Submission of Articles

The *Ontario Mathematics Gazette (OMG)* is looking for articles, news and "good ideas" useful to mathematics teachers or mathematics teacher education. We are seeking submissions from mathematics teachers K-12 and tertiary, that describe teaching mathematics content in an innovative way.

The criteria for manuscript submission to the *OMG* includes the following:

- The ideas/activities are of interest to the readership.
- The article/ideas are not widely known or practised and are innovative.
- The mathematics content is appropriate for the readership.
- The mathematics content is accurate.
- The article is well written and grammatically correct.
- The article/ideas are free of sexual, ethnic, racial and other bias.
- The article has not been published previously, nor is out for review by other publications.

Articles must be original. Your article must be word processed, preferably using *MS WORD*, double spaced on one side with wide margins, not exceeding 10 numbered pages of text and prepared according to the *Publication Manual of the American Psychological Association Fifth Edition*. Diagrams and figures should be drawn by computer if possible or neatly drawn in black ink in camera-ready form. Embedded images should also be submitted separately in jpeg or tif format. Proof of the photographers' permission is required. For photos of students, parent or guardian permission is required. Please number pages.

You must submit **4 hard copies** of your article to the Editor **Marilyn Hurrell** whose address appears on page 2. Your name may not appear anywhere in your article, including web sites. Your name and full mailing address and e-mail address must be included on a separate sheet. Your article will be sent out for blind review. If it is accepted as is, or with major/minor revisions or rejected, you will be notified. Once an article is accepted for publication, computer files of text, original graphics and photos will be required. E-mail submissions are welcome but must be followed by hard copies.

The Editor reserves the right to edit manuscripts before they are published. Once an article is published it becomes the property of OAME.

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Submission of Advertisements

Advertisements for 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

MARILYN HURRELL, EDITOR



OAME's first on-line election has concluded. The election was held on the OAME web site from March 16 to April 13 2007. Access was only for members. Dave and Sue Hessey, OAME Executive Directors, report that the turnout was about equivalent to the number of paper ballots returned in previous years. From their end of things it ran smoothly, without a hitch. They encourage more members to take advantage of this on-line opportunity next year. The list of the new and returning Board members is on the last page of this *Gazette*. Greg Clark, web master for OAME remarks: "Thanks to those who ventured into the 21st century and took part in democracy on-line. I applaud those who took this new approach."

Dave and Sue and Greg each put a lot of work into this venture and deserve a big vote of Thanks!

This issue of the *Gazette* contains an article by Margaret Sinclair and her colleagues at York U and Senneca College, on the College Math Project. This makes interesting reading for those who advise students on which mathematics courses to take for college preparation. I recently attended a similar workshop in Thunder Bay, conducted by Anthony Azzopardi and Rod Yeager, which discussed the new Grade 12 mathematics courses and their place in University/College curricula. Both are very timely topics.

Enjoy all of the other good reading in this issue.

Our spring seemed to start early with wonderfully warm temperatures in March, then a blinding snowstorm last week that still remains on the ground. As I write this in mid April, snow is forecast for tomorrow. This makes my wish for you more pronounced:

Have a warm, restful and safe summer holiday!

Marilyn

▲ President's Message

JACQUELINE HILL, PRESIDENT
E-MAIL: hill_jacqueline@durham.edu.on.ca



Welcome!

I am delighted to be your President for the 2007-2008 year! This is an amazing time in Mathematics!

My love of mathematics started as far back as I can remember, from those wonderful math games in early elementary school to the family vacation where we did mental calculations for the conversion of miles to kilometers to find how long it was to the next town. I really have my family to thank for lighting the mathematical flame for me and then for helping me to keep the fire burning throughout my teaching career. I am currently out of the classroom and working out of the board office as the K-12 Mathematics Facilitator for the Durham District School Board.

My OAME career started in the early 1990's when I became the Pine Ridge Mathematics Association chapter rep. Since then I have been a Director, VP, President-Elect and now President. I would like to take a moment to thank those fine presidents who have helped to guide my path: Peter Saaramaki, Barry Onslow, Judy Crompton, Ralph Connelly, Mary Howe, Shirley Dalrymple, Marg Warren, Stewart Craven, Gord Cooke, Kathy Kubota-Zarivnij, and Dan Chabonneau.

I started this President's Message by talking about the amazing time we are having in mathematics. More specifically I am thrilled with the Kindergarten to Grade 12 vision for mathematics that the province currently holds. It excites me to see manipulatives being used in so many ways in K-3 classrooms. I love the evolving and growing mathematical maturity in the 4-8 students, and seeing students who really are prepared for today's changing world coming out of high school.

OAME has done a lot of work on helping to set the stage for what K-12 mathematics needs to look like from the *Growing Up Mathematically* (or *GUM)* project, to writing up teacher friendly manipulatives tasks for K-12. I will strive to continue this vision.

I know our secondary folks are eagerly waiting for more summer writing to be done to help with the revised curriculum. Summer writing is planned for grade 12 courses, and the results of this will be posted on the OAME web site before the last week in August.

I would like to congratulate the recent winners of the OAME and Union Gas Awards.

OAME Awards

- Life Membership - Bill Morrison
- Award for Exceptional and Creative Teaching in Secondary Mathematics - Rob McLeish
- Award for Exceptional and Creative Teaching in Elementary Mathematics - Shelagh McCarthy
- Award for Outstanding Contribution to OAME - Dr. Lynda Colgan
- Kenneth D. Fryer Math Department Award - Fletcher's Meadow Secondary School

Union Gas Award Winners

- Elementary Teacher - Christine MacTavish
- Secondary Teacher - Paul Alves
- Leadership in Mathematics - Bonnie Jaakkimainen

I would also like to take the time to congratulate all of the committees that helped to make the OAME 2007 annual conference in Barrie a tremendous success!

On the topic of great jobs! Leadership 2008 will have a two fold structure. We will be looking at Lesson Study as well as Emerging Technologies. The flyer will be out in September 2007 and the dates for Leadership in 2008 are the evening of Thursday February 21, then Friday February 22 and half a day on Saturday February 23, 2008.

Finally, as many presidents before me have encouraged you, I would like to encourage you all to participate in your local chapter. I am from the Pine Ridge Mathematics Association chapter (PRMA) and we have been tagged with the title "the little choo choo train that could" since, even with a small executive, we managed to host OAME annual 2003, provincial OMO 2004 and will be hosting provincial OMO's 2008 and 2009. A great thanks to my chapter and all of the other chapters in the province that help to make OAME what it is today.

Yours in Mathematical fun,

Jacqueline Hill ▲

▲ From the Editor's Desk

This issue of the *OMG* marks the departure of two members of the support staff of the *OMG*.

The first is Trevor Brown, who has edited the *Abacus* for the past four years. Trevor has served the mathematics community as former Mathematics Consultant for the Toronto District School Board; as a Course Director in Intermediate Mathematics at OISE and University of Toronto; as writer and consultant for *Mathematics Makes Sense* [Pearson] and as a presenter at OAME and NCTM conferences.

I asked Trevor for a short message and this is his reply:

> *"Yes...please add that this was my second time as the editor of the Abacus and I thoroughly enjoyed the times I spent working on the journals!"*

I believe his first editorship was in the late 1980's, along with Lorna Morrow.

I have had a wonderful working relationship with Trevor: basically, he just quietly and efficiently produced 8 pages of *Abacus* material for each issue and submitted these to the graphic designer. Thank you Trevor!!

The September 2007 *Abacus* will be produced by the new Editorial team of Kathy Kubota-Zarivnij and Mary Lou Kestell, both former presidents of OAME.

The other member of the team who is choosing to retire is Dean Murray. I had the same working relationship with Dean as with Trevor: I just opened my issue of the *OMG* when it arrived and there were the ads! Made my job easy!

I asked both Louis Lim and Jack Weiner, who worked with Dean on the *OMG* for several years, for their comments.

Louis writes:

> *"Dean Murray was a long standing member of the OAME Publications Committee, as a result of being Advertising Manager. He worked hard to establish partnerships with advertisers (such as textbook publishers Texas Instruments; etc.). I recall attending the OAME Publication Meetings and Dean would always have his report for the committee — sometimes advertisers were hard to get due to the times. Good luck Dean."*

Jack Weiner, who has known Dean very well through GVMA, writes:

"There are several people on this planet who astound me for two reasons. First, I am amazed at the sheer volume of tasks they take on. Second, in spite overwhelming responsibilities—a set of tasks that would bring most of us to our "Give me a break! I need a break!" knees—they do so happily and SUCCESSFULLY. Dean Murray has been a teacher and mentor for thousands of students, as well as for hundreds of younger teachers entering our profession. I was pleased but not surprised when he won the Prime Minister's Award for Teaching Excellence. He has been on the Executive and later Chair of the Grand Valley Mathematics Association since before time began. Twice he has chaired or co-chaired an OAME conference. The GVMA conferences—all Dean, all the time. He has been an OAME board member for years, and on council, a strong advocate for Chapter rights.He has been by far the most successful advertising director for the OMG since the journal began to accept advertising back when someone named Winer or Whiner, something like that, was editor. (True, he has been the only person in this role. But he has been great!) Dean retired from Milton District High School three years ago and immediately joined the Centre for Education in Mathematics and Computing at the University of Waterloo, where he continues to support excellence in mathematics across Canada and the world. AND Dean is a supportive husband and father. In this last role, he put his GVMA and OAME conference coordinating experience to work to choreograph marriages of his two kids in the last three years. Dean, you astound me. I am honoured and privileged to say Dean is my colleague and friend. Good luck, Dean! Welcome, Robert Sherk, as new OMG Advertising Director. Robert, I am sure Dean would say, "Got a question? Call me anytime." Good luck, Robert!

And I'll let Dean have the last word:

"Here are some facts as requested. Through advertising I raised close to $140 000 for OAME as Advertising Manager for 50 issues or twelve and one-half volumes.

I was instrumental in getting colour added to the Gazette and helped to build an excellent working relationship for OAME with publishers

Thanks to Pole Printing (Terry Sheppard and Lynn Cole) for their much needed support for many years until digital art files began being used to print the Gazette.

Thanks to Penny Clemens for her much needed advice and flexibility when I needed it." ▲

▲ Letters to the Editor

Dear Editor:

Our members will be interested in learning that one of the members of OAME has been elected to the NCTM Board of Directors. Christine Suurtamm, assistant professor of mathematics at the University of Ottawa, began her 3 year term on the Board at the NCTM annual meeting in March in Atlanta. Christine has written many useful articles for the *Ontario Mathematics Gazette*. This election is a great honour for both Christine and Ontario. She is only the 3rd teacher to be elected from Ontario. I was the first serving from 1965 to 1968 and as president from 1975 to 1977. Bob Robinson was our second representative being on the Board from 1982 to 1985.

Sincerely,

John Egsgard

Dear Editor:

I just received the *Gazette* (March 2007) and what a nice collection of interesting stuff. It's a pleasure to read and touch base with the folks I have gotten to know via their columns.

I was glad to see the letter from Joanne Robinson. Bob Robinson got me interested in NCTM in 1984 when he was Ontario's NCTM rep.

Yours truly,

Frances Schatz

(Editor's note: Francis Schatz was Editor of the *Abacus* for 8 years and NCTM rep for OAME for many years also. She is enjoying retirement with her husband Frank and her grandchildren.)

Dear Editor:

Subject: Calculus the Musical: Web site / Performance Interview

Just a note that George Gadanidis has a web site with a bunch of materials related to Calculus the Musical: **http://www.edu.uwo.ca/dmp/calculus**

People might enjoy exploring this.

Walter Whiteley

Dear Editor:

Thanks for sending, as always, the *Gazette* (Volume 43 #4 June 2006). I enjoyed the tech article by Mary Bourassa and recalled seeing her in the list of speakers for our southern section, Palm Springs, conference. I'm working on editing that list now. On the next page, pg 7, I was very interested in the excellent article by Lynda Colgan. I told our editor, Janet, to be sure to check it out in case she was interested in using it for the *ComMuniCator*[1].

BTW, I didn't see an email for Shawn Godin, so you might pass along this extension to his pg 22 article:

The first time I saw a version of that problem was long before the *Discovery Channel*! You are to place the 13 cards so you remove cards as in his example, but say

"A, C, E" (And you remove 3 cards to the bottom) and then turn over the fourth card, say "Ace", and it is an Ace. Likewise 3 to the bottom and turn the fourth as you say, "T, W, O, two" and turn over the two. Then 5 to the bottom for "T, H, R, E, E, three" and flip the 3.

We also have a variant where the spelling is "uno, dos, quatto, cinco,... "but a more appropriate one for your group would be "un, ... trois..."

Again, thank you! Keep up the excellent work.

Mike Contino, Executive Secretary
California Mathematics Council

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[1] CMC is an affiliate of the National Council of Teachers of Mathematics

▲

▲ Technology Corner: A Focus on Functions and Modeling

MARY BOURASSA



Mary Bourassa teaches mathematics at Lisgar Collegiate Institute in Ottawa. She is a strong advocate for the appropriate use of technology in the classroom. She was also an OAME vice-president, past-president of COMA, gives workshops around the world and is a National Instructor for Texas Instruments.

Throughout high school students learn how to model various real-world situations with a graph or mathematical expression. In grade 9 they use linear models, in grade 10, quadratic models. The grade 11 U and U/C courses expose them to a toolkit of functions which they can now use in modeling. Modeling is all about determining the relationship between two quantities. Understanding both the situation you are trying to model and the mathematics you have as your tools is crucial to successful modeling. Models are usually simplified versions of what they represent. By simplifying the situation we can make accurate predictions about what will occur under certain circumstances. If the circumstances differ greatly then the model will not be useful.

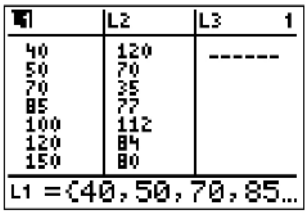
Example

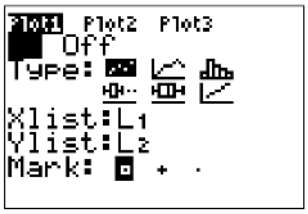
Students at a high school want to raise money for a music trip. They plan on selling tickets that will allow a family to attend all concerts put on at the school. In order to help decide how much to charge for the tickets, they put out a survey asking students and their parents what amount would be the most they would be willing to spend for an all-concert ticket.

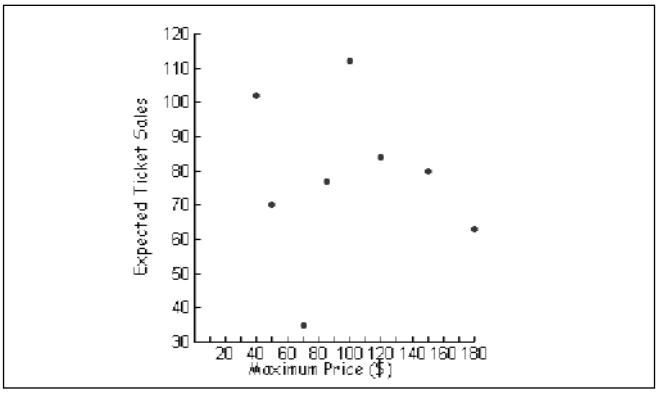
The results are given in the following table:

Maximum Price ($)	40	50	70	85	100	120	150	180
Expected Ticket Sales	120	70	35	77	112	84	80	63

What do we do with this data? One way of looking at data is to make a scatter plot. This allows us to see the general relationship, if one exists, between the two quantities. The independent variable should be on the horizontal axis, the dependent one on the vertical axis. Enter the data in List 1 and List 2 of your graphing calculator then plot the data.



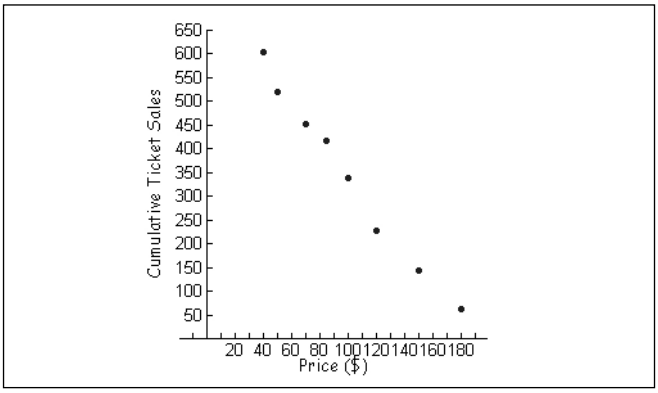




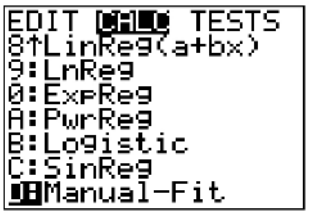
There is no obvious relationship between the data in this plot. We need to think about the data we have collected a little more. We can assume that each of the families that responded to the survey will purchase a ticket. If a family is willing to spend up to $180 for a ticket, then they would still purchase it if the price was $150 or $120 and so on. If a family is willing to spend up $150 for a ticket, then they would still purchase it if the price was $120 or $100 and so on. Therefore, what we need to look at is not the expected ticket sales for each price but the cumulative ticket sales for each price point.

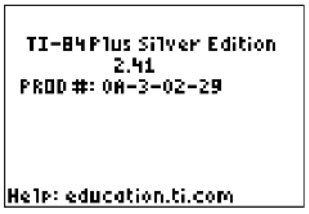
Enter the cumulative ticket sales in List 3 and create a new scatter plot of the data.

Maximum Price ($)	40	50	70	85	100	120	150	180
Expected Ticket Sales	641	521	451	416	339	227	143	63



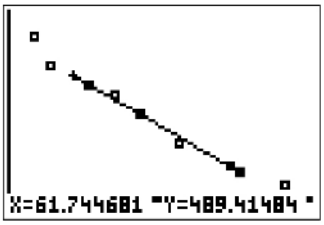
This scatter plot provides information about the relationship between the ticket price and the number of tickets – the higher the price, the lower the number of tickets that will be sold. The data looks linear. You can determine the equation of a line that models this data well in many ways. Try using Manual Fit on your graphing calculator. Press [STAT] ▶ [CALC] and choose option D:Manual-Fit.

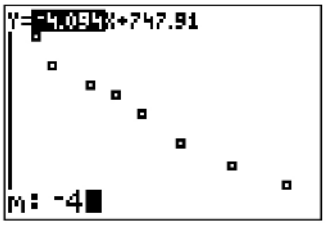


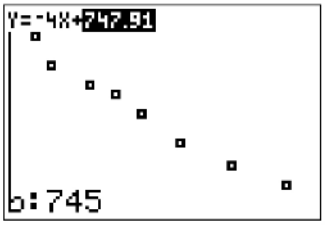


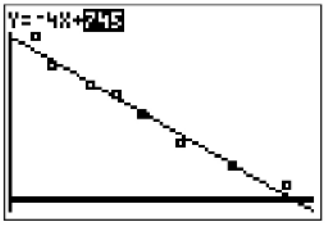
If you do not have this option then you need to upgrade your calculator's operating system. Press [2nd] [+] then choose 1:About to see the version you have. The latest version for the *TI-84* is 2.41 which can be downloaded from **education.ti.com**. Each operating system upgrade improves the functionality of your calculator. For example when you graph y = tan(x) now, it does not connect the pieces of the graph as it used to.

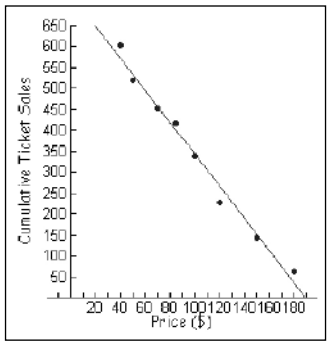
Using Manual-Fit, students choose a starting point then use the arrow keys to create a line of best fit. When they are happy with their line they press [ENTER] and the full line appears along with its equation. They can now adjust the values of m and b in the equation to further refine their line of best fit. The equation is automatically stored in Y1.











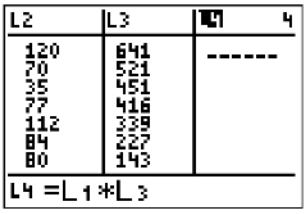
The equation here should be something like t(p) = –4 p + 745, where t is the cumulative ticket sales and p the price. Using this information we can now determine how many tickets will sell for a particular price.

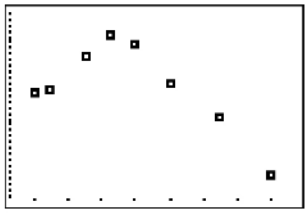
What the students need to know is how much to charge in order to make the most money. The revenue for a particular price point can be found by multiplying the price by the number of tickets sold at that price.

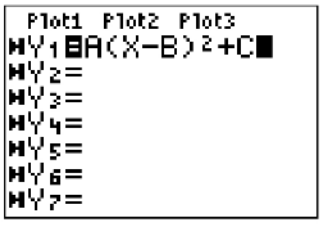
e.g., r(p) = p • T(p)

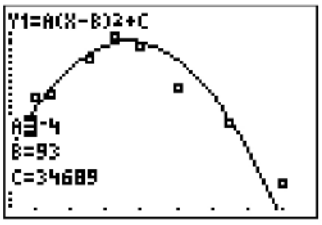
r(p) = p (–4p + 745)

This can be accomplished by creating a formula in List 4 which is: [L4] = [L1] * [L3]. If this option is chosen then using the Transformation Graphing App would be a great way of finding the equation that models the data. The maximum revenue and number of tickets sold will be evident once they have found a good model as the equation will be in vertex form,



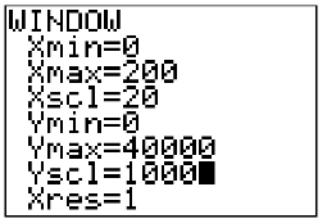


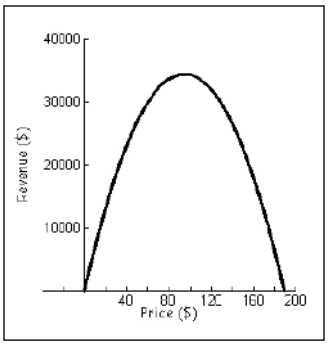




Another way of creating a graph of the revenue is to define a new equation using the equation already stored in Y1. Students will need to find a suitable window to view the new graph.

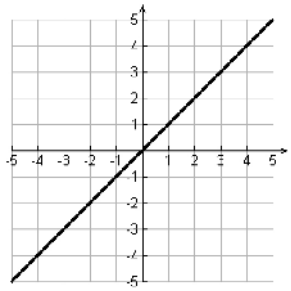




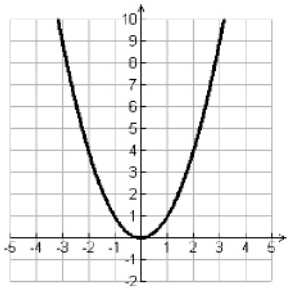


The revenue is a quadratic function. The price that corresponds to the maximum revenue can now be determined. With a graphing calculator you can perform a quadratic regression to find the vertex or students can use their knowledge of quadratics (we know that the vertex occurs mid-way between the zeros of a parabola) to determine the equation without technology. We find a maximum revenue of approximately $34 689 when each ticket costs approximately $93. At this price they can expect to sell approximately 373 tickets.

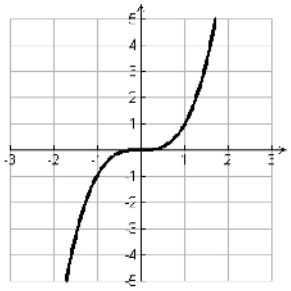
In order to be able to effectively model data students need a toolkit of functions.



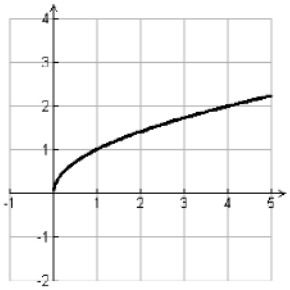
Linear: $y = x$



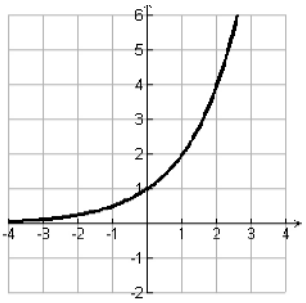
Quadratic: $y = x^2$



Cubic: $y = x^3$

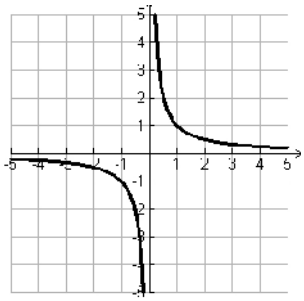


Square Root: $y = \sqrt{x}$



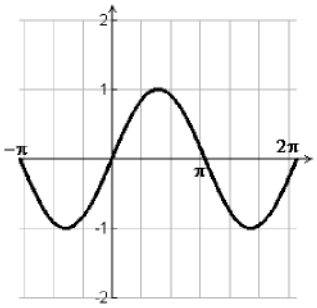
Exponential Function:

$y = 2^x$



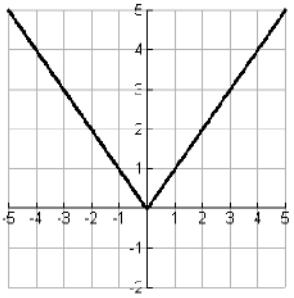
Reciprocal Function:

$y = \frac{1}{x}$



Sine Function:

$y = \sin x$



Absolute Value Function:

$y = |x|$

Note: There are many other types of functions other than those shown here.

Transformations can be applied to any of these functions. The effects can be summarized as follows:

Given $y = af[k(x – p)] + q$, compared to the graph of $y = f(x)$, the graph is…

- stretched vertically by a factor of “a”
- compressed horizontally by a factor of “k”
- translated to the right “p” units if $c > 0$ or to the left “p” units if $c < 0$
- translated up “q” units if $d > 0$ or down “q” units if $d < 0$

When completing investigations students should:

- Decide which basic toolkit function the scatter plot resembles.
- Determine a model for the relationship between the quantities.
- Decide whether their model is a good one – and supports their decision. This should lead to a good discussion about residuals. ▲

▲ 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

Marilyn Hurrell
mhurrell@tbaytel.net
for further details.

▲ Hey, It's Elementary! Benezet's Experiment: Fodder for Summer Coursework



LYNDA COLGAN

"If you would understand anything, observe its beginning and its development" Aristotle

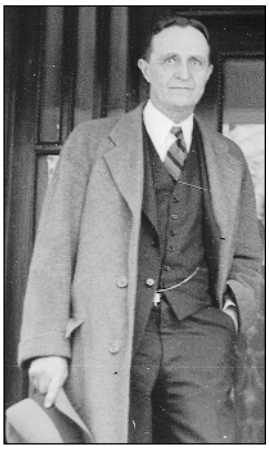
A few weeks from now, thousands of elementary teachers will switch sides on the desk and begin the new summer tradition for educators – taking courses. Some will be enrolled in additional qualifications courses; others, graduate studies. Many will be participating in specialized institutes organized by teacher federations, subject associations or private professional development providers. Books will be purchased, journal articles will be poured over, presentations will be prepared, papers will be written and *Google* will be working overtime, as teachers seek out everything from cutting-edge research that could inform their practice to innovative and motivating resources that they can use creatively with students.

As course-taking teachers prepare to debate, discuss, evaluate and critique new ideas, it seems timely to look back at an historical mathematical experiment that was conducted in the 1930's in Manchester, New Hampshire under the direction of the then Superintendent of Schools, Louis P. Benezet.

The excerpts are from his classic paper "The Teaching of Arithmetic I, II, III: The Story of an Experiment," which appeared in three editions of *Journal of the National Education Association* in 1935 and 1936.

> *In the first place, it seems to me that we waste much time in the elementary schools, wrestling with stuff that ought to be omitted or postponed until the children are in need of studying it. If I had my way, I would omit arithmetic from the first six grades. I would allow the children to practise making change with imitation money, if you wish, but outside of making change, where does an eleven-year-old child ever have to use arithmetic?*
>
> *I feel that it is all nonsense to take eight years to get children thru the ordinary arithmetic assignment of the elementary schools. What possible needs has a ten-year old child for a knowledge of long division? The whole subject of arithmetic could be postponed until the seventh year of school, and it could be mastered in two years' study by any normal child. For some years, I had noted that the effect of the early introduction of arithmetic had been to dull and almost chloroform the child's reasoning faculties. There was a certain problem which I tried out, not once but a hundred times, in grades six, seven, and eight. Here is the problem: "If I can walk a hundred yards in a minute [and I can], how many miles can I walk in an hour, keeping up the same rate of speed?"*
>
> *In nineteen cases out of twenty the answer given me would be six thousand, and, if I beamed approval and smiled, the class settled back, well satisfied. But if I should happen to say, "I see. That means that I could walk from here to San Francisco and back in an hour" there would invariably be a laugh and the children would look foolish.*

According to his rationale for the experiment, Benezet had been concerned not only that the standard of mathematics had been very disappointing in his school district, but that the children's ability to express themselves in speech and writing was "depressingly poor".



Louis Benezet

He argued that with less time wasted on long division, more time could be spent reading, writing, and thinking. He wrote:

> *In the fall of 1929, I made up my mind to try the experiment of abandoning all formal instruction in arithmetic below the seventh grade and concentrating on teaching the children to read, to reason, and to recite–my new Three R's. And by reciting I did not mean giving back, verbatim, the words of the teacher or of the textbook. I meant speaking the English language. I picked out five rooms–three third grades, one combining the third and fourth grades, and one fifth grade.*

Benezet instructed the teachers in the experimental classrooms not to teach arithmetic, but explained that they should give the children practice in estimating heights, lengths, areas, distances, and the like. Starting in 1932, children in the experimental rooms received no arithmetic teaching until 6th grade.

The results of Benezet's 3 year curriculum? There are two sources of evidence: Benezet's own qualitative data, collected when he went to a classroom, accompanied by a stenographer, assigned the class a problem and recorded their answers verbatim.

The second method used formal tests of mathematical achievement, along with IQ tests, given at three points in the sixth grade–on entry, after three months and after eight months. These quantitative data were collected by Etta Berman, a mathematics teacher as part of her Master of Education thesis study at Boston University. Her thesis supervisor was Guy Wilson, a leading expert in mathematics education and the author of the standardized tests widely used at the time, and employed in this study.

Here is an example of Benezet's method, excerpted from his papers.

THE REGULAR GROUP

"Here is a wooden pole that is stuck in the mud at the bottom of a pond. There is some water above the mud and part of the pole sticks up into the air. One-half of the pole is in the mud; 2/3 of the rest is in the water; and one foot is sticking out into the air. Now, how long is the pole?"

First child: "You multiply 1/2 by 2/3 and then you add one foot to that."

Second child: "Add one foot and 2/3 and 1/2."

Third child: "Add the 2/3 and 1/2 first and then add the one foot."

Fourth: "Add all of them and see how long the pole is."

Next child: "One foot equals 1/3. Two thirds divided into 6 equals 3 times 2 equals 6. Six and 4 equals 10. Ten and 3 equals 13 feet."

You will note that not one child saw the essential point, that half the pole was buried in the mud and the other half of it was above the mud and that one-third of this half equalled one foot. Their only thought was to manipulate the numbers, hoping that somehow they would get the right answer.

I next asked, "Is there anybody who knows some way to get the length?"

Next child: "One foot equals 3/3. Two-thirds and 1/2 multiplied by 6."

My next question was, "Why do you multiply by 6?"

The child, making a stab in the dark, said, "Divide."

Next, Benezet took the problem to a classroom that used the new curriculum. Here is what happened:

EXPERIMENTAL GROUP

First child: "You would have to find out how many feet there are in the mud."

"And what else?" said I.

Another child: "How many feet in the water and add them together."

"How would you go to work and get that?" said I to another child.

"There are 3 feet in a yard. One yard is in the mud. One yard equals 36 inches. If two-thirds of the rest is in the water and one foot in the air [one foot equals twelve inches] the part in the water is twice the part in the air so that it must be 2 feet or 24 inches. If there are 3 feet above the mud and 3 feet in the mud it means that the pole is 6 feet or 72 inches long. Seventy-two inches equals two yards."

It amazed me to see how this child translated all the measurements into inches. As a matter of fact, to her, the problem was so simple and was solved so easily, that she could not believe that she was doing all that was necessary in telling me that the pole was 6 feet long. She had to get it into 72 inches and two yards to make it hard enough to justify my asking such a problem.

The next child went on to say, "One-half of the pole is in the mud and half must be above the mud. If two thirds is in the water, then two-thirds and one foot equals 3 feet, plus the 3 feet in the mud equals 6 feet."

The problem seemed very simple to these children who had been taught to use their heads instead of their pencils.

To examine the participants in the study using a quantitative, rather than a qualitative approach, Berman paired 34 girls and 27 boys from 8 rooms in the regular and experimental groups, matched for intelligence on tests used at that time (Kuhlman-Anderson and Haggerty) and approximately for social background (though from the fact that more experimental mothers worked, Berman concludes they may have been of lower social background). Berman does not control for parents' first language. Benezet realized that he was going to have a better chance of trying this experiment with first-generation immigrant families, and he guessed that only one in ten had English as their language at home.

	Entry	Exp	Reg	Reg adv
Dec - Jan				
+	82	92	93	1
-	48	88	94	6
x	27	80	89	9
÷	18	73	92	19
÷ long	0	60	91	24
March				
+		47	48	0
-		45	48	3
x		36	42	6
÷		37	44	7
fractions		15	33	18
May				
+		46	47	1
-		46	46	0
x		36	39	3
fractions		41	44	3
		23	31	8

Berman's Stats from 1933

An examination of Berman's summary tables suggests that when the experimental children entered 6th grade, they were not as good at the formal tests as the regular children; however, they quickly caught up. Even though there was no formal work in arithmetic until the sixth grade, Benezet reported that by the end of one year, children who had started formal arithmetic in grade six had caught up with sixth graders who had started in grade three. More importantly, in problem–solving, the experimental group was vastly superior to the control group, and when the children in the experiment reached high school, the English teachers were impressed by their facility in language.

While the regular children were being drilled in arithmetic, the experimental children were engaged in Benezet's three Rs–reading, reciting and reasoning. According to Benezet's own accounts, there was quite a lot of number work e.g., teaching the children to recognize and read the numbers up to 100, dates and times, terms like "larger", "smaller", "twice", and money terms (Grades 1 and 2), measurement (Grades 3 and 4), and estimation in grade 5. The context for number topics emerged from topics the pupils themselves suggested.

The final result of focussing on the three Rs, according to Benezet, was that students' spoken and written products were far more interesting and imaginative. They used a wider range of words, and their spelling was better. Of interest to us, as mathematics educators is that they reasoned about arithmetical problems in a sensible way.

When one looks more closely at the study by Benezet, it becomes evident that arithmetic was not in fact postponed at all. In fact, what happened was that computational arithmetic was replaced by social or contextual arithmetic. Benezet's principal purpose was to eliminate rote learning and emphasize number meanings by developing an understanding of the ways in which number functions in the daily lives of children both in and out of school, and to develop what is called number "readiness" for the more formal work to follow.

His research approach may have been unconventional, but a consideration of his experiment should be a powerful reminder that many people have been trying for many years to help children learn mathematics successfully in a relevant and useful manner. It should also beg the question, "is it time for a replication study of the Benezet/Berman study?" I don't have an answer, and I'll be taking the summer off to work on my own research papers, so I won't even weigh in on the topic; however, I hope this overview of the experiment may be the catalyst for a few good assignments–or at least a few interesting debates over a beer on the dock at the cottage with friends.

References

To see reprints of Benezet's original article, go to **http://www.inference.phy.cam.ac.uk/sanjoy/benezet/** ▲

▲ Friday Special!

JACK WEINER



Fridays at the University of Guelph, five minutes before the end of class, I say, "Pens down, books closed, it's "Friday Special" time!" Then I show on screen an article or cartoon or letter or…something that has to do with math, the "real world" and has absolutely nothing to do with class, assignments, or tests. It is math for fun. Often, it is some flagrant example of how the media abuse math. I hope you use some of these. Make them "Monday Morning" specials or "We need a break!" specials. If one falls flat, blame me. If it works, you take the credit.

Here is a letter that goes back a LONG way. The issues, both in terms of the price of gas and the underlying math avoidance, are as contemporary as ever!

GAS PRICE HIKES ELIMINATE SAVINGS

(Letter to the Editor, The Toronto Star*, March, 1981)*

> *Despite the milder weather, I cannot agree we are saving any dollars using gas.*
>
> *My last gas bill showed an amount of $128.50 for February against $83.40 for the same time last year. When I asked about this of Consumers' Gas, I was informed I had used 15% less gas this year than last. When asked why my account was $45 more, the reply was that the price of gas increased 24% in the last year. Where are the 6 and 5% guidelines, or don't they apply to Consumers' gas?*
>
> *MG*
> *Downsview*

When I talk about this with students or teachers, I first give a little history lesson.

"Where are the 6 and 5% guidelines…" This was an era of rampant inflation! In 1979, in order to bring double digit inflation under control, then Prime Minister Joe Clark proposed wage and price controls. Opposition leader Pierre Trudeau ridiculed Mr. Clark for this "dumb" idea. The Conservative minority government brought in a budget which was defeated. The Liberals won the resultant election, and promptly instituted wage and price controls. That Pierre, love him or hate him, he had chutzpah!

I also talk about the disaster of 20% inflation for hundreds if not thousands of homeowners of that time. In the mid-seventies, builders made a hard to resist offer to renters: "Own your own home: $0 down with mortgages at 4% amortized over 25 years". That would have been great, save for the built in 5 year term. Around 1980, the mortgages were renegotiated at as much as 20%. If you do the math, you will see that monthly mortgage payments doubled, tripled, worse. And people simply walked away from their homes. We all know the nature of the up-front interest in a mortgage. Those folks took little equity with them when retreating to the rental world. Crazy and for many, tragic times.

That is not what this *Friday Special* is really all about.

Reread the letter. Doesn't there seem to be something wrong with the numbers, apart from the wage and price control issue?

MG rightly complains that *Consumer's Gas* should not be allowed a 24% increase in price when the government imposed 5 and 6% limits on him and everyone else.

However, there is something else going on here that MG and most people completely ignore because their minds stop working well when numbers, even worse, percents, come into play.

Notice that MG doesn't tell us exactly how much gas he used in February, 1980 or the price per litre he paid. Same for 1981. But he does tell us his monthly bill. This table summarizes what we know.

Month	Climate	Amount of gas in litres	Price per litre	Total paid
February, 1980	Brrr	g	p	gp
February, 1981	Ahhh	.85g	1.24p	(.85g)(1.24p)

By the way, when you ask students about how much gas MG used in 1981, you will be surprised (and maybe a little depressed) by how often g – 15 is given as the answer.

Anyway, MG paid gp = $83.40 in 1980. So the next year, he SHOULD have paid

(.85g)(1.24p) = (.85)(1.24)gp = (.85)(1.24)($83.4) = $87.90

Yes, MG, you should have paid more, $4.50 more, not $128.50 – $83.40 = $45.10 more!

That should have been MG's first complaint. Sadly, as we all know, when numbers come up, most minds shut down.

Did the gas company try to cheat the customer? Of course not. If MG has his numbers correct, then

someone inadvertently punched in the wrong numbers. This is a good lesson for us all. Check your bills, just as you check (I hope) your credit cards to ensure the charges there are valid.

The reason I really love this *Friday Special*, apart from getting to talk about history, inflation, tragedy, all that meaty stuff, is that it shows the power of math, and in particular here, the power of abstraction in math. We didn't know g or p. However, we had enough information that we were able, by labeling these quantities, to determine what we needed. Powerful, this thing we call mathematics!

BW, Jack ▲

▲ Upcoming Events

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See the last page in this *Gazette* for contact information. Also visit **www.oame.on.ca**

OAME Chapter Conferences and Events

October 11 2007	University of Waterloo	GVMA
October 19 2007	Annual Conference: St Charles College S.S. Sudbury 4 - 11 pm	NOMA

OAME Annual Conference

May 6 - 8 2008	TBA	Y^{4}MA

NCTM Regional Conferences

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▲ Assessment Corner: Thinking about Formative Assessment

ANN ARDEN & DR. CHRIS SUURTAMM



Dr. Christine Suurtamm is an Assistant Professor at the University of Ottawa.



Ann Arden is a mathematics teacher at Sir Wilfrid Laurier Secondary School in Orleans, and a graduate student at the University of Ottawa.

In a review of over 250 studies, Black and Wiliam (1998) make a very compelling argument that improving formative assessment can result in gains in student achievement that are larger than most other educational interventions. By their definition, formative assessment is when evidence collected about teaching and learning activities is "actually used to adapt the teaching to meet student needs" (1998, p. 140). Their review also points out "that improved formative assessment helps low achievers more than other students and so reduces the range of achievement while raising achievement overall" (p. 141). The use of formative assessment is also supported in the Ontario mathematics curriculum and the position is best reflected in the statement "The primary purpose of assessment and evaluation is to improve student learning" (OMET, 2005, p. 17).

However, some researchers suggest that "Although the rhetoric for assessment reform is strong, the way in which student learning is assessed in classrooms on a regular basis seems resistant to change" (Tierney, 2006, p. 239). Black and Wiliam (1998) also recognize that developing new assessment practices are a challenge and report that the grading function of assessment is often overemphasized at the expense of the analysis of students' work to determine learning needs. However, in all fairness to teachers, the most powerful models of teaching, learning and assessment come from the way that they were taught. And, for most of us, this was in a very traditional setting where assessment and evaluation consisted of submitted work or tests that were given towards the end of a unit and counted for marks, with very little feedback provided to improve learning. While Ontario mathematics teachers have had many professional learning opportunities in assessment over the past decade, there are still very few models of what sound classroom assessment actually looks like in practice on a day-to-day basis. Thus, the question remains, "How do we actually improve formative assessment in the classroom?" The following discussion brings together messages about formative assessment from research and from Ontario mathematics curriculum documents and makes some practical suggestions as to what this might look like in a classroom.

Using the Results of Formative Assessment to Adapt Instruction

As Black and Wiliam (1998) point out, formative assessment needs to be used to actually adapt instruction to help students, which means that the feedback from an end-of-unit test comes too late for students. The Ontario curriculum also states that evidence from assessment should "guide teachers in adapting curriculum and instructional approaches to students' needs" (OMET, 2005, p. 17).

For assessment to be more useful to students it needs to occur in the middle of teaching and learning rather than at the end (Shepard, 2000). This means giving students regular opportunities to have their work reviewed and feedback provided. This could include regular short quizzes that receive substantive comments rather than (or along with) a mark; opportunities for students to compare their work to samples of other students' (preferably anonymous) work and reflect on how well thinking has been explained or a concept applied or understood; or asking students to articulate their thinking about a problem or topic by responding to a writing prompt.

What is important is that the evidence collected, whether verbal or written, is then used in planning the "next steps" for the class, or for individual students. As Guskey (2003) points out, "To charge ahead knowing that students have not learned certain concepts or skills well would be foolish." (p. 10). Thus, based on these formative assessment tasks, teaching strategies may be altered and students may be given different tasks to develop, consolidate or extend their understanding.

Improving Feedback to Students

Several studies have shown that students do not benefit significantly from feedback that is only in the form of marks or grades and that student interest in learning is enhanced when feedback consists of informative comments (Black & Wiliam, 1998; Butler, 1988, cited in Nicol & Macfarlane-Dick, 2006). The Ontario mathematics curriculum states that: "As part of assessment, teachers provide students with descriptive feedback that guides their efforts towards improvement." (OMET, 2005, p. 17). However, some feedback can be difficult for students to interpret as "feedback messages are invariably complex and difficult to decipher" and "students require opportunities to construct actively an understanding of them (e.g. through discussion) before they can be used to regulate performance" (Nicol and Macfarlane-Dick, 2006, p. 201). In order to help students make sense of feedback in a way that they can use it to improve their work, it is important that they have opportunities for dialogue in the classroom, with the teacher or with their peers. The process of giving and receiving feedback with peers on class work can help students make judgments about the quality of their own work.

Also, feedback is most effective when it is focused on specific features of the task, rather than non-specific praise or normative comparisons (Kluger & DeNisi, 1996, cited in Shepard, 2005). Such feedback should be provided soon after the assessment task and rather than general statements of strengths and weakness, it is helpful if it focuses on a limited number of items so that students can respond to the feedback (Nicol and Macfarlane-Dick, 2006). Giving quality descriptive feedback can be particularly difficult with an assignment that has not been done well. With this type of assignment it may be best to spend some time individually with the student and focus on only two or three areas for improvement. After the conference the teacher could ask the student to summarize the feedback in written form and then show it to the teacher to ensure that the student really did understand the suggestions. This may be more helpful to a student than seeing their assignment covered in the teacher's written comments, and may even save the teacher time.

Involving Students in Self-assessment

Black and Wiliam (1998) argue that student self-assessment is "far from being a luxury, is in fact an essential component of formative assessment" (p. 143, emphasis in original). The Ontario curriculum supports this with "teachers must use assessment and evaluation strategies that…promote students' ability to assess their own learning" (OMET, 2005, p. 17). Shepard (2005) points out that student self-assessment "is not about saving teachers from the work of grading papers" (p. 69) but it can serve both meta-cognitive and motivational purposes and help students to internalize the standards by which their work is judged. One study (White & Frederikson, 2000, cited in Shepard, 2005) demonstrated that students who learned to self-assess had a much higher correlation between their judgments and the teacher's ratings, and subsequently showed greater gains in conceptual understanding than students in a control group.

To help develop a culture of self-assessment within the classroom, students can spend time evaluating a variety of samples of student work. For example, instead of a lesson in which the teacher solves a problem on the blackboard, students could work individually and then in groups on the problem and then be given two other solutions to the same problem and discuss the specific qualities of each solution. These solutions can be generated by the teacher, from other groups, or saved from work from previous years' classes (with identifying features removed). Examining other students' strategies and explanations of their thinking will help to improve a student's ability to assess and improve their own work.

Impact on Teaching

Formative assessment is not only used to improve student activity, but also to improve teaching. Stiggins (2004) argues that the most important instructional decisions are not made near the end of a course, but rather "every few minutes" (p. 26). What question to ask next, which student(s) to focus on, what problem to pose next, and how to differentiate instruction are all decisions that are made, consciously or not, "on the fly". Formative assessment is a way of providing appropriate feedback to teachers, as well as to students, so that those minute-by-minute decisions are well-informed and lessons and plans are adapted accordingly.

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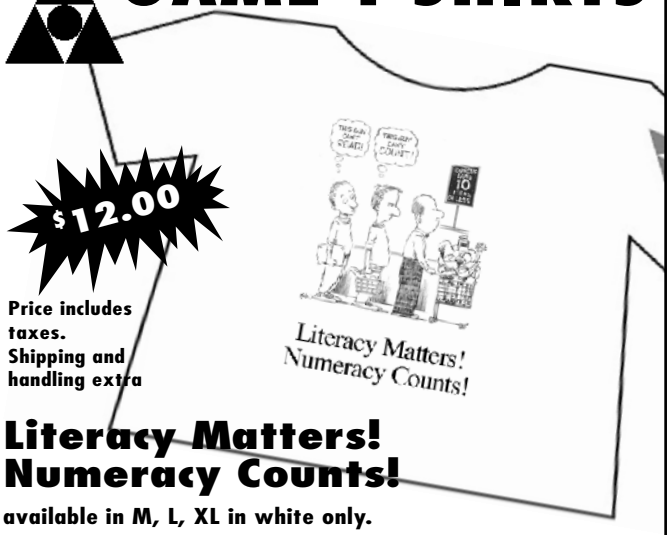
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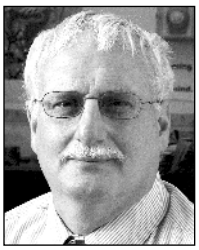
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▲ OAME/NCTM Report June 2007



JOHN KERSLEY

In my last report I mentioned a new NCTM initiative named *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*. In NCTM's view, these curriculum focal points are "clusters of related knowledge, skills and concepts" of topics at each grade level that need to be understood as a student develops mathematically. In short they are essentially the students' building blocks in mathematics. Detailed information including free downloading is available at **www.nctm.org/focalpoints**. NCTM reports that quite a few school districts in Canada and United States have begun to use this *Curriculum Focal Points* in discussions of their mathematics curriculum. NCTM recommends these focal points to be the areas of emphasis in mathematics at each grade level, but not the entire curriculum. NCTM suggests that the actual curriculum, expectations and outcomes be built around these *Curriculum Focal Points*. A proposed next step is publication(s) designed to indicate how to create a comprehensive curriculum with focal points. Stay tuned.

Just a reminder of some of the advantages of a NCTM membership:

- receive 1, 2, 3, or 4 print journals, an online journal subscription or journal downloads.
- access Student Math Notes from May 1998 to the present. An excellent source for activities.
- discounts on NCTM conference registration fees and NCTM products

Current Publications from NCTM

- *Empowering the Beginning Teacher of Mathematics*
  There are 3 volumes: Elementary, Middle and High School

Each volume deals at their own level with challenges and problems new teachers face inside and outside the classroom. The books focus on six broad categories: professional growth, curriculum and instruction, classroom assessment, classroom management and organization, equity, and school and community. The volumes are written by experienced educators to help the beginning teacher. The books are for supervisors, department heads, etc as well as for the new teacher.

- *Designing Professional Development for Teachers of Science and Mathematics 2nd edition*
  The book is a description and a discussion of the issues, problems and challenges in the development of mathematics and science programs now and in the future. It provides basic information on the principles of effective professional development and ways to create learning programs in mathematics and science.

Contact me or check web site, **www.nctm.org** for further details.

Web sites of Interest to Mathematics as Suggested by NCTM

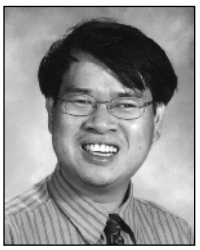
- COOL MATH lessons and learning tools for students, parents and teachers at various levels. Very colourful site. Lots of different things. **www.coolmath.com**
- MATH TUTOR: INTEGERS helps in the learning of the operations of integers, provides explanations, practice and videos **www.squidoo.com/ingers**
- DISCOVERSCHOOL.COM lessons plans for all grades for teachers by teachers. For practice and research **school.discovery.com/lesson plans/math.html/**
- MATH ONLINE free tests for student self-evaluation and for teachers assessment for secondary school. Good, varied data base of questions covering wide variety of material **www.mathonline.missouri.edu**
- TEACHENGINEERING over 500 lessons involving engineering concepts for K-12, including water, electricity, mass and energy consumption. Good for browsing and research **www.teachengineering.org**
- NCTM CONFERENCES **www.nctm.org/meetings**

NCTM Regional Conference and Exposition

- Richmond, Virginia October 11 – 13, 2007
  "Exploring Mathematical Horizons"
- Kansas City, Missouri October 25 – 27, 2007
  "Jazzed about Math"
- Houston, Texas November 29 – December 1, 2007
  "Energizing Mathematics" ▲

▲ Get Interactive! Incorporating the History of Mathematics

Louis Lim



Louis Lim is department head of mathematics at Richmond Hill High School, York Region DSB. Louis' involvement with the OAME includes being a former editor of the Ontario Mathematics Gazette*, presenter at chapter and annual conferences; and elected board of director. In spring 2005, he was recipient of OAME's "Exceptional and Creative Teaching in Secondary Mathematics" Award.*

I am currently enrolled in the Master of Arts Mathematics for Teachers program at York University. One of the course requirements is a history of mathematics course. I spoke with Professor Walter Whiteley about its importance and he invited me to present a talk as part of the Mathematics Education session at the Canadian Mathematics Society Winter 2006 Meeting in Toronto. In attendance was Dr. Lee Lorch, mathematics professor emeritus at York University, who provided positive feedback for my talk. Lorch is this year's recipient of the Mathematical Association of America's (MAA) "The Gung and Hu Award for Distinguished Service to Mathematics", and is known for his fight for equity and human rights. Be sure to read **http://www.maa.org/news/AwardsJMM07-Citations.html** and **http://www.yorku.ca/yfile/archive/index.asp?Article=7665** for information on this truly amazing and inspirational mathematician and human being.



Dr. Lee Lorch

I spoke with Anthony Azzopardi and Myrna Ingalls, Education Officers at the Ministry, about having specific expectations on the history of mathematics. Although supportive, they did not think it would be appropriate for the current revisions since no reference to the history of mathematics is made in the grades 1-11 mathematics curriculum. It is my hope that the next round of revisions will convey to students the rich mathematical history.

Below are web sites that can help incorporate the History of Mathematics. They can be "sprinkled" into an existing lesson (whether elementary or secondary mathematics) and can serve as motivation to a mathematical concept. Included are references to female mathematicians and mathematicians from different cultures. We need to convey to students that mathematics has and continues to be created all over the globe.

1.) Famous Problems in the History of Mathematics
http://mathforum.org/isaac/mathhist.html

Created by the Math Forum, this web site contains suitable material for middle and high school mathematics. Problems include the Konigsberg Bridges Problem, π, prime numbers, paradoxes, probability, Pythagorean Theorem and the irrational number e. Mathematicians include Euler, Euclid, Cantor, Eratosthenes, Pasca, Fermat, Fourier and Pythagoras.

2.) Biographies of Female Mathematicians
http://www.agnesscott.edu/lriddle/women/women.htm

Agnes Scott College in Atlanta, Georgia, maintains a web site that is a treasure trove of female mathematicians, organized by last name, century of contributions, birth location, doctoral degrees granted, and birth and death dates. Additional links are provided for further exploration.

3.) MacTutor History of Math
http://www-groups.dcs.st-and.ac.uk/~history/

This web site, maintained at the University of St. Andrews in Scotland, is organized by indexes of mathematicians (alphabetical, by year, and a separate link to female mathematicians), mathematical topic, culture, famous curves, as well as mathematicians who were born and died on a particular day. A must see due to its extensive collection!

4.) History of Mathematics
http://aleph0.clarku.edu/~djoyce/mathhist/mathhist.html

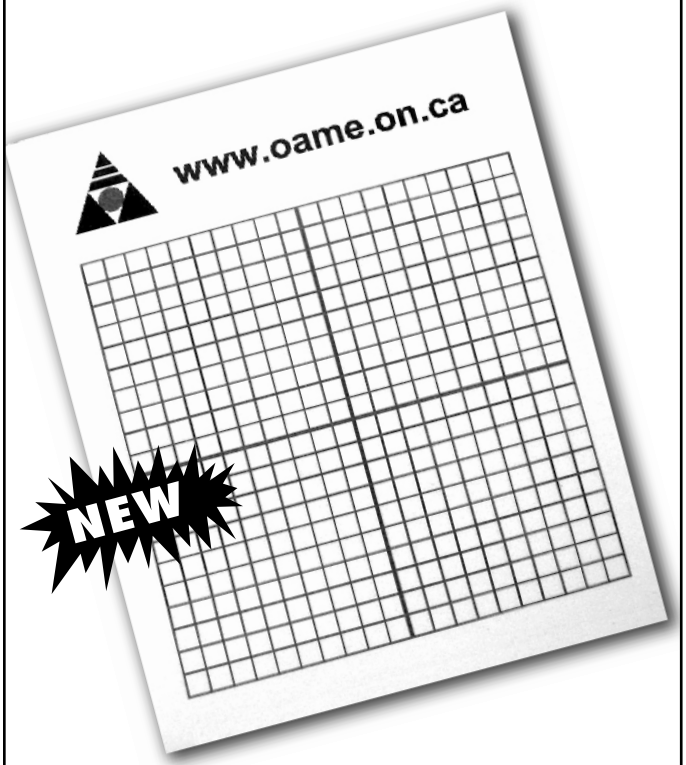
David Joyce of Clark University maintains this extensive history of mathematics web site, organized by region (Babylonia, Egypt, China, Greece, India, Arab, Japan, Europe) and mathematical content (number, algebra, geometry, analysis, probability), further reading (books, journals, organizations), and chronology. A nice balance of mathematicians and mathematical contributions!

As I mentioned in an earlier column, Leonhard Euler's 300th birthday is being celebrated this year (see **http://www.euler-2007.ch/en/index.htm**). Arguably the

greatest mathematician, a commemorative stamp was issued on March 6 by the Swiss Post to honour Euler, depicting a photo of him (after he lost his eyesight), a polyhedron with 12 vertices, 19 edges, and 9 faces, along with his famous formula, e – k + f = 2 (e.g., in English, vertices – edges + faces = 2). ▲



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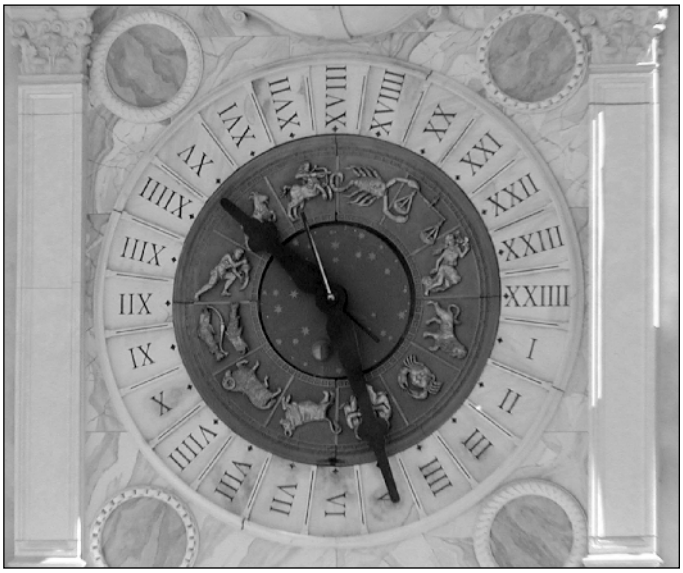
▲ Photo Math ~ The Fine Art of Viewing the World Through a Mathematical Lens

RON LANCASTER



Ron Lancaster is a Mathematics Lecturer in the Department of Curriculum, Teaching and Learning, the Ontario Institute for Studies in Education (OISE/UT) at the University of Toronto, 252 Bloor St West, Rm 11-162, Toronto Ontario M5S 1V6

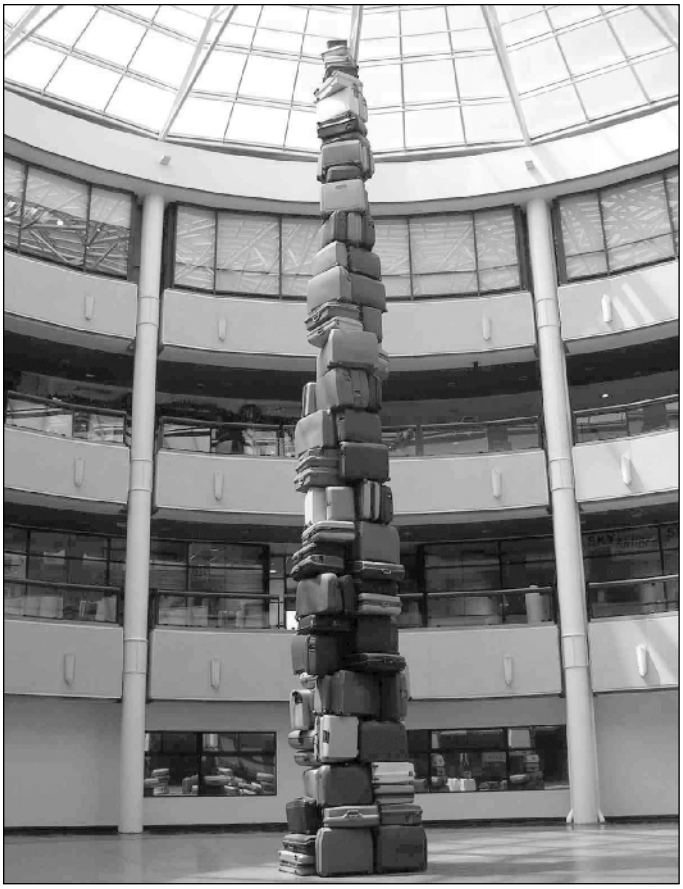
Teachers and students are encouraged to put on a pair of mathematical glasses and become a math spotter, someone who sees mathematics everywhere and then possibly poses mathematical questions based on the images taken. Ron Lancaster, the current Editor for Photo Math, welcomes photos with questions for possible publication in future columns. Material can be sent via e-mail or by regular mail to either of the two addresses given above.



Photograph 1 Photographer: Larry Ottman, ottman@ottman314.net
Location: Venetian Hotel, Las Vegas, Nevada

(a) According to this clock, what time is it?

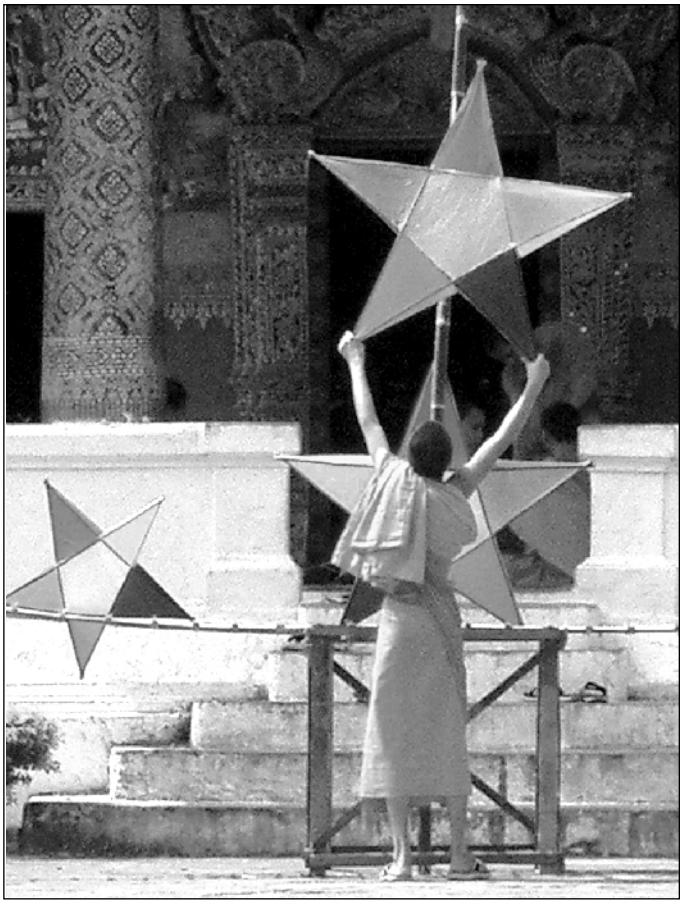
(b) Have all the numbers been correctly changed into Roman Numerals?



Photograph 2 Photographer: Ann Coiner, coinerann@yahoo.com
Location: El Alto International Airport, Bolivia

(a) Estimate the number of suitcases in the pile. How much would they weigh?

(b) Estimate the height of the pile.



Photograph 3 Photographer: Greg Bate, gbate@nist.ac.th
Location: Luang Prabang (the old Royal Capital), Laos

(a) Count the number of triangles that appear in the photo.

(b) What other shapes appear in the photo?



Photograph 4 Photographer: Ron Lancaster, ron2718@nas.net
Location: Bandung International School, Bandung, Indonesia

(a) Find the sum of the numbers for each step. Are the sums all the same? If not, which step has the biggest sum? Which one has the smallest sum?

(b) Find the product of the numbers for each step. Are the products all the same? If not, which step has the biggest product? Which one has the smallest product?

▲ What's the Problem?: Dividing by 8

SHAWN GODIN



Shawn is the head of Mathematics, Business and Technology at Cairine Wilson S.S. in Orleans, ON.

Welcome back problem solvers. Last issue I left you with a problem that appeared as M164 from the November 2004 issue of *Crux Mathematicorum with Mathematical Mayhem*. The solution appeared in the February 2006 issue. You can check out more problems at the *Crux Mathematicorum with Mathematical Mayhem*. web site **http://journals.cms.math.ca/CRUX/**

Dividing by 8

Consider the following procedure for dividing the three-digit number 375 by 8. Write down the number formed by the first two digits, namely, 37. Multiply this by 2 to get 74. Add to this the units digit of 375 (the original number), obtaining 74 + 5 = 79. Then divide by 8 to get 9 with a remainder of 7. Add this result (9, remainder 7) to the number 37 (the first two digits of 375) to get your answer: 46, remainder 7. Thus, 375 divided by 8 equals 46 with a remainder of 7.

Does this method always work for three digit numbers? Why, or why not?

This type of problem really cries out to do some testing of the waters. Suppose we pick a couple of three digit numbers and see what happens when we follow the procedure:

Try 649
649 ÷ 8 = 81 R1
The procedure gives:
64 x 2 = 128
128 + 9 = 137
137 ÷ 8 = 17 R1
64 + 17 R1 = 81 R1

Try 942
942 ÷ 8 = 117 R6
The procedure gives:
94 x 2 = 188
188 + 2 = 190
190 ÷ 8 = 23 R6
94 + 23 R6 = 117 R6

So the procedure works for 649 and 942. I would encourage you and your students to try a few numbers to convince yourselves that the procedure might possibly be valid. After you have tried a few numbers by hand, you may want to use technology to do the job for you. A graphing calculator or a simple computer program would work. I decided to use a spreadsheet. Any spreadsheet will work: *Excel, Quatro Pro, Lotus 1, 2, 3*. I am using the spreadsheet that comes with *Open Office*, a free office suite available at **http://www.openoffice.org**.

The truncate function is used to determine the integer part of the quotient. (See Figure 1) The function just chops off anything after the decimal. So in the first case, with the truncate function, it returns just 117. We can use the spreadsheet to determine a large number of values, like below.

Number	Step 1	Step 2	Step 3	Step 4	Rem.	Step 5	Actual	Rem.
942	94	188	190	23	6	117	117	6
649	64	458	137	17	1	81	81	1
101	10	20	21	2	5	12	12	5
102	10	20	22	2	6	12	12	6
103	10	20	23	2	7	12	12	7
104	10	20	24	3	0	13	13	0
105	10	20	25	3	1	13	13	1
106	10	20	26	3	2	13	13	2
107	10	20	27	3	3	13	13	3
108	10	20	28	3	4	13	13	4
109	10	20	29	3	5	13	13	5
110	11	22	22	2	6	13	13	6
111	11	22	23	2	7	13	13	7
112	11	22	24	3	0	14	14	0
113	11	22	25	3	1	14	14	1
114	11	22	26	3	2	14	14	2
115	11	22	27	3	3	14	14	3
116	11	22	28	3	4	14	14	4

Figure 1

It shouldn't take long to see that it seems to work for every value. The real test is to see if we can prove that it works. To do the proof will require a little algebra. Let the digits of our three digit number be A, B and C so that our number is 100A + 10B + C. Since we are dividing by 8, we can play with this expression to write it in the form

$$\begin{aligned} 100A+10B+C &= 80A+20A+8B+2B+C \\ &= 80A+8B+20A+2B+C \\ &= 8(10A+B)+2(10A+B)+C \end{aligned}$$

Now if we divide by 8 we get

$$\begin{aligned} \frac{100A+10B+C}{8} &= \frac{8(10A+B)+2(10A+B)+C}{8} \\ &= 10A+B+\frac{2(10A+B)+C}{8} \end{aligned}$$

Let's reconsider the algorithm and see how it relates to what we have here.

Write down the number formed by the first two digits

$$10A + B$$

Multiply this by 2 and add this to the units digit of the original number

$$2(10A + B) + C$$

Then divide by 8 and add this result to the number formed by the first two digits to get your answer

$$10A + B + \frac{2(10A + B) + C}{8}$$

So we can see that the algorithm gives us the desired result. Even if students cannot reproduce the algebraic steps, many will be able to follow the argument and understand what the algebraic notation is telling them about the problem.

There are several extensions to this problem that you may want to consider.

Extension #1.

There is nothing in the algebra that says that we couldn't have A = 0. If we do, we get a division algorithm for 2 digit number by 8 defined by

$$\frac{10B + C}{8} = \frac{8B + 2B + C}{8}$$
$$= B + \frac{2B + C}{8}.$$

So, to divide 75 by 8, you would take 2 x 7 + 5 = 19 and divide by 8, which gives 2 with a remainder of 3. Then add that to the first digit to get 9 with a remainder of 2, the result.

Extension #2.

There is nothing in the algebra that says that A must be less than 10. If we let A be 10 or larger, we can get an algorithm for dividing numbers with four or more digits. All you adventurous souls may want to look for a way to modify the original algorithm so that we can divide any number by 8 without having to do any division at all, just multiplication by 2 and addition.

Extension #3.

Devise an algorithm to divide by 7 or 9 or 11.

Finally, Here is Your Summer Homework

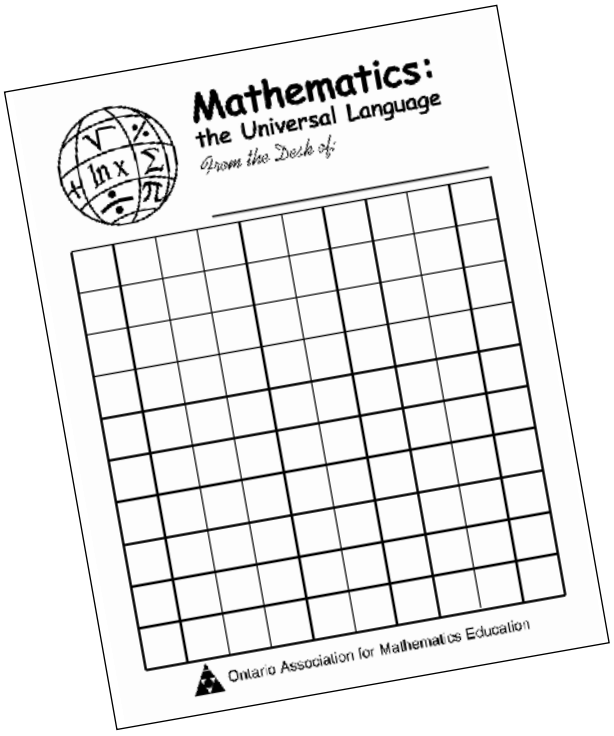
By the end of the season, Samuel had made more than 50% of his foul shots, even though at the start of the season his average was below 50%. Show that there was a time during the season when his average was exactly 50%.

Have a great summer, and happy problem solving! ▲

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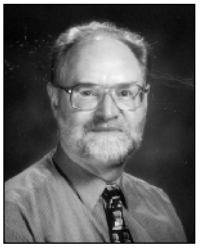


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▲ CAS Corner: Using the "Black Box" Features on a CAS Device

FRED FERNEYHOUGH



Fred Ferneyhough is former head of mathematics at Harold M. Brathwaite SS in Brampton. He retired from there in February 2006. Fred is an avid user of and advocate for the use of technology in the mathematics classroom. He is also an author and tech consultant for several books and a National Instructor for Texas Instruments.

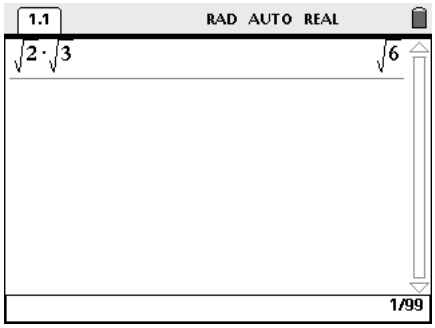
In the March article, we looked at using a Computer Algebra System device as a "white box" where the steps that students do are visible. In this article we start to look at using the CAS devices as a black box. The black box approach occurs when the student enters a command and the answer pops out. This is the approach that concerns teachers who consider the development of skills to be of paramount importance in teaching mathematics – and with good reason. If the device does everything for the student, what have they learned? The answer is obvious – nothing.

So, why use it in this way? The answer lies in how we present it to our students. Keep in mind that we are facing children who are technologically savvy and who tend to think that a tech device must always be right. In fact, if a handheld calculator says that the answer is such and such, then to them, it is such and such. It does not matter that you said that same thing five minutes ago and presented one of the best lessons of your career. Your word is not worth as much as the tech device. What I try to do is to leverage their attitude to advantage – ours and theirs.

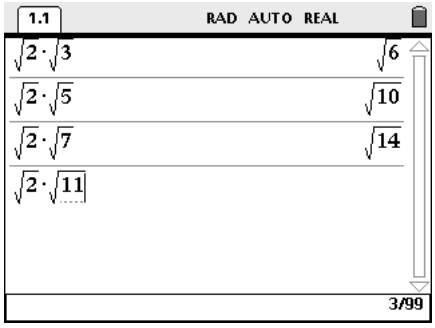
In teaching with a CAS device, I took advantage of this many times. I use a cycle of activities in the classroom. Using just one device at the front of the classroom, I present one example and ask "what happened". If someone sees the pattern immediately, great. If not, I can do a few more hoping that the pattern will become more obvious. Once it has been explained, I put one more on the screen and ask the class to predict the answer. Finally, I have them use their devices to create a few more examples of the same type.

In this article, we will look at using the CAS device to develop skills in the area of radicals.

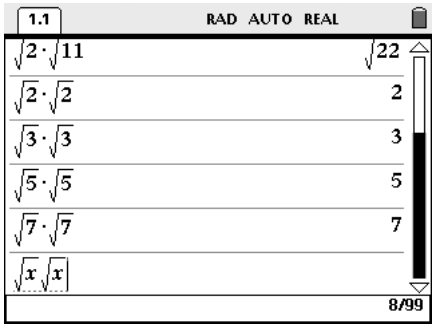
Take a look at the first screen. What I want students to think about is "just how did the device get from this question to the answer, because you won't always have this device with you and you have to understand how this works". Only the most intuitive student is going to see something with just one example, so let's look at a couple more.



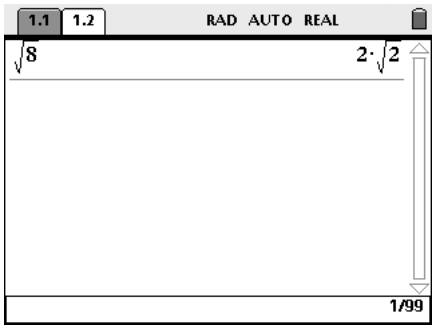
What I have done in the past is to present a few examples and then enter one more while asking if they can predict the answer. Then I ask them to explain what they've done. Notice that the examples all used prime numbers as the second factor. Hopefully, some student will ask about this. It's not important but I like the fact that someone notices. However, I have avoided second factors that are even so that I don't spoil what is coming later. At this point, I want my students to make up a few more examples.



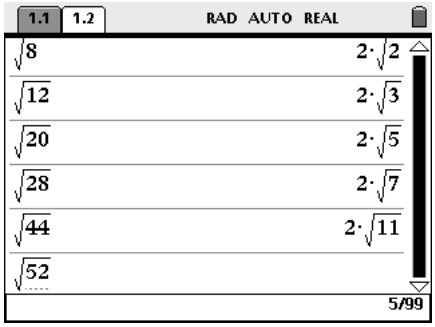
So, that's part one of my lesson. Now, let's move on to part two. I want to develop the idea that the square root of a value multiplied by itself is the value – that's a mouthful. Notice again that the final line has the question ready but no answer. I want my students to predict the answer and explain it. In other words, I turn this into a thinking, inquiry and communication exercise.



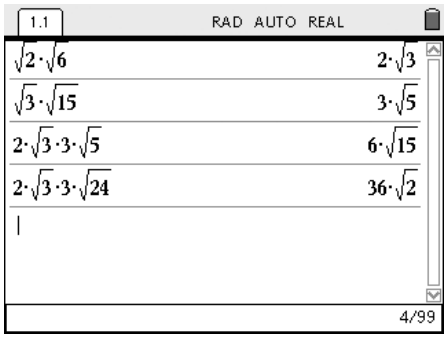
For part three, I want to start exploring problems where a pure radical is converted to a mixed radical. The device does the work of converting the form of the answer but to leave it at this does not ensure students' understanding. Some more examples are needed.



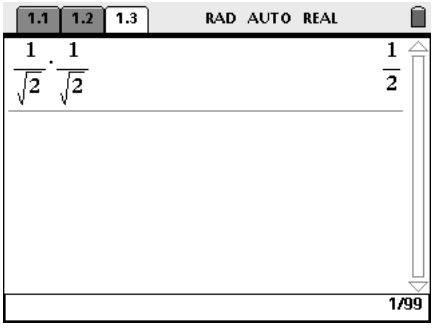
In the screen below, I am hoping that someone in the class notices that all of the arguments are multiples of 4. Once one student gets it, I'm also hoping that he/she is going to explain it to everyone in the class for me. Once that happens, they can predict the answer for the last problem posed on the last line. Once they have the idea, I want them make up some more examples on their own, this time without have a leading coefficient of 2. They should use their CAS device to test their hypothesis.



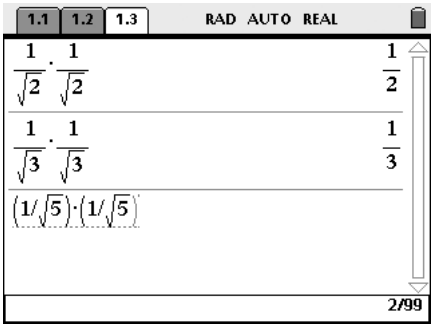
At this point, we can go back to two concepts omitted in the first section. What happens if we multiply two radicals which have common factors and what happens if we multiply mixed radicals? With the two sections completed above, most students will be able to follow the algebra completed by the device.



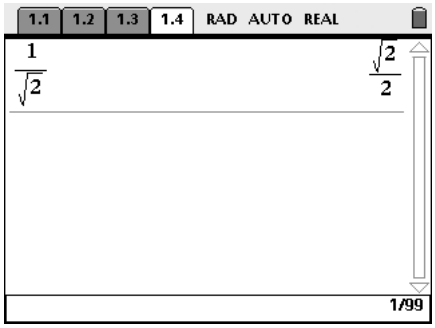
Moving on we can use the CAS to explore the concept of rationalizing denominators. Although it may be cumbersome to enter the expression to the right, it displays quite nicely. I want to know if the answer makes sense based upon the question.



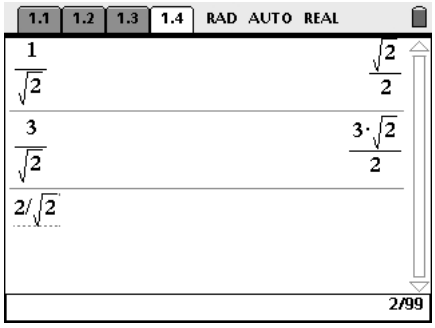
Doing another example and posing a third should help to solidify the concept. Notice how the expression is entered compared to how it is displayed. However, this has not completely addressed the idea of rationalizing the denominator. Once again, I want them to make up a few on their own and test them out on their own CAS device.



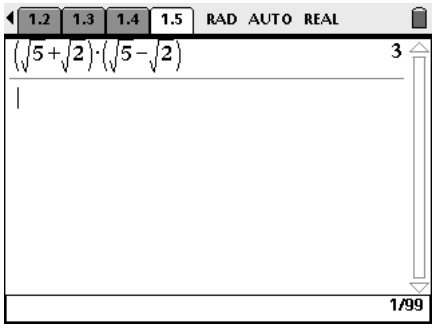
I prefer developing the concept in this manner so that the class can move on to rationalizing the denominator skills.



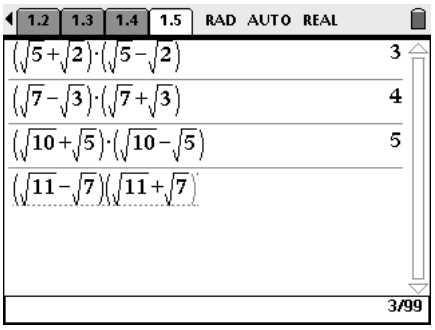
There may be a few students who can put the pieces together after one example, but most will need to see more. The really nice feature about using a CAS is that a large number of examples can be worked out in a short period of time, allowing students to pick up patterns. One problem that I have found in the past is that I haven't explained the idea of "rationalizing" well enough for them to understand what the result should look like. This is a good time to do that.



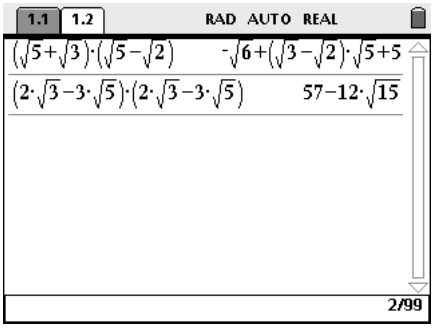
Of course, we may want to explore the products of conjugate radical expressions. I have found that this example catches the interest of students immediately. Almost everyone sees the pattern here and it's a good opportunity to use the CAS device to go back to a review of factoring the difference of squares. Hopefully, it's review and not new material - sigh.



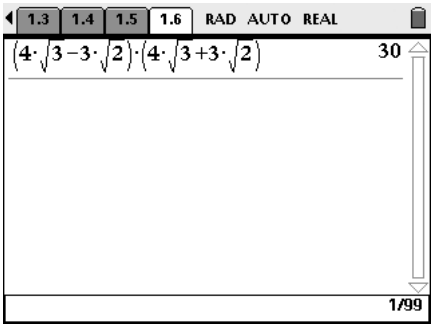
Just to ensure that the concept has been understood, we present a few more examples. A final example has been left unsolved and I want them to predict the answer. I also want to clarify that the product of these radical binomials produces a whole number or integer result. Afterwards, they are to make up a few of their own and test them.



Further, the CAS allows us to quickly explore what happens if the binomials are not conjugates. The second product is a very common error made by students. This example shows clearly that the factors used do not produce an integer result. Students should verify this result with a few examples of their own.

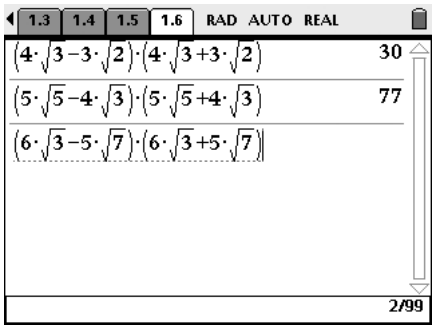


Hopefully, someone in the class is going to extend the idea. If no one does, I can present an example such as this one to see how the pattern extends. This is going to take a bit of explaining, but I'm hoping that students working in groups will come up with an explanation long before I have to. I haven't been disappointed yet.

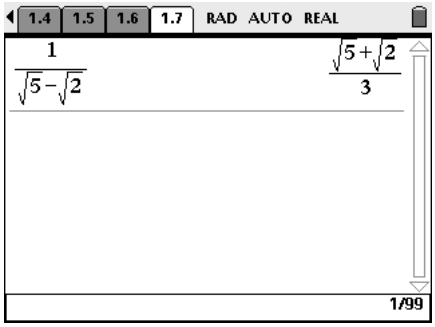


If this concept can be explained, then another

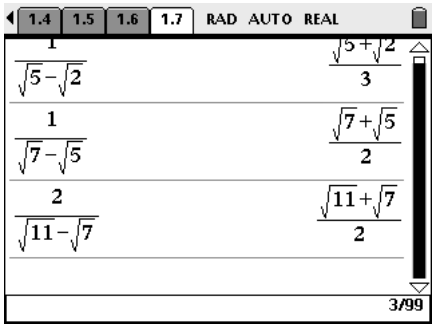
example is needed to test that explanation. A third example is there for them to work on by themselves. Once again, it is an easy matter to try out examples where the factors are not conjugates.



Finally, we move to expressions where the CAS is used to rationalize denominators of expressions where the denominator is a binomial. Not too many can see all of the steps that occur between the question and the answer, but normally someone is able to put a solution on the board with the missing steps included.



As always, more examples are helpful. What I want students to do at this point is to make up more examples and then try them without the CAS.



The black box capability of the device can be a very helpful teaching tool if used wisely. Allowing students to use it without guidance can be dangerous. That is not to say that students shouldn't be allowed to explore on their own. However, guided discovery allows us to use the device to explore and create a situation where students are required to explain the missing steps and make predictions to verify understanding. ▲

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▲ OAME Leadership Conference 2007

SUE HESSEY, EXECUTIVE DIRECTOR AND DAN CHARBONNEAU, PAST-PRESIDENT

The OAME Leadership conference, *Mathematics: Making Sense of it All*, was held Feb 15-17, 2007 at the Holiday Inn Select, Toronto. On Thursday night, one hundred and fifty delegates from across Ontario as well as twelve workshop presenters engaged in interactive activities demonstrating the big ideas in JK-12 mathematics. Dan Charbonneau, president, challenged delegates to consider global warming issues in their classrooms. To see the environmental weblinks used, click on links and resources at **www.oame.on.ca**. On Friday night, following an International Banquet, delegates were entertained and challenged to enjoy mathematics by keynote Dave Mitchell who uses puzzles, songs, raps, and stories to transform math class into a memorable and enjoyable experience for students. A Thursday publishers' luncheon highlighted new resources.

On Friday and Saturday, delegates participated for seven hours in a specific workshop, looking in depth and making sense of mathematical concepts in their chosen division or theme. Delegates had the opportunity to investigate the relationships among the characteristics of the learner, curriculum process expectations, big ideas in mathematics, and available resources. The JK- 3 workgroup looked at Patterning and Algebra and learned about the benefits of co-teaching. The 4-6 group investigated teaching through questions and discovered that knowing what doesn't work is as important as what does work. The 7-9 group marveled at the many uses of *Smartboards* and other technologies to help students succeed. The 10-12 workgroup examined *Growing Up Mathematically*, focused on process skills and enjoyed opportunities to reflect on and make connections with activities used. Delegates in the grades 7-12 At Risk workgroup appreciated the toolkit given that overflowed with many new strategies. A workshop on Complexity Theory and Learning Systems that continued the theme from Leadership 2006 had delegates thinking deeply on the broad spectrum of mathematics K-12.







When asked what aspect of the conference they found most valuable, delegates responded with comments like:

- interacting, collaborating and networking with other teachers and administrators
- examining activities in depth, receiving practical ideas and useable resources
- knowledgeable, enthusiastic, and approachable presenters who facilitated learning
- discovering how to use technology so students can learn
- seeing video clips of children working in Ontario classrooms
- participating in a community of "mathies"

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▲ Writing in Math

MARILYN BURNS, SAUSALITO



One of today's most highly respected mathematics educators, Marilyn Burns is the creator and founder of Math Solutions Professional Development, dedicated to the improvement of math instruction in Grades K–8. For more than 40 years, Ms. Burns has taught children, led in-service workshops, written professional development publications for teachers and administrators, created staff development videotapes, and written books for children. She teaches regularly in classrooms across the nation as an essential way of developing and testing new ideas and materials.

This article was originally printed in Education Leadership, *October 2004, pages 30–33, and is reprinted with permission from* Education Leadership. *©2004 Association for Supervision and Curriculum Development.*

One reason I chose mathematics for my undergraduate major was that it didn't require papers. Math homework called for solving problems or proving theorems, and that was just fine with me. Math and writing, like oil and water, seemed to have little in common. For my first twenty years as a middle school and elementary school teacher, writing played no role in my math teaching.

Today, my view has changed completely. I can no longer imagine teaching math without making writing an integral aspect of students' learning.

This transition occurred over a period of years as I gradually overcame my own writing phobia. After writing children's books, professional books, and numerous articles, I've faced my writing dragon. I've even come to appreciate writing as a tool for clarifying my thinking. As Zinsser (1998) says, "Writing is a way to work yourself into a subject and make it your own" (p. 16).

But the results I experienced with students were what clinched my commitment to making writing a regular part of math instruction. Not only did I see how writing helped students think more deeply and clearly about mathematics, but I also discovered that students' writing was an invaluable tool to help me assess their learning.

Writing in math class supports learning because it requires students to organize, clarify, and reflect on their ideas—all useful processes for making sense of mathematics. In addition, when students write, their papers provide a window into their understandings, their misconceptions, and their feelings about the content they're learning.

Of course, the writing that students do in math class generally differs from the writing they do in other subjects, such as language arts or social studies. Writing in math class isn't meant to produce a product suitable for publication, but rather to provide a way for students to reflect on their own learning and to explore, extend, and cement their ideas about the mathematics they study. Aside from the students themselves, I consider myself the primary audience for my students' writing, and I pay attention to what that writing shows about their math understanding—what they write, not how they write it.

A Variety of Writing Assignments

The writing assignments I give fall into four categories: keeping journals or logs, solving math problems, explaining mathematical ideas, and writing about learning processes. Each of these categories focuses the students on their math learning in a different way, and each provides useful information for assessing their progress.

1. Keeping journals or logs.

When students create ongoing records about what they're doing and learning in math class, they have a chronological record of their learning experiences. I often post suggestions such as these to help students focus on their journal writing, especially at the beginning of the year:

- Write about what you did in class.
- What did you learn?
- What are you unsure about, confused by, or wondering about?
- Describe what was easy and what was difficult for you.

At times I give guidelines that relate to a specific lesson. For example, "Explain why Raul's answer made sense," or "Write about why Kaisha and Robert disagreed."

I organize students' journal writing in various ways. Sometimes I staple sheets of paper into booklets with construction paper covers, giving students a new booklet—and thus a fresh start—several times a year.

(Remember the pleasant school ritual of having new notebooks for courses at the start of each semester?) Sometimes I ask students to write on loose paper, and I file their work in folders. One year I gave each student a spiral-bound notebook of 1/4-inch graph paper, an expensive investment but one that helped them graph with ease. Whatever the approach, I always keep student journals or logs in the classroom except when I take them home to read. I instituted this policy after too many students came to class without their logs.

2. Solving math problems.

Mathematics instruction should engage students in applying a variety of strategies for solving problems and also teach them to monitor and reflect on their problem-solving processes. Writing enhances both these skills. Even when students work cooperatively on a problem-solving situation, it's beneficial to have each student write his or her own paper. Although the group work gives them access to one another's ideas, writing requires students to clarify their thinking.

Sometimes problems have one right answer, even though there are different ways to get to the answer or explain why the answer makes sense. For example, to provide experience with reasoning proportionally and applying fractional concepts, I gave 5th graders a problem about mixing red and yellow paint to get orange paint. I told them I had made two batches: Batch A had two parts red paint and two parts yellow paint, and Batch B had three parts red paint and two parts yellow paint. "How would the colors of the two batches compare?" I asked them. The students easily understood that B would be a darker orange.

Then I asked them to compare two additional batches of paint—a new Batch A, with two parts red and one part yellow, and Batch B, with the same three parts red and two parts yellow—and write about their solutions. The class was divided in their opinions: Some thought that the two batches would be the same color, and some argued that Batch B would be darker. Becky, for example, wrote about why the colors would be the same:

> *There is always one more red than yellow, so B should have more parts, but A and B should be the same color.*

David, however, reasoned correctly that

> *A would be darker than B because there is twice as much red as yellow. In B there should be four parts red to make A and B the same color.*

The ensuing lively discussion was useful not only for the students but also for me because it gave me a chance to assess their understanding.

Other problems have more than one possible correct solution. For example, I told 3rd graders that I had bought an item and received 35 cents in change. "What might I have bought and how much did it cost?" I asked them.

Student responses to this problem resulted in a situation that I hadn't counted on but that added an interesting dimension to the lesson. Sam, the first student I called on, said, "You could have bought some candy that cost 70 cents and paid with a dollar bill and a nickel." I told Sam that his solution was mathematically correct but that it didn't make sense as a real-life solution. "If I were buying something for 70 cents," I asked him, "why wouldn't I merely pay with the dollar bill and get 30 cents in change?" Sam and the other students were surprised by my response, but they saw the sense in my analysis.

Next, Kellie suggested buying candy that cost 35 cents. "You'd pay with 70 cents," she said. "What coins would I use to pay for the candy?" I asked her. After a moment, she said, "Two quarters and two dimes." I responded, "But I could use just one quarter and one dime to pay, and then I wouldn't need change." Kellie groaned.

Next I asked the students to talk at their tables about the answers they had found. In a few minutes, one table was sure they had an answer that was mathematically correct and sensible, too: Nathan reported that I could have bought a game for $9.65 and paid with a $10 bill. At another table, Maria said that I could have bought a sandwich for $4.65 and paid with a $5 bill.

Now the time was ripe for a writing assignment. I asked the students to record an answer and write about why it made sense in two ways—mathematically and also as a real-life solution. The students' writing helped cement for them the idea that they needed to consider answers to problems from different perspectives.

3. Explaining mathematical ideas.

From time to time I ask students to write an essay about a math concept. Their responses often provide useful information for assessing what they understand. I structure these assignments in a straightforward manner. For example, during a unit on probability, I asked 3rd graders to write about equally likely, explaining what it means and giving an example. At the end of a unit on division, I asked 4th graders to write about how

multiplication and division were alike and different.

In the middle of a unit on fractions, I asked 5th graders to write on the topic "What I Know About Fractions So Far." (This title conveyed to them that I didn't expect them to know everything yet.) Nelson's response tipped me off to his misconception about the smallest possible fraction. He wrote,

I know about halves and fourths. I know about eighths, too. And I know that sixteenths are the smallest fractions there are.

I had recently introduced Fraction Kits to the students in which they cut strips of construction paper into halves, thirds, fourths, sixths, eighths, and sixteenths and then used the strips for a variety of games and activities. Nelson had erroneously generalized from this limited set of fractions. This was important information for me to have. The next day, I had the students cut another strip into sixteenths and then cut each of the sixteenths in half. We talked about the fractional part of the whole these pieces represented and labeled them each 1/32. We talked about continuing the pattern of cutting pieces into smaller pieces, resulting in fractions with larger and larger denominators. This seemed to help Nelson abandon his incorrect notion.

4. Writing about learning processes.

Some writing assignments don't focus on a math problem or concept but instead on some general aspect of the students' learning during math class. For example, students might discuss their favorite and least favorite activities in a unit. Or they might write about the qualities of a good problem-solving partner in math class. Sometimes they write directions for an activity or a game so they can teach it to someone at home. I've also had students write letters describing the activities we do in class, to be used as an introduction for visitors before they observe one of our math lessons.

With this variety of assignments, I make writing a regular feature of math class. Although different students enjoy different writing assignments, I find that incorporating a mix of writing activities gives me broader insights into my students' math experiences.

Strategies for Incorporating Writing

My skill and comfort with making writing integral to math learning evolved through years of experience, which included many mistakes and discoveries. Here are some classroom strategies that I recommend to teachers who want to incorporate writing into their math instruction.

- **Establish the purpose for writing in math class.** Make sure students understand the two basic reasons that writing is an important part of math: to support their learning and to help you establish their progress.
- **Establish yourself as the audience.** Let students know that their writing will help you teach them better by providing valuable insights into their understandings, misconceptions, and confusions.
- **Ask students to include details and to explain their thinking as thoroughly as possible.** Encourage them to use words, numbers, and, if they like, pictures to provide as much information as possible.
- **Have students discuss their ideas before writing.** Most students find talking easier than writing, and opportunities to talk about their thinking can help students formulate ideas they will then try to explain in writing. Class discussions are useful, but having students talk in small groups enables more students to express their ideas. After a discussion, remind students that they can write about any idea they heard as long as it makes sense to them and they can explain it.
- **Post useful mathematics vocabulary**. Maintain a class chart showing pertinent mathematics vocabulary that comes up in class discussions. Before students begin work on an assignment, ask if there are other terms they might use that they'd like to see on the chart. Keep this list posted and add to it during the year.
- **Write a prompt on the board to get students started on a writing assignment.** Sometimes a general prompt is appropriate: I think that the answer is _____. I think that because _____. Sometimes you'll want to use a prompt that relates more specifically to the assignment. For example, after asking 3rd graders how many chopsticks are needed for the 28 people in the room, I wrote on the board: We need ___ chopsticks. I figured it out by _____.
- **Give individual assistance as needed.** No matter how thoroughly you prepare students for a writing assignment, some will need additional assistance to get started. Talk with these students first to ascertain that they understand the assignment. Then encourage them to verbalize their thinking by asking them such questions as, "What do you think? What's one idea that you have? What do you remember about what others said?" After students offer an idea,

ask them to repeat it aloud. Then suggest that they repeat it silently to themselves. Finally, tell them to write those exact words on their paper. This process often helps jumpstart students' writing. If it doesn't, try refocusing the assignment and asking students to write about what they find confusing.

- **Have students share their writing in pairs or small groups.** Before handing in an assignment, students may benefit from reading their papers to another student or to a small group for feedback. This exercise not only serves the writer but also enables students to hear other points of view.
- **Use students' writing in subsequent instruction.** Student papers can provide useful springboards for extending lessons, and using them in this way reinforces the idea that you value students' writing.
- **Use student papers to create class inventories.** Reading a set of papers from an assignment can provide a useful overview of how the class responded to particular lessons. Was the experience accessible to all? Did it interest or challenge the more capable students? What additional instruction do students need?
- **Keep each student's work in an individual folder.** After reviewing students' papers, file them in folders to create a chronological collection of work for each student. Reading through individual folders of work done over time provides a useful record of the student's progress. The folders can also be a great tool for parent conferences.

Taking on the Challenge

The National Council of Teachers of Mathematics has acknowledged writing as an important component of math instruction. The Council's *Principles and Standards for School Mathematics* (2000) states that "written communication should be nurtured" (p. 62) and that math instruction should enable all students to:

- Organize and consolidate their mathematical thinking through communication.
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- Analyze and evaluate the mathematical thinking and strategies of others.
- Use the language of mathematics to express mathematical ideas precisely (p. 60).

It's up to mathematics teachers to take on the challenge of implementing these goals in classroom instruction. You can begin by understanding how writing benefits your students' understanding of mathematics and by working to incorporate a broad variety of writing activities into your classroom. As you hone your repertoire of instructional strategies, you'll find that students come to accept writing as a reasonable extension of what they're doing in class and, finally, as a natural and integral part of their math learning.

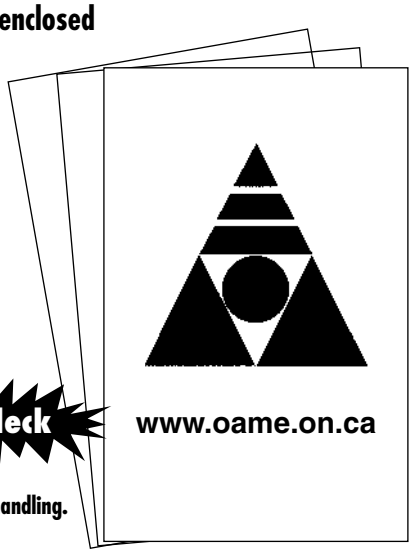
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Zinsser, W. *Writing to Learn.* New York: Harper and Rowe, 1988. ▲

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▲ The College Mathematics Project

MARGARET SINCLAIR

GRAHAM ORPWOOD

LAUREL SCHOLLEN

Dr. Margaret Sinclair is an Assistant Professor in the Faculty of Education at York University. She brings to this work almost twenty years of experience as an elementary and secondary classroom teacher and a secondary administrator. Her research focuses on the use of technology in elementary and secondary school mathematics, and on the use and design of mathematics learning objects. Dr. Sinclair recently served as a member of the Ontario Ministry of Education's Expert Panel on Mathematics in the Junior Division.

Laurel Schollen has been the Dean of Applied Sciences and Engineering Technology at Seneca College since 2002 and Co-Director of the York/Seneca Institute for Mathematics, Science and Technology Education since its inception in 1999. Laurel has been a member of the provincial Heads of Technology group for the past three years and most recently has served the group as chair of the Central Region and Treasurer. It was through her work with Heads of Technology that she became interested in examining the relationship between secondary school mathematics experience and first year college technology mathematics performance with a view to create a seamless math experience for students.

Graham Orpwood is Associate Professor of Science Education at York University and former Director of the York/Seneca Institute for Mathematics, Science and Technology Education (YSIMSTE). He is interested in curriculum and assessment policy and practice, especially in the areas of mathematics and science.

On June 15, 2006, more than 100 representatives from 11 colleges, 10 school boards, provincial associations and government ministries attended the *College Mathematics Project (CMP) Regional Forum* held at Seneca College's King Campus. The *Forum*, sponsored and coordinated by the Connecting GTA Teachers Regional Planning Team and funded by the School/College/Work Initiative was held to discuss the implications of the College Mathematics Project study and to make recommendations for further action.

A key recommendation of the *Forum* was to increase dialogue among stakeholders. Another was to raise awareness of MCT4C as a prerequisite for college technology programs. We hope, through this article, to address both of these recommendations.

The College Mathematics Project

Success rates in first year college technology mathematics courses are often unacceptably low. These low success rates are usually mirrored in other subjects in which mathematics is important and students who are unsuccessful in such key courses are usually unable to complete their chosen program, resulting in an unacceptably high drop out rate. The lack of research-based information on the factors contributing to this problem became evident during the SQC review of the secondary mathematics curriculum when the colleges were asked to provide feedback on the new mathematics curriculum.

Since there are no formal linkages between the Ministry of Education and MTCU to investigate issues such as this, a team from the York-Seneca Institute for Mathematics, Science, and Technology Education (YSIMSTE) set out to systematically examine the issue of student success in college technology programs. Our goal was to enable stakeholders to discuss factors leading to student success or failure from a factual and statistically relevant, rather than an anecdotal, perspective.

The College Mathematics Project, Pilot B, carried out in 2005-2006, and led by Seneca College, involved six participating Colleges of Applied Arts and Technology (Seneca, Sheridan, George Brown, Georgian, St. Clair and Fanshawe). The research included both a qualitative analysis of college policies and programs and a quantitative analysis of student data.

The results of the qualitative component found a wide range of policies, practices, curriculum, and support at the six participating colleges. For example, more than 30 different first semester mathematics courses were offered in technology programs!

The quantitative component involved developing a database of student mathematics experience, from Grade 9 to first year college for more than 5000 students

registered in more than 100 programs at six colleges, and then:

- Comparing achievement in secondary mathematics with achievement in first semester college mathematics
- Looking at pathways (secondary school mathematics course selections) to determine which (if any) are more predictive of success

Since this is an ongoing study, all CMP data must be viewed as preliminary at this time; nevertheless, while we continue to refine the research, the YSIMSTE team believes that it is critical to share our initial findings with those involved in mathematics education. Thus, we released a research brief in early March, 2007. It included the following statements:

- Choosing the right math course in Grade 12 can dramatically affect students' chances of future success in college technology programs, according to a recent analysis of research data collected by the College Mathematics Project (CMP).
- The latest CMP analyses show that, of more than 700 students entering first-year technology programs at five Ontario colleges in fall 2004, fewer than one quarter had taken MCT4C (Mathematics for College Technology). Sixty-nine per cent of these students achieved an A, B or C grade in their first semester college mathematics course, with 31 per cent obtaining a D or F or withdrawing from the course.
- By contrast, the Grade 12 mathematics course taken by over half of the students was MAP4C (College and Apprenticeship Mathematics). Of this group, fewer than 35 per cent achieved a good grade (A, B or C) in first semester college mathematics and 65 per cent obtained a D or F or withdrew from the course.
- The implication for students who plan to take a college technology program after high school is that taking MCT4C (instead of MAP4C) greatly increases their chance of success.

The implication for schools is that they should ensure that MCT4C is offered and that students considering technology careers are strongly advised to take this course.

Although there have been changes in the high school math curriculum, we believe that the central implication of the message in this research brief - that college technology programs are challenging and require the level of mathematics preparation provided by courses such as MCT4C - is vital to communicate to the OAME membership.

In addition, we would like to share with you some of the additional *Forum* recommendations for secondary schools:

- Increase dialogue with colleges, and encourage teachers to visit college classrooms.
- Honour all destinations, not just university, by:
  - helping students understand that MCT4C will better prepare them for college technology programs;
  - scheduling courses for college pathways even when there is low enrollment;
  - helping parents understand that the doors are still open to students in the applied stream, and that certain levels of achievement are required for success in later courses; and,
  - beginning career education on college destinations early – working together to inform students about pathways and where they lead.

By acting on these recommendations you can all help to improve the outcomes for those students interested in college technology, and thereby to address Canada's need for skilled technology graduates.

Note: This year we are expanding our research to include all college programs that require students to take mathematics, and hope to have additional information available by fall of 2007. ▲

▲ Call for NCTM Rep

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▲ Grade 11 Function Modelling with E-STAT Data: Exponential Potatoes and More!

JENNIFER HALL



Jennifer Hall is a Mathematics Microdata Learning Resources Officer at Statistics Canada in Ottawa. She assists Joel Yan in creating learning resources and giving presentations to students and teachers from the elementary to university level. She is also a full-time M.A. (Ed.) student at the University of Ottawa, studying under Dr. Christine Suurtamm. Her research interests are gender issues in high school gifted math classes and at a post-secondary level.

The revised version of the Ontario Grade 11 Mathematics Curriculum features specific expectations regarding collecting and graphing secondary data for exponential, quadratic, and sinusoidal functions in the University Preparation (MCR3U), University/College Preparation (MCF3M), and College Preparation (MBF3C) courses. An excellent source of this secondary data is Statistics Canada's E-STAT web site **http://estat.statcan.ca**.

E-STAT is available to all computers in educational institutions and Canadian depository libraries. For teacher or student use of E-STAT at home, a password and user name are required. User names can be found at **http://www.statcan.ca/english/Estat/Schools/school.htm**, in brackets beside the school name. Passwords can be obtained from your school principal. If you have any problems, please email **e-stat@statcan.ca** or call 1-800-465-1222 ext.1.

E-STAT tracks trends in virtually all aspects of Canadian life and offers over 2 600 tables from the Canadian Socio-economic Information Management System (CANSIM). The CANSIM database on E-STAT is updated annually and, as of July 2006, offers more than 36 million time series from over 250 different surveys.

With this enormous wealth of data available, it can be time-consuming for students and teachers to randomly search for data that might follow exponential, quadratic, or sinusoidal patterns. The September 2004 issue of the *Ontario Mathematics Gazette* featured an article by Joel Yan that provided examples of how E-STAT could be used for modelling functions related to the Grade 12 College Math Course (Yan, 2004). I wanted to find additional secondary data relevant to the expectations and types of curves featured in the Grade 11 Math curricula, so I spent time searching for relevant data for use in Grade 11 classrooms and found some fascinating results!

Exponential Functions:

- The farm value of potatoes [CANSIM Table 001-0014] has followed an exponential curve since 1908!

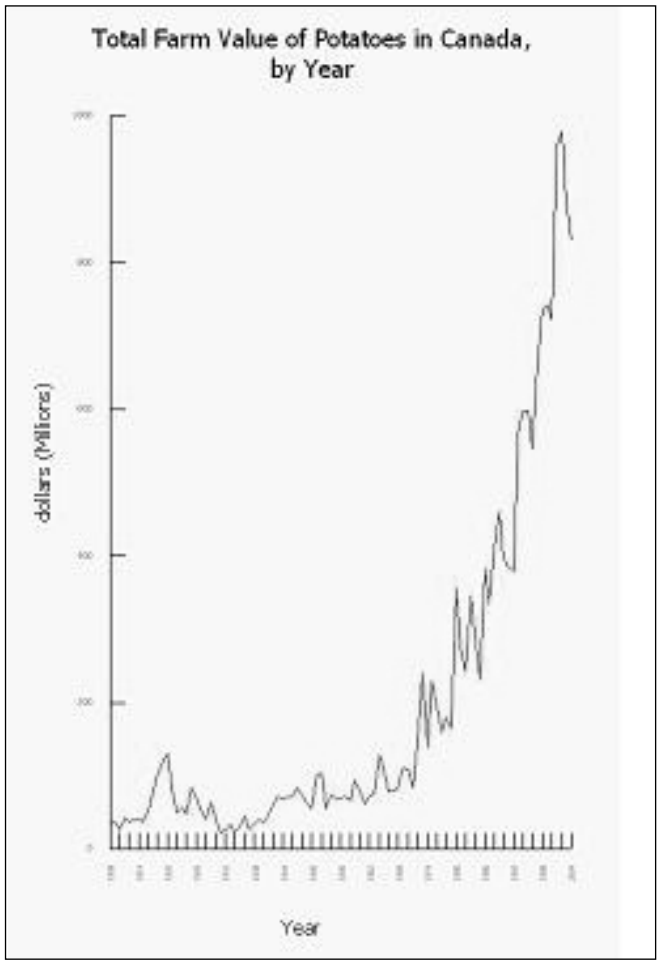


Figure 1: E-STAT Graph from CANSIM Table 001-0014.

Other data sets that follow exponential curves over certain time periods:

- Federal debt [CANSIM Table 385-0010]
- Consumer price index [CANSIM Table 326-0002]
- Absence rates of full-time female employees in occupations in social science, education, government service, and religion [CANSIM Table 279-0031]

Quadratic Functions:

- The number of males registered in trade programs from 1991 to 2001 follows a quadratic curve [CANSIM Table 477-0051].



Figure 2: E-STAT Graph for CANSIM Table 477-0051

Other data sets that follow quadratic curves over certain time periods:

- Canadian births [CANSIM Table 053-0001]
- Number of homicides by shooting [CANSIM Table 253-0002]
- Absence rates of full-time female employees in processing, manufacturing, and utilities [CANSIM Table 279-0031]

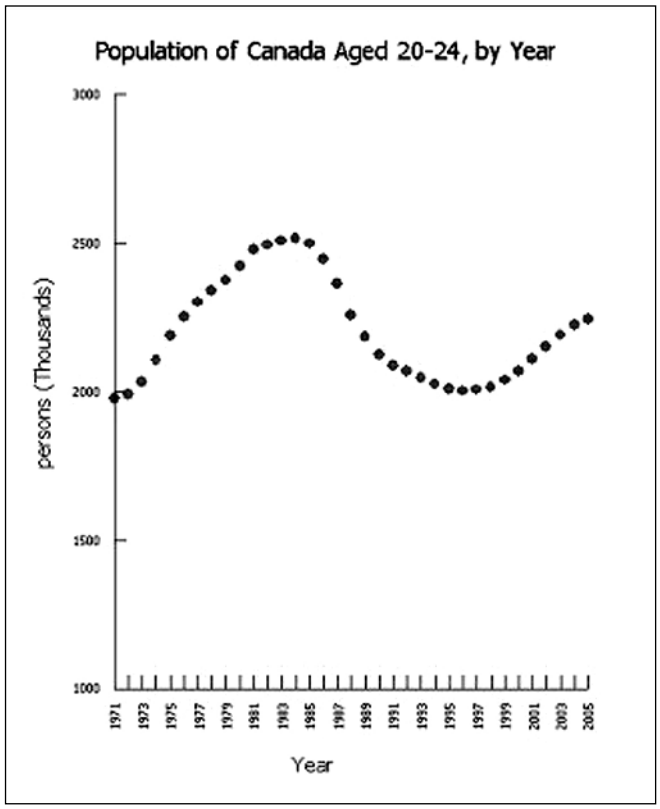


Figure 3: E-STAT graph of CANSIM Table 106-9034

Sinusoidal Functions:

- The population in Canada aged 20-24 [CANSIM Table 051-0001] follows a sinusoidal curve from 1971 to present.

Other data sets that follow sinusoidal curves over certain time periods:

- Canadian population aged 20-24 [CANSIM Table 051-0001]
- Number of international travellers into Canada [CANSIM Table 387-0004]
- Employment rate [CANSIM Table 282-0001]

Some of the above data sets are listed on the Ontario Association for Mathematics Education web site **http://www.oame.on.ca**, under "NEW Grade 11 Materials Available!!" on the main site. Then, click on "MCF3M Support Materials" and select the pdf file "Introduction to MCF3M". Page 7 of this document has a comprehensive table showing examples of quadratic, exponential, and sinusoidal E-STAT data sets.

As a result of finding the tables listed above, Joel Yan and I created an instructional resource for teachers who are interested in using E-STAT data for function modeling, which is located at **http://www.statcan.ca/english/edu/mathmodel.htm**. This resource features

▲ Call for Manuscripts

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Marilyn Hurrell for further details.

Letters to the Editor always welcome!

CANSIM table numbers and vector numbers (to retrieve the exact data we used) for data that approximate linear, quadratic, exponential and sinusoidal functions. Detailed steps for extracting E-STAT data are provided, as well as suggestions for classroom use. This resource is also available in French at **http://www.statcan.ca/francais/edu/mathmodel_f.htm**.

Data from the above CANSIM tables can be graphed directly in E-STAT in 15 graph formats (e.g., line graphs, scatter graphs, bar charts) as shown in the examples provided, displayed in table formats or directly downloaded. From a table format, the data can then be copied into *Fathom* (*Fathom*, 2006) or another data analysis program to be analyzed.

Fathom is provincially licensed for use in all Ontario schools. It is an excellent tool to teach students about the purpose of different parts of an equation. Students can plot a known function type, such as exponential or sinusoidal, and then use sliders to alter the variables to try to fit the data from their retrieved data set.

For example, as is shown in the *Fathom* screen shot below, the farm value of potatoes data (CANSIM Table 001-0014) can be modelled using the following function:

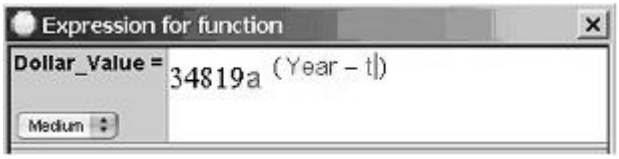


Figure 4: Fathom screen shot of function for farm value of potatoes.

The value 34 819 is used as it is the initial value for the data (dollar value - thousands, in 1908), in the interest of simplicity, though this may not provide the most precise line of best fit. Then, sliders can be applied for the values of **a**, the rate of increase or decrease, and **t**, the year in which the data begins to follow an exponential curve. By adjusting the values of the sliders individually, students can clearly see the purpose of each variable in the equation. Another important topic that can be discussed while using *Fathom* to analyze secondary data is residuals. By displaying a residual graph directly below the function graph, students can clearly see if they are choosing variable values that are closely approximating the function.

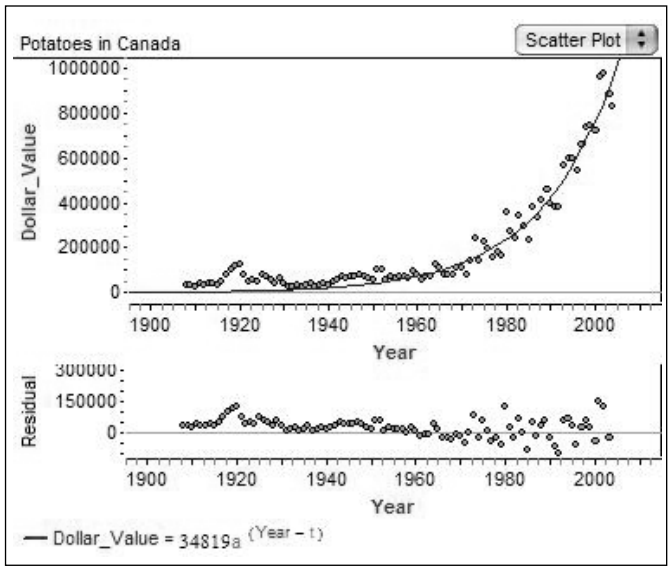


Figure 5: Fathom graphs showing exponential curve fitting to farm value of potatoes data and related residual graph.

A lesson using the farm value of potatoes data is available on our TeacherWeb web site, Math Resources using Canadian Data, at **www.teacherweb.com/on/statistics/math/** in the E-STAT and Community Profiles folder, as are lessons regarding modelling quadratic and sinusoidal functions. Also located in that folder are *Fathom* datasets about federal debt, consumer price index, and the aquaculture industry, an article about potatoes, a document with the aforementioned E-STAT graph examples, and tips on using moving averages in E-STAT (a tool which averages a time span of your choosing to better smooth the graph).

The most fascinating part of utilizing real-world, secondary data in the classroom is the discussions that will be sparked. Not only can you discuss different properties of equation types, but you can analyze the data to see why it follows such a pattern. For example, the farm value of potatoes graph increases exponentially in the late 1940s because of increased exports of frozen potato products and increased production for potato chips and French fries (McLaughlin, 2005), topics that students will definitely find more interesting than factoring! The more interesting and real-world applicable the topics we can introduce in math classes, the more fascinated students will become with the subject, which I believe is our goal as mathematics educators.

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▲ DIRECTORS' DIALOGUE

ANN MICHELE STENNING



Ann Michele Stenning is a mathematics teacher at South Secondary School with the Thames Valley District School Board. She is currently completing her Masters of Education in Curriculum Studies. Ann Michele was part of the planning committe for the 2006 OAME conference "Everyone Counts".

This edition of Directors' Dialogue highlights the events of the OAME Board of Director's meeting at the Holiday Inn Select, Toronto Airport on Friday February 2 and Saturday February 3 2007.

Chapter Representative's Meeting

Chapter representatives met to share useful teaching techniques. Representatives discussed the use of Maple 10 which is a comprehensive computer program , MATHO, and Clingers for classroom use. Charlotte Cutajar made a presentation from the Promotions committee on two ready-made workshops that could be used to promote OAME to teachers and pre-service teachers. The workshops include using a powerpoint featuring reasons to join OAME and the OAME resource, Growing Up Mathematically.

Board of Director's Meeting

President Dan Charbonneau welcomed new board members Rob Gleeson (GVMA) and John MacLennan (SAME). He highlighted environmental issues in anticipation of the day's professional development session.

Highlights: Curriculum Committee Meetings

JK-6: Committee members looked at literature suitable for studying mathematics. Pat Margerm reported that the JK-6 committee met and critically reviewed criteria for choosing literature for mathematics from articles by Marilyn Burns, Douglas Clements and David Whitin. In some cases the criteria was contradictory. The committee looked again at key mathematics and how literature would support students

in learning these skills and concepts. As a whole group a framework was developed for five lessons for the book *One Hundred Hungry Ants*. The working title for the resource is *Five Books: Twenty-five Problems*. Five lessons for each of the following books will be developed: *Ten Black Dots, Three Pigs, One Wolf and Seven Magic Shapes, The Doorbell Rang* and *The Grouchy Ladybug*.

7-9: Connie Quadrini reported that there was a review of grade-level *"Math in Flight"* product development. Draft lesson plans were developed which include a grade 7 and 9 toy company scenario as a summative activity, a grade 9 TIPS4RM MATCH template and two-variable data analysis with technology and a grade 8 paper airplane competition scenario with a TIPS4RM MATCH template to be developed.

10-12: Bev Farahani reported on a revised grade 12 curriculum implementation training session for grades 11 and 12 teachers. Articulation was presented: what information do teachers of Grade 12 need from the next level (workplace/college/university)? Discussion ensued over the issue of how marks are calculated when teachers track by the four categories: average vs. most consistent/more recent. Members were told that two teams were working on "year at a glance" based on the latest draft version of MCV4U, MHF4U, MAP4C and MCT4U. This is will include a day-by-day list of topics that flow logically for the entire course. Planning guides are also being created comparing current curriculum and revised curriculum.

Board members participated in a professional development session on environmental issues. The trailer for the movie *An Inconvenient Truth* and the accompanying website: **http://www.participate.net/educators/** was viewed. Many environmental issues were highlighted to show how mathematics could be used to understand environmental phenomena. Board members searched environmental sites and some of these are available through **www.oame.on.ca**.

The board meeting wrapped up with the announcement of the annual OAME conference in Barrie from May 3-5, 2007 and the Ontario Math Olympics in Ottawa from June 1-2, 2007. The meeting was adjourned with plans for the next meeting to occur on June 8-9, 2007.

Chapter Reports:

CHAMP - Rep: Lynda Ferneyhough:

The CHAMP Fall Event on Oct 19 2006 was a big success. Attendees liked the format with a guest speaker and then breakout groups by grade level. We challenged everyone who came to bring a friend to the next CHAMP event. We made enough money to send our OMO teams to the provincial contest

COMA - Rep: Ron Gaudreau:

Our annual Mini-Conference was held on Saturday, November 18 2006 at the University of Ottawa. The conference was very successful with approximately 150 teachers attending. Sixteen workshops were offered from Primary to Secondary divisions. COMA will be sponsoring the Ontario Math Olympics on June 1-2, 2007. Upcoming events include our local math Olympics to be held in April and two forums to be held on May 14. For the senior forum, publishers will be invited to present their new textbooks for secondary schools.

GOLDEN - Rep: Laura Tonin:

Our committee is busy working on our annual spring conference to be held at Brock University. The conference's theme is Visual Math and will be held on Thursday, April 26th, from 4–7. We have a variety of speakers presenting, including Richard Hoshino and Louis Lim.

GVMA - Rep: Rob Gleeson:

Rob is new to this post. Welcome!

ISOMA - Rep: Diane Lang:

The Executive of ISOMA met in November 2006 to debrief the Fall Conference hosted by Appleby College. At this meeting we were joined by Mark Suckling, from Crescent School, who is organizing the ISOMA Chapter Jr. Math Olympics. This event is being held on Sat., April 14th with teams from all independent schools in Ontario who can organize to send students. A planning meeting was held in January at Crescent School where representatives from several schools volunteered to help in the creation of events for our Math Olympics. Edith Louie, from Branksome Hall, has convened a meeting of Math Heads of the Metro Area Independent Schools. At this meeting we will discuss the impact of Grade 12 curriculum revisions on our programs and share ideas of how to accommodate the changes in our schools.

MAC² - Rep: Andrew Morrison:

Andrew was busy planning the OAME 2007 Annual.

NOMA - Rep: Sue Melville:

Plans for 2007 include extending an invitation to the local French school boards to nominate teachers to join the NOMA committee, adding teams from North Bay to our regional OMO playdown, and including more PD for committee members in monthly meetings. The 2007 Fall conference will be held on Friday, October 19, 2007 at St. Charles College in Sudbury.

Finally, after many years of serving as Treasurer, Bob Smith is stepping down from the position to enjoy his retirement. The NOMA committee welcomes Sheila Giroux as our new Treasurer. The NOMA committee meets on the second Wednesday of each month.

NWOAME - Rep: John Colledanchise:

NWOAME is undergoing restructure. We will hold an OMO event in April and hope to send a team to Ottawa.

PRMA - Rep: Sandra Jean Price:

After a very busy Fall, PRMA is currently planning ahead for our local Math Olympics playdowns on May 8, and our Annual Awards nights which are being held on June 4 for grades 4-8 and June 5 for grades 9-12. We are also evaluating how we are offering P.D. in our area, and are considering taking an OAME "Roadshow" to the Faculties of Education in our area.

QSLMA - Rep: Robert Sherk:

Last November 2006 QSLMA hosted its annual fall conference in Kingston. With about 50 in attendance it was a small but successful event. Special quest presenters included Fred Ferneyhough on CAS, Joel Yan on Estat and Tinkerplots, and Jacqueline Hill as keynote. In December, QSLMA sponsored a Math League competition for Grade 11 and 12 students in our area. This spring, we will focus on promoting the annual provincial conference in Barrie and keeping local members informed through an email newsletter. We will also be planning a local OMO with the support of faculty and students at Queens AC. of Ed.

SAME - Rep: Debbie Drape:

SAME held their mini-conference February 21st. Publishers were invited, speakers organized and the electronic version of our registration booklet sent out with paper copies distributed to schools. This year t-shirts have been ordered for the executive plus student volunteers. The Chapter is well on their way with the planning for their local OMO.

SWOAME - Rep: David Petro:

We will be having a presentation to a joint group of math teachers and guidance Counsellors regarding the new math pathways and the new grade 12 math courses (Date:TBA). Plus we are running the local math Olympiad where we will be selecting the three teams that we will send to the OMO 2007

TEAMS- Rep: Pat Margerm:

Plans are underway for the local TEAMS OMO competition on April 14, to choose teams for the provincial competition. The first annual award, in memory of the late president, Anne Cirillo, will be presented at this competition. TEAMS is also planning their second mini-conference for this school year on Mar 29 at St Basil the Great College. Laurissa Werhun has developed a web newsletter to send to all current TEAMS members with information about upcoming events as well as some recommended resources such as weblinks.

WOMA - Rep: Ann Michele Stenning:

WOMA is currently in the process of organizing their Spring mini-conference. As well, we continue to discuss how to best support WOMA educators using WOMA's financial resources. Our most recent initiative was to cover every WOMA member's cost of registration at our fall mini-conference.

Y^{4}MA - Rep: Pietrina Orlandi:

As the York chapter for OAME we continue to work at preparing for OAME 2008. Sub-committees have been formed and have started to organize themselves and get the information required. Our OMO committee organized a Coachs' Night on Jan 18 at Middlefield Middle School, Markham Ont from 4:30 to 6:30 which teachers were invited to come to for inservice that would assist them in coaching their students for our regional OMO scheduled for April 11, 2007. We also have planned a facilitated discussion on the revisions of the Grade 11 curriculum for Thursday February 22nd, 2007 from 4:15 - 7:00pm at St. Augustine CHS Markham. ▲