versa, & Commentariis illustrata,
Operâ atque studio
FRANCISCI à SCHOOTEN,
in Acad. Lugd. Batava Matheseos Professoris.
Nunc demum ab eodem diligenter recognita, locupletioribus Commentariis
instructa, multisque egregiis accessionibus, tam ad uberiorem explicationem, quàm ad ampliandam hujus Geometriæ excellentiam facientibus, exornata,
Quorum omnium Catalogum pagina versa exhibet.
AMSTELEDAMI,
Apud Ludovicum & Danielem Elzevirios,
CIↃ IↃC LIX.

Mathematics was revolutionized by French mathematicians René Descartes and Pierre de Fermat with the invention of Cartesian or analytical geometry. In his treatise *Discourse of the Method* (1637), Descartes shows how arithmetic is related to geometry. One of the sections of the book is entitled "How multiplication, division, and the extraction of square roots are performed geometrically." Once again, we see how the computational needs affected new mathematical discoveries. Although analytic geometry serves algebraic purposes (to find solutions for equations with two variables), its foundation is geometric. The following example illustrates the method of multiplication described by Descartes in *The Geometry* section of his treatise. This method emphasizes the idea of solving arithmetic questions, using geometrical constructions: Suppose we want to multiply two numbers. It can be any two numbers, so we use variables *a* and *b*.

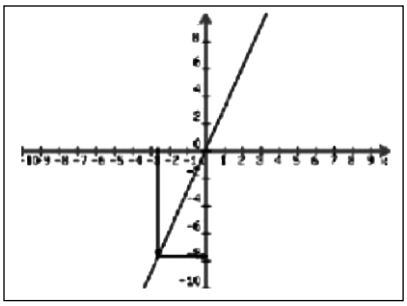


- Draw two intersecting lines.
- Mark lengths 1(unit) and *b* on one line and length *a* on the other line.
- Draw a line between 1 and *a*.



- Starting from *b*, draw a parallel line to the line between 1 and *a*.
- We have two similar triangles; thus $x/b = a/1$.
- Crossmultiply and $x = ab$!
- Mathematially obvious, but still magical!

The central concept of analytic geometry can be well illustrated to students in Grades 9 and 10 by showing them that graphs can be used as computing devices:



Let's say you want to multiply 3 by -2.6.

First, draw the graph of $y = 3x$ by plotting points (0,0) and (1,3) and drawing a line through them. Then find a corresponding *y*-value for the point with *x*-value equal to -2.6. The *y*-value is -7.8, which is the answer to 3 x (-2.6).

The graph is actually a limitless 3 times multiplication table for all rational numbers! Of course, the values are approximate, depending on the resolution of the plane. When students see this side of analytic geometry, it becomes increasingly easier for them to conceptualize deeper ideas and principles of graphical representation of functions and relations. Knowing the historical roots of analytic geometry gives students a solid foundation for their further studies.

Conclusion

The Ontario Mathematics Curriculum "recognizes different learning styles and sets expectations that call for the use of a variety of instructional and assessment tools and strategies." The history of mathematics provides teachers with an almost endless source of different strategies, methods, and approaches. There is growing evidence that the inclusion of some mathematics history in the school curriculum increases student motivation and achievement. It "(i) helps children to make more sense of mathematics, (ii) humanizes the subject, (iii) emphasizes the continuous and continuing development of mathematics, and (iv) fosters an appreciation of the multicultural inheritance and culturally dependent nature of the subject" (Lingard, 2000). However, the question remains: How can the historical approach become more prevalent in Ontario schools? The first step in this process can be realized through the in-service training of practising teachers in the relevant topics of mathematics history. The next step may lie in the explicit integration of the historical perspective into curriculum expectations during future updates, thus prompting Ontario teacher-training institutions to provide formal teaching in the subject area known as the history of mathematics.

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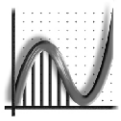
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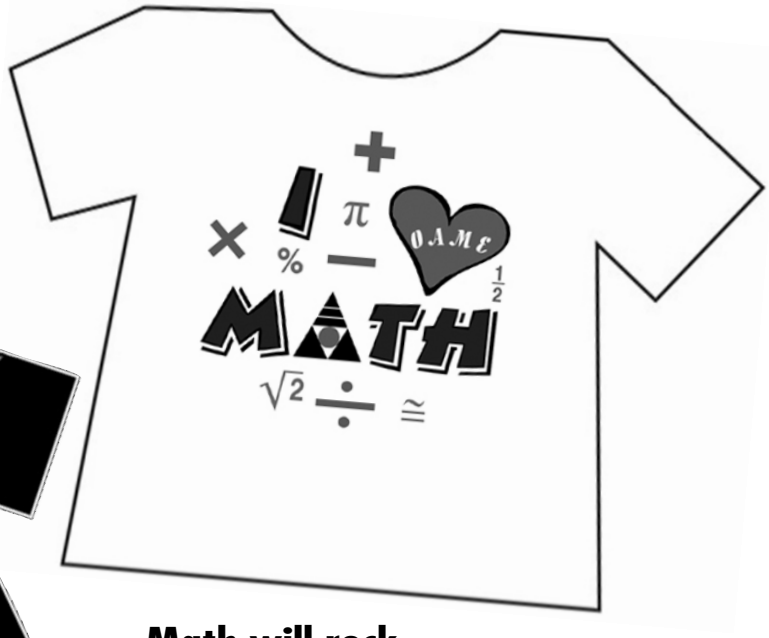
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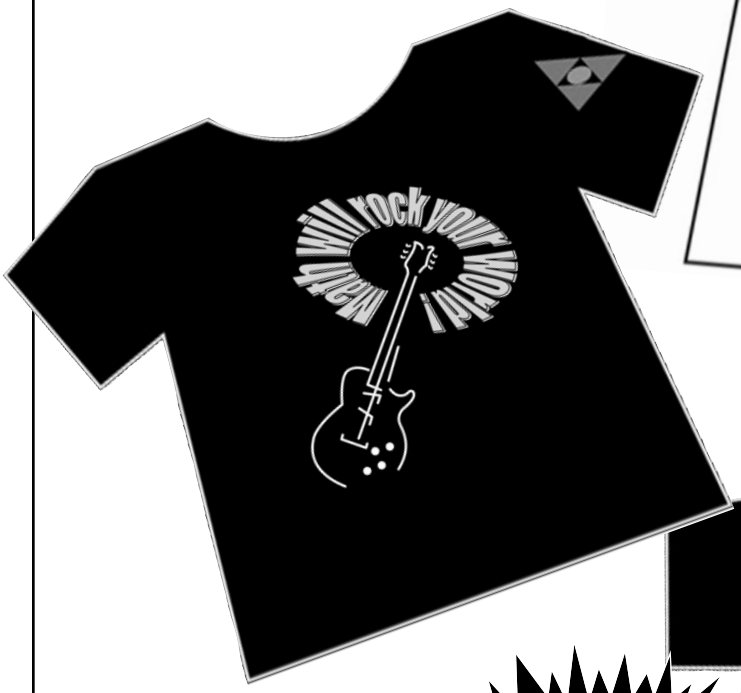
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