Vol. 36 #4, June 1998

Ontario Mathematics Gazette

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Why We Should Reduce Skills Teaching in the Math Class

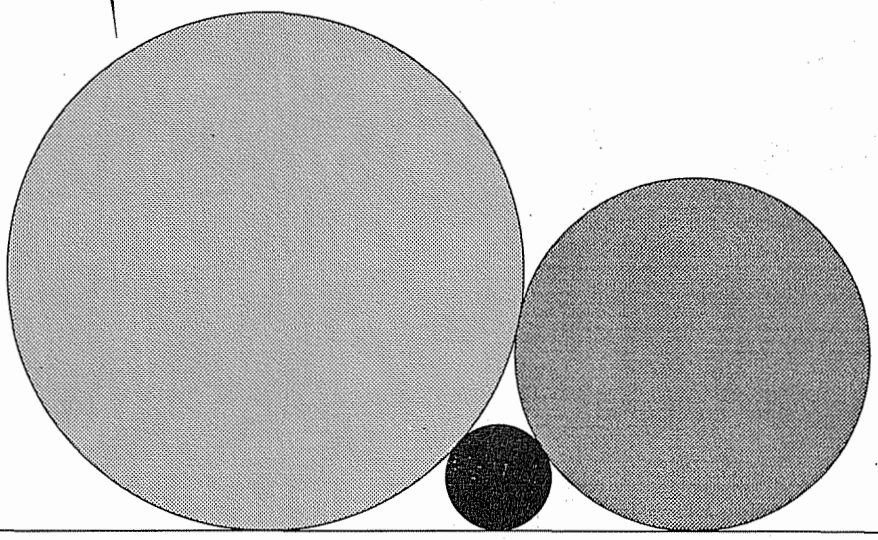
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What is the relationship among the radii of the three circles?

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

"by hand?"
(The old 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

3. Use a half-angle identity to find the exa

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

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

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

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

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

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

a) $\frac{4x^2-2x}{x+3}$ b) $\frac{4x^2+7x-6}{x+3}$ c)

"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 identity to find the exact value of cos 67.5°:

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

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 θ=-1/2 and θ is in qua

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

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

a) $\frac{4x^2-2x}{x+3}$ b) $\frac{4x^2+7x-6}{x+3}$

7. a) If $\sin\alpha=1/3$; $\cos\beta=3/4$; quadrant IV, find $\cos(\alpha-\beta)$

b) Evaluate: tan(arcsin$\frac{1}{3}$ + a quadrant angles.

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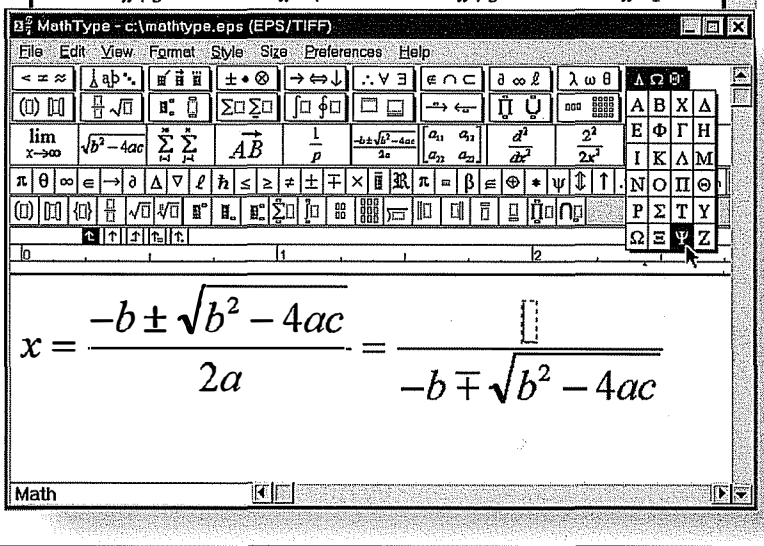
a) $y=\sqrt[3]{x-2}$ b) $y=\sqrt[3]{x}-2$ c) $y=\sqrt[3]{x+2}$ d) $\sqrt[3]{x}+2$

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 $g(x)=\frac{2}{x+3}$, find $[g\circ f](x)$:

a) $\frac{-(5x+11)}{x+3}$ b) $\frac{1}{x-4}$ c) $\frac{5x+13}{x+3}$ d) $\frac{1}{x-1}$



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Deadlines for information to be included in the Gazette or the Abacus are: June 15 for the September issue, October 15 for the December issue, January 15 for the March issue, and April 15 for the June issue.

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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

Many North Americans are disturbed by the poor results of their students on TIMMS, the Third International Mathematics and Science Study. Ontario hopes to improve its students' learning of mathematics by rewriting the mathematics curriculum. The article by Keith Devlin, *Why We Should Reduce Teaching Skills in the Math Class* indicates what one influential mathematician believes may help to solve the problem. In *Repairing School Mathematics in the US*, Frank Allen explains why many educators in the United States believe that the NCTM Standards are part of the problem rather than the solution. I hope the writers of the Ontario mathematics curriculum will study these article carefully. In *Oh Rats!*, Gary Flewelling indicates some things that can be done to help students learn mathematics better.

John Grant McLaughlin is back with an interesting problem solving article *Ideas from the Funfair* while the Devil's Advocate writes about *The Carrot*.

With the end of the school year approaching I wish everyone a relaxing and happy summer.



▲ Letter to the Editor

Dear Editor,

The article, *Using The Equation Editor With WordPerfect For Windows* in the March 1998 edition encourages math teachers to use obsolete technology and will likely confuse many *WordPerfect* users.

The *WordPerfect* 5.2 and 6.0 'equation editor' described in the article utilizes 1970's command-line technology and was subsequently replaced with a state-of-the-art *Equation Editor* with the release of *Corel WordPerfect 8*.

This is a *Windows95* world wherein math teachers need encouragement to increase productivity — not waste time learning old stuff. Modern math teachers can now type expressions in tests and assignments with the click of a button with *WordPerfect*'s new WYSIWYG

Equation Editor. Die hard Windows 3.1 users can click a button to use *MathType* to write expressions. *Equation Editor* and *MathType* are far more productive (faster and easier) and produce textbook-quality results. In fact, most textbook publishers use the same *Equation Editor* (or the full-featured *MathType*) to typeset math and science textbooks.

Respectfully, Bruce A. Virga
Vice President, Sales & Marketing, *Design Science, Inc.*

REPLY: by Greg Clarke

The reason that the *Equation Editor for Wordperfect*, versions 5.2 and 6.0, was detailed was for the sake of consistency across the province.

Currently, the *Ministry of Education and Training* for the Province of Ontario has only licensed those older versions of *Wordperfect* for the use in Ontario classrooms. Thus all schools have access to this software.

Unfortunately, many Ontario schools do NOT yet have access to *Windows95* machines, or the most recent suite of software applications, such as *Corel Wordperfect* version 8.0.

The purpose of my article was to assist teachers who were using provincially-licensed software to carry out certain tasks, and produce more professional-looking printouts. I assume that teachers who DO have access to newer machines and newer software with built-in WYSIWYG equation editors would make use of these newer tools.

Editorial comment

Since Greg Clarke's reply, the Ontario Ministry of Education and Training has announced that the most recent versions of Corel *WordPerfect,* versions 7 for Windows 3.1 and version 8 for *Windows95*, have been purchased for use in all publicly-funded schools in the province. These most current versions of the *WordPerfect* program do include graphical equation editors, which will no longer require the use of command syntaxes such as described in last issue's article.

However, it should be noted that there are still a large number of computers in Ontario schools that do not have the required memory and hard drive requirements, or processor speeds to take advantage of these newer programs, and thus, for some teachers in some schools, the command-based *Equation Editor* may still be the only viable method for including complex equations in a mathematics document.

▲ PRESIDENTS MESSAGE

RALPH CONNELLY

Well, preparing my first *President's Message* provides me with a good example of what life is like in a "time-warp." I'm writing it in April (so I'm not really President yet!), pretending that it's after the North Bay Conference, and you'll be reading it in June, so you won't have to pretend!

As my first "official" contact with the membership, I guess this can be regarded as kind of a "throne speech", but given the trouble generated by good old "whats-his-name's" throne speech [notice how I carefully avoided naming ANYBODY!] I don't really like that analogy. Of course, since you're reading this in June, the whole thing will probably have blown over, and you won't have any idea what I'm talking about—see what I mean about this "time-warp" thing?

Anyhow, let's get down to some OAME business. I anticipate that my year as President will be an exceptionally busy, but very exciting one. The excitement will start this summer. OAME is pleased to be involved in a new experiment in delivering mathematics leadership at the elementary level, a Summer Institute. Plans are to have two Institutes focusing on **Implementing the Mathematics 1-8 Curriculum**, one in Sudbury and one in Richmond Hill. There will likely be notices of those Institutes in or accompanying this issue of the *Gazette* (but of course I'm guessing at that, because remember its April!) At the secondary level, of course all the talk is about the RFP and the writing of the new curriculum. A team with much representation from OAME, including Past-President Judy Crompton, has progressed through most of the hurdles of the qualification process, and we are very hopeful that by the time you read this, that team will be the one involved with the writing of the new secondary school mathematics curriculum. If that is the case, we hope our membership realizes the "two-edged sword" nature of this task. While we will have the security of knowing that we have some of the very best mathematics people in the province working on the curriculum, they clearly will have some directives and restrictions placed on them throughout the process. One of these will be an "oath of secrecy" which will mean that

they would NOT be able to share with us information about what the document contains until it is finished. Other challenges for the team will be the extremely tight deadlines for delivery, etc.

Some of you will recall that last year's (1997) Leadership Conference, scheduled for November, had to be postponed until February (1998). To allow others to experience this time-warp thing I keep mentioning, the 1998 Leadership Conference is going to be held in February of 1999. There are lots of good reasons for this decision, but I won't bore you (any more than I already have!) by going into them here. Just keep in mind that there WILL be an OAME Leadership Conference, it will be in February, 1999, and plan to attend because it will be great!

Well, I'm sure that there's a "word limit" on the *President's Message* (or if there isn't, there certainly WILL be!), so I guess that's enough for this time. I'm looking forward to a most exciting year, and I'll be looking for lots of help and guidance from the Executive, the Board, and the membership during these rapidly changing, sometimes stressful, and frequently puzzling times for mathematics education in Ontario. Have a great summer!

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▲ Why We Should Reduce Skills Teaching in the Math Class

KEITH DEVLIN
DEAN OF SCIENCE
SAINT MARY'S COLLEGE OF CALIFORNIA



Dr. Keith Devlin is Dean of Science at Saint Mary's College of California and a Senior Researcher at Stanford University's Center for the Study of Language and Information. A shorter version of this article first appeared in an editorial by Devlin in the December 1997 issue of the MAA newsletter FOCUS, *which Devlin edited from 1991 to 1997.*

In an ideal world — at least, a world that most mathematics educators would probably see as ideal — almost everyone would see the need to have some mathematical skills, and would make the effort to acquire them.

Moreover, in that same ideal world, everyone would, at some stage in their education, get a good overall sense of mathematics and its importance, either by attending a "broad brush stroke" survey course on mathematics or by reading one of a small but growing number of excellent expository books on mathematics.

Unfortunately, the world we live in is far from being that mathematician's ideal. Rather, the real world is one in which there is math phobia among a sizeable minority, some level of math anxiety among many more, a general antipathy toward mathematics in the majority, and ignorance about the true nature of mathematics on the part of practically everyone but the professional mathematician.

Surely, none of these observations comes as a surprise to anyone. But to judge by much of the current national debate (in USA) about "math standards", you would think that my remarks constitute the discovery of the century.

At the risk of spoiling an enjoyable tussle, let me try to relocate the Great Math Education Debate from the ideal world of the students we would like to have — i.e., copies of our younger selves as we remember that long lost golden age of our youth — to the real world of the students who actually populate our classrooms.

I'll start with two observations concerning that ideal world I described in my opening paragraph:

Fact 1: Acquiring mathematical skills involves dedication and hard work. As such, it requires motivation. That is already problematic, since for most people the payoff comes later in life.

Fact 2: Getting a general sense of mathematics requires nothing more than interest.

At present, we put immense effort into trying to develop mathematical skills in our students, and we wring our hands endlessly when, for the majority of our students, we fail. At the same time, we rarely try to provide our students with a good, overall picture of the mathematical enterprise.

The paradox in this state of affairs is that Fact 2 probably provides the key to overcoming the obstacles stated in Fact 1. By providing our students with a good overall sense of mathematics, including the many major roles it plays in all our lives, we might well be able to provide the motivation the students need to spend some time acquiring basic skills.

By persisting with a largely unmotivated attempt to force feed the population with a set of perceived essential mathematical skills, we simply turn (what I think is) the majority of people off mathematics altogether and produce significant math anxiety in far too large a minority. As a result, even when people do subsequently find themselves in need of some mathematics, they are often too math phobic to acquire that knowledge.

I believe we need to reduce drastically the time we spend teaching basic skills in middle and high school mathematics classes. I do not see this as a great loss. The plain fact is, few citizens in modern society need or make real use of any appreciable knowledge of, or skill in, mathematics.

What mathematics they need and use they have probably already met by the time they are twelve years old.

On the other hand, the continuance of modern society requires a steady supply of a relatively small

number of individuals having considerable training in mathematics. In order that the critical future supply of mathematicians does not dry up, we must ensure that all high school and university students are made aware of the nature and importance of mathematics, so that those who find they have an interest in and aptitude for the subject can choose to study it in depth.

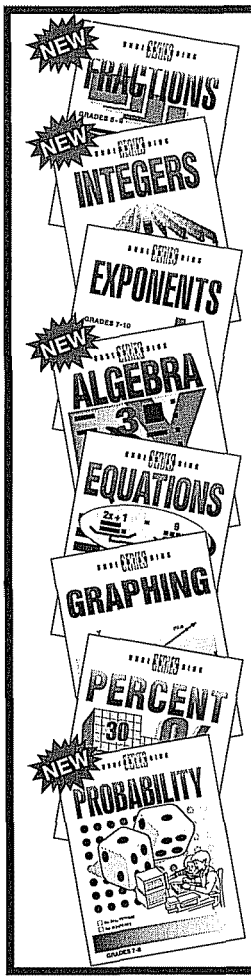
For the middle and high school grades, the main goal in the math class should be to create an awareness of the nature of mathematics and the role it plays in contemporary society. To do this, mathematics should be taught in much the same way as history or geography or English literature — not as a utilitarian toolbox but as a part of human culture.

In my view, an educated citizen should be able to answer the two questions:

What is mathematics?

Where and how is mathematics used?

At present, few people can answer either question correctly.



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Existing methods turn off students in droves and produce math anxiety in many, and this is counterproductive. Teach mathematics as a part of our culture and the result will be many more students who are motivated to want to learn mathematics. Surely, the aim of a mathematics education should be to produce an educated citizen, not a poor imitation of a $30 calculator.

I should stress that I am not saying that basic numerical skills are not important. On the contrary, I would put quantitative literacy on the same crucial footing as ordinary literacy: both are so fundamental in today's society that they are everybody's responsibility. The development of basic quantitative skills are as much the responsibility of, say, the social studies or the English teacher as language and presentation skills are the responsibility of the math and science teachers. To leave the development of quantitative skills to the mathematics teacher sends quite the wrong message to the student.

By changing our present education system radically so that, for the vast majority of students, the primary goal in the mathematics class is to create an awareness of the what, the how, and the why of mathematics, rather than the development of skills that, apart from a tiny majority, none of them will ever make use of, we will achieve two important goals:

1. Tomorrow's citizens will appreciate the pervasive role played by one of the main formers of the culture in which they live their lives. As such, if and when they find that they do have explicit need of some mathematics, they will not start with the disadvantage of having to overcome math anxiety, as is so often the case today.
2. Those individuals who turn out to have an interest in and a talent for advanced mathematics will be exposed to the true nature and the full extent of the subject at an early age, and as a result will have an opportunity to pursue that interest to the eventual benefit of both themselves and society as a whole.

Leaving aside the payoff for those people who eventually encounter a need for mathematical skills, the major justification for goal 1 is simply this: A human life is the richer for having greater understanding of the nature of that life. The more ways we have to know our world and ourselves, the richer are our lives.

Turning to goal 2, any university mathematics instructor will tell you that the present high school mathematics curriculum does not prepare students well

for university level mathematics. Nor is success at high school mathematics a good predictor of later success in mathematics.

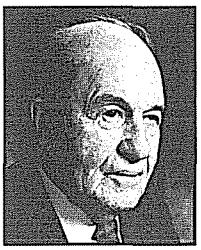
The reason is simple. School mathematics is largely algorithmic: To succeed, the student needs only to learn various rules and procedures and know when and how to apply them. In contrast, university level mathematics is highly creative, requiring original thought and the ability to see things in novel ways. Since the creative mathematician does often need to apply rules and use algorithmic thinking, many successful mathematicians did indeed excel in the high school mathematics class. But many university mathematics students who shone in high school find they struggle with and eventually give up the subject at university when they discover that algorithmic ability on its own is not enough. And the fact that some of the very best professional mathematicians did poorly at high school mathematics, but by some fluke were drawn to the discipline later in life, suggests that our present system of school mathematics education probably turns off a significant number of students who have the talent for later mathematical greatness.

So there you have it. Reduce skills teaching and concentrate on the big picture. And, please, don't pay so much attention to those international comparisons of math skills attainment. Parents and educators have been berating declining educational standards since the time of Euclid. There is surely something vaguely comical about the nation that leads the world in science and technology, and which virtually dominates the world in the development of computer hardware and software, constantly lamenting the poor math skills of its population. Sure the USA has to import a great deal of mathematical talent. That is because there are plenty of Americans with the talent, mathematical ability, and drive to generate a large demand for such people, a far greater demand than in any other country in the world. The time to worry would be when there is a major outflux of American mathematicians to one of those competitor countries we keep worrying about. Frankly, I don't see that happening any time soon.

That's not a "complacent, self-satisfied American" talking, by the way. Hey, I'm a Green Card carrying immigrant with the stamp on my entry visa barely a decade old. Now, if you want to know about the poor state of math education in my native Britain . . . but that's another story.

▲ Repairing School Mathematics in the US

FRANK B ALLEN



Emeritus Professor of Mathematics at Elmhurst College, Past President of NCTM, and National Advisor for Mathematically Correct.

The three-day meeting of the National Council of Teachers of Mathematics (NCTM) in Washington DC (April 2-4) should have served to focus the nation's attention on the crisis that exists in school mathematics today and on the NCTM's role in that crisis. That a crisis exists cannot be denied. The meeting comes just a few weeks after the nation was stunned by reports of the abysmal performance of our best high school seniors on the mathematics examination given to them and their peers from twenty other countries, by the Third International Mathematics and Science Study (TIMSS). On general math skills these US seniors, some of whom are taking calculus, came in 19th in the 21-nation field, surpassing only Cyprus and South Africa. Our performance was really worse than it sounds because, as John Leo notes in the 3/9/98 issue of the US News and World Report, "If the Asian countries who ordinarily score very high on TIMSS exams, had participated, we might have been fighting for 39th place in a field of 41."

Now NCTM policies, as expressed in their three "Standards" reports, have dominated American mathematics classrooms since well before these seniors entered high school. The first of these reports "Curriculum and Evaluation Standards for School Mathematics" appeared in draft form in 1987 and the theories involved were taught in our Teacher's Colleges long before that. When our fourth graders scored a little above the average nation on the TIMSS math exams, the NCTM was quick to claim credit. When we came in 28th out of 41 on the TIMSS eighth grade math exams, there were many rationalizations. Some of these were embarrassing. Now is the time to ask the leaders of

NCTM, "Is the disgraceful performance of our best high school seniors attributable in part to the policies you have imposed on mathematics classrooms throughout our nation?" [Hint — "Our policies have not had time to operate" and "We have been misinterpreted" are not acceptable answers.]

NCTM leaders must admit that they have urged the application, on a national scale, of highly controversial methods of teaching before they have been adequately debated or even understood and before researchers have verified them by well-controlled and replicated research studies. Should the FDA allow a new drug to go on the market under such circumstances? Under NCTM domination, our entire school system has become a laboratory for the testing of untried methods. Consider just a few examples:

The highly retentive memory of youth which has been used for centuries for learning the number facts and the fundamental operations (algorithms) of arithmetic, is being supplanted by the use of calculators in the early grades. This destroys the foundation on which the understanding of mathematical concepts can be built. Countries that score highest on the TIMSS tests do not allow such early use of calculators.

There has been widespread application of the doctrine of "constructivism" which asserts that students understand and remember only those concepts that they "construct" or discover for themselves. No longer should teachers (or even books) disseminate information. Instead, students are often placed in "cooperative learning" groups without direct instruction from the teacher who is relegated to the role of "facilitator." This requires students to reconstruct the great ideas of the past, starting at ground zero and aided only by their equally uninformed peers. Many well-informed people view this new classroom situation with alarm. They say that it destroys the cumulative nature of knowledge, strikes at the very heart of the education process and, according to the TIMSS test scores, is not working very well. Yet, group learning is spreading like wildfire in our nations mathematics classrooms and teachers are becoming facilitators on a wholesale basis.

The new math "facilitators" are now using "authentic" assessment (grading) systems which minimize the importance of correct answers and often include deliberately ambiguous questions (prompting the use of the term "fuzzy math"). They use subjective and inaccurate grading techniques that lack the reliability of objective tests. Worse yet are group tests, which often follow cooperative learning. They destroy the validity of course grades, mask individual performance levels, and make the assignment of individually prescribed remedial work impossible.

There has been a downgrading of proof in plane geometry almost to the point of elimination. The older geometry texts contained many challenging, highly instructive "originals" and construction problems requiring proof. During recent years the NCTM has watched, without protest, while these have virtually disappeared from the glossy 800-page "coffee table" books that pass for geometry texts in the US. At the same time they were speaking frequently about "mathematics as reasoning" and "higher thinking skills." This is an example of the vast discrepancy that exists between what NCTM says and the reality of NCTM-based programs.

Social engineering has crept into the math curriculum, including irrelevant material about student attitudes and social issues and misguided efforts to build self-esteem. Under the guise of opening the door to higher level math for all students, we now have algebra and geometry students who are not prepared. This sends students the wrong message and hampers instruction. Recall that Jaime Escalante, of "Stand and Deliver" fame, showed us how students can earn their self-esteem and triumph when properly taught and motivated.

Lacking support in either research or experience, these NCTM-based programs are worse than just fads — they are mistakes that have been systematized. They impair the quality and content of the mathematics our students are expected to learn. We must heed the warning provided by the timely publication of the TIMSS twelfth-grade test results and replace the fad-laden, NCTM-based programs now found in the mathematics classrooms of America.

California, perhaps having suffered the worst from these fads, is now moving in the correct direction. That state has, with the very substantial help of College and University mathematicians, adopted Standards that clearly describe the mathematics the student is expected to learn in each grade in elementary school and in each

subject in high school (despite the name, the NCTM "Standards" do not do this). Recently adopted by the California State Board of Education, these new standards will soon lead to new programs to replace the weak NCTM-based programs. That this is a vast improvement, there can be no doubt. In a recent review of state standards, the Fordham Foundation reports that the new California Standards are number one, surpassing even the equivalent document used in Japan.

Links to the new California Standards and to two papers — A Program for Raising the Level of Student Achievement in Secondary School Mathematics and A Plan for Improving Exposition in High School Mathematics — are available from the Mathematically Correct web site. (http://ourworld.compuserve.com/homepages/mathman/report.htm) The papers deal with a national effort to place mathematically well-prepared teachers in secure classrooms, where they are free to use any methods of presentation that yield good results on objective tests.

Using these materials, concerned parents can, with the advice of local mathematicians, duplicate California's new directions in other states. Proceeding thus, on a state-by-state basis, we can replace fuzzy math programs with programs of instruction in school mathematics that will enable our students to compete successfully with their peers in other industrialized countries.

OAME Award winners

The following OAME award winners for 1998 were honoured at the annual meeting in May in North Bay.

Life Membership: Mary Lou Kestell, Education Quality and Assessment Office

Morley MacGregor Award: Anne Muller, Lisgar Public School, Peel Board of Education

Don Attridge Award: John Savage, Lo Ellen Park Secondary School, Sudbury Board of Education

Mona MacGregor Award: Peter Rose, FPR Communications Ltd

K.D. Fryer Award: Mathematics staff of Barrie North Collegiate, Simcoe County Board of Education. Bill Morrison is the head of mathematics.

▲ The Devil's Advocate: The Carrot

ALEXANDRU PINTILIE
MATHEMATICS TEACHER,
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When Alexandru Pintilie, B.Sc. Math, M.Sc. Stats, ex-A.S.A., does not teach math, he boasts about it, chaperons the soccer team, chauffeurs the chess team or lectures his teenage son.

An old story from Ancient Greece: One of Euclid's pupils complained that learning mathematics was pointless - it was of no practical value. Euclid commanded a slave to give the boy a coin so that he could make a profit in studying geometry.

A corny joke from Eastern Europe (slightly adapted for the North American public): High school student Bula comes home with an F in mathematics. His father is not pleased and decides to teach Bula a lesson. He takes him to a ball game that night. During intermission, a group of cheer-leaders delight and entertain the public. Bula asks his father how could he get to know one of those gorgeous young women better. His father replies: "You need an A^+ in math to date a cheer-leader."

An ad from *The Globe and Mail*: The ad covers one entire page. It features a photo of Marie Curie - the double *Nobel Prize* laureate (Physics 1903, Chemistry 1911). After describing some of her qualities and achievements, the ad concludes that she could have been a successful car dealer.

What is the difference between the three anecdotes? The first two were tongue-in-cheek and vaguely amusing. The third one is scary.

Motivating students to learn mathematics has become one of the hottest topics in modern education. Unfortunately, we have too many answers before we have even managed to clarify the question. Does motivating mean keeping them blissfully happy during the math class so that they don't drop out of school?

Does it mean "tricking" them into believing that there is a very material treasure at the end of the rainbow? Do we, maybe, have to present math as it is, powerful and beautiful and bestow our trust upon students that are often brighter than we care to think they are?

The first interpretation of "motivation" is the most common. Teachers go to unbelievable lengths to please and amuse their audience. From coming dressed as the pink panther, a clown or a cool leather freak, to allowing students to call them names and pull their hair. Some climb on top of tables to make their students understand a vertical shift. Some others use Pentiums 233 to graph a line with slope 2. Trigonometry is SOHCAHTOA that is "Some Oakville Hippies etc... (sorry, I forgot the rest of my Trig)". The order of operations has been put on rap music. The division of polynomials is learned by either pinning slips of paper on the back of one's shirt or by playing Bingo.

Questions have to be so easy and formulated in such a way that it would take a rocket scientist to get them wrong.

The "pot of gold" version is also widely employed. Math teachers mention statistics that claim that people with a good math background earn more money . Some music teachers boast that learning music makes you successful in math. (And, therefore, makes you earn more money! Mozart should have died a billionaire. But I digress.) Math has been "glorified" as the science that helps you balance your cheque-book. Even geometry is worth studying because - as a colleague in the honours math specialist class enlightened us - people working in factories encounter wheels which are shaped as circles. Math is so cool that it even allows us to calculate batting averages! Selling BMWs is no problem for a nuclear physicist!

As often as our students err in choosing the right measure unit when they deliver the answer, we err in motivating them by using the wrong yard-stick and the results are just as humourous. We appreciate the sitcoms by how silly they are; we measure a mutual fund by how much money it can bring to us; we judge a politician based on how smart his media clips are; a vacuum cleaner or a car have to serve their purpose longer and better than the competitors. We are trying to shape math teaching according to fun, financial returns, charisma or long term efficiency, and God help us if we succeed.

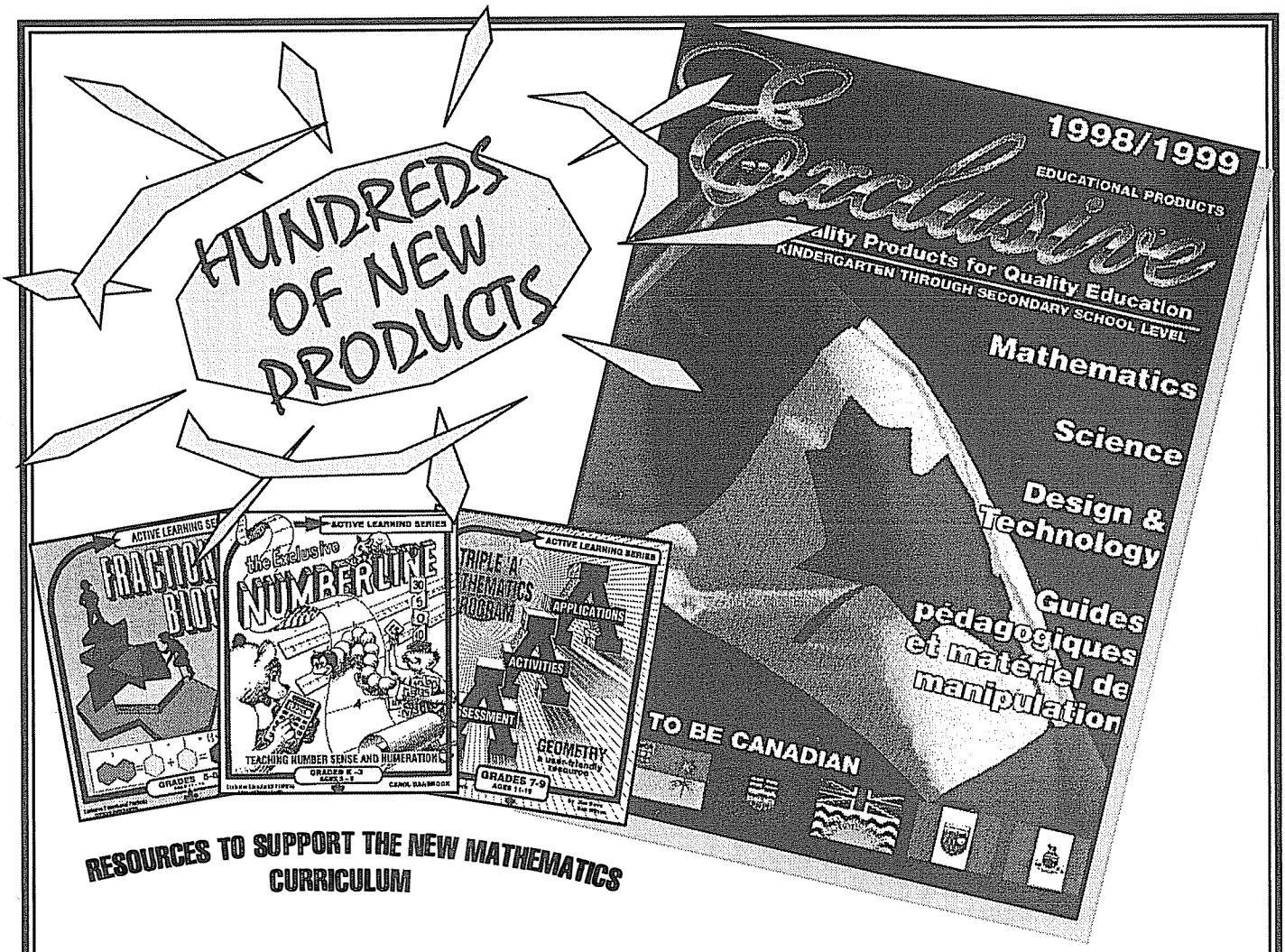
The purpose of Education - from visual arts to mathematics - should be to offer alternatives to the "accepted" values: money, sex and fun. Education is about being human, about having a soul, about searching for the truth, about learning how to use more than 1% of our brains. It teaches one to explore one's intuition, and to direct its energy by means of patient analytic thought processes. Math is a creation of some of the brightest minds that humanity ever had. It should make us proud and it does not need excuses or gimmicks to have a place in our schools. It is true that an intelligent and educated person is generally more likely to find a job and to obtain a certain level of financial security, but reducing the value of our youth to dollars, cents and employability is a crime.

How then are we to motivate our students, if we snub the means used in beer commercials, professional sports and election campaigns?

One must start with giving mathematics - and intellectual achievement in general - the status it deserves. I remember a number of years ago Toronto Star carried on the front page "the big news" of Ballard's son insulting Ballard's wife. On the seventh page there was a note mentioning a Canadian receiving the Nobel Prize. *The Funk and Wagnalls Encyclopedia* dedicates almost an entire page to Babe Ruth and only about 1/4 of a page to Norbert Wiener, who lived at the exact same time, in the same country, but who founded the study of cybernetics instead of swinging a bat.

Secondly, we have to put in front of our classrooms math teachers who have a solid background and a genuine love for this subject. One math teacher told me that not only does she dislike math but she has never met someone with an appreciation for it. Another (specialist) math teacher said that he would rather do lesson plans than solve geometry problems. I even heard from a (specialist) math teacher the following: (I quote from memory) "My Calculus teacher was a moron, but it does not matter since one does not really need Calculus for anything anyway." I guess that would chill out the Leibniz-Newton controversy.

Finally, the most important way to motivate students to study mathematics is to teach it to them the way it is. Some 60 years ago, my grandfather wrote a geography textbook to be used in grade three classes in the tiny county where he lived. The motto was simple but powerful: "You cannot love something that you don't know."



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▲ RANDOM VARIABLE EXPECTATIONS



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

Teachers of probability are always looking for real world situations which can be modeled using probability. We shall present one such situation involving a van service which picks up clients and takes them to the airport.

Suppose that the van holds no more than five passengers. The company receives telephone reservations for pick ups in various locations. Because of the size limitation of the van, the company will accept no more than seven reservations for a given trip from their office to the airport.

Based on experience the company concludes that the following are the probabilities for different numbers of reservations being made for a given trip.

number of reservations	0	1	2	3	4	5	6	7
probability	0.05	0.05	0.10	0.10	0.10	0.10	0.20	0.30

The company has also observed that only 70% of the people making reservations actually are there to be picked up; 30% are no-shows. Assume that the passengers represent independent cases. **[?]*** Because of the occasional overbooking (6 or 7 reservations made for only 5 positions), the van must occasionally refuse to pick up someone who has made a reservation.

The company wishes to analyze two random variables: the number of passengers actually taken to the airport on a given trip and the number of passengers with reservations that are "bumped" on a given trip.

* The symbol **[?]** indicates that something important is happening. Students should be able to explain the thinking involved.

I. The number of passengers actually taken to the airport.

To address this situation, we must first calculate, for each number of reservations, the probabilities for the possible numbers of passengers who come to the pickup points to be taken to the airport.

1. No reservations made.

   No passengers arrive at the pickup point.

2. One reservation made.

number of passengers (n) at pick up points	0	1
probability, P(n)	0.3	0.7

3. Two reservations made.

   There are 3 possible situations that can occur.

   A. 0 passengers: (.3) (.3) = 0.09 **[?]**

   B. 1 passenger: C(2,1) (.7)1 $(.3)^1$ = 0.42 **[?]**

   C. 2 passengers: $(.7)^2$ = 0.49 **[?]**

number of passengers (n) at pick up points	0	1	2
probability, P(n)	0.09	0.42	0.49

4. Three reservations made.

   Using a similar binomial analysis as for two passengers yields:

n	0	1	2	3 [?]
p(n)	$(.3)^3$ = 0.027	$C(3,1)(.7)^1(.3)^2$ = 0.189	$C(3,2)(.7)^2(.3)^1$ = 0.441	$(.7)^3$ = 0.343

5. Four reservations made.

n	0	1	2	3	4 [?]
P(n)	0.0081	0.0756	0.2646	0.4116	0.2401

6. Five reservations made.

n	0	1	2	3	4	5 [?]
P(n)	0.00243	0.02835	0.13230	0.30870	0.36015	0.16807

7. Six reservations made.

n	0	1	2	3	4	5	6[?]
P(n)	0.000729	0.010206	0.059535	0.185220	0.324135	0.302526	0.117649

8. Seven reservations made.

n	0	1	2	3	4	5	6	7[?]
P(n)	0.0002187	0.0035721	0.0250047	0.0972405	0.2268945	0.3176523	0.2470629	0.0823543

Let x = number of passengers actually picked up; x can assume values from 0 through 5. To find the probability of a given value of x, we must locate that value for each of the situations above.

For x = 0, the probability is calculated as follows: **[?]**

P(0 res and 0 pass) = P(0 res) · P(0 pass, given 0 res) = (0.05)(1) = 0.05
+
P(1 res and 0 pass) = P(1 res) · P(0 pass, given 1 res) = (0.05)(.3) = 0.015
+
P(2 res and 0 pass) = P(2 res) · P(0 pass, given 2 res) = (.1)(.09) = 0.009
+
P(3 res and 0 pass) = P(3 res) · P(0 pass, given 3 res) = (.1)(.027) = 0.0027
+
P(4 res and 0 pass) = P(4 res) · P(0 pass, given 4 res) = (.1)(.0081) = 0.00081
+
P(5 res and 0 pass) = P(5 res) · P(0 pass, given 5 res) = (.1)(.00243) = 0.000243
+
P(6 res and 0 pass) = P(6 res) · P(0 pass, given 6 res) = (.2)(.000729) = 0.0001458
+
P(7 res and 0 pass) = P(7 res) · P(0 pass, given 7 res) = (.3)(.0002187) = 0.00006561
Sum = 0.07796441

The probability of no passengers is thus 0.07796441.

The probability distribution chart for the random variable x follows. Its calculation pattern is similar to that of x = 0.

Probability distribution chart for x (actual number of passengers):

x	0	1	2	3	4	5	[?]
P(x)	0.07796441	0.10940783	0.15219841	0.17254615	0.19292035	0.29496285	

The case of x = 5 deserves special attention. It can occur in the following ways:

- 5 res, 5 show up
  P = (.1)(.16807) = 0.016807 **[?]**
- 6 res, 5 or 6 show up
  P = (.2)(.302526 + .117649) = 0.084035 **[?]**
- 7 res, 5, 6, or 7 show up
  P = .3(.3176523 + .2470629 + .0823543) = 0.19412085 **[?]**

So, P(x = 5) = 0.016807 + 0.084035 + 0.19412085 = 0.29496285. The mean value of x is $\Sigma\, x \cdot P(x) = 3.18$; **[?]** the average number of passengers actually picked up is 3.18. Since the van holds 5 passengers, the mean number of empty seats is 1.82. A "typical" trip would have 3 seats occupied and 2 seats vacant.

II. The number of bumped reservations.

A. One bump **[?]**

1. 6 res, 6 show up P = (.2)(.117649)
2. 7 res, 6 show up P = (.3)(.2470629)

Sum = 0.09764867

B. Two bumps **[?]**

7 res, 7 show up
P = (.3)(.0823543) = 0.02470629.

C. No bumps **[?]**

1 - (0.09764867 + 0.02470629) = 0.87764504

If b = the number of bumps, the following probability distribution chart applies.

b	0	1	2
P(b)	0.87764504	0.09764867	0.02470629

The mean value of b is then $\Sigma\, b \cdot P(b) = 0.147 \approx \frac{1}{7}$. **[?]**
The number of bumps per trip "averages" $\frac{1}{7}$.

CHALLENGES:

1. How will the company view the findings in I and II? Which will concern the company more — the relatively large average number of empty seats per trip or the relatively small average number of bumps per trip?

   A first reaction is to focus on the empty seats and attempt to reduce these by either taking more than 7 reservations or buying a smaller van that seats fewer people. Redo these problems for each of these two changes, assigning plausible probabilities for more than 7 reservations.

2. Another way to analyze the findings is to reason that a bumped reservation holder is unlikely to make a future reservation and is likely to tell his/her friends not to do so either. Consequently, the number of reservations may fall over time if passengers are bumped. How can the problem be reorganized to take this into account?

3. Explain how two companies, each with a 5-passenger van, might cooperate to their mutual benefit.

4. Develop and analyze a second "real-life" scenario involving reservations and no-shows.

5. Simulate this situation on a computer rather than doing the calculations of this article.

▲ IMPORTING DIAGRAMS FROM PAINTBRUSH INTO WORDPERFECT FOR WINDOWS

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Greg is the Chairperson for Information Technology & Science at Patrick Fogarty Secondary School in Orillia, Ontario, as well as the school's Computer Site Administrator and acting Math Department Head. He graduated from the University of Waterloo and is presently in his tenth year of teaching. His wife Julie teaches French at Patrick Fogarty S. S., and they have three very busy children, Jonathan,7, Alexandra, 6, and Daniel, 2 1/2 .

When doing a test, handout, or assignment sheet, it is often necessary to include diagrams. It is possible to generate most of these diagrams with a computer program, and then insert these pictures into your test, handout, or assignment document in *WordPerfect,* or any other word processor. These pictures would be inserted as graphics, in a *WordPerfect* graphics box.

BACKGROUND NOTE:

WordPerfect can treat graphics boxes in two different ways:

1. They can take up space on the screen in a graphics box which has left, right, top and bottom margins around which text will flow. (default *WordPerfect* method). OR
2. *WordPerfect* can treat the graphic like a background picture, and all other text on the page will ignore the graphic, and flow right over top of it. THIS METHOD is often easier to use for greater control and accuracy over the placement of diagrams , as long as the text does not obscure the details.

STEP ONE: Go to PAINTBRUSH to DRAW your diagram.

1. If you are currently in *WordPerfect*, press ALT+TAB to get to the Program Manager.

   NOTE: *Pressing ALT+TAB takes you from one Windows program to another. It is possible to run many programs at the same time in Windows.*

   To see a list of programs that are running at any one time, press CTRL+ESC, or you can HOLD DOWN the ALT key, while pressing the TAB key repeatedly
2. Start the PAINTBRUSH program.
3. Draw your diagram.

   NOTE: *To draw a perfect square, or a perfect circle, hold down the SHIFT key while using the corresponding drawing tools.*

STEP TWO: Copy the diagram just drawn.

1. Select the COPY icon from the PaintBrush palette.
2. Use the mouse cursor to make a box around the diagram you have just designed.
3. Click on EDIT - COPY, to save this diagram to the Windows Clipboard. *(temporary memory)*

STEP THREE: Return to WordPerfect.

1. Press ALT+TAB to return to WordPerfect *(or, you may have to try CTRL+ESC, or HOLD down ALT, and press TAB a number of times)*

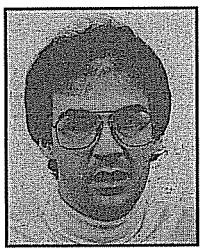
STEP FOUR: Paste your diagram into the WordPerfect document.

1. Once you are in the WordPerfect screen, choose EDIT - PASTE

STEP FIVE: Position your diagram, and adjust the Graphics Box settings, if needed.

1. Use the mouse to position your diagram so that it is at the right place on the page.
2. Right-Click on the Diagram, and a Menu will pop-up —> Choose Edit BOX POSITION.
3. By default, the **BoxType** will be set to **FIGURE**. If you want an outline around your diagram, leave that alone. If you DO NOT want an outline around your diagram, then change that to **USER BOX**.
4. By default, the setting will be to automatically **Wrap Text Around Box**. If your un-check this option, the diagram will become a background picture, and text will flow overtop of it, or not be bumped out of the way because of it.
   *(My preferences are USER BOX and **NO** Wrap Text Around Box (un-checked))*
5. Click OK, and then continue with WordPerfect
   (It is a good idea to save after every picture is pasted)

ABOUT PROBLEM SOLVING: IDEAS FROM THE MATHEMATICAL FUNFAIR



JOHN GRANT MCLOUGHLIN
FACULTY OF EDUCATION
MEMORIAL UNIVERSITY OF NEWFOUNDLAND

The Mathematical Funfair (Cambridge University Press, 1989) is an entertaining book of mathematical recreations. Brian Bolt, the author, manages to organize a healthy blend of challenges ranging from strategy games to numerical niceties to topological twists. Some of the challenges will be shared here in the second of a series of three columns focusing attention on recreational mathematics as a source of mathematical problem solving.

Number the sectors

A circle is divided into six sectors labelled A, B, C, D, E, and F respectively. Find numbers A, B, C, D, E, and F for the six sectors so that the number in a sector, or the total of the numbers in a set of adjacent sectors, gives all the integers from 1 to 25 inclusive. Is it possible to obtain a larger range of numbers in this way?

A doubly magic triangle

The numbers 1,2,3,...,9 can be arranged in the form of a triangle (four numbers along each side) in many ways so that their sum along each side is the same. But can you find such an arrangement where the sum of the squares along each side are also equal to one another?

Three of a kind

Find A, B, and C to make the addition sum correct:

$$\begin{array}{r} ABC \\ ABC \\ +\ ABC \\ \hline BBB \end{array}$$

Make a century

Observe that $96+\frac{2148}{537}=100$.

There are ten other ways in which the digits 1,2,3,...,9 can be arranged as a whole number plus a rational number whose sum is 100. See how many of them you can find.

Intersecting lines

Five straight lines can be drawn in a plane in an infinite number of ways. For example, they could be parallel so that they do not cross anywhere or they could pass through one common point of intersection. The largest number of intersections attainable is 10. (You may wish to try to construct such an arrangement.)

Here are two challenges based on this idea:

(i) Draw 5 straight lines with exactly 8 intersections. Try to do this in more than one way.

(ii) Draw 10 straight lines so that they make exactly 27 intersections.

The problems posed in this selection are particularly attractive due to their accessibility. The mathematics involved is accessible to elementary school students because the level of mathematical sophistication is relatively low. Meanwhile these same problems are offered with another goal in mind. It is hoped that some solvers, both teachers and students, will not be satisfied with simply finding a solution. Rather it is intended that these problems may provoke questions such as "What if...?", "Why...?", and "Are there other examples...?"

The initial problem, 'Number the sectors', is one that I have dealt with in a number of ways during this school year. As the calendar editor for *The Mathematics Teacher*, I included a variation of the problem in a calendar. Responses from readers offered different possible solutions that extended the range significantly beyond 25. Further, I offered an open ended version of the problem to grade five students at Black Mountain Elementary in Kelowna by not indicating any particular target value such as 25. The students worked well with this problem and found it to be a stimulating activity. Any further insights on this problem or any of the others posed here are welcomed. I am particularly interested in any feedback from teachers who may have shared some of these problems in their own classes. Comments may be directed to johngm@morgan.ucs.mun.ca or the address shown above.

OAME/AOEM AWARDS NOMINATION PROCESS

Deadlines

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

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

The OAME/AOEM Nomination Form

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

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

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

The Nomination Cover Page

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

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

OAME/AOEM LIFE MEMBERSHIP AWARD

The Life Membership Award is given to recognize a person who has contributed in a significant 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

Send to: David Zimmer

Intended Award (please check one)

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

Nominee Information:

_____

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

_____

_____

School, Organization or Business Address

Telephone Number ( ) _____

Fax Number ( ) _____

Home Address_____

_____

Home Phone ( ) _____

Nominator Information:

_____

Name of Nominator

_____

_____

School, Organization or Business Address

Telephone Number ( ) _____

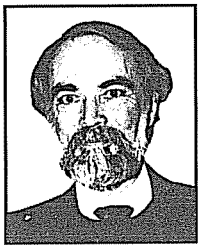
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▲ OH RATS!



GARY FLEWELLING

This article looks at the characteristics and importance of rich learning tasks (RLT's) and rich assessment tasks (RAT's). Think of RLT's and RAT's as one and the same thing (but that RAT works better in a title).

Sample Learning/Assessment Tasks

Scenario 1: The Highway Problem

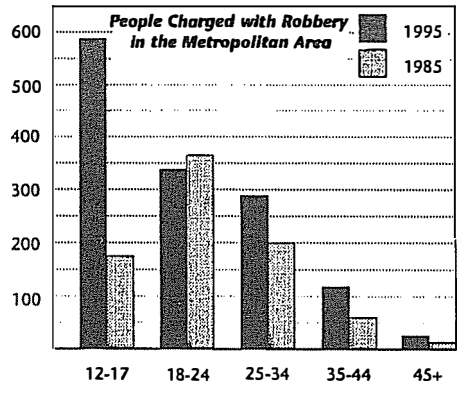
A grade seven class and their teacher are talking about the loss of farm land to urban sprawl. The following question arises.

How much land has to be taken out of production to build a new, 36 kilometre-long, 2-lane highway?

Students discuss the problem in small groups, make (and test) some assumptions, make (and refine) some estimates, bring in non-mathematical issues and, collectively, come up with ball park estimates of the amount of land taken out of production. The teacher asks each student to explain, in writing, how they arrived at their answer (their group's result or what they consider to be a better estimate.) and to justify the reasonableness of their estimate.

Scenario 2: Crime Stats

A grade eight class and their teacher are talking about crime, motivated by a local occurrence that made the news the night before. The group comes up with the following question.



The crime statistics shown were originally presented at a press conference by the chief of police of a large Canadian city.

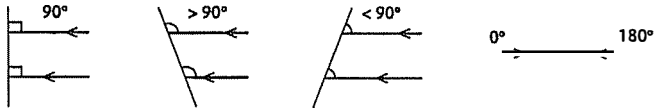
Suppose that you are a reporter. File a one-paragraph story to your paper (or TV or radio station) based on these statistics.

Scenario 3: The Moth Problem

A teacher has just come back off a holiday in England and tells her grade twelve students about visiting the Natural History Museum in London. The following museum-found fact is related.

Moths fly by keeping a constant angle with a distant light source (like the moon).

The teacher leads a class discussion about the shape of the path that a moth would/might fly under such a condition. After several minutes, students have drawn straight line 'moth paths' on the blackboard for a variety of fixed angles.

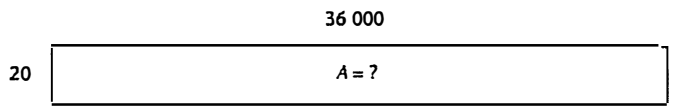


One student then asks the following question.

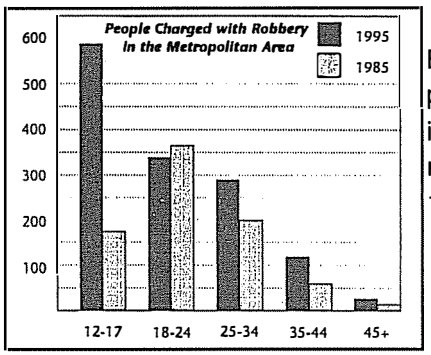
"(How) would our answers change if the light source is not 'distant', like a candle or a street lamp?"

Students hive off into small groups to discuss this question and . . .

Scenario 4: Area of a Rectangle



Scenario 5: Increase in Crime



Express, as a percent, the change in the number of robberies between 1985 and 1995.

Scenario 6: Locus Problem

Point P moves such that PC = 1O

C is the fixed point C(10,0).

Find the equation of the locus of point P.

The Teacher's Task

The main responsibility of teachers is to provide their students with rich opportunities to learn and rich

opportunities to demonstrate just what they have learned (that is, what they know and are able to do). Focussing on tasks like those in the first three scenarios gives students just such opportunities. By comparison, the tasks in the last three scenarios don't.

Traditional Tasks

Scenario 4 can be used to check to see if students can calculate the area of a rectangle. Scenario 5 can be used to see if students can (to some extent) interpret bar graphs and calculate percentages. Scenario 6 can be used to check if students can find the equation of a circle knowing its centre and radius. Tasks such as the last three are often seen on blackboards, in student notebooks, on drill sheets, in text books, and on tests. To prepare students to be successful on such tasks is to prepare students for success in school. The trouble is that life outside of school does not present people with such challenges.

Rich Tasks

The first three, less common, scenarios do very much more. They are richer tasks because they give students the opportunity to choose from, and to use, a larger set of mathematical and non-mathematical skills and to use them in an integrated, and often creative fashion, to a purpose.

Integration

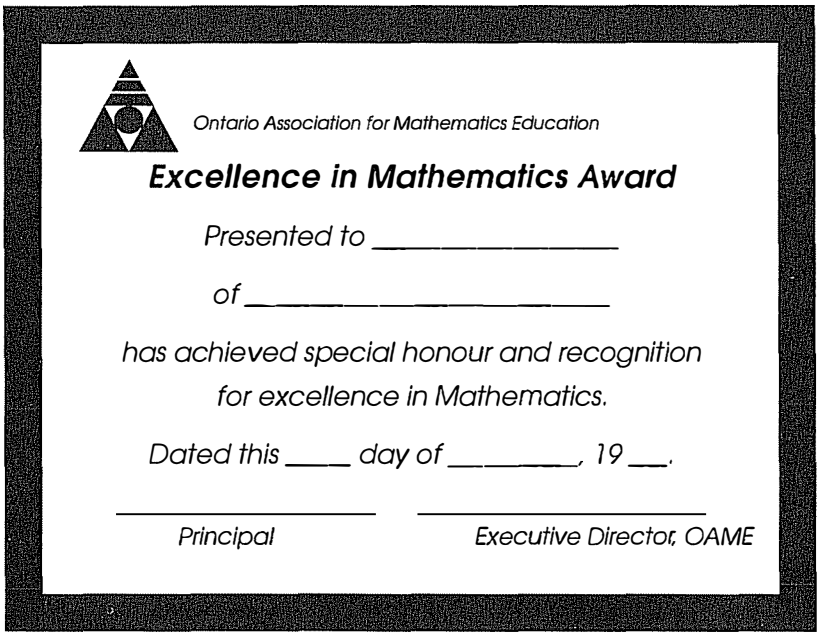
When people talk about integration these days they usually mean using themes and integrating subjects. For me the really important aspect of integration is achieved when students get an opportunity to get good at using their mathematical and non-mathematical skills in an integrated, and often creative fashion, to a purpose. Rich tasks give students the opportunity to do just that.

Life Outside the Classroom

The way in which the student has to think in these scenarios is much like they will have to think when faced with a problem outside of school. Preparing students for success on these tasks is to prepare students for success in life outside of school.

Authentic/Real Tasks

When people talk about authentic tasks or real tasks, they often think or real world, everyday, practical tasks. For me learning or assessment tasks can be quite fanciful, abstract, highly mathematical, or just plain weird. The really important thing is that each task gives students the opportunity to use their knowledge and skills in real/authentic ways, that is, in the same ways that good problem solvers do in that real/authentic world outside of school.



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Contextualized Tasks

Rich tasks give students the opportunity to meet and use their skills in contexts that let them tell themselves things like, *"so that's where it comes from, so that's what it's connected to, so those are the conditions that precede its use, so that's what triggers this procedure, so that's what I have to do to prepare for its use, so, that's why I need it, so that's how it's used, so that's what it leads to, so those are its limitations, so that's what it tells me about this kind of situation."*

Task Length

The time students take to work on a traditional task is usually measured in seconds or minutes. The time students take to work on a rich task is usually measured in minutes, hours, days, or weeks. Traditional tasks end. Rich tasks can go on.

Tasks Likened to the Writing Process

If learning tasks are likened to the actions of writing, words, phrases, sentences, paragraphs, chapters, or stories, then traditional tasks tend to be found on the left of this continuum and rich tasks tend to be found on the right.

The Math Component of Tasks

Traditional math tasks are often purely (though narrowly) mathematical in make-up, focus, and flavour. Rich tasks often draw from more than one strand of mathematics. Mathematics is often just a part (albeit a significant part) of a rich task. The focus and flavour of the task may or may not be mathematical. A rich task encourages students to use mathematics in ways that can have significance and relevance for the student in and beyond the math classroom. Rich tasks may lead the students to significant new mathematical ideas. Rich tasks may lead the student to consider significant non-mathematical issues.

The 'Traditional' Skills

When I say 'traditional' skills I mean things like being able to factor quadratics, solve quadratic equations, define trig functions, use trig to solve triangles, and so on.

If a rich task is a hamburger, then 'traditional' skills are the meat patty. A hamburger without the patty is not a hamburger. A patty without the bun and fix'ns is not a hamburger. You could have a steady diet of either pattyless hamburgers and bunless/fix'nsless patties but both would be unsatisfactory for a bunch of reasons. (How long or well would a person live on just the one or the other? Which would you prefer, anemia or blocked arteries?) We shouldn't have to choose between one or the other. We need both, at the same time, in the same meal.

I didn't call this section *Learning Basic Skills* because all of the skills (mathematical, cross- curricular, and non-mathematical) needed to engage successfully in rich learning tasks should be considered basic skills. For example, being able to clearly and convincingly communicate a position should be as important a collection of skills, in the math classroom, as the skills needed to collect the data on which the position is based. To say I won't tackle rich learning tasks until all traditional tasks have been mastered is like saying we won't eat hamburgers until all the patties are cooked and eaten.

When should 'traditional' skills be taught?

Traditional skills should be taught when they are needed to allow a student to successfully engage in a rich learning task (It's sort of like 'just-in-time' delivery of parts in the car industry. You need the chassis at the time the car is being assembled.)

What should lessons that teach traditional skills look like?

Lessons that teach traditional skills should probably look just like good traditional lessons look now.

How much traditional skill needs to be taught?

Not as many 'traditional' skills need to taught as many people think (and not as few as some people think people like me are advocating.) On this issue, I agree with the position taken by Peter Taylor at Queen's. In an e-mail communication to Fields Institute Mathematics Education Forum members he said, "How much algebraic manipulation is enough?" The best answer to this is that in a curriculum organized around big ideas, the right amount of algebraic manipulation is the amount that's needed to explore and encompass the big idea. And if the set of big ideas is rich enough, there will be enough manipulation.

How often do we do rich learning tasks?

Rich tasks should provide the raison d'etre for 'traditional' skill development. They should motivate (all?) learning. Rich activities should provide the arena in which students play with (and test and sharpen) their skills. Rich tasks should provide a backdrop for every math lesson, whether the lesson is more or less traditional in nature.

How many rich tasks should a teacher be expected to do in a course? Probably more than most do now. Probably fewer than most will likely want to do in the future.

Student Actions

When solving problems, there is the potential that students will be involved in many of the following actions.

ACTIONS	EXAMPLES
explore	*play, risk, mess around, interpret, discuss, try, assume, investigate, ...*
model/formulate	*identify strategy, plan, select, find patterns, mathematize, represent, ...*
manipulate/transform	*calculate, solve, substitute, factor, operate, graph, construct, process,...*
conclude/infer	*justify, evaluate, monitor, predict, compare, generalize, defend, ...*
communicate	*read, write, speak, listen, report, record, draw, chart, explain, interact, ...*

A rich learning task will give a student the opportunity to be involved in all of the actions listed under ACTIONS. More traditional tasks over-emphasize the manipulation and transformation actions.

Basic Skills

Basic/fundamental/critical (mathematical, cross-curricular, and non-mathematical) skills, "the basics", of which traditional mathematics skills are an important subset, are the tools that student need to explore, model, formulate, manipulate, transform, conclude, infer, and communicate. I find it strange that so many believe that an emphasis on rich tasks implies a de-emphasis of these basic skills. The truth of the matter is that an emphasis on rich tasks implies an even more sophisticated (though more selective) use of these tools than is presently the case. Many who call for a 'return to the basics' need to be reminded about just what these basics are, and that you don't 'return' to a place you've never been before.

A Problem-Centered Curriculum

An Inquiry Model

(pg 74, *The Ontario Curriculum, Grades 1-8: Mathematics*)

Understand the Problem

- rereading and restating the problem
- identifying information given and needed

Communicate:

- talking about the problem to understand it better

Make a Plan

- comparing the problem to previous experience
- considering possible strategies
- selecting a strategy or a blend of strategies

Communicate:

- talking to clarify the method
- listening to ideas of others

Carry Out the Plan

- executing the chosen strategy
- doing the calculations
- monitoring success
- revising as necessary

Communicate:

- drawing pictures, using manipulatives to illustrate projections or interim results
- writing words and symbols to represent steps of "doing"
- sharing output from computer or calculator operations

Look Back

- checking the reasonableness of the answer
- reviewing the method: Does it make sense? Is there a better way?
- considering extensions or variations

Communicate:

- choosing the best format for describing and explaining how the solution was reached.

The inquiry model, set out above, is really Polya's 4-step problem solving model. Notice the connections between the actions listed on the previous page and the actions listed in this model. Most modern mathematics curriculum are supposed to be problem-centred. Rich learning and assessment tasks naturally place the focus on problem solving and are a crucial ingredient of a problem-centred curriculum.

An Inquiry-Based Curriculum

The Inquiry Process

(from Shared Discovery: *Teaching and Learning in the Primary Grades*, Ontario MET, 1985)

EXPLORE: Students learn by exploring materials and events through the use of all their senses.

↓

INQUIRING: Students ask questions of themselves and of others to clarify an issue or pose a problem.

↓

PREDICTING: Students can think of a range of reasonable possibilities to answer a question or solve a problem.

↓

PLANNING & COLLECTING Students collect information about each predicted possibility.

↓

DECIDING: Students arrive at a conclusion by deciding which possibility provides the best answer to the question or solution to the problem.

↓

COMMUNICATING: Students choose the best way to present their findings.

↓

EVALUATING: Students check whether their decision or conclusion was correct.

Once again, notice the connection between the actions from two page ago and the actions of the student engaged in conducting an inquiry as described above. Rich tasks support a inquiry approach to learning. Rich tasks support an inquiry-centred curriculum.

Learning and Assessment

Rich learning tasks also provide students with an opportunity to demonstrate what they know and can do. Rich assessment tasks also give students an opportunity to learn. As recently retired coordinator Ron Sauer reminded me, rich learning tasks promote assessment and rich assessment tasks promote learning.

Levels of Student Performance

The same rich task will allow different students to demonstrate (very) different kinds and levels of performance. More traditional tasks usually don't have this property.

Levels of Performance

Level 1 novice, beginner, unskilled, limited, hesitant, lacking experience, simple tools, ...

Level 2 apprentice, semi-skilled, inconsistent, some experience, some understanding, ...

Level 3 craftsperson, skilled, consistent, experienced, understanding, confident, ...

Level 4 master craftsperson, highly skilled, originality, widely experienced, insight, excited,...

More traditional tasks are usually highly structured and allow students to demonstrate a narrow range of behavior. Rich tasks are sufficiently structured to address certain sets of learning outcomes but leave students with sufficient autonomy to allow them to surprise both themselves and their teachers with the quality of their thinking (or the depths of their misunderstanding).

More traditional tasks usually allow students to demonstrate achievement of a few specific learning outcomes. Rich tasks usually allow the student to demonstrate achievement in many specific learning outcomes and just as importantly many of the big cross-curricular outcomes that are so valued in a modern forward-looking curriculum.

Remediation

Both types of tasks provide the student with an opportunity for remediation. Compared to more traditional tasks, rich tasks open a bigger window on the student allowing both the teacher and the student an opportunity to identify, more broadly and clearly, areas of strength and weakness and more clearly establish the need for additional instruction.

Rich tasks motivate students to want to be successful.

Enrichment

Often, more traditional tasks do not lend themselves to extension. Enrichment is often provided by the teacher as something extra, another challenge, an add-on to the task at hand, a 'reward' for good work, a task for the talented few.

Rich tasks motivate more students to do more mathematics. Rich tasks often encourage students to ask their own 'what if's' and to pursue related paths of investigation. The teacher, in the latter case, through discussion, often encourages students to pursue even

richer targets of opportunity and helps them to reflect on the implications of their work.

Teaching and Assessment Strategies

Rich learning and assessment tasks, to work effectively, require the teacher to use a wide variety of teaching and assessment strategies and the student to use a wide variety of learning strategies.

The methodology or strategy chosen is not a matter of taste or style. Each rich task mandates its own set and natural sequence of methods and strategies. Traditional tasks aren't as demanding (but then they don't do as much either.)

Conclusion

A modern forward-looking curriculum will never be implemented as intended and students will not be prepared as they should without the widespread use of rich learning and assessment tasks in our schools. Tom Kieren, recently retired from the University of Alberta, once described teaching as an intellectual game of ping-pong where the purpose of the game is not to win but to keep the players in the game. Rich learning tasks will go a long way towards involving our students willingly and enthusiastically in the game. And, rich learning tasks will go a long way towards helping our students to play the game at a high level.

Comparison of Rich Tasks with More Traditional Tasks: A (Crude) Summary

Rich Tasks	More Traditional Tasks
1. prepare for success outside of school	1. prepare for success in school
2. address relatively many learning outcomes	2. address relatively few learning outcomes
3. address mathematical, non-mathematical, and cross-curricular learning outcomes	3. address primarily mathematical learning outcomes
4. provide an opportunity to use math and non-math skills in an integrated, often creative fashion, to a purpose	4. isolate on the use of relatively few math skills
5. are authentic	5. are more artificial
6. are in context	6. are usually out of context
7. encourage a balanced use of actions	7. encourage an unbalanced use of actions
8. are more like writing a story	8. are more like writing a sentence
9. emphasize problem solving	9. emphasize procedures
10. encourage more thinking and reflecting	10. encourage more recollection and practice
11. allow for demonstration of a wide range of performance	11. allow for demonstration of a narrow range of performance
12. need performance assessment strategies	12. need traditional assessment strategies
13. provide enrichment within the task	13. usually require enrichment to be added after the task
14. encourage the use of wide variety of teaching and learning strategies	14. permit the use of fewer teaching and learning strategies
15. encourage greater engagement of students and teachers in task	15. keep students and teachers distanced from the task
16. not a new/untried idea	16. a much-applied idea

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▲ Teaching Ideas from the Editor

Using Transformations to graph y = a sin (kx + d)

To Graph y = a sin (kx + d) using transformations several ideas must be understood.

1) The graph of y = sin x
   a) The graph of y = sin x is a wave with wavelength (and period) equal to 2π and amplitude equal to 1.
   b) Wavelength is a distance along the x-axis.
   c) Amplitude is a distance parallel to the y-axis.
2) Properties of Transformations
   a) x's are disobedient, for example, multiplication produces division and addition produces subtraction .
   b) y's are obedient, for example, multiplication produces multiplication and addition produces addition .

Application to the graph of $y = 4 \sin (3x+\pi)$

a) The" 4 sin" tells us that 4 multiplies y. Since y's are obedient, and amplitude is a y distance, the new amplitude is 4 x 1 = 4.

b) The "3x" tells us that 3 multiplies x. Since x's are disobedient, multiplication becomes division. Because wavelength is an x distance, the new wavelength (and period) is $\frac{2\pi}{3}$.

   Note that this implies the important fact for graphing that there are 3 wavelengths in 2π

c) The "$3x+\pi$" tells us that π is added to 3x, and hence $\frac{\pi}{3}$ is added to x $\left[3x+\pi = 3\left(x+\frac{\pi}{3}\right)\right]$.

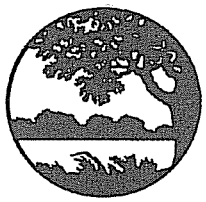
   Since x's are disobedient and $\frac{\pi}{3}$ is **added** to x, the graph of y = 4 sin 3x is moved $\frac{\pi}{3}$ units to the **left.**

Similar arguments can be used to graph y = a cos (kx + d) using the graph of y = cos x.

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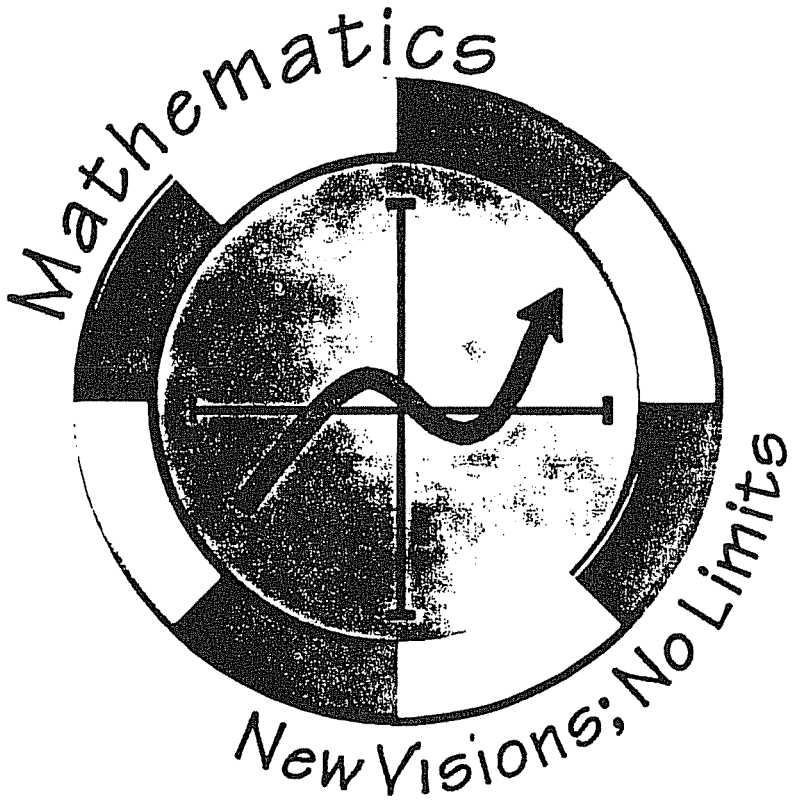
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▲ Directors' Dialogue



These notes are from the last meeting of the 1997-98 OAME Board of Directors held February 21, 1998.

This last meeting of the 1997-98 Board of Directors, was held on a warm, sunny Saturday (sounds like most days this winter!). With almost all Directors present, president Judy wished well all those retiring from the Board and extended best wishes to those seeking re-election. Special appreciation was shown for the valuable contributions of Nancy Moore, Shirley Fairfield, Rob McLeish and Barry Onslow. It is volunteers like these who make OAME the vital force it is today in Ontario's educational scene.

Secondary Reform

Judy Crompton and Myrna Ingalls reported on the work of the OAME-Fields consortium that was going after the contract to write the secondary mathematics guidelines. Even though you know the results of that bid now (June) the Directors did not know how it would turn out at the time. The OAME is always on top of things, and it is only the delays of printing and publishing that makes some news stale. For a different perspective on timelines, see the Internet version of this report at the OAME web site at:

http://www.mathstat.uoguelph.ca/oame/index.html.

If you have any interest in the direction that secondary education is taking, you will keep informed. The OAME is the best organized, most forward thinking subject organization in Ontario. You could have no better leaders working to move mathematics education forward to the 21st century.

Representatives

The OTF Curriculum Forum report was given in the last *Gazette.* Frances Schatz reported that through her efforts NCTM gave OAME a credit of over $1000 from some earlier bulk orders. If you plan to place any orders for NCTM materials, don't forget that placing your order through our OAME representative will generate a 20% rebate to OAME. You don't pay any more, but mathematics education in Ontario gets a bonus.

Professional Development

OAME 1998 is past - those who attended I'm sure had a wonderful time. Thanks were extended to Susan Stuart, Shawn Godin and the committee chairs for their innovative planning, inspirational locale and hard work. We also had a small sample of an inspirational vocal, with the North Bay choral group putting up a challenge to chapters attending to . . . shut up or sing! Leadership '97, delayed till early February '98 due to the fall job action, was also a resounding success. The average delegate rating was 4.8 out of 5. Way ta go, gang (and the gangsters were . . . Judy Crompton, Ron Sauer, Ralph Connelly and the many scintillating speakers and winsome workshoppers).

The timing and format of Leadership '98 was discussed, with Ralph Connelly sent away with several possibilities (No. He wasn't really sent away - get real!). Suggestions included summer institutes, fall sessions, winter interludes, separating panels, combining grades, and holding the sessions regionally. Look elsewhere in this *Gazette* for more information.

Resources

John Kersley again shared clippings and educational materials, including a publication from the Canadian Bankers Association. Yours truly shared some light electronic humour (not electric light humour) that has been making the email rounds.

Barry Scully showed a thought-provoking video about a teacher they hope will speak at OAME '99. Many members of Y^{4}MA have planning well underway for a return to the venue of the highly successful 1992 OAME Annual. The '99 theme is ***Mathematics: New Visions - No Limits***. It is not too soon to mark May 6, 7, 8, 1999 on your calendar.

As the OAME Annual conference continues its travels around the province, we move from North Bay in '98, to Richmond Hill, just slightly above Toronto, in '99 and on to the University of Ottawa where COMA is working on '00. (Now there! I don't see what all the fuss is about. My computer didn't blow up when I input '00 sputter, sputter, 00 00 00 0 00 .. 0 . . 0 . . 0 FATAL ERROR! ABORT! ABORT!)

Executive Directors

Dave and Bonnie issued rebate cheques to chapters according to the number of OAME members listed with them. Overall, membership is starting to rise again, but we must continue our efforts to make more teachers aware of the benefits of joining OAME. Sales of the Assessment booklets has been encouraging, with one currently out of print and one soon coming into print.

COMMITTEES

Awards: Mary Lou Kestell was awarded a Life Award. Her only publishable comment, when informed the next week, referred to her belief that this award was usually handed out to someone at the end of the road, and she "ain*t done yet!" If you want to see some of her recent accomplishments, check out Mary Lou's home page on the web at: http:// www.e-commerce.com/kestell/.

Mary Lou is currently seconded to the EQAO and has been working on the Grade 9 Provincial Mathematics Assessment. The Life Award is not given in just any year, **unless** there is someone exceptional that OAME wishes to recognize: Mary Lou definitely fits the bill. Congratulations!!

The Constitution committee reported on a change to the term of Vice Presidents, starting with the 1999 elections. Futures committee had to report that funding had not been found for this year's OMO. Thanks were extended to Don Gray for his preliminary planning and attempts to get local funding. Several chapters have expressed tentative interest in hosting the 1999 and 2000 OMOs. Hosts will be needed for 2001 for both the OMO and the Annual conference.

Barry Scully and Don Gray described a kit encouraging girls to study math, science and computers from Victoria B.C. (your chapter rep has the details). Math Equity has in fact moved on to recognize that, ***Everybody Matters - Everybody Counts***.

Nominations committee announced the election slate, but that's old news now. The Promotions committee has plans to visit the Faculties of Education to bring the good news of OAME to future teachers. For example, when Math-TE^{2}Y^{2}MS held its regional OMO, we had over 25 teacher candidates helping out. They spent the Saturday working with over 100 enthusiastic and eager grade 7 and 8 students, made useful career connections, obtained valuable practical, professional development, . . . and had a good time.

The **Publications committee** announced the extension for the two editors for another year, which will give time for a search for the next two literary leaders. This will definitely stretch John and Frances to their limits!

Each of the **curriculum committees** has been busy as well. *The Early/Formative Years* youngsters continue to collect articles and activities for the *Abacus*. In addition they are finishing the *Primary Assessment* document for the fall. The intermediaries on the Transitions team have prepared scope and sequence charts for grades 6, 7 and 8 to supplement the new *Ontario Curriculum*. These charts, along with posters, went on sale at OAME '98.

And finally the special people on the **Specialization Years committee** prepared a binder of resources, *Teaching Mathematics through Technology* , that is also now on sale. Included in the binder are Black Line Masters and 2 discs, slipped in the back. They are also collecting examples of exemplary *Rich Learning Tasks* to be distributed to Chapter reps and OAME members in the future.

As you can see from the brief summary above, your Chapter reps and Directors have been doing a lot of work for mathematics and education on these committees. Well done, thou true and faithful servants of OAME!

Chapters

The fall disruptions may have cancelled or postponed many PD workshops, but chapters continued to produce newsletters, run regional **Math Olympics** for grade 7/8 students, and plan for future mini-conferences. The best way to know what is happening in your area, in time to benefit, is to become involved. It need not take much of your time either. Sure you can wait for newsletters or peek at their web-sites to see if anything new is listed, but chapters do their best work with the help of many dedicated volunteers. Another set of helping hands, another point of view, another collection of experiences is always welcome, and need not take up very much of your time. The teacher candidates mentioned earlier, said that they got more insight into students and learning activities in one Saturday at the Olympics than reading several books. NOTE: they did NOT say the day was more meaningful that working with their faculty advisor, and it wasn't only because they were there with them! Check out the list on the back cover for your chapter rep and get in touch.

Adieu and à bientôt

This is my last column. As observant types have noticed, I have now taken on the position of President-elect. As such, it is not appropriate for me to report on the goings-on from the floor. The column will continue though, with Louis Lim letting you in on Directors' meeting happenings.

When Bob Robinson left the country, it provided me with an opportunity to take over his column, at that time

called Council Comments. I have enjoyed this opportunity and I hope I have been able to provide those not in attendance with a bit of the flavour of what your directors do for you and mathematics education in Ontario.

Summer looms on the horizon: a welcome relief for many, but with stress and anxiety abounding for many others. As you slip into a different schedule, try to remember the moral of the story of the glass of water that is either half empty or half full, and as Brian sang, "Always look on the bright side of life!" and now you can whistle a little tune . . .

Specialization Years Committee Report

The "Specialization Years" Committee of the OAME is looking at the ever changing challenge of making old tasks new. During a brain storming session, we came up with these starting points and ideas.

Making Old Tasks New

With an overhaul of the curriculum in motion, it might be easier than we think to change the way we teach mathematics. We are looking to model, transform, manipulate, consolidate and then communicate mathematics to our students. To achieve this, firstly, it would be nice if we could plan in larger blocks of time. In this way we could leave some 'explore' time. It would be ideal if we were given enough leeway to say "Over the next week I am going to cover...", and "I want the students to be able to..." . Then you have built in explore time. With blocks of time and some student directed activities, a teacher can take time for observations and recording. Secondly, we need to engage our students in the learning process. Instead of the teacher presenting all of the material, we should use activities such as whole group discussions. In these discussions, students would look at experimental results and suggest possible solutions to explain their results. Students could sit together in pairs and look for other connections in the material presented. Using web diagrams, they could draw all possible connections. A task could be explored which could link the web diagram and lead to an expected solution. We need to be open to what students say (seize the teaching moment). One way to communicate is for students to write up an account of what happened during the process. Consolidate, summarise and help make final connections to the content. Never underestimate the need to debrief the experience. Ask questions such as "What if?", "Any problems?", or "Can you change the numbers? If so, is this change significant?" Respond and keep track of what students do and say in the classroom. Thirdly, we need to look at how or why you got stuck in a lesson. Reflect on materials and process. After the activity, go home and say "How will I change this for next time".

We would like to see mathematics taught in a model, transform, manipulate, consolidate and communicate fashion. There is a place for the chalk board and chalk. But we on the **Specialization Years Committee** feel it should not be the only teaching tool in mathematics education.

collated by Jacqueline Hill (Pine Ridge Chapter rep)

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Hilroy Award Winner
Ron Lancaster

Ron Lancaster, a past OAME president, and a teacher at St. Mildred's-Lighbourn School won his third **Hilroy Award**. The Hilroy Award honours innovative and creative teaching. The September issue of the *Gazette* will contain an article on his development of the *Toronto Math Trails*.



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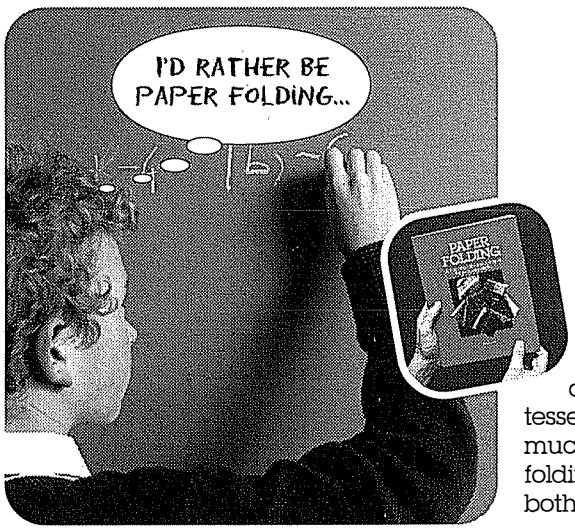
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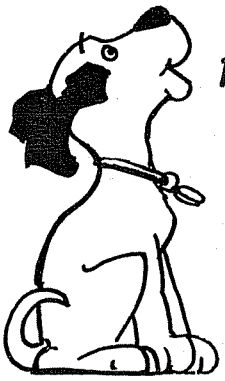
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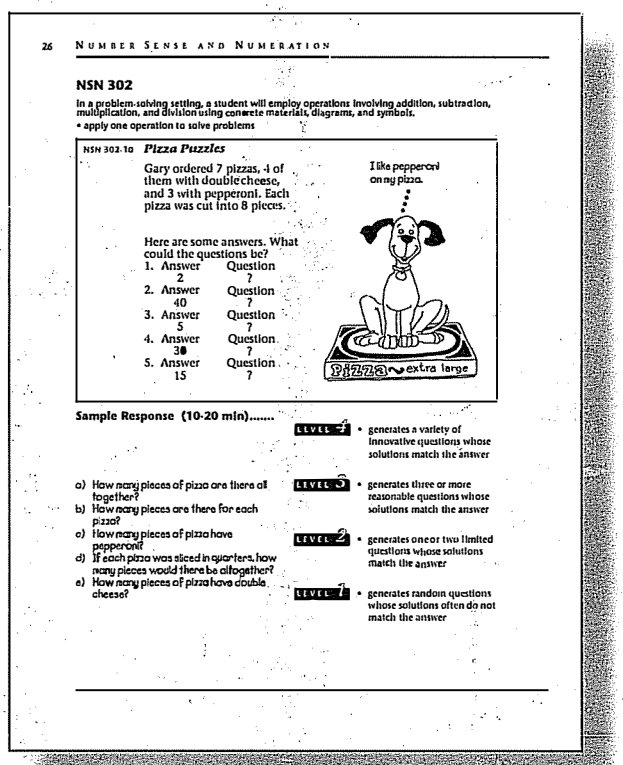
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26 NUMBER SENSE AND NUMERATION

NSN 302

In a problem-solving setting, a student will employ operations involving addition, subtraction, multiplication, and division using concrete materials, diagrams, and symbols.
• apply one operation to solve problems

NSN 302-10 ***Pizza Puzzles***

Gary ordered 7 pizzas, 4 of them with double cheese, and 3 with pepperoni. Each pizza was cut into 8 pieces.

I like pepperoni on my pizza.

Here are some answers. What could the questions be?

1.	Answer 2	Question ?
2.	Answer 40	Question ?
3.	Answer 5	Question ?
4.	Answer 30	Question ?
5.	Answer 15	Question ?

Pizza extra large

Sample Response (10-20 min).....

a) How many pieces of pizza are there all together?
b) How many pieces are there for each pizza?
c) How many pieces of pizza have pepperoni?
d) If each pizza was sliced in quarters, how many pieces would there be altogether?
e) How many pieces of pizza have double cheese?

LEVEL 4 • generates a variety of innovative questions whose solutions match the answer

LEVEL 3 • generates three or more reasonable questions whose solutions match the answer

LEVEL 2 • generates one or two limited questions whose solutions match the answer

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Sample activity page from
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