Vol. 35 #3, March 1997

Ontario Mathematics Gazette

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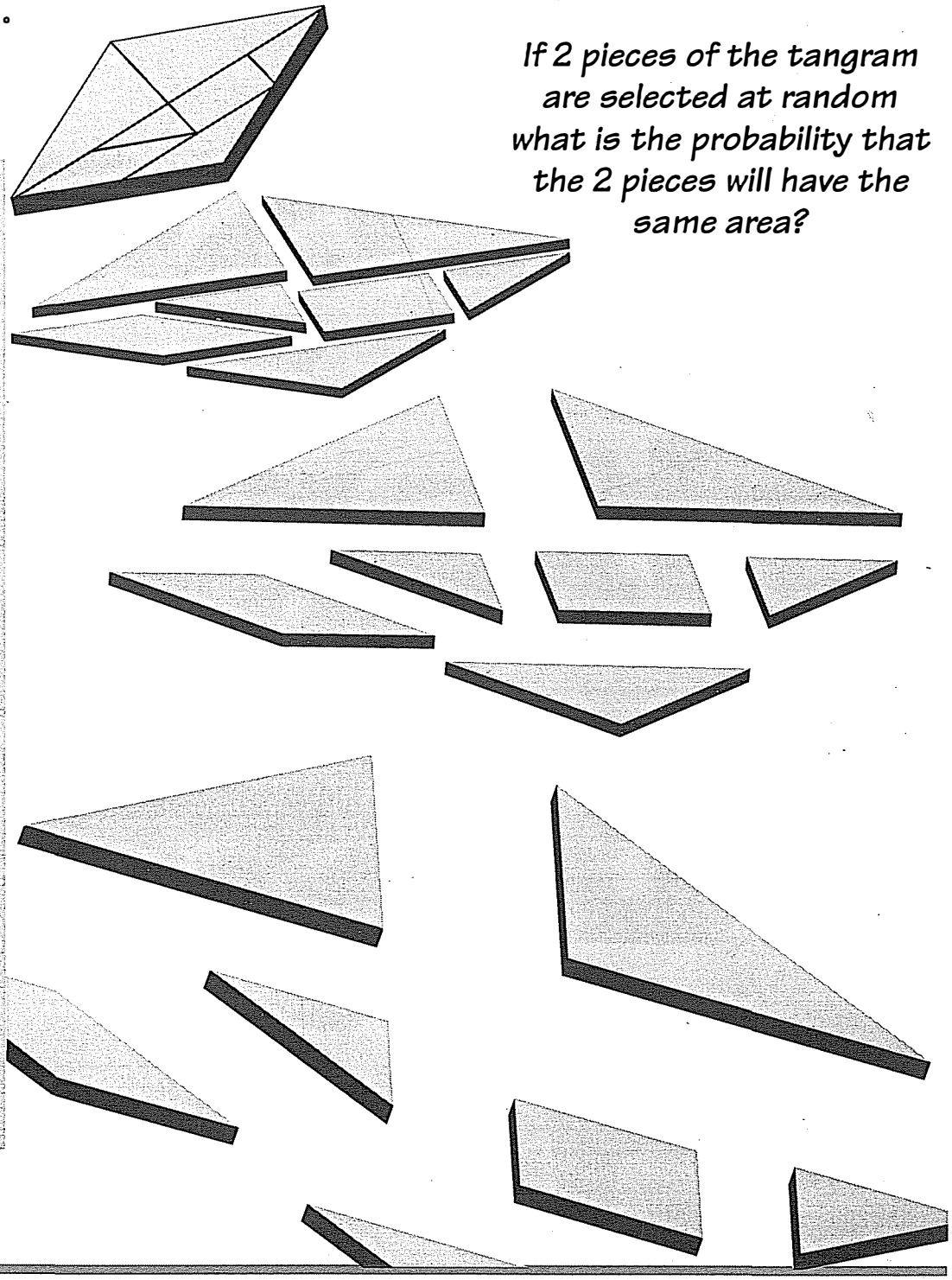
Probabilities on the Tangram: an Example of Linking Mathematical Ideas

Twiddling with Transformations

An Independent Study Assignment: Grade 10 Statistics

All Girls' Math Classes at Unionville High School

Examining Portfolio Assessment: What It Is and How It Measures Up



If 2 pieces of the tangram are selected at random what is the probability that the 2 pieces will have the same area?

ONTARIO ASSOCIATION FOR MATHEMATICS EDUCATION
ASSOCIATION ONTARIENNE POUR L'ENSEIGNEMENT DES MATHÉMATIQUES

"How do you write tests, homework & classwork?"

"by hand?"
(The old way)

F inh Exa ns

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

2. Which relation is the inverse o

3. Use a half-angle identity to find

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

4. If $f(x) = 2x-5$ and $g(x) = \frac{2}{x+3}$

a) $\frac{-(5x+11)}{x+3}$ b) $\frac{1}{x-4}$

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

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

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

Final Exam

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

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

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 ider
cos 67.5°:

a) $1/2\sqrt{2-\sqrt{2}}$ b)

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

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

5. If sin θ=-1/2 and θ i

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

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

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

"With MathType!"
(The right way)

FINAL EXAM

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

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) $\sqrt[3]{x}+2$

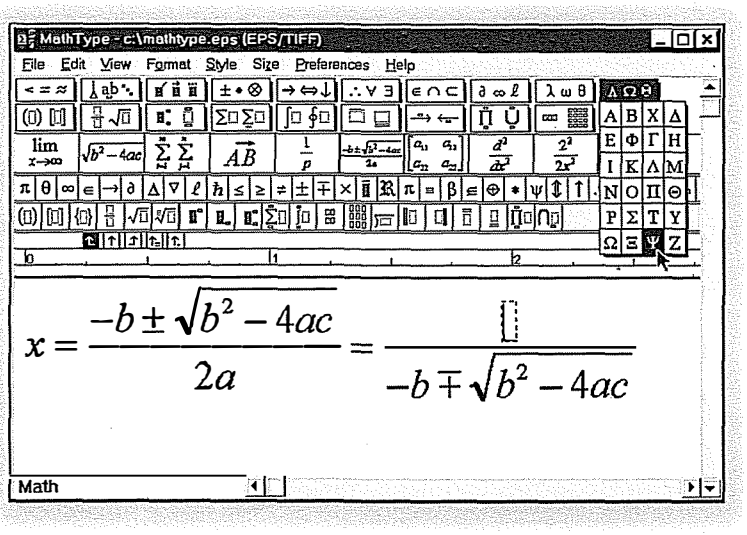
3. Use a half-angle identity to find the exact value of cos 67.5°:

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

4. If $f(x)=2x-5$ and $g(x)=\dfrac{2}{x+3}$, find $[g \circ f]\,(x)$:

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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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Full page advertisements are to be on 8.5" by 11" paper with a minimum of 1/2" margins and single sided. Each advertisement should be camera-ready and colour advertisements should have no bleeds.

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Notice to Authors

Your article should be typewritten or 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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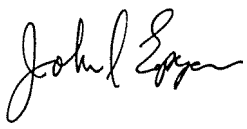
▲ Editorial

JOHN EGSGARD



Ministers of Education and school administrators seem to forget that teachers are the key to success in the classroom. One of the great assets of the *Gazette* is that it gives teachers the opportunity to share their teaching ideas with other teachers. The *Gazette* can also be a forum to discuss educational challenges that come from outside the classroom. In this issue Ron Dunkley, in a letter to the editor, continues the dialogue on entrance examinations begun in the December 1996 issue by Peter Taylor. Personally I have always been in favour of external examinations provided that they can be prepared in a fair manner similar to that suggested by Ron in his letter.

Because the computer must have a place in every math classroom Eric Wood, with his article *"Twiddling with Transformations"*, is beginning a series on programmes available on the internet. Other teaching ideas are contained in my teaching hints column, an article on an independent study activity in statistics, and one on the use of tangrams as a source of probability problems. This issue concludes with two articles that could be considered controversial: one on all girls classes and another on portfolio assessment. The latter appeals to the NCTM Standards of which I have always been critical.



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The Ontario Association of Mathematics Education requires a NCTM Representative.

The NCTM Representative provides liaison between NCTM and OAME and is responsible for the sale of NCTM materials in Ontario.

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Candidates for this position should apply in writing, stating related qualifications,

by April 15, 1997 to OAME P.O. Box 96, Rosseau ON POC 1JO

▲ PRESIDENT'S MESSAGE



BARRY ONSLOW

1997 is going to be a most important year for education in Ontario. Apart from the massive changes in funding and School Board boundaries, Secondary School Reform will have a profound effect on mathematics teaching at all levels, not just the high school. To this end, OAME's Specialization Years and Special Projects Committees will be working diligently on your behalf to ensure that Ontario's students and teachers receive the best possible mathematics curriculum. It was good news to learn that Geoff Roulet was awarded the Ministry of Education and Training contract to research and write the curriculum background paper for mathematics. Those of you who read Geoff's article, *Developing a Specialization Years Mathematics Curriculum,* in the December '96 issue of the *Gazette,* know that Geoff is extremely knowledgeable in this domain and has a sound framework for writing his paper. We are fortunate to have Geoff as a member of our Specialization Years' Committee, and I know that he has contacted several of OAME's Board members to hear their opinions. Please remember, it is very important that OAME speak for you, our members. Therefore, if you have some thoughts on the directions we should be opting for in mathematics, please write a letter to the editor, contact your local Chapter Representative, or write to me. We will listen.

The Fields Institute for Research in Mathematical Sciences contacted me in the Fall of '96 to enquire how they might assist the school mathematics community. The Institute has agreed to host meetings for representatives from some of the key Ontario organizations interested in mathematics education. Representatives from Ontario high schools, university mathematics' departments, colleges, faculties of education, OAME, OMCA, OCMA and CMS met on Saturday, November 23, 1996 for the first exploratory meeting. Delegates from business and industry were included for the second meeting, which was held February 1st. It is anticipated that this group, brought together at the Fields Institute, will be in a unique position to contribute to the critically important process of developing a sound and balanced long-term program for mathematics education in Ontario. A curriculum must be developed to meet the needs of the students of the twenty-first century. There will have to be a decrease in emphasis on topics that are no longer as important as they once were, and an increase in emphasis on those topics necessary for a rapidly changing technological world. Back to the basics is just not good enough for our future students. My grandfather needed to know the basic skill of saddling a horse. He could not drive a car. My grandson certainly will not need the same basic skills as his great, great grandfather. We must look forward and decide on the basic skills and concepts necessary for our students to be successful in the next century.

The Third International Mathematics and Science Study (TIMSS), did not bring good news to the mathematics teachers of Ontario. However, neither did it bring the doom and gloom broadcast by several newspaper columnists. We appear to be in the middle of the pack. No time to celebrate, but also no time for despair. When one compares the content of the test with our current curriculum, it is not surprising that many students could not answer several of the test questions. I believe the mathematics assessment of the Education Quality and Accountability Office will be far more valid for informing us about whether or not our students are meeting the expected outcomes of the provincial curriculum.

The 1996 Leadership Conference, *Connecting Assessment to Learning,* was a great success. A special thanks to all of the speakers and organizers. When asked to evaluate the conference, delegates gave it a mean score of 4.6 (on a 5-point scale). The new Junior Year's Assessment Document was shared with many of the delegates at the conference and received very positive feedback. It is now for sale at a very reasonable price (see the advertisement on page 28 of this issue). The document is an excellent resource for teachers of grades 4, 5, and 6, and provides many suitable sample activities for those people seeking professional development on assessment.

The third annual Ontario Mathematics Olympics (OMO) will be held on Saturday, June 7, 1997, at the Kempenfelt Centre in Barrie. The joint chairs for the competition are Jack LeSage, Bill Morrison and Paul Pogue, and the OMO is once again being sponsored by Rockwell International of Canada. The generous financial support of Rockwell and the commitment of our volunteers in the MAC^2 Chapter makes it possible for OAME to provide our talented grade 7 and 8 mathematics' students with an enjoyable, challenging experience in a friendly environment. Ensure that your students become involved in the local Chapter play downs. See your Chapter Representative (name and address on the inside back cover) for details.

Plan on attending the OAME Annual Spring Conference, May 8-10, 1997, in Toronto. The conference theme is The Name of the Game, and the TEY^{2}MS Conference Committee have numerous extra-curricular activities and worthwhile sessions planned for those who can make it to Toronto. We are truly fortunate to have so many volunteers who are willing to support mathematics education. Come out, enjoy the fun, and play the game.

Hop you had a relaxing and pleasant March Break. See you in Toronto.

▲ LETTER TO THE EDITOR



RON DUNKLEY
CENTRE FOR EDUCATION IN MATHEMATICS AND COMPUTING
UNIVERSITY OF WATERLOO

The December Gazette carried an article by Peter Taylor concerning possible university (post-secondary?) entrance examinations. In the article Peter discussed what form such an examination might take, but he made no attempt to address reasons for having an examination or to consider how it might be implemented. I shared in the discussions mentioned by Peter, and his observations are a good summary of them, although the primary reason for their existence was a discussion of curriculum. I was also involved in discussions held later where the possibility of a mathematics examination was discussed more fully. In the interest of keeping all concerned persons informed, I pass on to Gazette readers the rationale for, and suggestions for implementation of, a university entrance examination in mathematics.

The discussions were based on the following premises.

1. The exam would have nothing to do with graduation from secondary school.
2. The exam would be used in conjunction with currently provided school grades. It would not replace them.
3. The exam would be set by those persons involved in the mathematics education of the students who would write the paper; hence the exam would be prepared by a committee of secondary teachers, who have taught the students, and university teachers, who will teach them at the next level.

Readers familiar with the Department exams of thirty years ago will recall that they were used for both school leaving and university entrance, and that they were set primarily by university professors who had little understanding of the level of preparation of the students. It is extremely doubtful that an exam can be set that serves for school graduation purposes and simultaneously for university entrance purposes. It is, in my opinion, absolutely certain that an exam that will provide a fair test for the latter purpose must be set by a committee that includes both secondary and university faculty.

Why an examination?

Students would:

- be better prepared for post-secondary study. Preparing for an exam would require them to review and to master topics most important in their development.
- be better placed in programs. Many students discover during the first year that they are in the wrong program. An exam would assist students in making program decisions.

Teachers would:

- be able to assume their proper role as coaches. Because they would not be involved in the assigning of a grade to their students, they would not be susceptible to external pressures.
- be better able to determine topics for emphasis. There is no intent to dictate curriculum, but there clearly are topics that teachers would emphasize if they knew what university people really wanted.
- gain in professional growth. The absolutely necessary involvement of a great number of teachers working collaboratively with university teachers in the preparation, administration, and grading of papers, would be a very positive thing.

Universities would:

- be better informed in making admissions decisions.
- be able to design introductory courses with greater assurance that they are properly suited to the abilities of students.

The gain to the system at both levels says that this idea should be explored in detail. In fact, there are a number of universities already committed to doing so. It is recognized that this should be a collaborative effort, and this is welcomed by the university personnel involved. This could be an ideal means of providing opportunities for secondary and university people to work together, some in preparing the paper, but many in the marking of it. After all, we're looking at the possibility of thirty to forty thousand papers.

What form should a paper take?

In his article Peter has given a very nice analysis of what universities would like to see in incoming students:

technical skills (but not on as large a base as school curricula suggest), solving of problems, organizing of material, and presenting of results in a coherent, readable manner. He rightly stresses that thinking is the single most important skill looked for.

The sample exam Peter presented probably frightened many readers. It frightened me, too, because while I agree with what he is suggesting, to make the whole paper one of this form is to ignore two things: first, universities do want some assurance of technical proficiency, and second, the number of teachers who, in today's school with today's curriculum, could possibly prepare students for this exam is probably not very large.

It seems to me that the paper ought to contain a section of some 50 - 60 marks that tests technical ability and a second section that tests problem-solving ability. There might even be different sections for students applying to math-engineering-technology programs as opposed to commerce-business programs. I'm sure that readers will have their views on this, and I assure them that comments passed on to me will be shared with others involved in the current dialogue.

Is Peter accurate in predicting the likelihood of an exam in mathematics? I hope so, for I am convinced that if we do this as a shared activity between secondary and university educators that we'd all be better off, and that students in particular would benefit.

Computers are now being applied to almost every aspect of human activity. Every field of science, of medicine, engineering, business - you name it - is being computerized in some way. However, before you can put a problem into a computer and efficiently find a solution, you must abstract it, you have to build a model. Before you start to do anything with the model, you have to mathematize it. It is this process of abstracting applications from every aspect of life that has given rise to a vast new world of mathematics ....

George B. Dantzig, the Father of Linear Programming

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▲ TWIDDLING WITH TRANSFORMATIONS

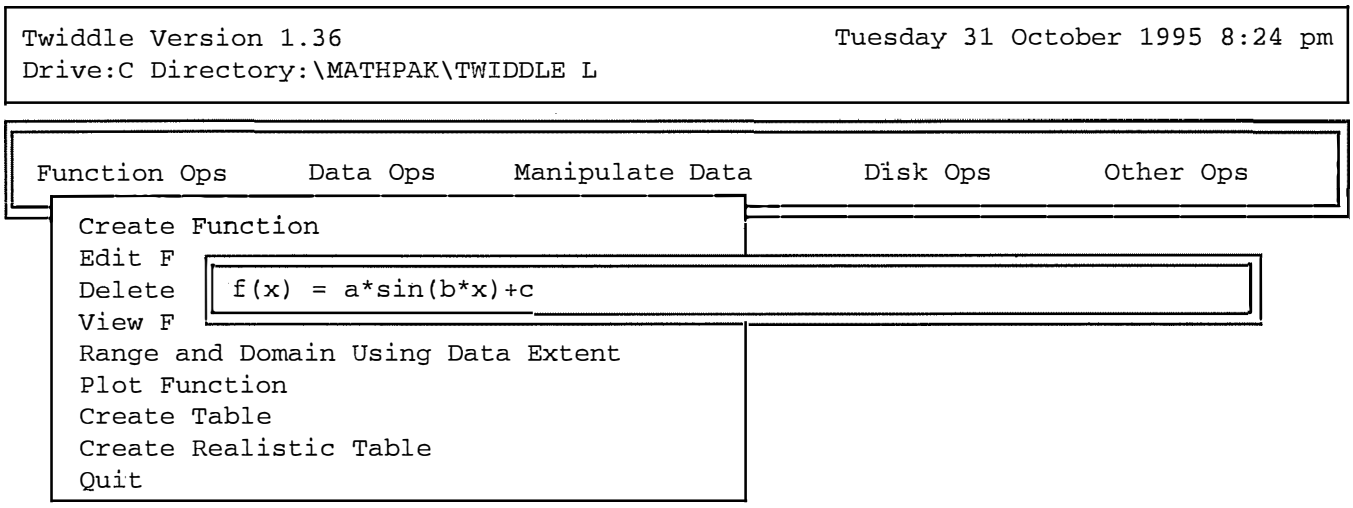
DR. ERIC WOOD
UNIVERSITY OF WESTERN ONTARIO
FACULTY OF EDUCATION
E-MAIL WOOD@EDU.UWO.CA

Eric Wood teaches preservice secondary teachers. He is primarily interested in the long term growth and development of teaching expertise; and, how the predisposition to learn can be fostered in student teachers.

Computers are powerful tools for allowing students to conjecture and explore mathematical ideas; however, one of the problems with making effective use of computers in the teaching of mathematics is the availability and cost of software. Fortunately, there are a number of excellent, freely distributable, programs on the INTERNET that can be used profitably in the secondary classroom. This article describes one such program and provides a sample of an activity that allows students to truly explore how graphs are transformed by changes in their defining equations. The program that is used in this activity is called TWIDDLE and is one of a number of high quality programs produced for IBM-compatible computers under the direction of Dr. David Lovelock at the University of Arizona. The program is without question the easiest program to use for this purpose that I have ever seen.

Running the program gives an opening screen which features pull down menus, from which choices can be selected by using the cursor keys and pressing the ENTER key. A typical screen is shown below with a function to be explored defined with 3 different parameters (the maximum allowed).

In this case the function that was entered was f(x)=asin(bx)+c. Note that brackets should be used where appropriate and that multiplication is denoted by a * symbol. Similarly, the function $f(x) = ax^2 + bx + c$ would become f(x)=a*x^2 + b*x + c; $f(x) = a\log_{10}bx$ would become f(x)=a*log(b*x), and so on. Pressing ENTER allows students to modify the domain and range as well as the initial parameter values if they like. Once this is done, the function is graphed by selecting the **Plot Function** choice from the menu. The graphing screen for



$-2\pi \leq x \leq 2\pi$ and $-10 \leq y \leq 10$ is shown in Figure 1. The real strength of this program lies in the ease with which the parameter values can be changed. Pressing a capital letter increases a parameter's value and pressing a lower case letter decreases it. Pressing the ENTER key graphs the new curve on the same axes. It is easy to get a series of curves as shown in Figure 2 with only a few simple keystrokes.

The designers of this program have concentrated their efforts on making it easy for students to use in their development of mathematical understanding. Although the focus of this article is the use of this program in the study of transformations the program will also do many other things. It is worth spending some time experimenting with some of the other features of this program — there are many other applications for it in the high school classroom.

The accompanying series of worksheets assume that students will be alone or in pairs at a computer and that they will work through the activities independently with the teacher acting as a resource person. Activities are self-explanatory and help students get acquainted with various features of the program as they work through the exploration. Students do need to keep a record of what appears on the screen for later reference; and, having the hardcopy match the screen helps in this endeavour. (These screens were captured by using the program GRAB.EXE which comes with Wordperfect 5.1). Once students have worked through this first activity they should be sufficiently familiar with the program that they can do further explorations without the same level of explanation. It would be appropriate to have students follow this first activity with an exploration of , y = sin (b*x) , y = sin (x) + c and y = a*sin (b*x) + c.

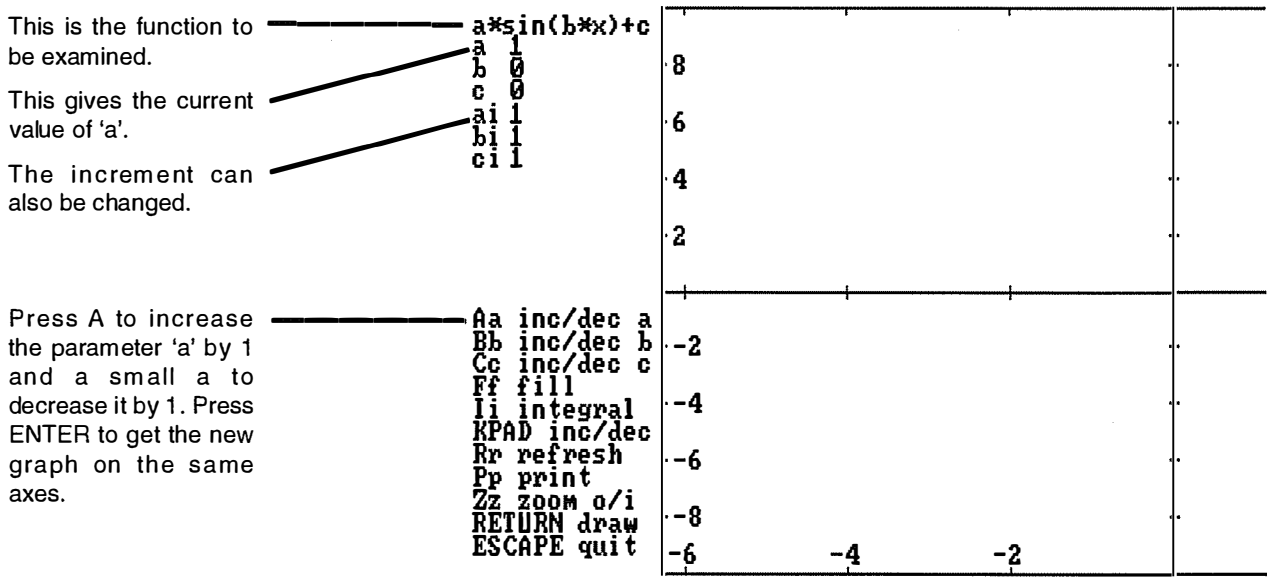


Figure 1

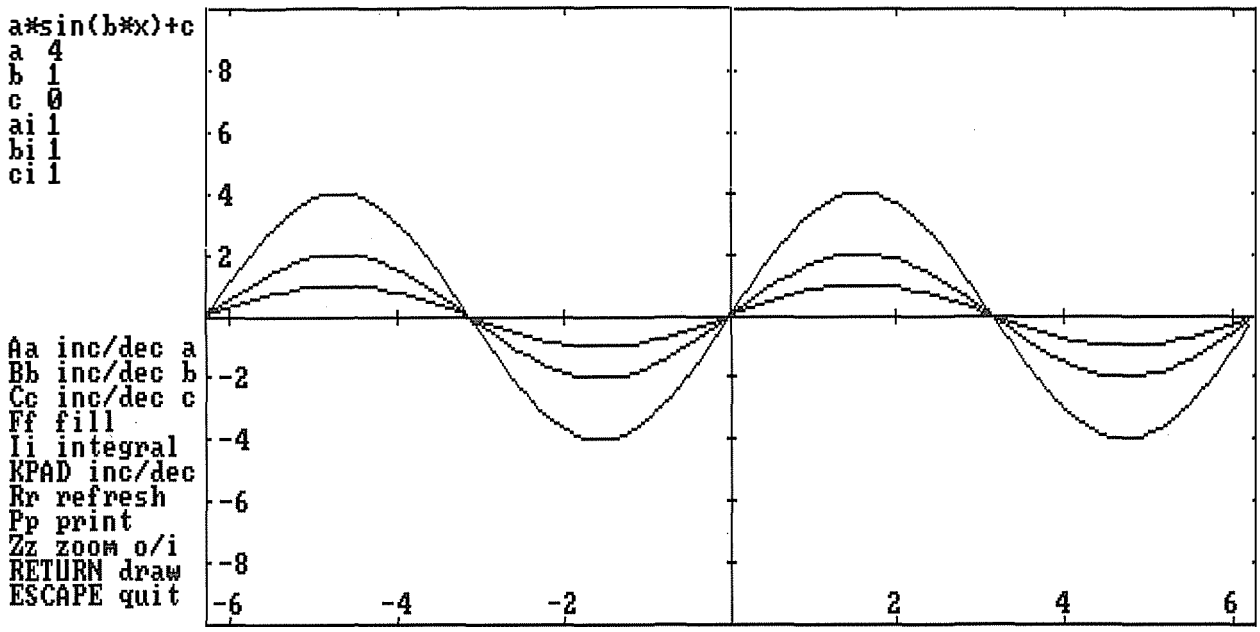


Figure 2

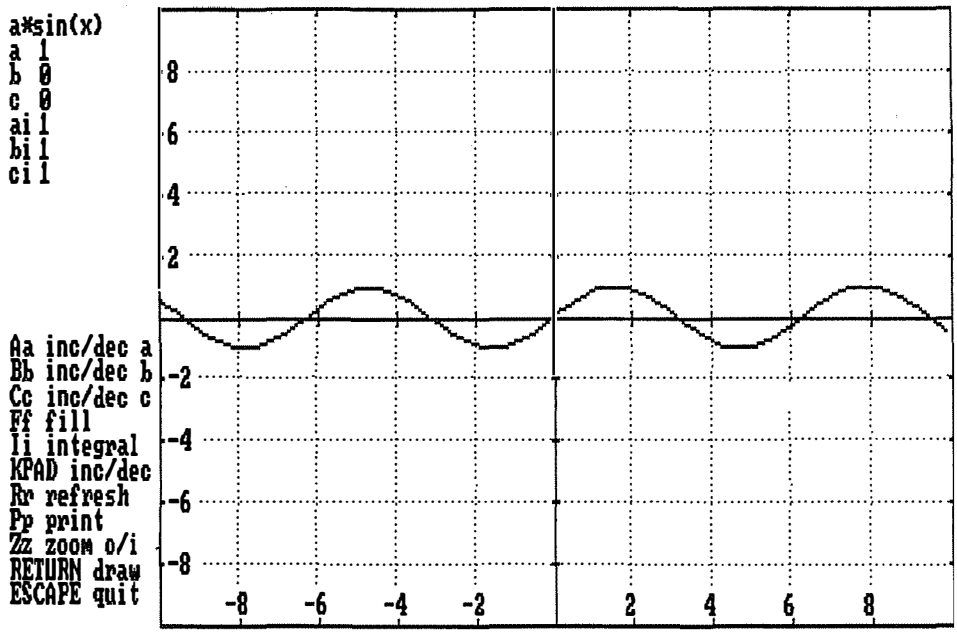
Similar explorations can be done just as easily with quadratics or other functions.

This program can be downloaded free of charge via anonymous ftp from the archives at the University of Tennessee at Knoxville. Just ftp to math.archives.utk.edu and look for the program TWIDDLE.ZIP in the **software/msdos/graphing/twiddle** directory. If you are using the World Wide Web, the address is http://math.archives.utk.edu. Select **Software, MSDOS, Graphing** and **Twiddle.** If you want the MacIntosh versions just substitute MAC for MSDOS in the instructions above. Remember to download it as a binary file and that it will need to be UNZIPed once it has been retrieved. Readers who are not familiar with ZIP files can download a self-extracting version from http://www.uwo.ca/edu/math/. Just select the **Download Software from Local Archive** option and follow the instructions given. Readers who do not have INTERNET access can receive a ready to run diskette which can then be freely copied by sending $5 to cover packaging, media and postage to TWIDDLE, P.O. Box 413, Delaware, Ontario, Canada. N0L 1E0.

Activity #1 - The Graph of f(x) = a sin(x)

In this activity you will explore how the graph of f(x) = a sin(x) changes as the value of the parameter 'a' is varied. The computer program that will help you in this investigation can be started by typing the word RUNME and then pressing the ENTER key. Follow the instructions on the screen — if you have a color monitor press 2 and wait a few seconds for the program to load. When you are asked if you want instructions use the arrow keys to highlight the word NO and press ENTER. Note that at any time you can get help by pressing the F1 key.

1. Use the arrow keys (<- and ->) to highlight **Function Ops** and then the down arrow to highlight **Create Function** and press ENTER. Now type in the expression **a*sin(x)**. Use the BACKSPACE key to correct any typing errors. When you press ENTER you will have a chance to set the initial parameter value, but for now just press ENTER to accept the value that is given. Likewise, each time you press ENTER you will have the opportunity to set the domain and range for your graph but for this exercise you can just keep pressing ENTER to accept the values that are given. When you return to the menu use the down arrow to highlight **Plot Function,** press ENTER and the screen should look like the one in Grid 1 except that a grid has been added to help in the sketching of your graphs later.
2. Note that the function to be explored, f(x) = a sin(x) is shown in the top left hand corner of the screen as is the value of the parameter a, in this case 1. Now hold down the shift key and press the letter a once. The parameter value will increase to 2. Use the capital A again to make the parameter value 7.



Grid 1

Now press the a key unshifted and you will see the value of a decrease. Reset the parameter value to 1.

3. Change the parameter value to 2 and press ENTER. *Sketch* and *label* (in this case f(x) = 2 sin(x)) the resulting graph on Grid 1. Repeat for parameter values of 3, 4, 6 and 8.
4. (a) State in words what seems to be happening to the curve as the value of a is increased.

   (b) State the amplitude and period of each of the graphs. How do these values relate to the values of the parameter a?

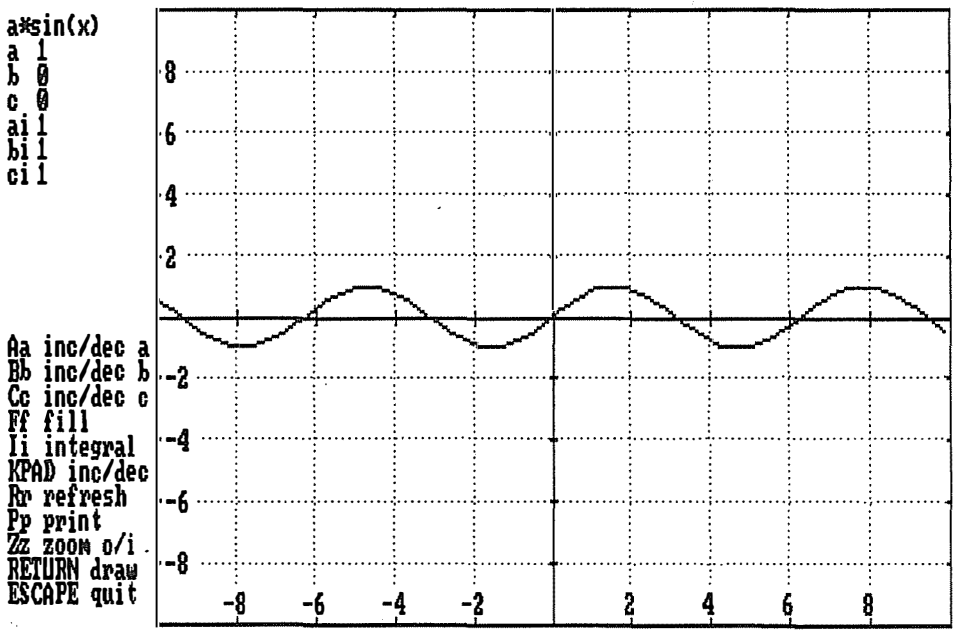
   (c) What are the co-ordinates of points that remain fixed under these changes?
5. Reset the value of a to 1 and press ENTER to get a new graph, then press r to clear the screen of all but the last graph. The screen should look like Grid 2.

Now press the END key to change the value of a_i (the amount by which a changes with each key press) to 0.1. Press the HOME key to increase its value by a factor of 10 back to 1. Set the value of a_i to 0.01 and this will then allow you to get values for the parameter a that are decimals.

6. Set the value of a to 0.5 (using a or A as required) and press ENTER. Sketch and label the resulting graph on Grid 2. Repeat for parameter values of 0.25, 1.5 and 0.8. Do the results of this exploration confirm your hypothesis in #4?
7. Set the value of a_i to 1 and the value of a to 1. Press ENTER to get a new graph and r to clear all but the last graph from the screen. The screen should look like Grid 2.

Set the parameter value to -1 and press ENTER. Sketch and label the resulting graph on Grid 2. Repeat for parameter values of -3, -5, -7 and -2.

8. How is this change in the curve the same or different from the previous results? Explain.
9. Press the ESC key to return to the main screen and choose **Edit Function**. Change the function to f(x) = a*cos(x). Select **Plot Function** and repeat #3, #4, #5, #6, #7 and #8. You need not sketch the resulting graphs. Are the results the same or different? Explain.
10. Press the ESC key to return to the main screen and choose **Edit Function**. Change the function to f(x) = a*tan(x). Select **Plot Function** and repeat #3, #4, #5, #6, #7 and #8. You need not sketch the resulting graphs. Are the results the same or different? Explain.
11. Summarize what you have learned about the effect on the graph of transforming the function f(x) to the function a f(x).



Grid 2

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▲ An Independent Study Assignment: Grade 10 Statistics

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LAKEHEAD UNIVERSITY
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After 15 years of teaching mathematics, James M. Haines assumed a position at Lakehead University's School of Education. His areas of interest include preservice teacher education, mathematics education and classroom management.

The teaching of statistics in the past has been very limited and "has not yet made it into the mainstream of school mathematics" (Shaughnessy, 1992, p.466). The NCTM Standards document recommends more attention be paid to the teaching of statistics, because "a knowledge of statistics is necessary if students are to become intelligent consumers who can make critical and informed decisions" (NCTM, 1989, p. 105).

"Collecting, organizing, describing, displaying, and interpreting data, as well as making decisions and predictions on the basis of that information, are skills that are increasingly important in a society based on technology and communication" (NCTM, 1989, p. 54). The NCTM Standards state that "students need to be actively involved in each of the steps that comprise statistics, from gathering information to communicating results" (p. 105). The use of the described structure as an **independent** statistics assignment has proven successful in engaging students and addressing the NCTM goals.

An underlying principle to this approach described is clear communication, between the teacher, students and parents. The avoidance of misunderstanding is designed to promote success on the part of the student. Ames (1993) has confirmed that school-to-home communications positively influences parent perceptions about school. Any opportunity to promote home support should be welcomed.

Figures 1 and 2 not only describe the requirements of the assignment for the student but require a parent signature. The first page, Figure 1, attempts to address concerns which students typically have in beginning an assignment. Issues addressed in this **Information Sheet** include: the due dates, the nature of the data to be collected, evaluation procedures, and the teacher's willingness to help.

The **Grade Sheet** (Figure 2) states the weighting of each requirement of the assignment. The goal is to promote an openness regarding the evaluation process. By requiring that it be submitted as the last sheet of the assignment, the teacher's final evaluation sheet will already be attached as part of each assignment. The weight of each part is flexible. Individual teachers may decide to alter the value associated with any aspect of this assignment. Similarly, the bonus marks for an early submission and the cumulative frequency curve could be eliminated. The cumulative frequency is not included in the text at this grade level. The student is being challenged and rewarded for the additional work involved.

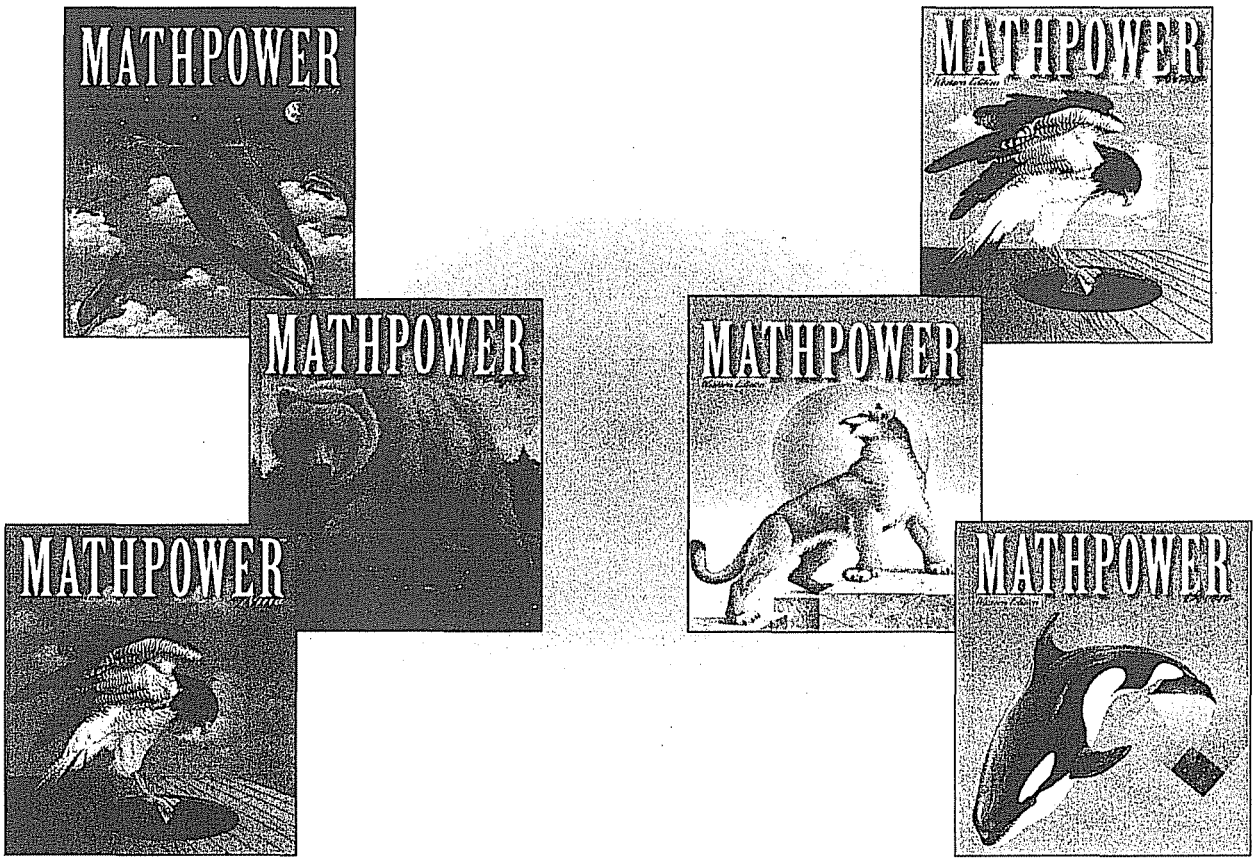
Figure 3, the **Sources of Assistance Sheet,** provides references in the school mathematics text or other designated books where assistance may be obtained. The objective of this sheet is to promote as much student independence from the teacher as possible, while minimizing the stress level of the student. The intent of Figure 3 is to provide an example. **Applied Mathematics** 10 is the text cited, however, minor alterations would be easily made if a different text is used.

The **Phase I Proposal Sheet** (Figure 4) encourages the student to plan ahead and allows the teacher an opportunity to screen each student's work before the student has proceeded too far into the assignment. By anticipating potential problems which might be encountered, chances for success are maximized and frustration minimized. Examples of the types of data which have been used are: height or age of students, average number of cigarettes smoked per day, length (in minutes) of songs, age at death (taken from tomb stones), number of children per family, number of pairs of shoes or jeans owned, and number of CD's owned. This

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Statistics Assignment * Information Sheet

Due Dates: * September 25, 1994 (This sheet to be signed and dated by parent/guardian.)

* October 3, 1994 (Phase I)

* October 24, 1994 (Complete Assignment)

This assignment will be graded out of 100 and will replace the "normal" unit evaluation, a test. Each student is to complete this independent study unit alone. No two students are to collect or use the same data. Prior to beginning the collection of data each student **must** submit to the teacher the Phase I form completed no later than October 3, 1994.

General Guidelines

1. The data collected should be numerical. That is, "yes-no" data is unacceptable. Other data such as colours, and multiple choice options which are not numerical in description are also not acceptable.

   Numerical data allows you to calculate a mean (i.e. the mean of 12 and 20 is 16). It would be difficult to determine the average colour of three shirts which are blue, brown and red.

2. Each student should collect 50 pieces of data (numerical values).
3. The final product (for this assignment) should contain all relevant work, particularly the Phase I, II, and III sheets and an appropriate cover sheet.
4. Each mark (out of 100) will be based on:

   i) Neatness

   ii) Presentation of Data including:

   - random procedures in collection of data (avoiding biases)
   - validity of data
   - accuracy of calculations
   - ease of interpretation of assignment
   - quality of interpretation of results
   - completeness of assignment (Be sure to include all information indicated on the next page, the **Grade Sheet**, including this sheet with the signature of your parent or guardian. The **Grade Sheet** must be included as the last page of your completed assignment.)

   iii) Submission of Phases I, II, and III on or before deadlines.

5. Help is available from the teacher at mutually agreeable times. The "sources of assistance" sheet should assist you in calculating and presenting your data.
6. A penalty of 1 point per day will be assessed for each day that this sheet is not returned with a signature of either a parent or guardian.
7. A penalty of 1 point per day will be assessed for each day that the Phase I sheet is late.
8. A penalty of 10% will be subtracted for each day a student fails to meet final due date of October 24.
9. Any complete assignment submitted prior to October 17, 1994 will receive a 5-point bonus.

Parent(s)/Guardian(s):

Please sign below to indicate that you are aware of this assignment (as described by this page and the next page, the Grade Sheet) for your son/daughter and the three due dates of September 25, October 3, and October 24, with the Bonus Date of October 17.

_____ _____

date Signature of Parent/Guardian

Fig. 1 The Information Sheet

phase could be expanded to incorporate more aspects of problem solving, another important area of mathematics education (NCTM, 1989). Shaughnessy (1992) encourages teachers to include both problem solving and statistics in the curriculum that they teach.

The questions in Phase III, the **Analysis of Results** (Figure 5), are designed to encourage students to interpret the results and reflect on the process. Other questions could be added to supplement or replace those used in this phase.

A reason for the signature of the parent/guardian and the three due dates (see Figure 1) is to minimize the typical night-before rush, and the potential stress that students and their families experience. Other intermediate due dates could be added. For example, students might be required to show the teacher the raw data between the Phase I and the complete assignment. For senior students, parental signatures and intermediate due dates may not be required.

The content of the assignment can vary depending on the level of the students. Additional requirements might be the calculations of quartiles, percentiles, deciles, interquartile range, mean for grouped data, and standard deviation.

Statistics Assignment
*** Grade Sheet**

Date Submitted: _____

Deadlines and Contents

Signature of Parent/Guardian (September 25)	/5 pts
Phase I (by October 3)	/5 pts
Title Page	/5 pts
Phase II (by October 24)	
Raw (original unaltered) data	/5 pts
Frequency Distribution Table	/8 pts
Bar Graph	/8 pts
Broken Line Graph	/8 pts
Circle Graph	/8 pts
Stem-and-Leaf Plot	/8 pts
Box-and-Whisker Plot	/8 pts
Mean (including definition & organized calculations)	/4 pts
Median (including definition)	/4 pts
Mode (including definition)	/4 pts
Phase III	/10 pts
Neatness	/10 pts
Bonus: Cumulative Frequency Curve	/5 pts
Bonus: October 17, 1994 Deadline	/5 pts
Penalty Points (for any lateness)	

Final Grade _____

SUBMIT THIS SHEET AS THE FINAL PAGE OF YOUR ASSIGNMENT.

Fig. 2 The Grade Sheet

BIBLIOGRAPHY

Ames, C. "How School-to-Home Communications Influence Parent Beliefs and Perceptions." *Equity & Choice*, 9(3) (1993): 44-49.

Dottori, D., Knill, G., McLean, R., Seymour, J., & McPhail, D. (1990). *Applied Mathematics 10.* (3rd ed.). Toronto, ON: McGraw-Hill Ryerson.

National Council of Teachers of Mathematics. *Curriculum and evaluation standards for school mathematics.* Reston, Virginia: NCTM, 1989.

Shaughnessy, J. M. "Research in probability and statistic: Reflections and directions". In *Handbook of Research on Mathematics Teaching and Learning,* edited by Douglas A. Grouws, 465-494. New York: Macmillan, 1992.

Statistics Assignment *
Sources of Assistance

The following information/examples may be found in your mathematics textbook, Applied Mathematics 10, written by Dottori, Knill, McLean, Seymour and McPhail (1990).

1. A frequency distribution table (page 170).
2. A bar graph (page 172).
3. A broken line graph (page 174).
4. A circle graph (pages 174-175).
5. A stem-and-leaf plot (page 180).
6. A box-and-whisker plot (page 180).
7. Mean, median, and mode (page 176).

Fig. 3 Sources of Assistance Sheet

Statistics Assignment * Phase I * Proposal Sheet

This Phase is to be completed and submitted to the teacher before proceeded any further. Specifically, the student should not move into Phase II (see Information Sheet) until the teacher has approved the experiment.

Respond to each of the following.

1. Describe the numerical data you propose to collect.
2. Describe how you intend to collect the data.
3. Give an example of the data you expect to collect.
4. What steps are being taken to ensure a degree of randomness and a lack of bias in your sample?

Approval granted for further work.

Yes _____ No _____

If "no", please submit another proposal, after a discussion with the teacher.

Fig. 4 The Proposal Sheet

Statistics Assignment Phase III * Analysis of Results

Respond to the following questions.

1. How do you think your collection of data (quality of questions, randomness, bias, etc.) influenced your results?
2. How could this experiment have been conducted to obtain a more representative set of data?
3. If you had to make an important decision based on these results, would you feel confident or would you recommend more study? Explain.
4. How might an unscrupulous person have biased the results at any stage in this experiment?
5. State any knowledge you may have gained from this experiment?

*Fig. 5 Phase III * Analysis of Results*

▲ PROBABILITIES ON THE TANGRAM: AN EXAMPLE OF LINKING MATHEMATICAL IDEAS

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



David Duncan and Bonnie Litwiller teach a variety of mathematics courses at the University of Northern Iowa. Much of Duncan's teaching involves content courses for non-mathematics majors; much of Litwiller's teaching involves methods courses for several grade levels of prospective mathematics teachers.
In their writing they attempt to motivate, interpret and exemplify mathematics ideas for teachers at many grade levels.

Teachers are always seeking situations in which mathematical ideas can be connected. We shall discuss ways in which the tangram can be used to connect geometry and probability. These activities assume a background in algebra and geometry, and a familiarity with the basic language of probability. These activities can be done by the whole class or in group settings, at the discretion of the teacher.

Tangrams are puzzles which may be arranged to form a square. One familiar 7-piece tangram which is often used in school mathematics is shown in Figure I, with the defining distance equalities as shown.

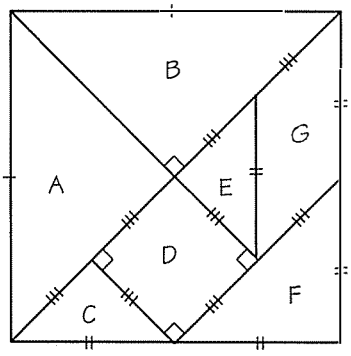


FIGURE I

Properties of geometric figures can be used to find the lengths of the line segments of this tangram. Assume that this tangram is a 2 unit square. Have your students verify the distances of Figure II, using the Pythagorean Theorem and properties of parallelograms.

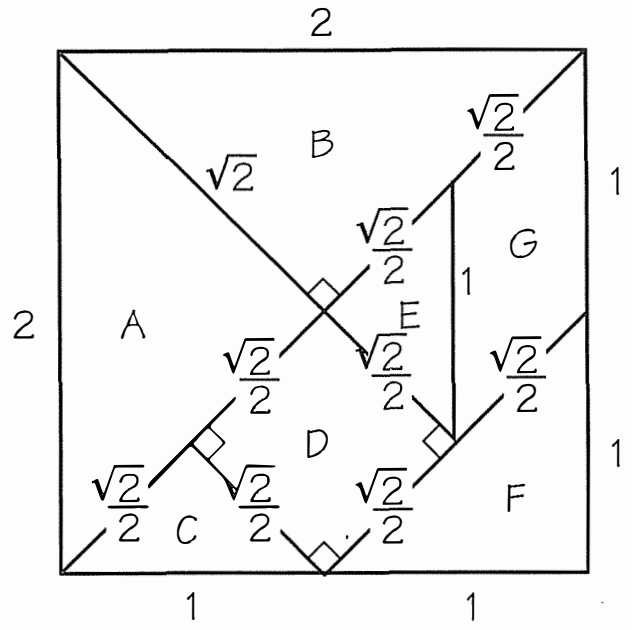


FIGURE II

Now find the areas of all the pieces.

$$\text{Area of A} = \frac{1}{2}(\sqrt{2})\left(\frac{\sqrt{2}}{2}+\frac{\sqrt{2}}{2}\right)$$
$$= \frac{\sqrt{2}}{2}(\sqrt{2})$$
$$= 1$$

Area of B = 1 since A ≅ B

$$\text{Area of C} = \frac{1}{2}\left(\frac{\sqrt{2}}{2}\right)\left(\frac{\sqrt{2}}{2}\right)$$
$$= \frac{1}{4}$$

$$\text{Area of D} = \left(\frac{\sqrt{2}}{2}\right)^2$$
$$= \frac{1}{2}$$

Area of E = $\frac{1}{4}$ since C ≅ E

$$\text{Area of F} = \frac{1}{2}(1)(1)$$
$$= \frac{1}{2}$$

To find the area of G, note that C, D, E, F, and G have a total area of 2, that is, half the area of the 2-unit square. Thus the area of

$$G = 2-\left(\frac{1}{4}+\frac{1}{2}+\frac{1}{4}+\frac{1}{2}\right)$$
$$= 2-\frac{3}{2}$$
$$= \frac{1}{2}$$

The perimeters of the seven pieces can be found by summing the indicated lengths on Figure II. Table I shows the results of all computations.

FIGURE	AREA (in square units)	PERIMETER (in units)
A	1	$2+2\sqrt{2}$
B	1	$2+2\sqrt{2}$
C	$\frac{1}{4}$	$1+\sqrt{2}$
D	$\frac{1}{2}$	$2\sqrt{2}$
E	$\frac{1}{4}$	$1+\sqrt{2}$
F	$\frac{1}{2}$	$2+\sqrt{2}$
G	$\frac{1}{2}$	$2+\sqrt{2}$

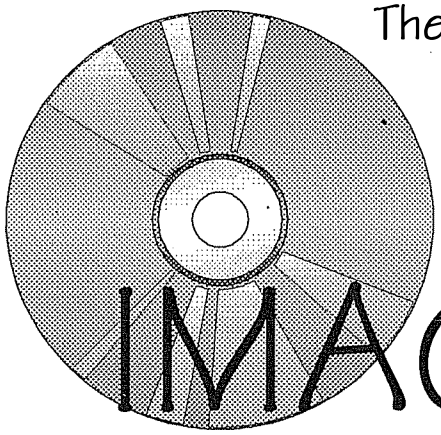
TABLE I

Links to probability can now be discussed. Suppose that the tangram is cut into its seven pieces.

1. If two pieces are selected at random, with replacement (the first piece is returned before the second piece is selected), what is the probability that their areas are equal. What is the probability that their perimeters are equal?

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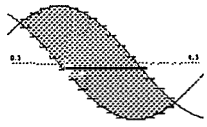


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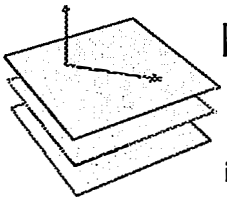


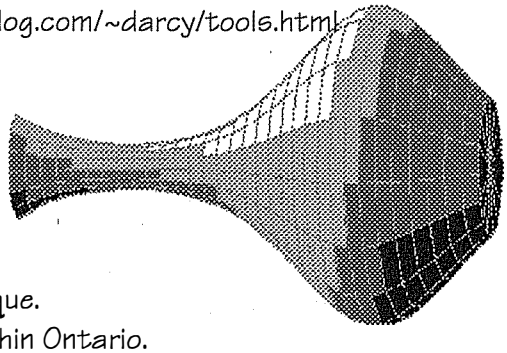
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There are 49 possible pairings. These are listed in Table II.

AA	AB	AC	AD	AE	AF	AG
BA	BB	BC	BD	BE	BF	BG
CA	CB	CC	CD	CE	CF	CG
DA	DB	DC	DD	DE	DF	DG
EA	EB	EC	ED	EE	EF	EG
FA	FB	FC	FD	FE	FF	FG
GA	GB	GC	GD	GE	GF	GG

TABLE II

AREAS

Of the 49 equally likely pairs of Table II, the following contain figures of equal areas:

AA AB BA BB (areas = 1, 4 pairs)

CC CE EC EE (areas = $\frac{1}{4}$, 4 pairs)

DD DF DG FD FF FG GD GF GG

(areas = $\frac{1}{2}$, 9 pairs)

Thus, the probability of drawing two pieces of the same area is

$$\frac{4+4+9}{49} = \frac{17}{49}.$$

This is slightly larger than $\frac{1}{3}$.

PERIMETERS

Of the 49 equally likely pairs of Table II, the following contain figures of equal perimeter.

AA AB BA BB (perimeters = $2+2\sqrt{2}$, 4 pairs)

CC CE EC EE (perimeters = $1+\sqrt{2}$, 4 pairs)

DD (perimeters = $2\sqrt{2}$, 1 pair)

FF FG GF GG (perimeters = $2+\sqrt{2}$, 4 pairs)

Thus the probability of drawing two pieces of the same perimeter is

$$\frac{4+4+1+4}{49} = \frac{13}{49}.$$

This is slightly larger than $\frac{1}{4}$.

The chances of drawing two figures with the same area are greater than that of drawing two pieces with the same perimeter.

2. Let us redo problem 1, this time without replacement (the first piece is not replaced before the second is drawn). Table II must be adjusted to eliminate all pairs in which the same piece is selected twice.

	AB	AC	AD	AE	AF	AG
BA		BC	BD	BE	BF	BG
CA	CB		CD	CE	CF	CG
DA	DB	DC		DE	DF	DG
EA	EB	EC	ED		EF	EG
FA	FB	FC	FD	FE		FG
GA	GB	GC	GD	GE	GF	

There are 42 pairs which remain.

AREAS

The 17 pairs used in problem 1 must now be reduced by eliminating all seven pairs in which a letter is repeated; 10 pairs then remain. The probability of drawing two pieces with the same area is $\frac{10}{42}$. This is considerably less than the probability with replacement.

PERIMETERS

By the same reasoning as for area, seven pairs are eliminated from both the numerator and denominator of the perimeter problem of problem 1. This reduces the probability from $\frac{13}{49}$ to $\frac{6}{42}$.

Again the probability of matching areas is greater than that of matching perimeters.

Interesting exercises for the reader and his/her students.

1. If you threw a dart at a tangram board, what is the probability of hitting any one of the seven pieces?

$$\text{For example, P(square)} = \frac{\frac{1}{2}}{4} = \frac{1}{8}.$$

2. If two pieces were selected at random, what is the probability that they will have at least one pair of sides which are the same length?
3. Use the Fundamental Principle of Counting from probability to determine the numbers of figure pairs with the same area or the same perimeter.
4. Find and investigate other situations in which geometry and probability can be linked.

▲ All Girls' Math Classes at Unionville High School

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The issue of girls and mathematics is important for all teachers. At the elementary level, girls often enjoy mathematics and attain achievement levels equal to or higher than those of boys. By the time they reach high school, many bright girls become disinterested in mathematics, enroll in fewer advanced mathematics classes, and are less likely to choose careers that are highly math-related (Sadker and Sadker 1994). Mathematics is an important foundation for many rewarding occupations. In neglecting to develop their math skills, many girls are excluding themselves from a large number of potentially satisfying careers.

The American Association of University Women's landmark report, "How Schools Shortchange Girls," synthesizes hundreds of research studies and articles on gender equity in education. The 1992 report finds that girls receive less attention from teachers than boys. Girls who do well in math and science are much less likely than boys to pursue scientific or technological careers. Boys often blame their academic failing on lack of effort, while girls tend to trace their failure to lack of ability. Equal proportions of boys and girls have learning disabilities, yet boys are twice as likely to be identified as needing special help. Books and curricula continue to offer stereotypical images of women and ignore female role models.

The reasons for high school girls' loss of interest and relatively lower achievement in math has been carefully studied by many researchers over the past ten years. No single cause has emerged. Instead, we find an interrelated set of attitudes, self-perceptions and feelings reinforced by society, parents, teachers, and peers that combine to produce strong barriers toward girls' excelling in mathematics. As in any other discipline, achievement in mathematics is directly related to confidence in one's ability in mathematics. At each grade level from six through eleven, boys are more confident than girls of their math abilities (Fennema and Sherman 1978). At all grade levels, girls are more likely to experience "math anxiety" - an extremely debilitating fear of mathematics (Boswell and Katz 1980). Bright female students are the most likely of any student groups to underestimate their chances of success in mathematics (Licht and Dweck 1983).

Two messages emerge repeatedly from the research on gender and schooling. First, what is good for males is not necessarily good for females. Second, if a choice must be made, the education establishment will base policy and instruction on that which is good for males. Although females mature earlier, are ready for verbal and math skills at a younger age, and have control of small-motor skills sooner than males, the curriculum has been constructed to mirror the development of males. The result is that girls are often ahead of the game in some areas and never in the game in others. Some grow bored, others give up, but most learn to hold back, be quiet, and smile (Shakeshaft, 1986).

An examination of the use of competition as a learning style provides an illustration of the ways in which male development guides instructional style. The "I win, you lose" philosophy is seldom questioned, and is constantly reinforced in classrooms and on playing fields, and, according to Carol Gilligan (1982), is not the best learning environment for girls. Gilligan found that boys gravitate towards competition while girls prefer connection. For girls, "I win, you lose" is a problematic stance, since it is potentially divisive and threatens connections between group members.

For girls, a single-sex environment provides more positive academic and growth experiences. In single-sex classes, girls exhibit higher self-esteem, more involvement with academic life, and increased participation in a range of social and leadership activities. Girls may be more willing to take intellectual

risks or explore feelings and concerns openly when there are no boys in the group (Fox 1981).

It was for all these above-mentioned reasons that two all girls' classes in grade ten and grade eleven mathematics were initiated in September 1993 at Unionville High School. One of these classes was a grade 10 enriched mathematics class. This particular class was chosen to be segregated because the grade eleven and grade twelve enriched classes in mathematics were extremely under-represented by female students. The grade twelve enriched class in the previous year had only one female student. This had occurred in spite of the fact that seven of the twelve math teachers were female and provided a positive role model for the female students. We hoped that we could better encourage girls to continue studying at the enriched level if we could employ some intervention strategies in an all-girls' grade ten enriched class.

The fifty students who chose to study grade ten mathematics at the enriched level were segregated into one all-boys' class and one all-girls' class. The students did not have the choice to be segregated or not, but found themselves in two sex-segregated classes on the first day of class. I had the opportunity to teach the all-girls' class and found the class to be very receptive to the idea of studying mathematics with no boys present in the classroom. They indicated in a study that they liked the quiet, comfortable atmosphere of a segregated class where, away from socially immature boys, they were able to get more work done. In the evaluation of this



phase of the project, it was found that choice is very important for the students. Not all students benefit from being in a segregated class; in fact some students objected to the idea. The boys were more negative than the girls concerning segregation. These particular girls were strong math students who would have continued their studies in mathematics in any type of class, but the fact that more of these girls chose to continue to study mathematics at the enriched level in grade eleven was apparent in the following year.

The other sex-segregated class was at the grade eleven advanced level in mathematics. The girls who participated in this class chose to do so in the spring of 1993. Since there were 60 more females than males enrolled in grade eleven at Unionville High School, we hoped that enough girls would choose to study mathematics in segregated classes so that we could form two classes. Thirty-two girls chose to take part in the pilot project.

The data collected in interviews with the girls in the segregated class show that females are more comfortable and less anxious in an all-girls class. As a result of their comfort level, girls ask more questions and learn more mathematics. They are more likely to continue studying mathematics in senior grades after positive experiences in grade eleven. The achievement and success in the all-girls' class was relatively high; in fact, they scored the highest average among the grade eleven classes in their final mathematics marks! This fact is particularly encouraging because all of our classes write common final exams.

Students in the all-girls' class preferred the co-operative learning approach. They liked helping each other to solve problems and did not see other students as a threat to themselves. They disliked the competitive learning environment in traditional mixed-gender classes where they had tended to withdraw from these activities in the past.

Some comments expressed by the students in the all-girls class were:

"We're more into helping each other than competing with one another. I mean, I don't feel intimidated. I mean, I don't feel that I have to do better than this person. I mean we're just doing our work."

"I'm a lot more happy about math. I like coming to class. I don't dread it. Like before I dreaded coming to math... I'm not afraid of the math. I'm thinking I'll just stick to doing the work."

"I thought it would be really fun. It would be very focused. Everyone would be really thinking of math and nothing else. Totally focused and really pleasant, no negative things anywhere. Really friendly too."

"I feel pretty comfortable ... I'm always willing to help people, like I like to offer my things no matter whatever it is."

"...not afraid to ask questions, not afraid because usually when there's males in the class, you're afraid of what they're going to think of you, like stupid teenager things.'

"I think I'll like it because I won't be scared to excel. Sometimes when guys are in the class, they're always the ones that are better and everything."

The findings in this study do support the hypothesis that girls benefit by participating in a sex-segregated mathematics class. Their attitudes are more positive towards learning mathematics in the absence of adolescent male students. The behaviour of some adolescent males inhibits girls from freely asking questions in the classroom. The learning preferences of many girls are more cooperative and less competitive. Girls need to be more engaged in classroom activities and see connections and relevance in what they are studying to the world around them.

The optional all-girls' class at the grades ten and eleven advanced level in mathematics continue to be offered at Unionville High School. The girls who select to study mathematics in a segregated class have the opportunity to work in an environment where they feel less inhibited to investigate and learn mathematics. The following questions still need to be researched. Did the girls in the grade eleven advanced all-girls class raise their marks in math? Did they perform better overall from grade ten to grade eleven than non-segregated girls? Will they continue to study mathematics at the OAC level more than other girls? In the mean time, building self-esteem and exploring non-traditional careers for women in mathematics will certainly have a positive effect in enhancing future opportunities for females in the rapidly changing world we face in the next century.

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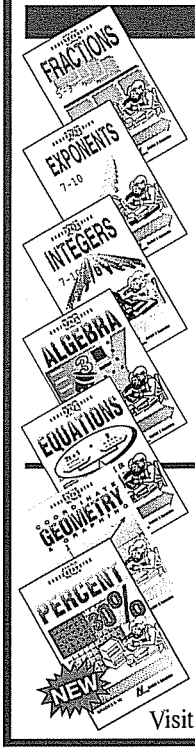
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▲ Examining Portfolio Assessment: What It Is and How It Measures Up

CHRISTINE SUURTAMM
LORNE PARK SECONDARY SCHOOL
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Christine is Mathematics Head at Lorne Park Secondary School with previous teaching experience at Meadowvale, Glenforest and Westview. She is also working on her doctorate at OISE/UT in Mathematics Curriculum, focusing on assessment in secondary school mathematics.

Assessment practices in mathematics are undergoing drastic changes. Mathematics teachers are being challenged to adopt a wider range of teaching strategies in their classrooms and as they change their instruction they are also examining the way that they are assessing mathematics learning. Where portfolios were once only found in art classes they are now making their way into mathematics classrooms. This article will discuss portfolio assessment as one of many assessment techniques that could be used in mathematics classes. It also will discuss the issue of choosing authentic assessment strategies that meet rigorous standards. These standards are clearly laid out in a recent document, the *NCTM Standards for Assessment* (1995), which defines six assessment standards which should be considered when deciding on assessment techniques. Portfolio assessment will be measured against these clearly defined standards to ascertain whether it meets these newly defined criteria.

Background of Changes to Assessment in Mathematics

The *NCTM Curriculum and Evaluation Standards for School Mathematics (*1989) as well as the *OAME Focus*

on Renewal (1993) call for a participatory, constructivist approach to mathematics education. This approach is intended to encourage students to develop their own meaning from mathematics, to build confidence in their ability to do mathematics, to make connections between mathematics and their world and to become true problem solvers. These documents have had a tremendous impact on mathematics educators at every level across Canada and the United States..

Assessment must match instruction and as curriculum and instructional practices in mathematics change then so must assessment practices. Paper and pencil tests do not address all of the learning outcomes that are included in mathematics education. A wide variety of assessment techniques are moving into the mathematics classroom. (Stenmark,1991) Journals, self-evaluation, peer evaluation, observational checklists, assessment rubrics and portfolios are just a few of the techniques that are appearing in mathematics classrooms in an attempt to capture a window into the process of mathematics learning. And it is a collection of assessment strategies rather than a specific strategy that is advocated to produce a total picture of students' learning. Portfolio assessment is one recent entry into the arena of mathematics assessment. The following is a brief description of what a portfolio is, why portfolios in math should be used and how they should be assessed.

Portfolio Assessment

Portfolios allow students to demonstrate mathematics learning and understanding beyond merely facts and knowledge. Portfolio assessment permits the demonstration of learning outcomes that are difficult to assess using traditional assessment techniques.

What Is A Portfolio?

A portfolio is a familiar concept in art and languages. It is a fairly new and unfamiliar idea to most mathematics teachers. A portfolio is more than just a folder of work for it holds evidence of an individual's skills, ideas, interests and accomplishments. (Hart, 1994) It is a systematic, organized collection of evidence used by the teacher and student to monitor the growth of the student's knowledge, skills, and attitudes.(Vavrus, 1990) It tells the story of the student's efforts, progress or achievement. An important component of a portfolio is the inclusion of self-reflection on the student's part. The student participates in the selection of portfolio content as well as in determining the criteria for selection and judging merit. (Arter and Paulson, 1991)

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What's Inside A Portfolio?

A portfolio can contain a wide variety of pieces of work. It is important that students know the purpose of the portfolio that they are creating as well as the criteria by which it will be judged. This knowledge will help the student determine what will be put into the portfolio. (Arter & Spandel, 1992) It should also be mentioned that some teachers use two portfolios for each student: a working portfolio containing much of the student's work as well as a show portfolio with particular works included that were chosen from the working portfolio.

Entries in a portfolio might include:

- Photos or sketches of models constructed by the student
- Notes from conferences with the teacher
- Samples of mathematics puzzles that were either solved and/or created by the student
- Mathematics journal writing samples
- Table of contents
- Evidence of readings about mathematics
- Solutions to problem-solving activities including all phases of the problem-solving process
- Videotapes of working with mathematics manipulatives or building models of multi-dimensional figures
- Copies of self, peer and teacher assessments
- Mathematical autobiography

As well, each entry should have a note written by the student to the reader explaining why that piece of work was chosen to go in the portfolio and detailing what that piece of work shows about the student's learning. (Hart, 1994, Farr, 1994, Vavrus, 1990) Entries are chosen to show a variety of things such as growth, connections, feelings, problem-solving ability, effort or a student's development of thinking skills. (Stenmark, 1991)

Why Use A Portfolio?

In general, a portfolio documents learning over time. This long term perspective emphasizes what students can do rather than what they cannot do. The assessment experience is affirming rather than demoralizing. (Hart,1994) On one level, portfolio assessment helps teachers and students assess a students' progress and on another level, portfolios assist teachers, parents, supervisor and other educators to assess and evaluate instructional programs. (Vermont, 1991)

Portfolios help to develop student growth by encouraging students to become partners with teachers in the assessment process. Through their decision making and reflection, students develop the ability to evaluate their own work and begin to take responsibility for their own learning. Portfolios encourage the multiple dimensions of learning and allow students the opportunity to express themselves in a variety of ways.

Portfolios are also an excellent starting point to establish sound communication among parent, teacher and student about a student's work. Some teachers use portfolio evenings to have students present their portfolios in groups to parents. Teachers encourage students to present their portfolio to their parents during a parent and teacher interview. (Farr, 1994) Portfolios allow students to take pride in their learning and that in turn encourages others to take pride in it as well.

Portfolios are used as a tool for the assessment of students but they also are a tool to examine instructional practices. (Zarinnia & Romberg, 1992) Portfolios provide teachers, administrators, parent groups and others with a window into the learning process in a classroom. They display the kinds of activities that are encouraged in the classroom and reveal whether instructional goals, objectives or outcomes are being met. The use of portfolio assessment encourages teachers to develop a broad range of instructional activities that integrate subject skills with thinking and self-reflective skills.

How Do We Assess A Portfolio?

Development of Assessment Criteria – It is important that teachers develop the criteria for the assessment of portfolios and that the areas of assessment be communicated to the students at the beginning of the portfolio process. ***The criteria should reflect the outcomes of the instructional program and should be referred to throughout the portfolio and conferencing processes.***

A rubric, checklist or rating scale could be developed to include specific outcomes related to categories such as organization, communication, problem-solving and self-evaluation skills. The teacher and others responsible for the instructional program, along with the students need to develop and clarify the learning outcomes and indicators in detail.

A large scale mathematics portfolio assessment project, used in the state of Vermont (1991) assessed portfolios based on problem solving skills and mathematical communication. The problem solving skills were assessed using the criteria of understanding the

task, selecting strategies, reflecting on and analyzing the problem as well as the use of generalizations to solve the problem. Mathematical communication was assessed using the criteria of use of the language of mathematics, use of mathematical representations and the clarity of presentation.

Self-Evaluation – Students develop the ability to reflect on their learning by making decisions about what should be placed in their portfolio, writing about why they have chosen the items to be placed in their portfolios and seeing their growth as they look through their portfolio. Self-evaluation is enhanced through conferencing with the teacher and others about their personal goals.

Conferencing – Conferencing between teacher and student is an integral part of the assessment process of portfolios. Teacher and student need to meet on a regular basis to confer about the student's portfolio. These conferences are multi-purpose. The dialogue should emphasize the process of the student's growth in mathematics learning. It should also strengthen individualized instruction, goals and priorities. As well, the student should be encouraged to set objectives for himself.(Farr, 1994) Students should be encouraged to dialogue with others about their portfolios. The more they discuss and share their portfolios, the greater their metacognitive skills will develop.

How Do Portfolios "Measure Up" as an Assessment Technique?

Rightly or wrongly, most teachers feel confident in the validity of paper and pencil tests. However, as many new non-traditional assessment techniques enter the mathematics classroom it is important to ascertain the purpose and validity of these new techniques. One recent publication , the *NCTM Assessment Standards for School Mathematics* (1995) attempts to come to grips with this dilemma. This document clearly describes six Standards for Assessment by which we can judge assessment strategies.

> *The Assessment Standards presented in this document reflect the values and goals associated with the type of assessment system that must be achieved if the reforms envisioned in the teaching and learning of mathematics are to become reality.(p.3)*

These Assessment Standards clearly define rigorous characteristics of quality assessment. The following gives an overview of the document, describes each of the six assessment standards and relates each standard to portfolio assessment.

Overview

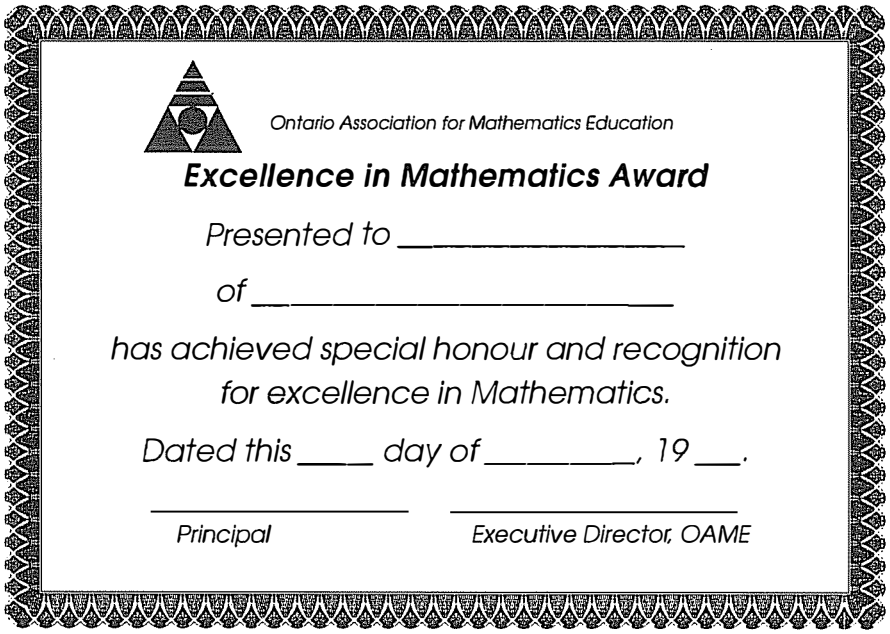
In general, The NCTM's recent publication *Assessment Standards for School Mathematics* (NCTM, 1995) encourages major shifts in assessment practice to match major shifts in instructional practice that were called for in *Curriculum and Evaluation Standards for School Mathematics* (1989). The *Assessment Standards* document suggests that assessment should be assessing students' full mathematical power and should be using established criteria to compare students' performance as well as supporting teachers' informed judgment. The assessment process should be a dynamic one that is participatory and accessible to the public, giving a shared vision of what and how to assess.

As well, assessment should give students many opportunities to display their full mathematical power by basing inferences on multiple sources of evidence and by aligning assessment with curriculum and instruction on a continual and recursive basis. The document further states that all concerned with mathematics learning should be accountable for assessment results and that those results should ensure that all students have the opportunity to achieve their potential. (NCTM, 1995, p. 83) Six Mathematics Assessment Standards are established. A description of each of these standards follows as well as an examination of how portfolio assessment measures against each standard as a viable assessment technique.

The Mathematics Standard

> ***Assessment should reflect the mathematics that all students need to know and be able to do.*** *(NCTM, 1995, p.11)*

This Standard asserts that teachers need to develop mathematics activities and assessment techniques that match the current thinking concerning mathematics education as characterized by the *NCTM Curriculum and Evaluation Standards* (1989). Activities should offer students opportunities to solve open-ended problems, reason mathematically, make connections between mathematics and the student's world, and communicate about mathematics. The assessment activities should encourage the empowerment of students as mathematicians. Mathematical skills and knowledge should be taught within the context of a problem solving mode that uses real world applications and technologies. A wide range of mathematics activities should form the



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framework for an assessment structure in the classroom.

Such a range of activities have been suggested as being included in a mathematics portfolio project. The nature of portfolio assessment suggests that teachers create authentic assessment activities that will engage students in meaningful work. (Hart, 1994) By including portfolio assessment as one assessment technique in a mathematics classroom a teacher will be impelled to develop a wide range of problem solving activities.

The Learning Standard

Assessment should enhance mathematics learning. *(NCTM, 1995,p.13)*

This second assessment standard clearly states that assessment should encourage students to become independent learners who are responsible for their own learning. It suggests that students should be active participants in the assessment process so that teachers can gain a better understanding of what the student can do and students can gain a better understanding of what the teacher or assessor values. Students should become participants in the creation of tasks, development of criteria and in the application of the criteria to their work and their peers. This shift to a more student-centred view of assessment is an attempt to encourage and develop self-reflection of and more responsibility for a student's own learning.

It should be clear to the reader that the self-reflection, conferencing and development of assessment criteria inherent in portfolio assessment would help the teacher meet the needs expressed in this *Learning Standard.* In working with portfolios, Frazier expressed:

> *The greatest asset of portfolios, I've found is in self-evaluation. Portfolio assessment offers students a way to take charge of their learning; it also encourages ownership, pride and high self-esteem.(p.64)*

Portfolio assessment encourages students to become partners with teachers in the assessment process.

The Equity Standard

Assessment should promote equity.
(NCTM,1995,p.15)

For assessment to be equitable, each student should have the chance to substantiate his or her mathematical capabilities. Assessment should allow for multiple approaches so that students have the opportunity to show their expertise and experiences. Assessment should acknowledge and celebrate differences. Students bring with them different backgrounds and experiences and these influence how students learn mathematics and how they respond in different situations including assessment situations. They need a forum to communicate what they have learned and that forum may be different for each child. Assessments have traditionally ignored differences and have expected students to be judged by how they all respond in the same situation. A variety of assessment techniques allows the student the opportunity to display their expertise in one or more of those settings.

Portfolios show what students can do rather than what they cannot do. (Hart, 1994) Portfolio assessment provides a forum to celebrate the differences among students. It allows students to bring forward their various backgrounds and experiences and to tell their own story. A student is assessed based on his or her own growth over time rather than simply against the benchmark of the other students in the class.

The Openness Standard

Assessment should be an open process.
(NCTM, 1995, p.17)

Openness in assessment includes informing students about what they need to know, how they will be assessed and how that assessment will be used. Openness also means that the public, that is, parents, administrators and the educational community at large is informed abut the process of assessment. Educators should work together to reach a consensus about suitable assessment activities, techniques, criteria, learning goals and reporting methods. Open assessment means that the responsibility for assessment is shared. This collaboration will ensure that high standards of performance are maintained and that a variety of valid assessment tools are used.

Portfolios by their very nature are open. Students are encouraged to share their portfolio with their teacher, their peers and their parents. The assessment criteria by which portfolios are judged are clearly set out at the beginning of the compilation of work for the portfolio. Students, parents and teachers are partners in the assessment process. (Valencia,1990) It is important, however, that teachers do not work in isolation on portfolio assessment. Collaboration is necessary so that individual teachers can share their assessment criteria with other educators so that discussion and possible consensus can be reached.

Openness is also created as portfolios provide administrators, parents and supervisors a window into the learning that is taking place in the mathematics classroom.

Each portfolio gives the viewer a glimpse into the types of activities that are provided to the student. The portfolio tells the viewer whether mathematical communication is encouraged, mathematical skills developed, and open-ended problems which encourage mathematical reasoning were presented. As well, the portfolio's teacher and student reflections apprise us of the kind of encouragement and support that the teacher is providing to the student.

The Inferences Standard

Assessment should promote valid inferences about mathematics learning. *(NCTM, 1995, p.15)*

Teachers make inferences about students' learning of mathematics based on evidence from assessment. This standard recommends that multiple sources of evidence be used to improve the validity of the inferences. Using a variety of sources allows the strength of one source to compensate for the weakness in another which promotes consistency.

The document cautions against potential bias in new forms of assessment such as portfolios. Students bring many previous experiences with them to the portfolio tasks and these experiences and resources differ greatly from one child to the next. Some experiences are richer than others. Assessment must be based on what has been done with the experiences and resources rather than comparing finished products. It is suggested that others be involved in the assessment of portfolios so that individual bias may be balanced by the assessment of others. As well, a clear effort needs to be made so that the assessor is sensitive to his/her own bias and uses portfolios as only one source of evidence.

The Coherence Standard

Assessment should be a coherent process.*(NCTM, 1995, p.21)*



To be a coherent process, assessment must be seen as a whole so that all phases in the assessment process relate to one another. Assessment must match the purpose for which it was intended and must be aligned with curriculum and instruction. Coherence helps students see that assessment is related to what they learn. A coherent system of assessment gives students, parents, teachers and administrators a clear and comprehensive picture of mathematics learning in a classroom.

Portfolio assessment is a practice that gathers a wide variety of instructional activities. The instructional activities along with the student's reflection become an integral part of the assessment plan and show a more total picture of what is happening in the classroom. Supervisors can see how comprehensive a program is offered to students. (Vermont, 1991)

Summary

Portfolio assessment is an assessment technique that is being used successfully in mathematics classrooms. It helps to form part of a comprehensive assessment program when used with other assessment strategies. Portfolio assessment is a viable assessment technique when measured against *NCTM's Standards of Assessment.* A coherent and open assessment structure is supported by portfolio assessment. This type of assessment has the potential to create equity in assessment providing inferences made in using portfolios are free of bias. The self-reflective framework of portfolios encourage an instructional and assessment model which is student-centred. Portfolios also encourage teachers to develop activities which facilitate development of problem solving and communication in mathematics. A collaborative effort by mathematics

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educators to develop and share meaningful tasks, criteria and standards for portfolio assessment will continue to establish portfolio assessment as one of many authentic assessment techniques in mathematics education.

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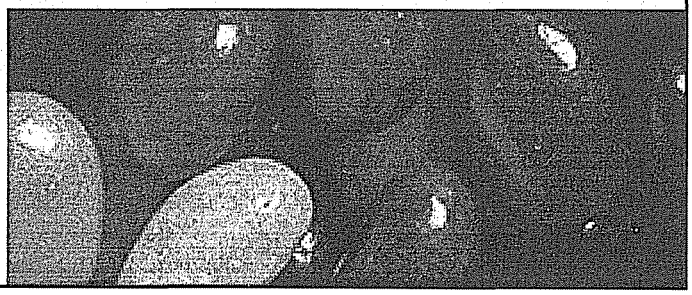
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▲ Teaching Ideas from the Editor

A Grade 9 Introduction to Probability

Bring to class a container with a sufficient number of coloured jelly beans so that each student can be given at least 10. Have about the same number extra jelly beans in the container. Mix the jelly beans and randomly distribute the jelly beans to the class warning them not to eat the jelly beans until they are told to do so. If you ordinarily do not allow students to eat in class the fact that you will permit them to do so shortly adds excitement. Have the students count the number of jelly beans of each colour they have been given. While they are doing this you should draw a chart on the blackboard. The students then put their numbers in the chart. I allow the students to eat the jelly beans at this point. Have each student total the number of each colour in the chart. Lead the students through the construction of a histogram using "colour of jelly beans" along the "x-axis" and "number of jelly beans" along the "y-axis".

Have a student count the number of jelly beans remaining in the original container. Then ask the students how they can use the numbers from the histogram to predict the number of each colour remaining in the container. If no one can answer this question help them to do so by working out the percentages of each colour in the sample on the blackboard. If this does not give someone a hint then you will have to decide whether to show how it is done or leave this as a challenge for homework. I prefer to explain the method, calculate the expectation, and then compare this with the number of each colour in the container. I am not above "cooking" the result by a careful selection of the jelly beans to be distributed and the ones left in the container.



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- 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.

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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 was 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 (Copy this form and attach it to the nomination letter)

Intended Award (please check one)

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

Nominator Information:

_____

Name of Nominee (Principale 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 ( ) _____

▲ Directors' Dialogue



PETER SAARIMAKI
COORDINATOR OF MATHEMATICS
TORONTO BOARD OF EDUCATION

Introduction

These notes were written prior to the OAME Board of Directors meeting which was to be held Saturday, February 8, 1997 and so those comments will be found in the next Gazette. These comments are the result of my role as OAME rep to the OTF Curriculum Forum.

OTF Curriculum Forum

The OTF Curriculum Forum has been dormant for the past two years as the OTF executive committee did not provide funding for it in their budget. Last fall, Pierre Lalonde, Executive Assistant at OTF, was able to revive funding for at least one meeting this school year.

The Curriculum Forum is composed of subject associations (OAME and OMCA are the only math ones currently recognized). The people attending are there as representatives of their associations and cannot make decisions without consulting with their executives.

At the meeting Saturday November 16, 1996, members overwhelmingly endorsed suggestions that each subject organization make connections to the Ministry personnel in charge of Secondary Reform. For the OAME, this is nothing new (see below). The OAME responses to the Secondary Reform Initiative, from the Transition Years and Specialization Years committees, supported other subject and federation responses.

Ministry of Education and Training Activities

In preparation for the curriculum work to be undertaken in support of secondary reform, the MET anticipated that people will require some accessible documents to help initiate discussion on subject related issues. MET decided in December, therefore, to have background papers developed before it begins widespread dialogue. The papers are not intended to govern the curriculum development process, but rather to be an initial stimulus for dialogue and discussion.

Sylvia Solomon, from the MET, has been very helpful to the process by sharing information and answering questions in an open Electronic Network conference. She explained that the Faculties of Education were invited to participate in the writing of these papers for the major subject areas.

Mathematics is one of twelve such areas.

The papers are a review of the literature relevant to the subject, indicating the key issues, the range of current opinion on the subject, and best practices in Ontario and other jurisdictions. They are written by subject experts with prior knowledge of current professional writing, research and instruction in their field and will be relatively brief (10 - 15 pages). While it is expected that key issues in the subject areas will be identified, writers were asked to avoid taking a stand in individual issues.

Geoff Roulet was awarded the contract for the mathematics paper. Geoff is an OAME director, providing OAME with a unique involvement in this process. OTF and MET agreed that, as part of the process, Geoff, as the selected writer from the Faculties, would seek input from OAME through yours truly as our OTF rep.

As was discussed on the Electronic Network, even though there has been some terrific curriculum written in the past few years, there is still a need for curriculum renewal. There is also a need to develop curriculum in a way that is constantly renewing so that we do not need major overhauls every ten years but rather are in a constant growth and change pattern. How else can we possibly stay current?

Curriculum Reform and the Expert Panels

Geoff's research paper will help move the necessary discussions forward through new Ministry Expert Panels. These groups of about 5 people will use the background papers to make recommendations regarding the renewal of secondary curriculum. There will be two OTF reps on each subject Panel, including at least one recommended by OAME, along with reps from the University and Community College level, and the community.

For up-to-date information, stay in contact with directors on the OAME executive, members of the Specialization Years committee, your local chapter or through the Internet.



Book Review

by Peter Saarimaki

Coodinator of Mathematics Toronto Board of Education

Mathematics Textbooks: A Comparative Study of Grade 8 Texts - TIMSS Monograph No. 3

by Geoffrey Howson

Pacific Educational Press, 1995.

96 pages @ $16.95

The Third International Mathematics and Science Study (TIMSS) has been administered and the results are eagerly awaited. In the meantime, we can refer to the third book in a series (the Curriculum Frameworks was reviewed in the Dec., 1994 Gazette. Another booklet on Research Questions and Study Design is also available).

The conceptual framework for TIMSS involves studying three curricula:

- the intended (system) - the society at large
- the implemented (classroom) - local community
- the attained (student) - personal background

and textbooks are considered as a subset of the intended curriculum.

Geoffrey Howson has reviewed several mathematics texts as representatives of the work expected at about grade 8, from England, France, Japan, the Netherlands, Norway, Spain, Switzerland and the USA. (Reading the descriptions of the American texts raises the question of how alike Canadian texts are to the American example). Geoffrey has been closely involved in curriculum development, has published extensively in the fields of mathematics and education for decades, and has investigated and compared national curricula for many years.

Each textbook was analyzed according to certain characteristics, including topics covered, student expectations, instructional features and perspectives.

The first item of business was to discuss the history and role of textbooks, noting

> *the average text was likely to present mathematics in a monolithic way: "this is how it is done , now go and do it for yourself".*

Might this be the place to comment, "the more things change, the more they stay the same"?

The differences noted between these texts and those of thirty years ago include an increased emphasis on contextualizing examples and exercises, the use of new technological tools, and the greater weight placed on statistics and probability. These differences have good and bad implications. For example,

> *so little use is made in these texts of the microcomputer that it is almost premature to comment.*

The pedagogy and philosophy of mathematics is examined next, looking at the standard framework for textbooks around he world, as well as the differences. Even such a comparison as the number of chapters reveals a lot (from 8 to 29). Several topics are studied to provide insights, including the percentage of chapters devoted to algebra (from as little as 11% to as much as 100%).

The third and final major chapter takes a close-up look at some of the contents and aims. When the topics within Probability and Statistics are compared (13 in this list), the U.S. text covers them all, while at the other extreme, Englands representative deals with only two and Spain and the Netherlands ignore them altogether.

> *The fundamental difference between school geometry and university geometry is that the former is a branch of physics and the latter a branch of mathematics.*

There are many other interesting comments on arithmetic, algebra, geometry, integration with other disciplines, and mathematics in society. The differing target populations are discussed, along with their homogeneity or lack thereof. We are continually reminded that what is in a textbook is not necessarily the mathematics program.

This is a highly recommended little book, providing as it does an outsiders view of North American texts in a global context. Questions are answered and questions still abound, but they will be much more focussed after this monograph.

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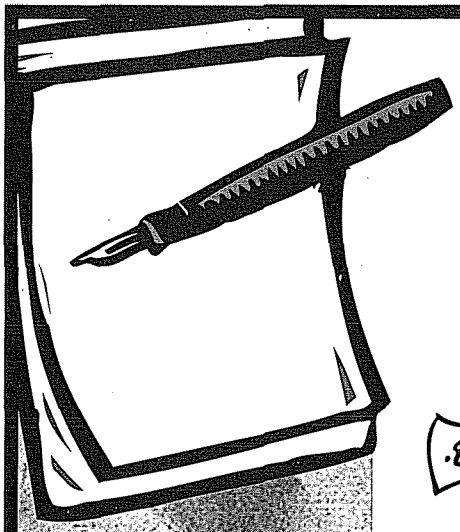
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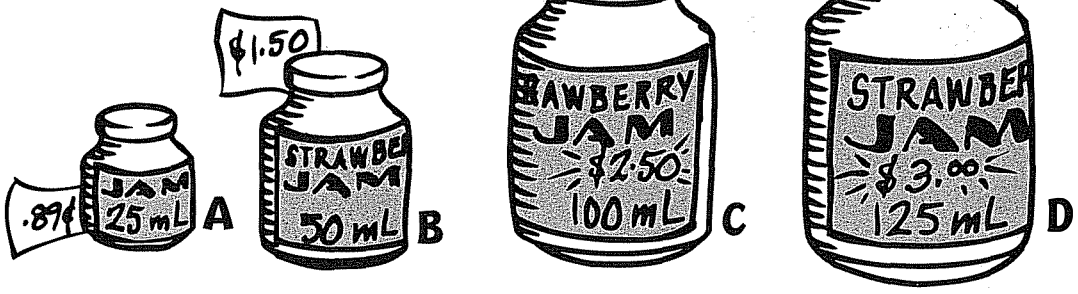
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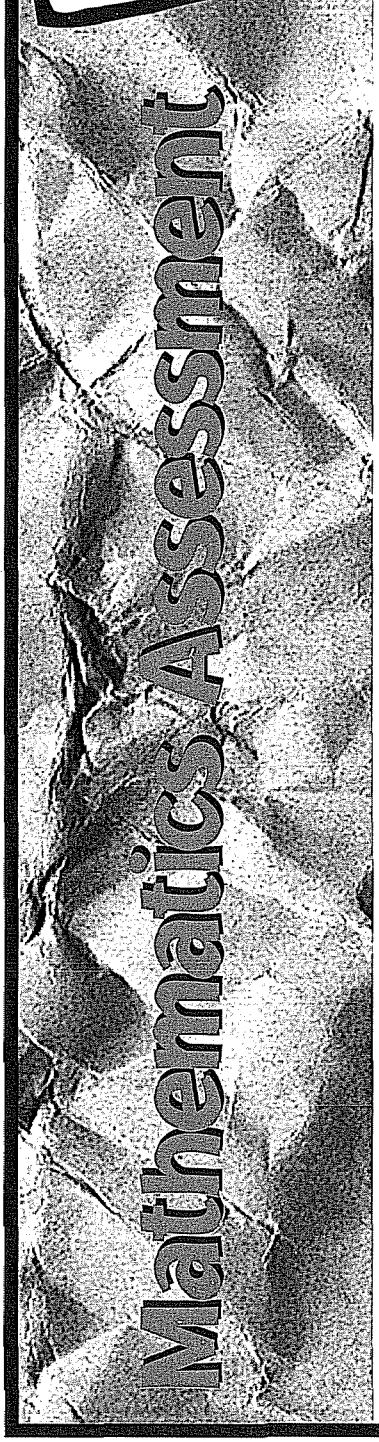
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