Vol. 38 #4, June 2000

Ontario Mathematics Gazette

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Implementing Student Portfolios In the New Grade 9 Mathematics Course

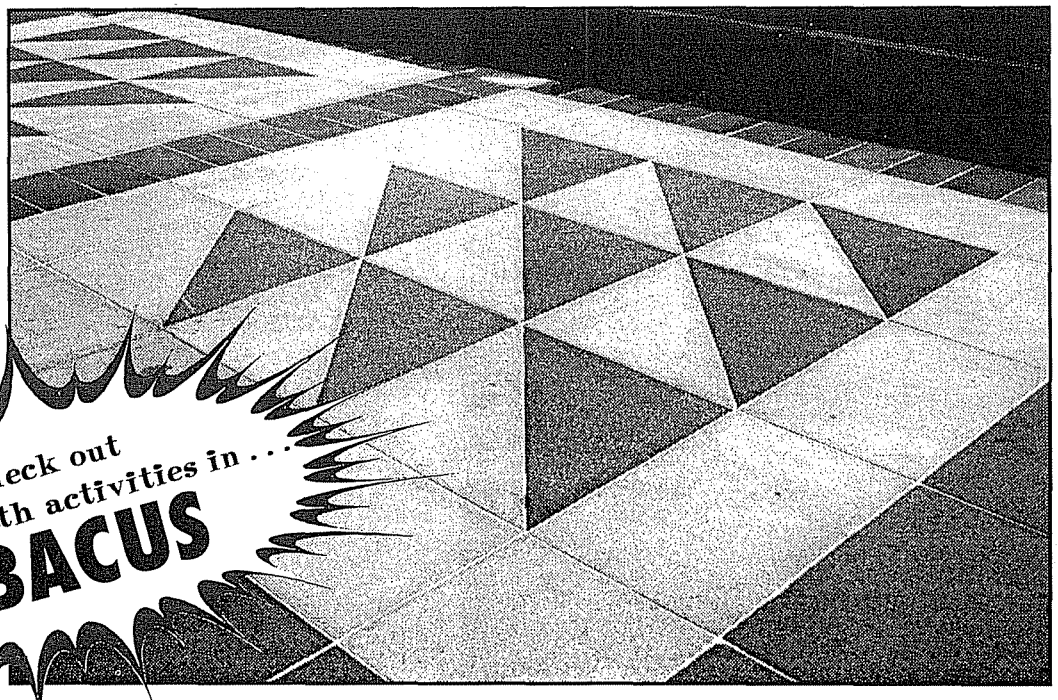
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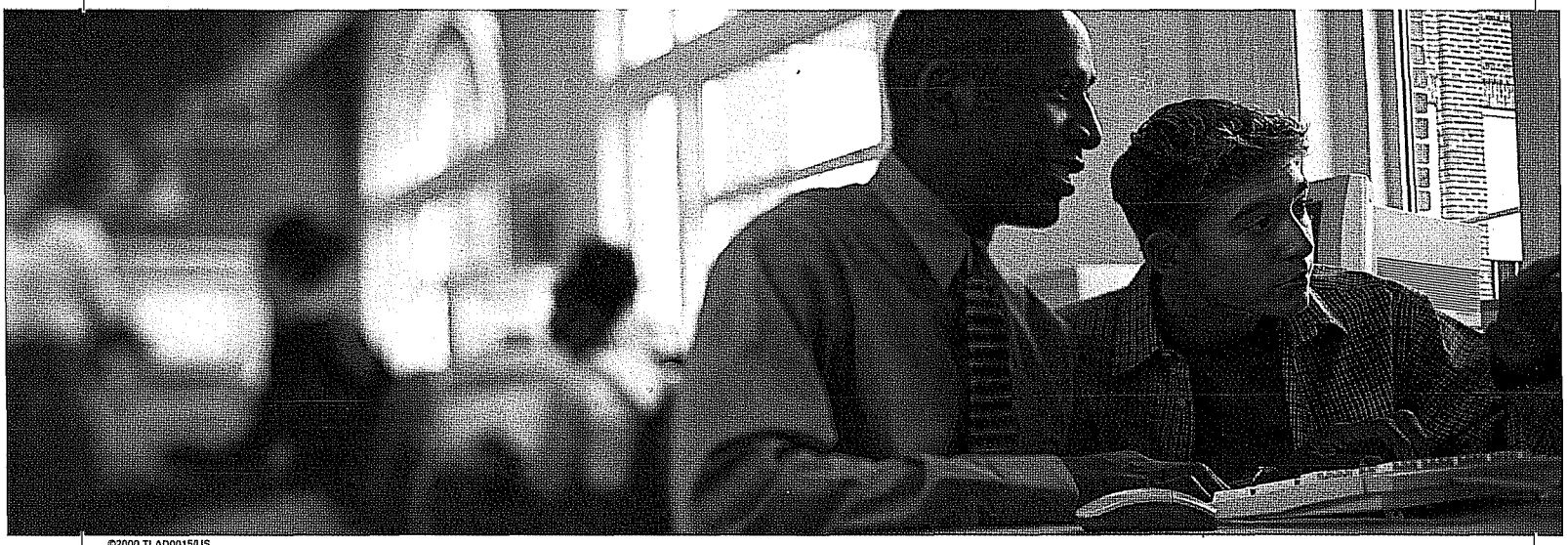
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The *Gazette*—ISSN 0030–3211—is indexed in the Canadian Education Index and is published four times per year. Its Canadian Publication Mail Product Sales Agreement Number is 601349.

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Articles for the *Gazette* should be submitted to Todd Romiens or Louis Lim at the address on the left.

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Notice to Authors

Articles must be original and/or references clearly stated. Your article should be word-processed, double-spaced on one side of 21.6 cm x 27.9 cm paper with 3 cm margins. Diagrams and figures should be drawn by computer, if possible, or neatly drawn in black ink in camera-ready form. Please submit **four** copies to the editor and keep one as protection against loss. Submissions are blind-reviewed, so please send your full address and affiliation on a page **separate** from the manuscript. Computer files of text, and graphics where possible, will be requested later if your article is accepted.

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▲ Editorial

CO-EDITOR, TODD ROMIENS



As I teach in the Faculty of Education at the University of Windsor, I have a great deal of concern for the number (or lack) of students we get with any mathematical background. This past year, my math as a teachable subject class, for Junior/Intermediate, had three students, and the Intermediate/Senior, had twelve. This, out of a total of over seven hundred enrolled in the Faculty. Last year the total was eighteen. This statistic is alarming, but the solution to the problem is not an easy one. Most students entering our faculty want to teach the Primary/Junior grades. They enter with degrees in Psychology, History or other Social Sciences, with very little mathematics. In fact I've had two students recently who had no more than Grade Ten general level math themselves. These people will be teaching mathematics to your children during years which may be the most important from a developmental and appreciative point of view.

This concern has not been lost on our colleagues, as I recently attended a meeting at the Fields Institute, where about fifty educators from all stakeholders spent the day dialoguing about this issue. There is no easy solution, as we are up against stiff competition from business and industry in the salary and benefits department. Some useful recommendations did however come out of this discussion. They include:

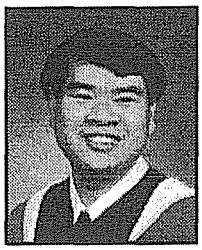
- Construct more courses in the Faculty of Education that enhance the learning and teaching of mathematics (Brock is doing this).
- Require math prerequisites to enter the Faculty of Education.
- Get more students into concurrent programs at the Faculty of Education.
- Get well known people to advocate the benefits of teaching, with math as a focus.
- Allow more time for teaching mathematics methodology in Faculties of Education.
- Governments give more money to education to attract math graduates.

While not an exhaustive list, it is a start. You will be hearing more about this issue in future editorials. Your comments are welcome. ▲

Todd Romiens

▲ Editorial

CO-EDITOR, LOUIS LIM



The quality of the articles in the *Gazette* is dependent upon the reviewers who recommend which articles should be published, along with providing suggestions to strengthen articles. Reviewers consist of elementary, secondary, and post-secondary educators, and they are asked which panel (elementary or secondary) and topics they prefer to review. Articles are blind-reviewed by at least two reviewers, and reviewers have approximately two weeks to complete their review. Reviewers can expect to perform their duties 1 to 3 times per year using specific criteria (e.g., ensuring the mathematics is accurate, interest to our readers, editing).

Serving as a reviewer to the *Gazette* has its rewards. In addition to having a say/direction on which articles would be of interest to our members, it is also an invaluable professional development opportunity through reflecting on one's practice. Authors appreciate the feedback they receive from the reviewers to enhance the quality of their submissions before publication.

Below is a revised list of reviewers which Todd Romiens and I have compiled. Since there are almost 1500 OAME members, it is easy to have overlooked people. If you are an OAME member and would like to serve as a reviewer, or need additional information, please contact Todd or I. We appreciate the contributions of the reviewers as they help advance mathematics education in Ontario.

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▲



▲ Outgoing President's Message

PETER SAARIMAKI



"Imagine a classroom, . . . where all students have access to high-quality, engaging mathematics instruction."

Have you seen the new NCTM *Standards 2000* yet? It's full title is "Principles and Standards for School Mathematics". This is the update of the earlier landmark trio of *Curriculum and Evaluation Standards, Professional Standards* and *Assessment Standards*.

I was able to be in Chicago for the official release (thank you TDSB!) and had the opportunity to see the energy, excitement and enthusiasm generated by discussions around this expanded vision of mathematics and mathematics education.

Our new Ontario curricula, 1 - 8 and secondary, were heavily influenced by the original *Standards* and we will find a lot of support in this new version, . . . and a lot to think about!

Consider, for example, the six Principles on which *Standards 2000* is based:

Equity. Excellence in mathematics education requires equity - high expectations and strong support for all students.

Curriculum. A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.

Teaching. Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.

Learning. Students learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.

Assessment. Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.

Technology. Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.

There are also ten Standards enunciated in each grade-band, gathering the mathematical content and process expectations that we see reflected in Ontario's strands and categories. An interesting chart (on page 30) illustrates the relative emphasis of the Content Standards as they change across the grades.

The Process Standards highlight ways of acquiring and using content knowledge and include: Problem Solving, Communication, Reasoning and Proof, Connections, and Representation.

It is made quite clear that the Content and Process Standards are inextricably linked, just as the Ontario strands and categories are interwoven to form a complete picture of the program. One cannot solve problems without understanding and using mathematical content. Communication is a must to demonstrate understanding of concepts and applications. Because mathematics as a discipline is highly interconnected, the areas described by the Standards overlap and are integrated.

Throughout the sections are activities, examples of student work and commentaries. As well, there is a host of quotable quotes, such as:

A coherent curriculum effectively organizes and integrates important mathematical ideas.

There is no one "right way" to teach.

Opportunities to reflect on and refine instructional practice are crucial.

Learning with understanding is essential to enable students to solve the new kinds of problems they will inevitably face in the future.

Assessment should become a routine part of the ongoing classroom activity rather than an interruption.

Assembling evidence from a variety of sources is more likely to yield an accurate picture.

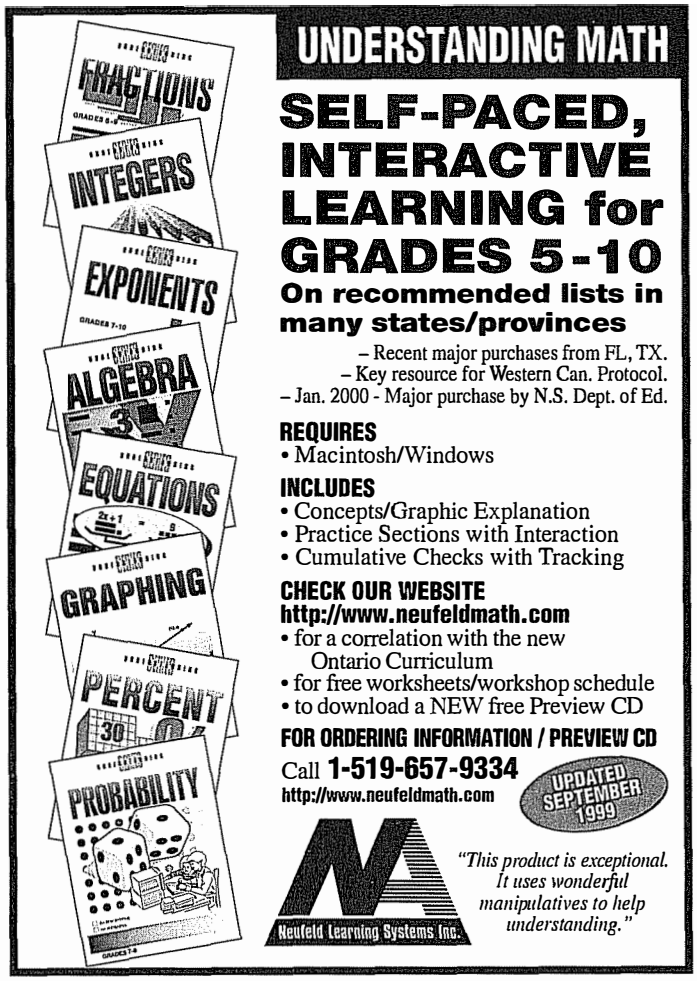
Technology enhances mathematics learning and supports effective mathematics teaching.

As my outgoing column, I hope my sharing of future possibilities will be more useful than a summary of activities of the past year.

NCTM members will have received their free copy of *Standards 2000* already. Others can purchase the whole document in hard copy, on CD-ROM or in a pdf file, or simply purchase the appropriate grade-band materials (the grade-bands are pre-K - 2, 3 - 5, 6 - 8 and 9 - 12). Full information and other electronic resources are available on the web at **www.nctm.org/standards**. Visit soon and often!

Rejuvenate yourself this summer, spend some relaxing times thinking about the BIG picture, and consider what messages you want your students to take with them concerning mathematics after your classes next year.

Cheers, Pierre



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▲ OAME-NCTM Report



FRANCES SCHATZ

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The benefits of NCTM membership add up quickly. You get a 20% discount on NCTM educational materials. You help OAME since an additional 20% of sales goes to OAME.

You receive discounts on regional and annual NCTM meetings. For each new NCTM individual membership, OAME receives $5.00 US. If you need more information, please contact me, your OAME-NCTM representative. The price (one journal included) is $88.00 Canadian made payable to OAME-NCTM. The only way to obtain the membership with the new CAD cap of 25% is via cash or Canadian cheque to OAME-NCTM.

NCTM Award Winner

Congratulations to our *Gazette* co-editor, Louis Lim, who attended the NCTM Annual Meeting 2000 in Chicago by winning NCTM's FLAMeS Award (Future Leaders Annual Meeting Support). Louis was also OAME's representative at this year's Delegate Assembly. Louis enjoyed the conference immensely, brought back a collection of useful information for me, and appreciated the award which helped cover airfare, hotel, and supply teacher. Louis was an excellent ambassador for OAME at the NCTM annual.

FLAMeS Project Award

The Mathematics Education Trust will fund travel, subsistence expenses, and substitute teacher costs for up to $1000 US to attend the Annual NCTM meeting. This award is available for up to six classroom teachers in grades K-12 who have never attended an NCTM annual meeting and who are NCTM members. For more information about this award, contact me or check the website www.nctm.org/about/met/flames.htm.

51st Delegate Assembly In Chicago – April 2000

Each Affiliate is eligible to send one delegate, Louis Lim for OAME, and resolutions submitted by Affiliates are discussed, amended, and voted on as necessary.

Resolution O.R.00.01 (passed)

Be it resolved that the Delegate Assembly recommend to the NCTM Board of Directors that the NCTM and its affiliates use their leadership and influence to address mathematical content and teaching/learning issues for adults enrolled in adult mathematics education (basic skills, literacy, numeracy, and high school equivalency, etc.) programs by actively seeking to include teachers of adult students at their conferences and in their publications, and by adding 'adult numeracy' as an additional category in conferences and publications.

Resolution O.N.00.06

Be it resolved that NCTM not implement the Affiliate Sales Program as proposed; but that the program (consignments and special orders from conferences and school boards) be reviewed and revised with input from the Affiliate Groups.

(I have submitted input to continue with the setup already in place. NCTM had proposed that Affiliates purchase NCTM materials and resell them with returns of unsold materials not allowed. Currently, the NCTM representative can obtain the materials on consignment and the Affiliate receives 20% of the sales; unsold materials can be returned.)

Other Highlights from the Delegate Assembly

Addenda Series, now called 'Navigations', will be released at the NCTM annual conference in Florida, 2001, with the Algebra Across the Standards strand. Other strands to follow.

Locations of the PD Academies (2 & 5 days) TBA – contact me for grant applications of $1500 (deadline November 1, 2000).

The resolution of 50% of the NCTM Board of Directors being K-12 teachers was not passed – discussion in the Canadian caucus about how difficult it would be for teachers to receive between 20-30 school days off to perform NCTM duties.

The resolution was passed that the Board of Directors return to the policy of one free speaker registration per

regular speaker session at NCTM Annual and Regional Conferences. There was strong opposition of charging speakers 1 day conference fee.

Role of the OAME-NCTM Representative

This person has been given more responsibilities and must be proactive. As your representative, I will do my best with the following responsibilities:

- Promote membership with both organizations.
- Communicate information on NCTM activities to the OAME board and readers of this publication, the *Gazette*.
- Check the Online Affiliate Resource Centre to obtain information you request and keep abreast of new developments at NCTM headquarters.
- Participate in the annual NCTM Canadian Leadership conference.
- Make NCTM Educational Materials and Special Products available to Ontario mathematics educators at meetings, conferences, and by mail order to me.
- Use the correct consignment procedures for ordering, selling and returning NCTM materials.
- Communicate effectively with NCTM via email, fax, Internet, and telephone.

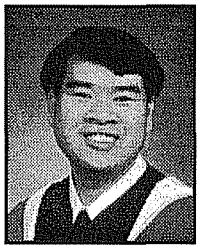
Visit the NCTM Booth

I have a good selection of NCTM Educational materials and special products available to show at chapter meetings, regional conferences in Ontario, and I encourage you to drop by and visit our large display of new materials. You can also request items, prepaid, by mail order. ▲

"The known is finite, the unknown infinite; intellectually we stand on an island in the midst of an illimitable ocean of inexplicability. Our business in every generation is to reclaim a little more land."
(Thomas Huxley)

▲ Implementing Student Portfolios in the New Grade 9 Mathematics Course

LOUIS LIM
QUINTE SECONDARY SCHOOL, BELLEVILLE, ON



Louis Lim is a fourth year mathematics teacher at Quinte S.S. in Belleville, ON. The following article, a balance between theory and application, will provide teachers with a "push" to begin implementing portfolios in their classrooms. It was written during the summer of 1999 when Louis was a student in Dr. Lynda Colgan's "Measurement and Evaluation" Master of Education course at Queen's University.

With a new mathematics curriculum that emphasizes problem solving and hands-on exploration, several questions come to mind: Do we need to incorporate assessments other than tests and examinations to measure what our students know? Can alternative assessments actually **create** learning opportunities in-line with the new curriculum? Is assessment and evaluation a critical ingredient to consider as we alter the way mathematics is taught? These are questions I pondered, and specifically address in this article, through the use of student portfolios.

I have been fortunate in never encountering a parent who wanted me to provide evidence that their child was performing at the level I provided. As a teacher who has relied heavily on tests and examinations, how would I respond to a parent who says, "My child has difficulty writing tests and exams, but does understand the concepts. I don't think that it is fair that s/he should be given such a low mark?" or a parent who says, "Does your evaluation reflect what my child knows, can do, and apply to his (her) everyday life? Prove it to me."

During my first year of teaching, I was told by my computer science department head that I was to use portfolios to assess my grade 7 and 8 students. Unfortunately, I was not given (and unaware of) a rationale as to why I had to incorporate portfolios in my computer studies program; nor was I aware how to implement them effectively. In fact, my students were not part of the process of gathering submissions (everyone had the same work samples included) to their portfolios, nor were they even aware that I was keeping one for them. It was simply an administrative task for me which eventually went to the students' teacher the following year.

During the past decade, much research has been conducted in incorporating student portfolios in the mathematics classroom. Pam Knight (1992) describes her experiences using portfolios to alter her instructional practices so that a variety of assignments can be included in the portfolios (p. 72). Christine Suurtamm (1997) adds that portfolios showcase "whether mathematical communication is encouraged, mathematical skills developed, and open-ended problems which encourage mathematical reasoning" (p. 26).

Judith Arter and Vicki Spandel (1992) define student portfolios as "a purposeful collection of student work that tells the story of the student's efforts, progress, or achievement in (a) given area(s). This collection must include student participation in selection of portfolio content; the guidelines for selection; the criteria for judging merit; and evidence of student self-reflection" (p. 36). Many of us may have seen university and college level visual arts students carry huge portfolios, and they are usually required to submit their portfolios for entrance to post-secondary programs and when they find employment.

Perhaps the greatest benefit of incorporating portfolios in the mathematics classroom occurs during the process when students assemble their portfolios. Through self-reflection, students take ownership of their learning as they analyze their personal growth, connections, feelings toward mathematics, problem solving abilities, effort, and development of thinking skills (Suurtamm, p. 23). Thus, the purposes of student portfolios in the mathematics courses are (i) for instruction (monitors student progress and development, create types of learning experiences which can go in the portfolio); (ii) communication with parents; (iii) celebrate what students can do (rather than cannot do), and (iv) pass on information to next year's teacher (Arter & Spandel, p. 39).

The research above convinces me that we must determine what our students know and can do since tests cannot assess everything. I am a product of our secondary and university mathematics' programs where grades were based entirely on tests and examinations. Usually, I memorized my way through the procedures, and did very well. It has been through teaching high school mathematics that I have been able to see "the big picture". Unfortunately, my assessments so far have mirrored my own schooling, but now I do not think that only one assessment strategy can give me a clear picture of each student's achievement. I recall many hours puzzling why hard-working students end up doing poorly on tests (due to test anxiety) when they can demonstrate their understanding afterwards to me.

Like journals, student portfolios should be introduced to the students at the beginning of the course, and will be secured safely but available to the students at any time. Each student will be provided with a file folder to assemble, and thus, store their submissions. They can be asked to create a title page to personalize their portfolio. All work done during the course needs to be dated so that growth can be documented when it is placed in the portfolio. Since students should have enough work samples to select from, I believe that assembling the portfolio can occur after every quarter completion of the course. Thus, students will be given opportunities to self-reflect on why they chose particular items four times in the course. In the mean time, everything can be stored in the student's notebook with dividers such as (i) class notes; (ii) problem solving; (iii) investigations; (iv) homework, and (v) tests. I believe it is important to reiterate consistently to students to file **every** work sample away in their binders and not throw anything out. The teacher should have binder checks early in the semester. Without clear guidelines of what to include, portfolios have the potential danger of becoming increasingly thick and difficult to assess.

Unlike my first experiences with implementing student portfolios, Suurtamm suggests that it is important for students to be part of the process of selecting some of the items (while others are mandatory) as they provide opportunities for students to self-reflect on their learning (p. 24). Hence, the process is very important and can itself be an instructional strategy. Knight suggests that students include a letter introducing the reader to its content, and a personal statement attached to each work sample as to why it was important for them to (p. 71).

Through the literature review, many of the authors provide possible portfolio submissions: mathematics autobiography, solutions to problem solving, photocopies of journal writing, solutions to open-ended problems, assignments, projects, reports, homework problems, feelings toward mathematics, copies of tests (with corrections), use of technology, and what they enjoyed/found difficult doing.

Since I suggest that students assemble their portfolios after each quarter of the course, I will use chapters 1 to 3 (Numeracy, Relationships, Slope) from the Addison Wesley textbook, *Mathematics 9, Ontario Edition*, to provide the reader with what could be included in the first assembly. As stated, it is important for students to date and keep all work in their binders separated by dividers, along with maintaining an organized and up-to-date notebook. Included with each selection, students will attach a 3" x 5" sticky Post-It note explaining why that particular work sample was selected.

Portfolio Entry #1: Mathematics Autobiography

During the first week of school, each student will write their own mathematics autobiography. It should be approximately 1 page, and written in paragraph form. Some questions to consider include:

- What is mathematics?
- Where did mathematics come from?
- How do you use mathematics in your daily life?
- Do you like or dislike mathematics? Why? When did you start to like/dislike it?
- How will your future career involve the use of mathematics?
- What are your goals for the upcoming year in the course?
- What do you have difficulty in mathematics that you would like to work on?
- What can your teacher do to help you succeed in the course?
- Are you a good mathematics student?

Portfolio Entry #2: Journal Entries

Students will select three entries from their journal for submission. The teacher can photocopy the student's choices if they write their journals in notebooks.

- One entry will demonstrate the student's improved attitude to mathematics – or at least maintained the enthusiasm;
- A second entry will be an example where the student has an "aha ... I get it!" experience;
- The final submission will demonstrate the student's ability to communicate mathematically.

Portfolio Entry #3: Problem Solving

Students will include two samples of problems solved. These will demonstrate students' abilities to tackle level 4 problems or problems taken from the "C" section of the Addison Wesley textbook. Examples include:

- Page 33 #27 – students read a newspaper clipping and answer questions;
- Page 46 #24 – "the time you arrive is the price you pay" problem;
- Page 108 #17 – students determine how many mL a 40 kg patient should take;
- Page 155 #11 – body mass index problem;

Other resources for problems can be selected from chapter 1 of *MathPlus 9*, McGraw-Hill Ryerson's *MathPower 9*, calendar problems in the *Mathematics Teacher* journal, Doug Rohrer's *Thought Provokers*, and *Teaching Mathematics: A Sourcebook of Aids, Activities, and Strategies*.

Portfolio Entry #4: Group Work Experience/Investigation

Students will provide evidence of a work sample which was completed in a small group. They will describe their contributions to the group. Examples from the textbook include:

- Pages 21-25 – "How many cereal boxes?";
- Pages 72-73 – pendulum experiment;
- Page 78 – mass of textbooks;
- Page 121 – calculating the slope of a staircase.

Portfolio Entry #5: Use of Technology

Students will provide evidence of their experiences with computer technology (such as a graphing calculator or Calculator-Based Ranger (CBR)). One submission can come from (again with a note attached why it was selected):

- Pages 23 & 25 – using spreadsheets and graphing calculators to simulate the number of boxes of cereal needed to get all prizes;
- Page 88 – "Distance to a Wall" CBR activity;
- Page 93 – "Flyer Advertising Rates" vs. "Newspaper Advertising Rates";

RUBRIC TO ASSESS STUDENT PORTFOLIO

Components	Level 1	Level 2	Level 3	Level 4
Communication	Communication is unclear — makes frequent misuse of mathematical language and notation. The student has difficulty communicating ideas and thoughts to others (e.g., does not include major steps in an explanation).	Communication is generally clear – but makes several incorrect uses of mathematical language and notation, or does not include some steps in the reasoning. There is limited evidence that the student has made connections of concepts.	Student communicates effectively — writing is clear, uses correct mathematical language and notation. The student is able to make connections of concepts to each other.	Student communicates effectively – in addition to meeting the criteria in level 3, the student provides detailed explanations, and effectively communicates new learning in the process.
Organization	Portfolio is unorganized – either missing several work samples, or is arranged in an unsequenced order.	Portfolio is generally organized – but missing either an introductory letter, a table of contents, or a work sample.	Portfolio is organized – contains an introductory letter, a title page, table of contents, all requested work samples, assembled in logical order, and is neat.	Portfolio is eye-appealing and very well organized – contains all required features, is neat, and there is clear evidence that the student has valued the activity immensely.
Problem Solving	Student either does not understand the problem or has used an incorrect strategy without any justification. The solution contains major gaps or errors, or simply contains the final solution.	Student has generally understood the problem and selected the correct strategy to solve the problem, but has made minor errors in the solution, or does not solve the problem to completion.	Student uses appropriate strategies, presents solutions clearly, and displays clear understanding of the problem.	In addition to meeting the criteria of level 3, student has clearly thought about the problem and has made extensions. The solution is clear, complete, and thoroughly presented.
Self-Reflection	Student provides limited evidence that learning has taken place in selecting the work samples. Descriptions of why each particular sample was selected do not demonstrate much self-reflection. The student does not see the connections of learning and growth in this exercise.	Student is beginning to self-reflect in his/her learning. The written descriptions included provide some rationale why each work sample was provided. The student has limited ability to assess own level of achievement, and requires assistance from the classroom teacher.	Student provides evidence of self-reflection by including descriptions of why each particular sample was selected. The student is able to assess his/her level of achievement, and has clearly grown from the experience.	In addition to meeting the criteria in level 3, the student has consolidated his/her learning and growth. There is much evidence that the student has benefitted from this exercise, and has set clear goals for improvement.

- Page 136 – "The CBR Distance Math Activity";
- Page 143 – "Investigating the Relation y = 3x – 1."

Portfolio Entry #6: Test

Students will include a copy of a test which they believe reflects what they achieved in the unit. It should demonstrate what they understand, and include corrections (in a different ink colour) to any question which full marks were not granted.

Another benefit of student portfolios is that they provide evidence of student achievement during parent/teacher interviews. No longer will I only say, "(student's name) has an overall mark of (mark)." The focus can be on student growth and what has specifically been achieved. An added bonus is to have the student present, and allow the student to describe the contents of the portfolio to his/her parents.

The previous page is a holistic scoring rubric I designed to assess students' portfolios. I suggest that students be provided with a copy of the rubric at the beginning of the year so that they can strive to meet the criteria of at least level 3 achievement. In my rubric, I have included four categories which I will use to assess the portfolios: communication, organization, problem solving, and self-reflection. When assessing each portfolio, the teacher can highlight the criteria that best matches the student's work in each category. To determine the student's level of achievement, the Ministry of Education calls for taking the highest, most consistent level of achievement (*The Ontario Mathematics Grades 9 and 10: Mathematics*, p. 37).

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OAME/AOEM Awards Nomination Process

Deadlines

Nominations for awards to be presented at the Annual Conference must be received by January 31 of the calendar year in which the conference takes place.

Nominations received after January 31 will be considered for awards to be presented during the next three calendar years. A nomination will be allowed to stand for three consecutive years. After that time, the nomination must be renewed. A standing nomination may be amended at any time by the original nominator. The nominator need only inform the chair of the Awards Committee in writing of the proposed changes to the nomination form.

The OAME/AOEM Nomination Form

Write a letter supporting the nomination of your candidate for the indicated award. Provide specific and detailed information about the nominee's activities as they relate to the following areas of consideration;

- demonstrations of excellence and creativity in mathematics education.
- specific contributions to mathematics education in the school, region, province or nation.
- demonstrates leadership in mathematics education in the school, region, province or nation.
- support of and contribution to the activities of OAME/AOEM.
- contribution to the development of students both within and outside of the classroom.

Please include any additional information that you feel may be relevant to the nomination, but which may not be specifically mentioned above.

The Nomination Cover Page

Complete the Nomination Cover Page and attach it to your letter of recommendation for the nominee.

Incomplete or inaccurate information may cause a nomination to be withheld form consideration.

OAME/AOEM LIFE MEMBERSHIP AWARD

The Life Membership Award is given to recognize a person who has contributed in a significant way to OAME/AOEM; demonstrated outstanding leadership in mathematics education; and accumulated 10 or more years of membership in OAME/AOEM.

KENNETH D. FRYER AWARD

In Memory of the late Kenneth D. Fryer, OAME/AOEM, in conjunction with the Grand Valley Mathematics Association, established the Kenneth D. Fryer Award. The award is to be given annually to recognize a mathematics department which fosters collegiality, team work, and excellent classroom teaching; contributes to the overall development of students; and demonstrates leadership in the mathematics education community.

MONA MACGREGOR AWARD

In recognition of the contributions made by Mona MacGregor, former OAME/AOEM Co-Secretary-Treasurer, OAME/AOEM established the Mona MacGregor Award. This is to recognize an individual who has made significant contribution to OAME/AOEM, but who is not necessarily an educator or a member of OAME/AOEM.

MORLEY MACGREGOR AWARD

In Memory of the late Morley MacGregor, former OAME/AOEM Secretary-Treasurer, OAME/AOEM established the Morley MacGregor Award. The award is to be given annually to recognize an elementary teacher who has demonstrated excellence in mathematics education, as well as contributing to the overall development of students beyond classroom activities.

DON ATTRIDGE AWARD

In recognition of the contributions made by Don Attridge, a founding member, former president and the previous Executive Director of OAME/AOEM, OAME/AOEM established the Don Attridge Award in the spring of 1995. The award is presented annually to recognize an exceptional and creative secondary school mathematics teacher who enhances the teaching of mathematics in Ontario.

AWARD NOMINATION COVER PAGE

Send to: Shirley Dalrymple

Intended Award (please check one)

❑ Life Membership ❑ Mona MacGregor ❑ Morley MacGregor ❑ Kenneth D. Fryer ❑ Don Attridge

Nominee Information:

_____

Name of Nominee (Principal and Department Head for K.D. Fryer Award)

_____

_____

School, Organization or Business Address

Telephone Number ( ) _____

Fax Number ( ) _____

Home Address _____

_____

Home Phone ( ) _____

Nominator Information:

_____

Name of Nominator

_____

_____

School, Organization or Business Address

Telephone Number ( ) _____

Fax Number ( ) _____

Home Address _____

_____

Home Phone ( ) _____

▲ Tour of the Towns Treasure Hunt

JACQUELINE HILL
R.S. MCLAUGHLIN HIGH SCHOOL
OSHAWA, ONTARIO

SHELLEY CLARK
HEAD OF MATH AT BROCK HIGH SCHOOL
CANNINGTON, ONTARIO



Jacqueline Hill has been a teacher with the Durham Board of Education for 10 years. She is active in curriculum writing at the Board level. She regularly contributes at math conferences as a speaker and key note speaker. As an Assistant Head of Mathematics and a classroom teacher, she always strives to help her collegues and students enjoy success.



Shelley Clark has been teaching for the Durham Board of Education for 6 years. As a member of the curriculum writing team, Shelley has ensured that all teachers in Durham have a firm grasp of the new Ontario curriculum for Mathematics.

This combined effort is a project designed as a final assessment tool. It is user-friendly to both teacher and student. It is a precise assessment tool for the new curriculum.

Problem:

To find all of the clues to the treasure hunt to solve the final problem.

Materials:

- A treasure hunt map for each pair of students
- A marking scheme for each student
- Envelopes to house the clues
- Approximately 15 copies of each Clue sheet cut up and distributed into envelopes

Procedure:

Briefly describe that the students will be doing a review of the entire year by following a tour of the towns treasure map. Be sure to hand students out the marking scheme so they know what each location is worth (thus they can gauge the complexity of their answers). Have students glue their marking scheme to the last page of their passport (journal). Each pair of students will be given a different location point to start their treasure hunt (this will ensure that everyone is not calling the teacher over for the same clue envelope at the same time). They then pick out the clue from the envelope, glue it onto their passport sheet (journal), and solve the problem. The solution of the problem will lead them to another location on the map. When students have solved all of the problems at the map locations they will have the answer to a final code solution. Students are then to use any remaining time to work on their passport cover/title page. The teacher will take in their work and mark it for both completion and correct solutions (see solutions attached).

Modifications:

If you have identified students or students that have difficulty retaining information over long periods of time, you can do this activity as an open note book activity (or open Survival guide activity) so that students are not required to remember all aspects of the entire course.

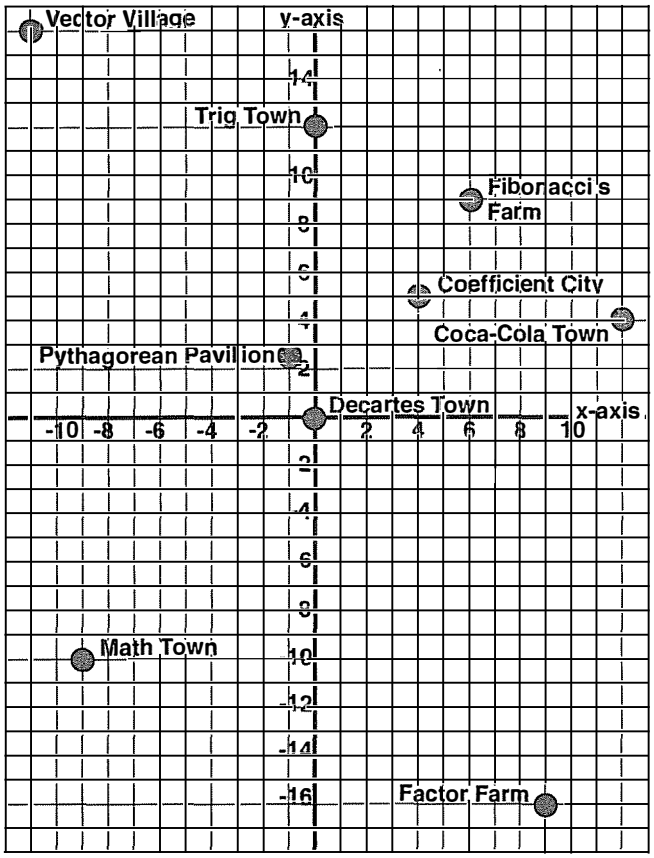
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Purpose: The T3 AdvStat Institute is a week-long professional development program for secondary mathematics instructors using the TI-83 Plus to prepare for teaching a senior-level statistics course. The institute activities will focus on the exploration of statisticol concepts and problems that are the core of the Advanced Placement Statistics Curriculum, with a strong emphasis on inferential statistics.

Participants will take part in hands-on investigation modelling effective classroom use of technology for teaching statistics. The gool of the institute's program is to instruct teachers to effectively teach Advanced Placement Statistics using technology in the spirit of the NCTM's Curriculum and Evaluation Standards for Mathematics (NCTM, 1989), Professional Standards for Teaching Mathematics (NCTM, 1991) and Assessment Standards for School Mathematics (NCTM, 1995),and Standards 2000 (NCTM). (Note: AP is a registered trademark of the College Entrance Examination Boord. This course is neither affiliated with nor endorsed by the CEEB.)

Further Information: Please contact Arthur Wenk by e-mail at awenk@sac.on.ca or by phone at 905-727-3178, ext. 428, or by fax at 905-841-6911. You may also wish to visit the TI web-site at http://www.t3ww.org/t3/t3sumcanada00.htm.

Tour of the Towns Treasure Hunt Map



___	___	___	___	___	___
3	10	4	1	9	5

___	___	___	___
2	7	7	6

Descartes Town

Proceed to (0,12). (0,12) is called an _____ pair. The 0 is the ____ co-ordinate, while the 12 is the ___ co-ordinate. The entire map is located on a _____. The horizontal axis is called the _____ axis, while the vertical axis is called the _____ axis.

On the bottom of the map is a cryptic code, anywhere you see a 9 place the letter I. Proceed 3 steps from Descartes Town using a slope $\frac{3}{2}$. Collect the card from the envelope with the destination at which you just arrived.

Coca-Cola Town

You have just stumbled upon a location that contains some litter. You pick up a Coke can and read the note attached:

"If I am a cylinder with radius 3cm and length 10 cm, find my surface area and volume."

Given that aluminum costs $\frac{2}{100}$ of a cent per cm² (that is 0.02 of a cent), how much does my aluminum cost? Given that it costs $\frac{15}{1000}$ of a cent per mL (that is .015 of a cent), how much does my Coke cost? Given that you can buy a case of 24 Coke on sale for $4.99, is the cost of making the product reasonable? What factors would you have to take into account?

On the bottom of the map is a cryptic code, anywhere you see a 10 place the letter A.

Connect Coca-Cola Town to the origin.

Collect the envelope from the town at which you just arrived.

Fibonacci's Farm

Given the equation $5x - 2y + 10 = 0$. Find the x - intercept and the y - intercept. Plot them on your map. Connect them. Proceed to the town you just crossed over.

On the bottom of the map is a cryptic code, anywhere you see a 7 place the letter O.

Collect the card from the envelope with the destination at which you just arrived.

Vector Village

a) Michael Johnson and Donevan Bailey just can't decide who is the fastest man. Describe the aspects of the mathematics that help us decide. What factors (other than mathematical) need to be taken into account?

b) Graph the line $y = \frac{-4}{11}x + 12$.

On the bottom of the map is a cryptic code, anywhere you see a 4 place the letter T.

Proceed to the town you intercept on your graph.

Coefficient City

Describe in your own word how to find mean, mode, and median.

Given the following data, find the median.

3 1 7 9 2 5 4

That is the quadrant in which you will find the next town.

On the bottom of the map is a cryptic code, anywhere you see a 6 place the letter L.

Please proceed to pick up the card for the destination at which you just arrived.

Factor Farm

Describe in your own words:

1) what factoring is and

2) What 'expanding' has to do with factoring?

Factor the following:

1) $3x + 6$ **2)** $-x^4 - x^2$ **3)** $-2xy - 16x^2$

4) $5x^2 - 3x + 4 - 2x^2 + 6x + 5$ **5)** $x(x - 7) - 4(x - 7)$

A trinomial is a mathematical expression with _____ terms.

On the bottom of the map is a cryptic code, anywhere you see a 5 place the letter S.

Please proceed to the town located in this quadrant that has as many terms as a trinomial.

Math Town

A group of math students would like to find out:

a) which is the best buy: 24 calculators for $169.95 or 30 calculators for $199.99.

b) Now these same Mathematicians have erasers and pencils in the ratio of 3:7. If they have 21 erasers, how many erasers and pencils do they have in all?

c) The x-coordinate of the next destination of your journey is found by filling in the blank for the sequence 3, 1, -1 , -3 , -5 , -7 , -9 , _____.

The y - coordinate is the slope of the relation $y = \frac{32x - 7}{2}$.

On the bottom of the map is a cryptic code; anywhere you see a 3 place the letter M.

Please proceed to pick up the card for the destination at which you just arrived.

Trig Town

Summarize the following properties by drawing diagrams and using words:

a) The sum of the interior angles in a triangle.

b) The sum of the exterior angles.

c) Angles in parallel lines.

Describe how geometry would allow a carpenter to create a set of wooden stairs.

After such a long question, please proceed to the town that sounds like it should offer something to quench your thirst.

Pythagorean Pavilion

1. For the linear relations $5x + 4y = 40$ and $5x + 6y = 50$ find the point of intersection.

2. For the two linear relations listed in 1 find the x - and y - intercepts using an algebraic solution.

Anywhere you see a 1 place an H on your cryptic, and anywhere you see a 2 place a C.

Proceed to the town located at the intersection of the relations found in 1.

Teacher Note:

The following Units of Study (from the Addison-Wesley Text) are dealt with at each destination of the Tour of the Towns.

Vector Village - Chapters 3 & 5

Coefficient City - Chapter 9

Descartes Town - Chapters 2 & 3

Pythagorean Pavilion - Chapter 8

Math Town - Chapters 1, 2 & 3

Coca-Cola Town - Chapters 1 & 10

Factor Farm - Chapters 6 & 7

Fibonacci's Farm - Chapter 8

Trig Town - Chapter 11

Tour of the Towns "Marking Scheme"

CRITERIA							
Title Page	0 -none	1 -title -somewhat neat	2 -title -neat	3 -title and diagrams -use of colour			
Cryptic Message	0 -unsolved	1 -solved					
Map (Connect the dots)	0 -lines not drown	1 -lines drawn					
Coca Cola Town	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -incomplete -a few correct answers -many hints required	3 -incomplete -some correct answers -more than 5 hints required	4 -complete -mostly accurate -3 or 4 hints required	5 -complete -accurate -1 or 2 hints required	6 -complete -accurate -no hints required
Vector Village	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -incomplete -a few correct answers -many hints required	3 -incomplete -some correct answers -more than 5 hints required	4 -complete -mostly accurate -3 or 4 hints required	5 -complete -accurate -1 or 2 hints required	6 -complete -accurate -no hints required
Math Town	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -incomplete -a few correct answers -many hints required	3 -1 or 2 questions incomplete -mostly accurate -more than 4 hints required	4 -complete -mostly accurate -3 or 4 hints required	5 -complete -accurate -1 or 2 hints required	6 -complete -accurate -no hints required
Fibonacci's Farm	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -complete -mostly accurate -3 or 4 hints required	3 -complete -accurate -1 or 2 hints required	4 -complete -accurate -no hints required		
Descartes Town	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -complete -accurate -1 or 2 hints required	3 -complete -accurate -no hints required			
Trig Town	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -complete -mostly accurate -3 or 4 hints required	3 -complete -accurate -1 or 2 hints required	4 -complete -accurate -no hints required		
Factor Farm	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -complete -mostly accurate -3 or 4 hints required	3 -complete -accurate -1 or 2 hints required	4 -complete -accurate -no hints required		
Pythagorean Pavilion	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -complete -mostly accurate -3 or 4 hints required	3 -complete -accurate -1 or 2 hints required	4 -complete -accurate -no hints required		
Coefficient City	0 -not attempted	1 -incomplete -1 or 2 correct answers -many hints required	2 -complete -accurate -1 or 2 hints required	3 -complete -accurate -no hints required			
Mathematical Terminology	0 -not attempted	1 -limited use of terminology	2 -some use of terminology	3 -always uses correct terminology			
Ideas Clear and Precise	0 -not attempted	1 -somewhat coherent	2 -coherent				

Tour of the Towns Solutions

Math Town

a) 24 calculators for $169.95

$$\text{cost/calc.} = \frac{169.95}{24}$$

$$= \$7.08125/\text{calc.}$$

30 calculators for $199.99

$$\text{cost/calc.} = \frac{199.99}{30}$$

$$= \$6.666333/\text{calc.}$$

$\therefore$ the 30 calculators for $199.99 is the better buy.

b) erasers:pencils = 3:7

Let x represent the number of pencils.

$\frac{3}{7} = \frac{21}{x}$ # of erasers & pencils = 49 + 21

$3x = 147$ = 70

$x = 49$ $\therefore$ there are 70 pencils & erasers in total.

c) (-11,16) → Vector Village

Vector Village

a) Michael Johnson & Donevan Bailey - answers may vary.

b) graph the line $y = \frac{-4}{11}x$.

Trig Town

a) sum of interior angles → 180°

b) sum of exterior angles → 360°

c) interior angles add to 180°, alternating angles are equal, corresponding angles are equal.

Describe → build set of wooden stairs.

Coca-Cola Town

r = 3 cm
h = 10 cm
aluminum: .02¢ / cm²
Coke: .015¢ / mL

$$S.A. = 2\pi rh + 2\pi r^2$$

$$= 2(3.14)(3)(10) + 2(3.14)(3)^2$$

$$= 188.4 + 56.52$$

$$S.A. = 244.92\text{cm}^2$$

cost for aluminum = 244.92cm² x .02¢ / cm²
= 4.8984¢

$V = \pi r^2 h = (3.14)(3)^2(10) = 282.6$ mL
cost for Coke = 282.6 mL x .015¢ /mL = 4.239¢

Total cost / can = 4.8984 + 4.239
= 9.1374¢ / can

Total cost / case = 9.1374 x 24
= 219.2976¢
= $2.19 / case

Decartes Town

ordered, x, y, Cartesian plane, x-axis, y-axis

Fibonacci's Farm

$5x - 2y + 10 = 0$

x – int., let y = 0

$5x - 2(0) + 10 = 0$

$5x + 10 = 0$

$5x + 10 - 10 = 0 - 10$

$\frac{5x}{5} = \frac{-10}{5}$

$x = -2$ (–2,0)

y – int., let x = 0

$5(0) - 2y + 10 = 0$

$-2y + 10 - 10 = 0 - 10$

$\frac{-2y}{-2} = \frac{-10}{-2}$

$y = 5$ (0,5)

Pythagorean Pavilion

1. $5x + 4y = 40$
2. $5x + 6y = 50$

Point of intersection: (4,5)

1. x-int., let y = 0
   $5x + 4(0) = 40$
   $5x = 40$
   $x = 8$ (8,0)

   y-int., let x = 0
   $5(0) + 4y = 40$
   $4y = 40$
   $y = 10$ (0,10)

2. x-int., let y = 0
   $5x + 6(0) = 50$
   $5x = 50$
   $x = 10$ (10,0)

   let x = -2
   $5(-2) + 6y = 50$
   $-10 + 6y = 50$
   $-10 + 6y + 10 = 50 + 10$
   $6y = 60$
   $y = 10$ (-2,10)

Coefficient City

How to find mean, median and mode.

median 1, 2, 3, 4, 5, 7, 9 median = 4

Factor Farm

Describe: factoring & expanding

1. $3x + 6 = 3(x + 2)$
2. $-x^4 - x^2 = -x^2(x^2 + 1)$
3. $-2xy - 16x^2 = -2x(y + 8x)$
4. $5x^2 - 3x + 4 - 2x^2 + 6x + 5$
   $= 3x^2 + 3x + 9$
   $= 3(x^2 + x + 3)$
5. $x(x - 7) - 4(x - 7) = (x - 7)(x - 4)$

Trinomial has 3 terms. ▲

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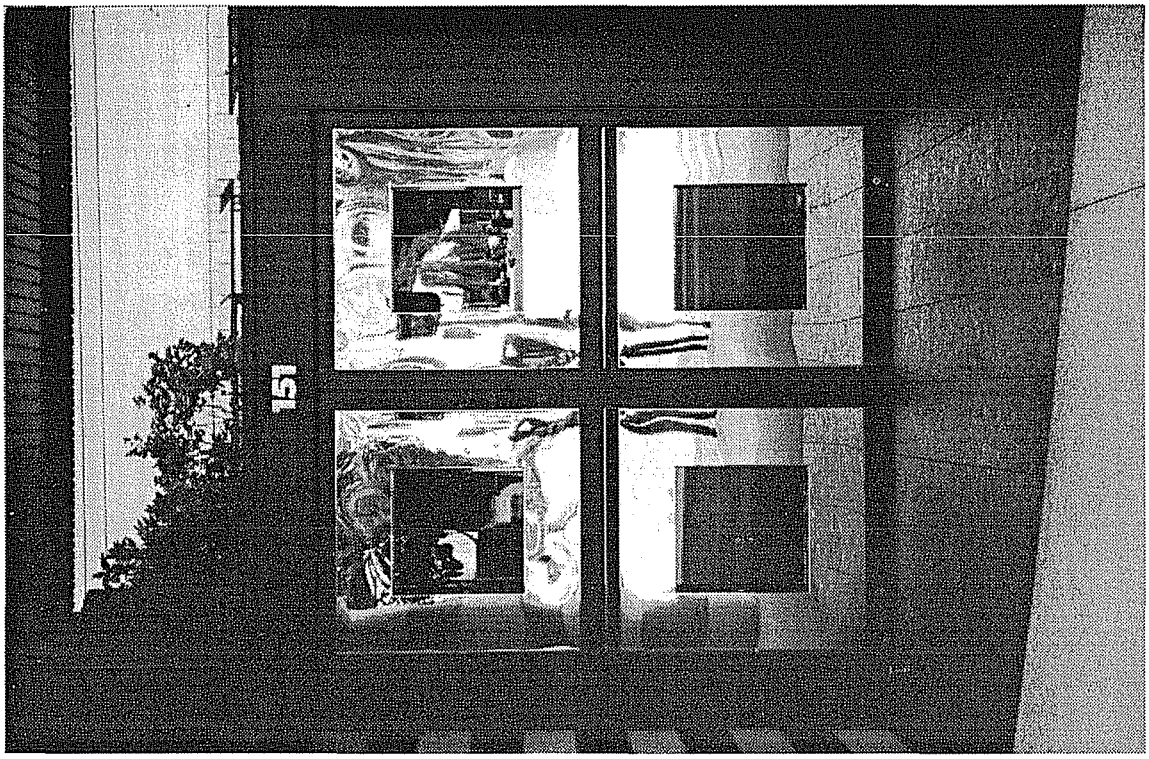


Ron Lancaster is a middle and high school mathematics teacher, currently on staff at the Bishop Strachan School as a mathematics consultant. Ron also works as an Independent Consultant throughout North America and Asia, and is also an Instructor for Texas Instruments.

"A picture is worth a thousand words" is an expression that is often used to convey the importance of using images to make a point. The point of this column is to go beyond this notion and promote the idea that in fact "A picture is worth a thousand numbers". Photos with Math is what readers can expect to find in every Photo Math column and the emphasis will be on seeing and doing mathematics everywhere. Teachers may want to assign these questions to their students as part of an overall effort to make connections between the curriculum and the world around us. Establishing these connections is at the heart of the new Ontario curriculum as well as the new NCTM document, Principles and Standards for School Mathematics. It is hoped that these questions will inspire students to be more creative and playful, and that in the end, students will develop an ability to see the world from a different perspective.

Teachers and students are encouraged to pose mathematical questions related to their own encounters and to submit these problems along with photographs to Ron Lancaster for possible publication in future columns. The Editor of this column does not presently have a cable modem and in order to avoid long periods of downloading items, submissions to this column should be sent via Canada Post to the address given on the left.

Photograph 1
Front entrance to the San Francisco Museum of Modern Art



Consider the sequence of numbers given below:

1999, 11990, 21901, 32813, ...

While not obvious, the rule used to form this sequence is actually quite simple. The first term, 1999, is arbitrary. It could have been any positive integer. After the first term, each new term is found by applying the following process to the term before it: Take the previous term, reverse its digits to form a new number and then add this number to the original number. For example, the second term, 11990, was found by adding 9991 to 1999. The third number, 21901, was found by adding the two numbers 09911 (9911) and 11990. Continue to find new terms of the sequence until you obtain a number that fits in perfectly with the design of the front entrance and with the street address of the Museum.

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Photograph 2
Entrance to Yerba Buena Gardens, San Francisco

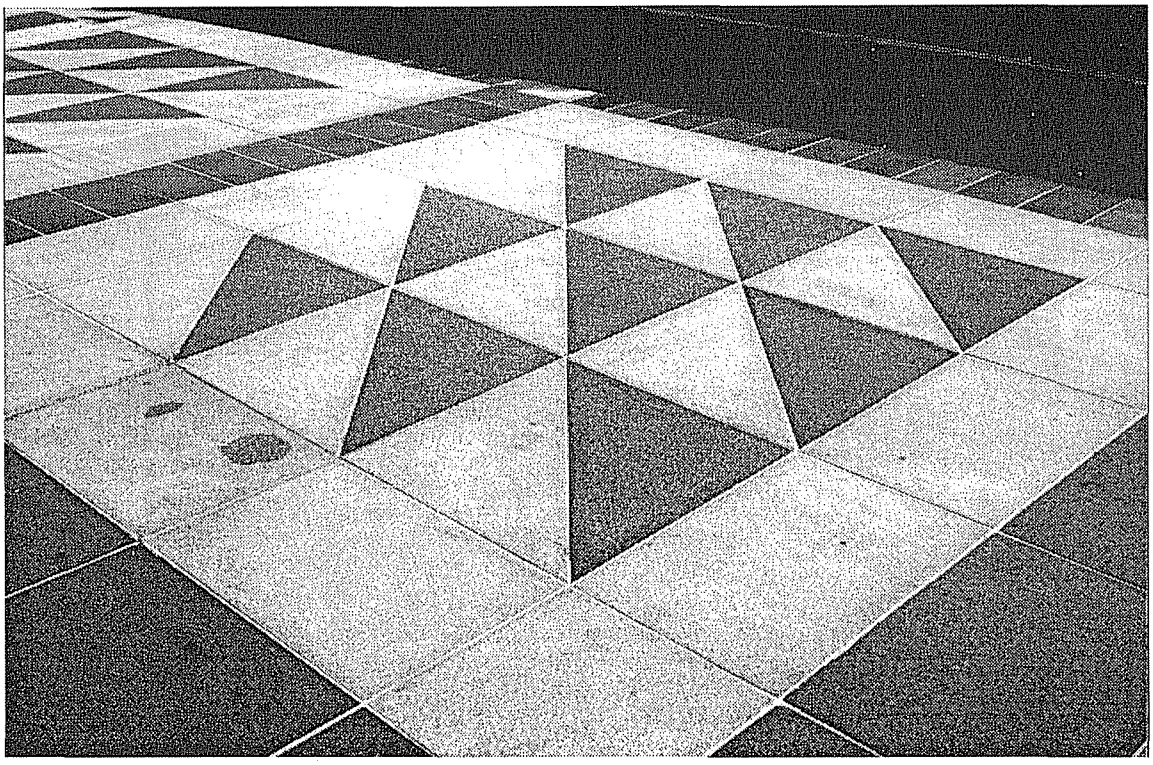


(a) Starting on January 1st and ending on December 31, how would the number of hours that this area is open to the public change? Include both a written and a graphical description of how the number of hours would change from day to day.

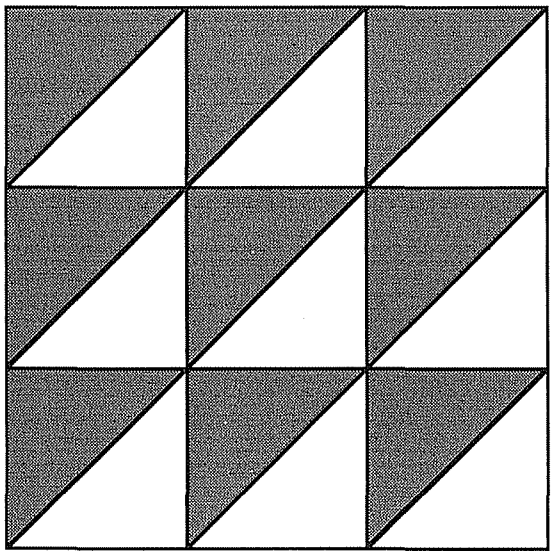
(b) As noted on the sign, this space opens at sunrise, and instead of closing at sunset, it closes at a fixed time. Shed some light on this apparent inconsistency between the opening and closing times.

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Photograph 3
Walkway, Yerba Buena Gardens, San Francisco



(a) The tessellation on the walkway is formed by a series of translations of a rectangle containing a black and a white triangle. On the sketch given below, indicate the direction of these translations.

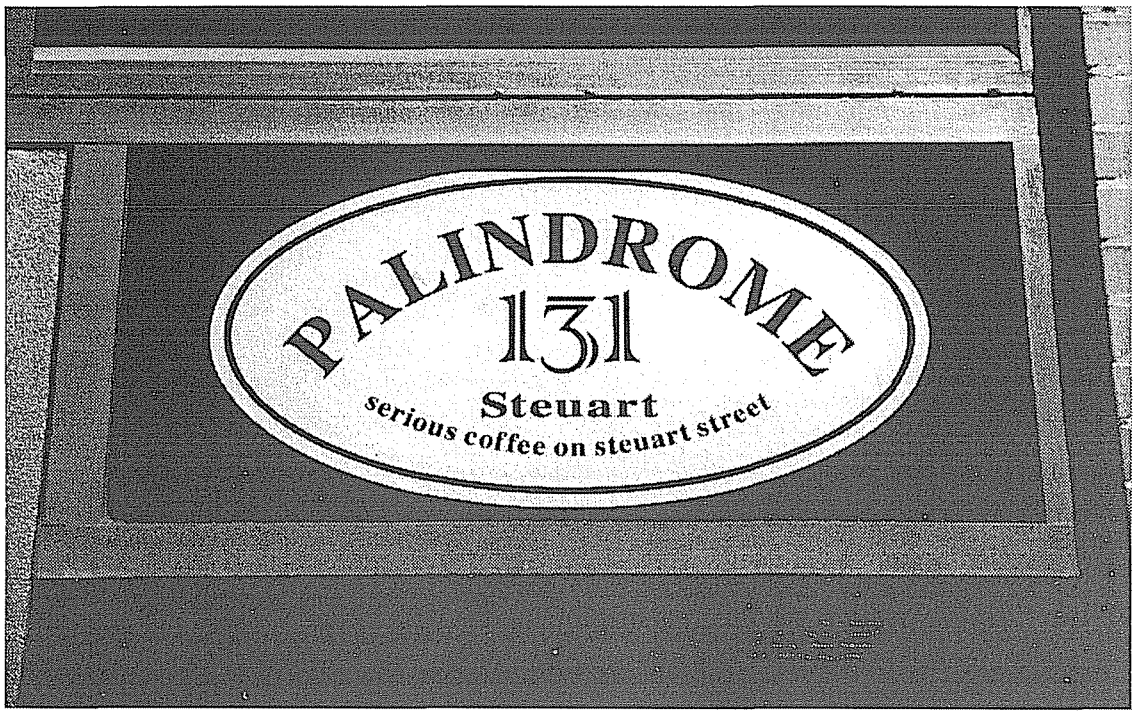


(b) Redesign the floor, by reflections of the rectangle along its sides. You may want to make use of some filing cards to carry out this task and the one in part (c).

(c) Redesign the floor, by rotation about the midpoints of its sides.

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Photograph 4
Palindrome, serious coffee on steuart street



The number 131 is both a prime number and a palindrome. Any prime number that remains prime when reversed is commonly called an *emirp.*

(a) Explain the derivation of the name *emirp.*

(b) Find all emirps less than 131.

(c) Show that the total number of emirps greater than 131 and less than 1000 is itself an emirp.

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Comments and partial answers

In April 1999, along with two other teachers (Kimberley Nick from Toronto and Brigitte Bentele from New York City), I created a Math Trail for teachers attending the NCTM Annual Conference. The setting for this math path was the San Francisco Museum of Modern Art and the nearby Yerba Buena Gardens. All of the questions used in this column are from this Math Trail. For those readers not familiar with the concept of a Math Trail, essentially it is a guided walk in which participants answer and even pose mathematical questions related to things encountered along the route.

Photograph 1

I field-tested the questions from the Museum of Modern Art Math Trail with students from two schools in San Francisco and it was interesting to listen to their thoughts as they worked on this particular question. With each new term they kept looking at the front entrance of the building and there seemed to be an expectation that at some point the street address of the Museum (151) would appear as a term in the sequence. The next four terms of the sequence are 64636, 128282, 411103 and 712217. Most students and teachers at the conference continued to find additional terms but eventually there was someone who connected the term 712217 to the front entrance. Both this number and the front entrance look the same when viewed from left to right or from right to left.

This is a fascinating algorithm and it has been conjectured that no matter what starting number is used, a palindrome eventually appears as a term in the sequence. It may come as no surprise to readers that in spite of a great deal of work, no one has been able to prove this conjecture. Some numbers such as 87 lead to a palindrome very quickly (it takes four steps), while other numbers like 1999, require more steps. The number 196 is the only number less than 10 000 that has not yet produced a palindrome. It has been subjected to over 50 000 reversals and no palindrome has been obtained. Additional information about this problem (as well as a wealth of other interesting sequences) can be found in the following two books:

The Penguin Dictionary of Curious and Interesting Numbers David Wells. Penguin Books. ISBN 0-14-026149-4

A Number For Your Thoughts. Malcolm E. Lines. Institute of Physics publishing. ISBN 0-85274-495-1

The following internet sites contain information about this problem as well. They were found by doing a search for pages that contain the words palindrome and reversal:

www.floot.demon.co.uk/palindromes.html

www.seanet.com/~ksbrown/kmath004.htm

www.saintmarys.edu/~psmith/palindrome.htm

Photograph 2

(a) Like other places throughout the world, the time of the sunrise in San Francisco varies throughout the year in a sinusoidal manner. As such a sine or a cosine function can be used to create the graph of the data for the time that the Gardens is open to the public. Readers interested in obtaining data for the sunrise and sunset for any city or airport in the world can do so by visiting the Internet site located at www.cmpsolv.com/los/sunset.html.

In March 2000 I spoke at the SEEC Conference in Bali, Indonesia and presented this problem to a group of teachers. We discussed what the graph for this question would look like if the Gardens were located in Bali. Readers are invited to send in their thoughts about this as well as what the graph would like near the north or south pole.

(b) The students that I worked with were not sure why the hours were set in this manner. Teachers from the San Francisco area who participated in the Trail felt that the real issue was preventing the homeless from staying overnight in the Gardens. Readers might want to think about the validity of this reasoning. For the record, before Yerba Buena gardens existed, this area was a place where the homeless congregated and slept overnight.

Photograph 3

The answers to these questions are straightforward, particularly if you actually take some filing cards and carry out the transformations.

Photograph 4

Because of my involvement as a writer for the new NCTM document, *Standards and Principles for School Mathematics*, I was a regular visitor to San Francisco for meetings of the writers. This allowed me to plan the Math Trail over the course of a number of visits. On one such visit I decided to take a walk after a visit to the Museum and needless to say I was ecstatic when I came across a coffee store named Palindrome. I met the owner on several occasions and he said that his main reason for choosing this name was that he loved puzzles

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and playing with words. I was delighted to find that his home phone number, the phone number for the store, and his fax number were all palindromes. For an extra fee he had arranged to select these numbers from the local telephone company. Even some of the names of the coffees are palindromes as shown in Photograph 5! Amazing!

(a) There are 5 emirps less than 131. They are 2, 3, 5, 7 and 11.

(b) There are 11 emirps that are greater than 131 and less than 1000. It is left as an exercise for readers to find these primes. The list will be published in the next issue of the *Gazette*. ▲

Photograph 5
Menu for Palindrome, serious coffee on steuart street



▲ Call for Applications for OAME Executive Directors

The Ontario Association for Mathematics Education is looking for new Executive Directors to take over the full responsibility of day-to-day operations September 2001. The appointment is to be made February 2001 to allow for a staged transfer of duties from the current Executive Directors.

Responsibilities include:

- Maintenance of the membership database
- Liaison with the printer and mailing house for *Gazette* mailings
- Managing the finances and the financial records
- Supervision of the sale of resource documents
- Arrangements for Board meetings, Executive meetings and Annual General Meeting and recording of minutes of each
- Arrangements for the Annual Leadership Conference
- Acting as an advisor to the Executive and Board regarding Constitution, By-laws, and terms of reference

The position requires:

- some experience with OAME at the provincial or chapter level
- computer literacy, including e-mail
- available space for the OAME office records, supplies, and equipment
- availability to communicate with members and educators during working hours
- bookkeeping skills
- organizational skills

Ideally the position would be filled by a couple rather than an individual since many of tasks require the cooperation of two people.

There is a modest monthly fee paid to the Executive Directors as well as travel, telephone, and other expenses incurred in conducting OAME business.

Candidates should apply in writing, stating qualifications, prior to November 1, 2000 to: Peter Saarimaki, Chair of Search Committee, 67 Erinlea Crescent, Scarborough ON M1H 2S8.

Successful candidates will be interviewed by a panel in early 2001.

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1 -10 copies $25.00 each;
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(FEBRUARY 1999)

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- Notes to Teachers
- All investigations now keyed to Specific Expectations of The Ontario Curriculum

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- Communication of Required Knowledge

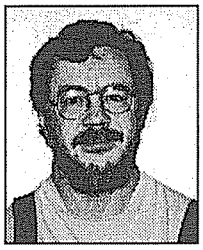
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▲ Encouraging Mathematics Communication in Children

STEWART CRAVEN



Stewart is the District-wide Coordinator for Mathematics and Numeracy in the Toronto School Board. He is a vice president in the OAME and past president of the OMCA. *This article was written with the generous help of the Early Years Committee, Ralph Connelly (committee chair), Laurie Moher, and Lyn Vause.*

Imagine a grade two classroom somewhere in Ontario where math is really happening. How might such a classroom look, sound and feel?



Draped over two chairs at the front of the room is a large, colourful patchwork quilt made from simple geometric shapes. It is highly pleasing to the eye. As the children enter the classroom, they spontaneously gather around the quilt to touch it and look more closely at its colourful patterns. The teacher encourages the children to chat with one another for a few moments about what they see and feel.

The teacher then gathers the children around the quilt and initiates a discussion about the quilt's appearance – more specifically, how the quilt's patterns and designs relate to the mathematics in which the students are presently engaged. The children are encouraged to use the math vocabulary they have been learning to describe the patterns and geometric shapes they see.

Without hesitation, a multitude of hands spring up. Ravi offers that the quilt is made up of a "whole bunch of squares" and Judith adds that the squares are "lined up in rows just like tomato plants in a garden". Pat chimes in that each big square is made up of smaller shapes like triangles. As the children make their observations, the teacher records on flip chart paper the key mathematical words and phrases the children are using.

When Zia exclaims that one square has a design that can be "folded," the teacher probes her understanding by asking, "What do you mean when you say the design folds? Is there a mathematical word we have learned that means the same thing?"

Zia asks if she can show everybody what she means. She quickly draws an isosceles triangle on a piece of paper and folds one half of the triangle onto the other side. Tommy asks, "Isn't that called symmetry?"

And so the introduction of the lesson goes. The next day the children are given the following assignment:

- ideally, a copy of an assignment where each child is required to use pattern blocks or squares to create a small 4-square quilt.
- a key part of the assignment must be the requirement to describe the quilt using mathematical language.

The teacher encourages the children to discuss their discoveries with a partner and to use manipulatives to investigate various designs. There is a constant hum in the room, but it is evident that the children are focused on what they are doing and that most of the conversation is clearly on task.

Let's have a closer look at the classroom environment. Learning is evident everywhere. Children's work from all subject areas is posted prominently. The alphabet is stretched above the front board and "high-use words" are arranged on a bulletin board just to the right of the classroom door. Shelves of books and buckets of math and science manipulatives are found underneath the windows. Student artwork, paints, brushes, and simple musical instruments all have their place. Geometric solids are displayed on the teacher's desk, student-made prisms hang from the ceiling, and a bulletin board at the front of the room is devoted to the math vocabulary the children have been learning.

By the end of the week, each student has created a "quilt" along with a description of his or her discoveries. Every student is given the opportunity to describe his or her quilt to the class. The teacher positively reinforces the appropriate use of mathematical terms and celebrates each child's discovery. All of the work is then proudly displayed on the bulletin board outside the classroom for others to admire.

I descuvered that the core scrar is sametrickel. it dusint meen that the quilt is the same

This child's words and picture clearly communicate his understanding of symmetry.

Communication in the mathematics classroom

What does this vignette have to do with communication in mathematics? In answering the questions:

1) why should children learn to communicate mathematically, and
2) how can teachers foster mathematical communication in their classrooms,

it becomes evident that teacher pedagogy and the learning environment are integral pieces of the puzzle.

Why should children learn to communicate mathematically?

There are many compelling reasons for having children explain their mathematical understanding.

Over the course of their schooling, children must acquire the skill to conjecture, infer, analyze, justify, and draw conclusions when they are confronted with problems that are mathematical in nature. Students must be able to construct their arguments so that others can understand them. To do this, they must use appropriate mathematical terms and present their ideas clearly and precisely.

When our children become adults they must be able to critically analyse newspapers, web sites, and various other sources of information so that they can determine whether the mathematical information given, supports the conclusions drawn from it. In their jobs, they will need to be able to detect patterns, analyze numerical data, take exact measurements, and put forward logical arguments to support their decisions. It is therefore not enough that students have mathematical understanding – they must also possess the ability to communicate that understanding to others.

Perhaps one of the more pressing reasons for educators to emphasize mathematical communication is that the new Ontario curriculum mandates that students be assessed on their ability to communicate their understanding of mathematical concepts:

> *"Young Children learn language - including the language of mathematics through verbal communication. It is therefore important to encourage them to "talk mathematics" both with their teacher and classmates."*
> **(The Ontario Curriculum, Grades 1-8 Mathematics, 1997)**

EQAO tests, even in grades 3 and 6, require students to communicate clearly and precisely. These tests are filled with such phrases as "explain your thinking" and "justify your answer".

How can teachers foster mathematical communication in the classroom?

All children will become engaged in learning mathematics if they are given the opportunity to talk, play, and perform interesting tasks.

Children begin to construct their understanding of mathematics by making sense of patterns they observe. They must make connections between concepts they have already learned and new ideas they are investigating. Fleshing out these ideas requires that children (with teacher support) talk among themselves in pairs or in small groups. Teachers must also talk with children about their ideas, individually and in group situations. "Often when children attempt to explain their ideas, they realize in midstream a distinction they had not made, gain a new insight, notice a new piece of information, or spot a flaw in their own logic" (Arthur and Pamela Hyde, 1991).

Teachers can model and encourage mathematical communication by helping children create charts and tables, draw pictures, record calculations, and write mathematical terms and phrases. Understanding can be fostered by giving students ample time to investigate mathematical ideas when working in pairs or small groups.

Ultimately, the ideas of all the children should be consolidated in a whole-class discussion. Key mathematical words and phrases must be highlighted and the children should be encouraged to record what they have learned. This could take a variety of forms:

a) journal entry/learning log

b) report

c) poster

d) letter

e) story

f) three-dimensional model

g) sketch or drawing with an explanation or

h) oral presentation

Tasks must be constructed so that students will talk with each other and with their teacher in an effort to construct their understanding and create a product that explains their thinking. Students must be encouraged to use pictures, words, and numbers to clearly illustrate their strategy, procedure, and reasoning.

> *I deckuverd that triangles can make a hexagon by just flipping / turning. I tried to make a square out of triangles it did not make a square so I made a hexagon*

This child has used a combination of mathematical terms and pictures to explain his understanding.

Conclusion

Children must feel free to explore, talk, create and write about mathematics in a classroom environment that honours the beauty and importance of the subject. Children must be empowered to take risks and encouraged to explain their thinking. Teachers must construct tasks that will generate discussion and provide an opportunity for students to explain their understanding of mathematical concepts through pictures, words, and numbers.

References

Hyde, Arthur and Pamela. "." the journal volume/issue (1991): .

Ontario Ministry of Education and Training. (1997). *The Ontario Curriculum Grades 1-8: Mathematics.* Toronto: Queen's Printer for Ontario.

"Mathematics reveals its secrets only to those who approach it with pure love, for its own beauty."

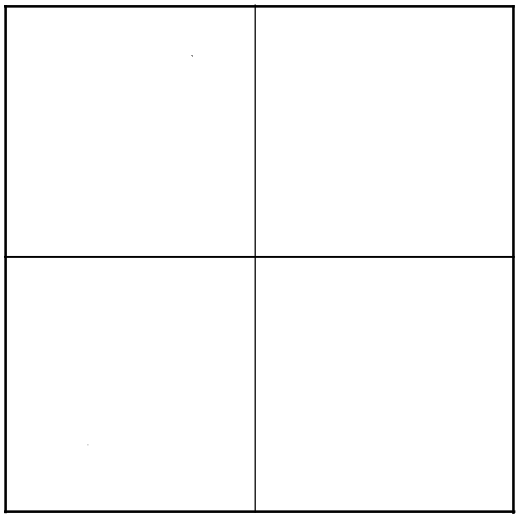
(Archimedes)

Quilt Math

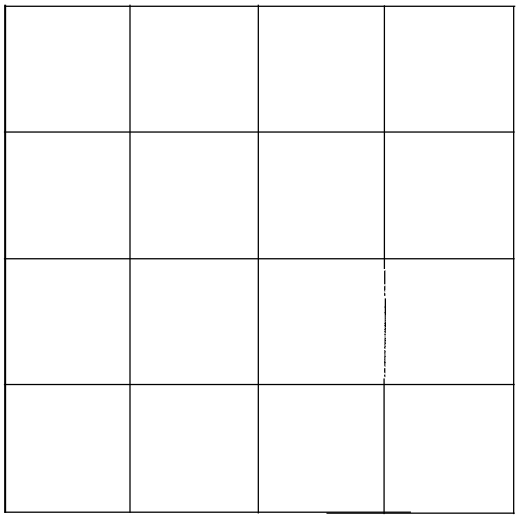
Materials:

- different colours of squares and triangles pre-cut from construction paper
- 4 basic patch mats for each child

Each child uses squares and triangles of two different colours to create a basic patch (repeating unit). At least four triangles must be used.



The student creates the basic patch three more times.



The student then uses slides, flips and turns to create a 2 x 2 quilt.

Ask each child, "Describe how you created your quilt pattern (using slides, flips and turns)? Does it have symmetry? What shapes can you find?"

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▲ Directors' Dialogue



MARILYN HURRELL, NWOAME
LAKEHEAD DISTRICT SCHOOL BOARD
THUNDER BAY, ON
MHURRELL@ALUMNI.LAKEHEADU.CA

This edition of *Directors' Dialogue* summarizes the Saturday, February 12, 2000 OAME Board of Directors' meeting at the Four Points Hotel in Mississauga.

Louis Lim is a hard act to follow. He has set a new standard for *Directors' Dialogue*, as he reported on all facets of our Directors' Meetings. This makes for good and informative reading. I'll do my best to follow his lead.

PRESIDENT PETER ON THE MOVE

Peter Saarimaki announced that he has attended meetings of over half of the 15 chapters of OAME this year. We welcomed him here in Thunder Bay in November. Peter's mother was born here; we have the largest Finnish population in Canada. Peter announced the following: the development of the Middle School Assessment Document is underway; a project similar to Impact Math is being funded by the Ministry of Education (MOE) for math and science grades 4, 5, 6. Summer Institutes will be handled this year by the Ontario Teachers' Federation (OTF). The Ontario Mathematics Coordinators' Association (OMCA) will develop resources for these. The Fields Institute has recognized the need for math teachers and is hosting a meeting in April (sorry, it's over!) of interested persons. See Louis' report in the Sept 1999 *Gazette* and contact Peter for details.

OAME MEMBERSHIP HIGHEST IN 5 YEARS

Executive Directors Dave and Bonnie Alexander reported that the membership as of February 2000 was 1470. This is up from that same time in 1997 which saw 1360 members. Chapter Reps have been given lists of new and returning members. Remember that chapters depend on membership rebates of 30% to fund chapter activities. Bonnie reminded those present that posters for Grade 6-8 Scope and Sequence and copies of the Tech Document are still available for sale at Chapter functions.

SHARING OF RESOURCES

For several years, John Kersley has been hard at work collecting and distributing packages of resources to members of the Board. The packages include newspaper reports, updates, cartoons, and interesting mathematical puzzles. Everyone is encouraged to help John in his quest for contents. This time, Peter Saarimaki, Jackie Hill, and Mary Howe included articles. Thanks, John.

PROFESSIONAL DEVELOPMENT.

OAME 2000: Ron Bender and Peter Lenczewski reported that plans for the conference are going well. You may register at OAME2000.magma.ca.

OMO 2000: Gord Cooke reported that all is ready for June 1 and 2. Chapter Reps are asked to get necessary forms into Cindy Harvey by March 15. Good luck with this event!

Leadership 2000: Peter Saarimaki reported that all Secondary and most Elementary sessions are full, and looks forward to another successful Leadership Conference.

OAME 2001: Kirsten Boucher (SAME) says the location will be Delta Hotel Toronto East, Scarborough, as well as the nearby Holiday Inn and Centennial College.

OMO 2001: Marilyn Hurrell and Wayne Fletcher are co-chairing the event in Thunder Bay (NWOAME). It is scheduled for June 10, 11, 12 at Lakehead University. Plans are going well.

Leadership 2001: Mary Howe indicated that her plans would be for a session for grade 11 teachers (60), one for grades 9 & 10 (30) on assessment, grades 6-8 (24) on new Middle School LIAM, and grades 3-6 (24) on communication.

NCTM. Frances Schatz reminds us that NCTM Membership adds up to savings...20% discount on materials and if you order through her, OAME gets another 20%. Watch for her booth, featuring new publications, at OAME 2000.

COMMITTEE REPORTS

AWARDS: A recommendation has been made for the Life Award, to be presented at OAME 2000 in Ottawa in May. Congratulations to the recipient!!

FUTURES: the Committee is looking for host chapters for OAME 2002 and 2003, as well as a host for OMO 2004. An attempt is made to have a 5 year plan for events.

MATH EQUITY: this Committee addresses all issues of equity as it applies to the study of Mathematics. The Equity Committee Breakfast at OAME 2000 will feature speaker Dr. Julia O'Sullivan, Dean of Education, at Lakehead University in Thunder Bay.

PROMOTIONS: The Committee would like to see a calendar of events as a feature of the OAME web page, which would include chapter meeting dates. Chapter Reps are encouraged to send this information to Doug Evans (devans@rideau.net).

JK - 5: Laurie Moher reported that the committee has prepared an article for the *Gazette* on 'communication in the primary classroom' (see page 25 in this *Gazette*). A mini-unit on quilting has been prepared which links directly to the *Gazette* article. A focus section for the *Abacus* on JK/SK is also being prepared. All of these will be ready for submission April 1, 2000. Committee members will be submitting suggestions for links to elementary math web sites on the OAME site.

6-8: Ed Barbeau stated that Barry Onslow has attended a meeting to report on the progress of the Middle Years project. The committee is planning a sequence of four articles for the *Gazette,* featuring assessment profiles for the 6-8 level. Other articles for the *Gazette* are also planned.

Secondary: Myrna Ingalls announced that there will be excerpts from a grade 9 exam in the next *Abacus*. Other excerpts from this exam may be printed in future issues. A joint OAME/OMCA project to produce a package on Assessment and Reflective Evaluation for the OTF Summer Institutes has been proposed. Peter Saarimaki reported that a consortium is working on the grade 9 Essentials course. Also copies of a video by the Ministry, on the new curriculum, are available for preview.

CHAPTER NEWS

CHAMP: Rep John Rodger. The local CHAMP Math Contest was held in December. OMO play downs will be held in late April and three teams will be sent to OMO 2000 in Kingston.

COMA: Rep Ron Bender. COMA members are busy preparing for OAME 2000. However, COMA is still providing in-service to teachers of Grade 9. In November, Myrna Ingalls spoke with Grade 9 teachers on "From Profiles to Classroom." In February, a second session will see semester 1 teachers sharing strategies with semester 2 teachers. A third forum will be held in April to look at the grade 10 program. Thanks to all our Volunteers.

GVMA: Rep Murray McLennan. The Spring Conference will be held April 13. Its focus will be the grade 10 curriculum. Check the web site at home.golden.net/~gvma.

ISOMA: Rep Ian Robertson. A mini-conference on grades 9 and 10 curriculum is planned for February. Many ISOMA members are presenting at OAME 2000, particularly in technology. Because ISOMA is so spread out, the chapter will have difficulty hosting OMO 2002 as requested.

MAC²: Rep Lyn Vause. Annual Meeting is planned for April 12.

NOMA: Rep Carol Lemmon. NOMA has conducted a series of mini-workshops after school on Geometer's Sketchpad and TI-calculators. NOMA will send three teams to OMO 2000.

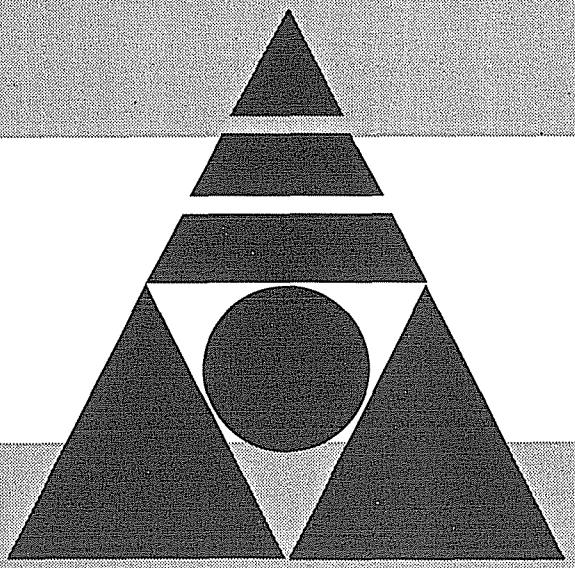
NWOAME: Rep Wayne Fletcher. The fall conference was a great success, with more than 100 teachers attending a day and half of workshops. Membership increased by 15. OMO 2000 will be held April 29 at Confederation College and again NWOAME plans to fund raise and send three teams to Kingston. The NWOAME Annual General Meeting will be held May 2. The speaker will be Marilyn Gouthro, newly appointed Director of the Lakehead District School Board. Math Contest Awards Day will be held June 9 at Lakehead University.

PINE RIDGE: Rep Jackie Hill. A mini-conference entitled "Time for Math" runs April 12 in Port Perry. The Durham District School Board and the Pine Ridge Mathematics Association are co-sponsoring a math competition in late May for Grade 7 and 8 students. Two top teams will be sent to Kingston OMO. The 17th Annual Math Awards Night will be held in early June.

QSLMA: Rep Gord Cooke. All eyes are on June as QSLMA prepares to host this year's OMO. The committee is chaired by Cindy Harvey and includes Joan McDuff and Lynda Colgan of Queen's Faculty of Education. Otherwise, QSLMA is in a holding pattern. Good luck with your event.

SAME: Rep Kirsten Boucher. A mini-conference, "Are you Feeling Stranded?", will be held April 18 at Maplewood HS in Scarborough. SAME is very involved with OAME 2001: A Math Odyssey.

SWOAME: Rep Frank Di Pietro. Frank reports that



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SWOAME is presently selecting OMO Teams and will send two teams to Kingston; a "Dinnerlude" is planned with speaker Judy Crompton; a workshop on Grade 10 Profiles is planned for June; teachers will be encouraged to attend Summer Institutes; teachers are being recruited for the SWOAME T-cubed Institute. A very busy chapter!

TE²Y²MS: Rep Kathy Kubota-Zarivnij. A very picturesque report was submitted, which showed photos of sessions held at the "Building a Math Community" conference in February at East York Collegiate. Over 280 elementary and secondary teachers attended. Presenters included Stewart Craven, Shirley Dalrymple, and Judy Crompton. The local OMO will be held March 4.

WOMA: Rep Linda Alton. Following the very successful workshop series "Grade 9 for 99" will be a spring series "Millennium for Grade 10ium". Myrna Ingalls will conduct three workshops. Plans are underway for a workshop for grades 8 & 9 teachers to get together and learn about EQAO.

Y⁴MA: OAME welcomed new Rep Rosie Mastrofrancesco. The Chapter will commit to sending three teams to each of OMO 2000 and OMO 2001. In the case of Thunder Bay, the cost per student is deemed to be $500. Y⁴MA will engage in fundraising activities to help with costs; i.e., a $5 per head fee will be charged for the mini conference on February 10.

OMO events are planned for April 13. Y⁴MA is also holding several mini conferences on technology to support elementary and secondary teachers.

CLOSING REMARKS

And to close with a contest. Who was the original writer of *Directors' Dialogue* (called *Council Report*)? The first person to e-mail me with the answer wins (something). Members of the current Board are not eligible. Aren't you glad you read to the end? It will be June when you read this, so have a happy summer and give serious thought to attending a Summer Institute.

Marilyn ▲

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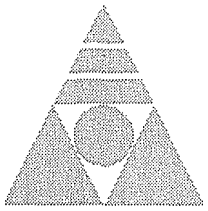
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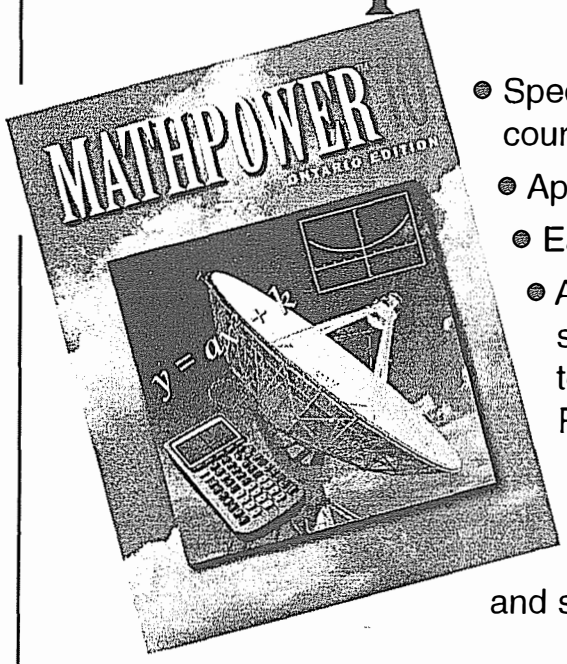
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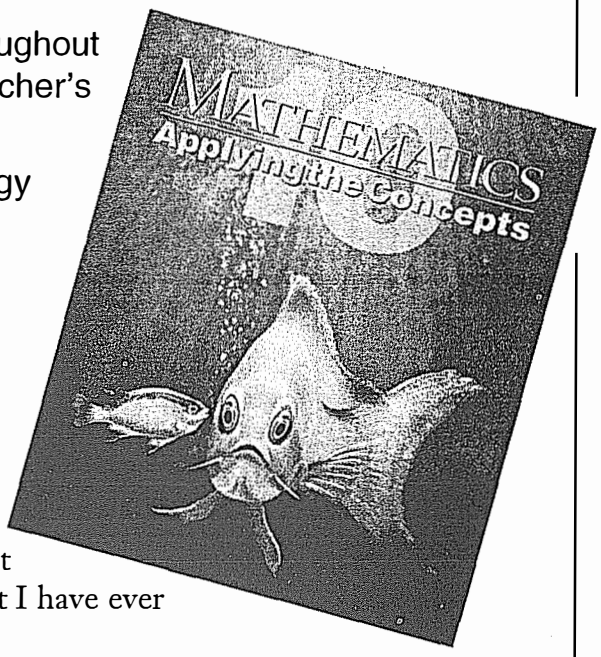
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1. State the Domain of $y = \frac{x-10}{\sqrt{x^2-16}}$.

2. Which relation is the inverse of y

3. Use a half-angle identity to find the

a) $\frac{1}{2}\sqrt{2-\sqrt{2}}$ b) $-\frac{1}{2}\sqrt{2-\sqrt{2}}$ c)

4. If $f(x)=2x-5$ and $g(x)=$

a) $\frac{-(5x+11)}{x+3}$ b)

5. If $\sin\theta = -\frac{1}{2}$ and θ

a) $\frac{-\sqrt{3}}{3}$ b) $\frac{\sqrt{3}}{3}$

6. Given $f(x) = \frac{x^2}{x+3}$ and

a) $\frac{4x^2-2x}{x+3}$ b)

"struggling with a word processor?"
(The hard way)

Final Exam

1. State the Domain of $\frac{y=x-10}{\sqrt{x^2-16}}$

2. Which relation is the inverse of $y=(x-2)^3$?

a) $y=\sqrt[3]{x-2}$ b) $y=\sqrt[3]{x}-2$ c) $y=\sqrt[3]{x+2}$ d) $\sqrt[3]{x}+2$

3. Use a half-angle identity to find the exact value of cos 67.5°:

a) $1/2\sqrt{2-\sqrt{2}}$ b) $-1/2\sqrt{2-\sqrt{2}}$ c) $-1/2\sqrt{2+\sqrt{2}}$ d) $\sqrt{3+2\sqrt{2}}$

"with MathType!"
(The right way)

FINAL EXAM

1. State the Domain of $y=\frac{x-10}{\sqrt{x^2-16}}$.

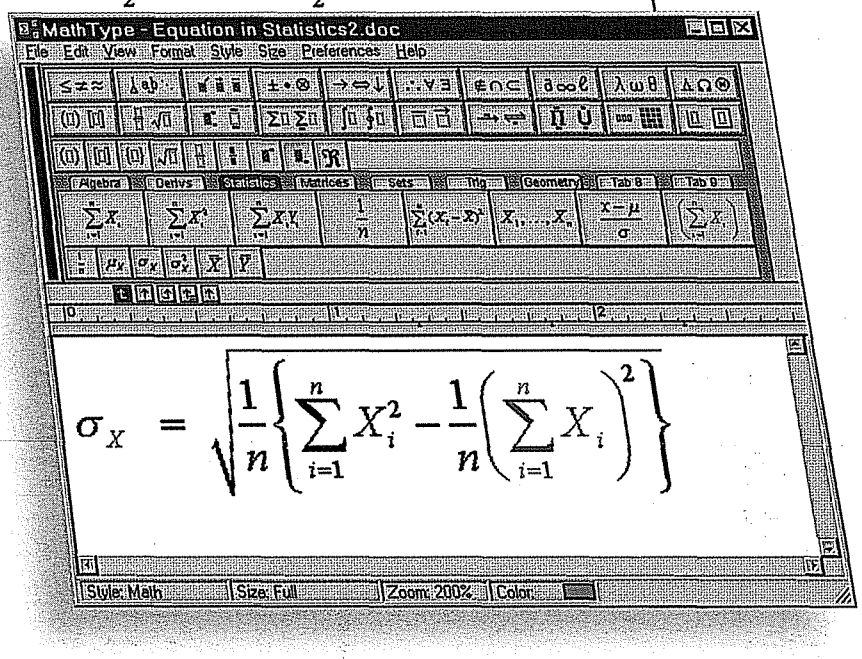
2. Which relation is the inverse of $y=(x-2)^3$?

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3. Use a half-angle identity to find the exact value of cos 67.5°:

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