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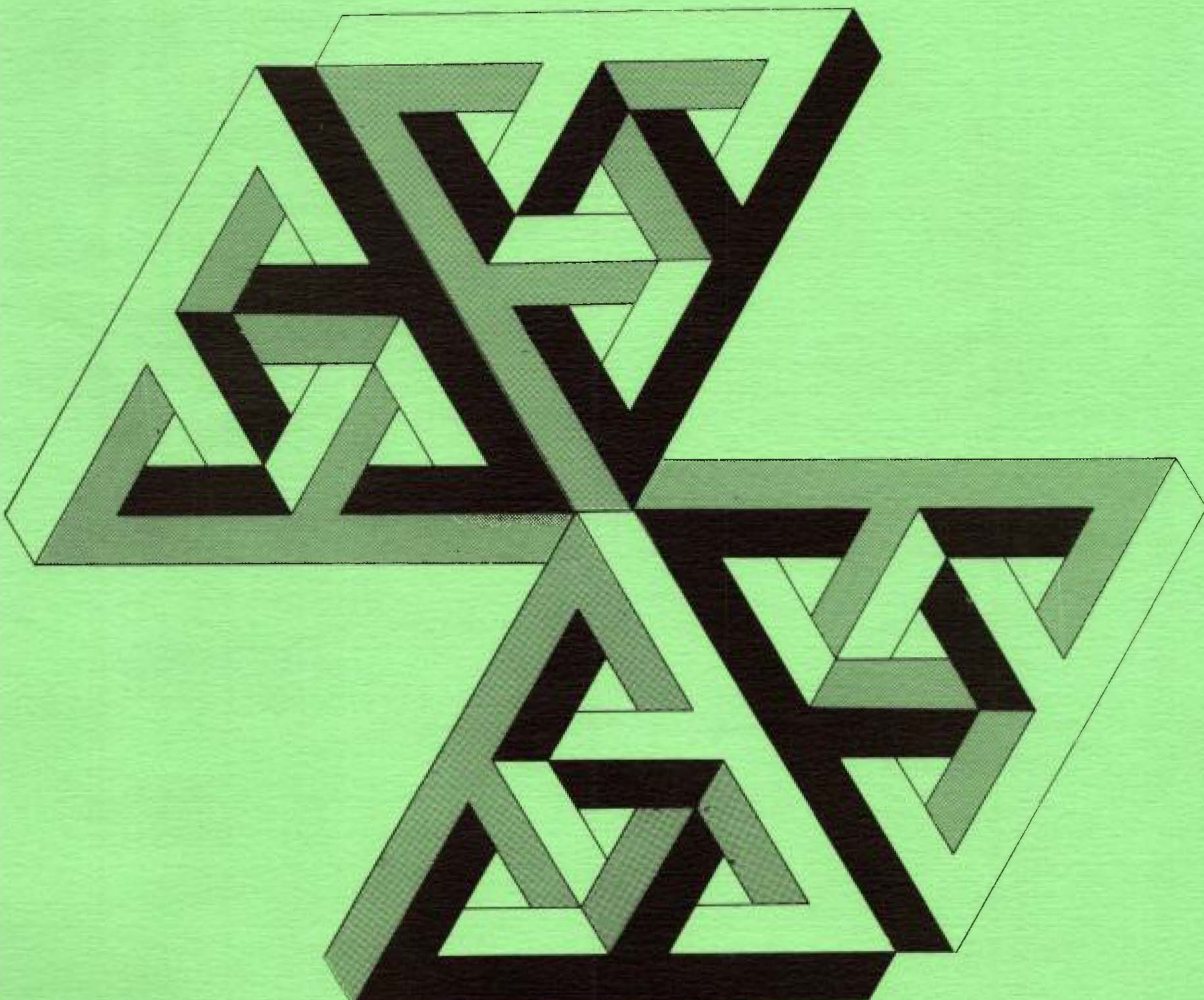
delta-k

THE ALBERTA TEACHERS' ASSOCIATION MATHEMATICS COUNCIL

Volume XX, Number 1 September 1980



National Council of Teachers of Mathematics

Regina Meeting

October 23-25, 1980

Host: Saskatchewan Mathematics Teachers' Society

The Saskatchewan Mathematics Teachers' Society invites mathematics teachers at all levels to the center of the Canadian grain belt for an outstanding NCTM meeting on October 23-25, 1980.

Regina, a city of 155,000, is located mid-way between Montreal and Vancouver. It is the heartland of rich Canadian prairies, home of the Royal Canadian Mounted Police, focus of potash production, and has large man-made parks, lake, and recreational areas.

The conference will focus on the current status of problem-solving, micro-computers and calculators, applications of mathematics, and mathematics education for the '80s. Notable speakers include NCTM President Max A. Sobel; former NCTM presidents John C. Egsgard and E. Glenadine Gibb; Charles E. Allen, Oscar F. Schaaf; Jane Martin; Gail Lowe, R.D. Phillips of Australia, Frank Ebos, W. Stannard, David H. Wheeler, Tom Kierens, Ruth Hoffman, Joseph Agassi, David Robitaille and Jim Prekeges. More than 70 sessions and workshops are planned.

Hotel rooms have been reserved at the Sheraton Centre and Saskatchewan Hotel. All convention activities will be in these two facilities.

The complete program booklet was mailed in July to NCTM members. Others may request copies from the NCTM Headquarters Office, 1906 Association Drive, Reston VA 22091.

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EDPRESS

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From the Editor's Desk

Future meetings of The National Council of Teachers of Mathematics:

"Name-of-Site" - Regina, Sask., October 23-25, 1980
59th Annual Meeting - St. Louis, Mo., April 22-25, 1981
60th Annual Meeting - Toronto, Ont., April 14-17, 1982

For other meetings, see the listings in *The Arithmetic Teacher* or *The Mathematics Teacher*. Some of these meetings may be convenient to a few of you, while the above should interest many more by reason of location or nature of meeting.

We wish to acknowledge many years of good and faithful service on the part of Don Hinde, who is retiring as Math Council treasurer. Thanks for all your hard work, Don, and good luck in future endeavors.

I would also like to thank all of you for your part in making *delta-k* a newsletter/journal which has partially met the needs of MCATA members as a regular item of communication. Thank you for your articles, items of information, activities and ideas.

At the time of writing this editorial, the Council lacks a vice-president, treasurer, new editor, three directors and a mathematics representative. Perhaps some members who are not now too active in professional activities would let the executive know if they are willing to use their talent to help MCATA continue to serve mathematics teachers throughout Alberta.

Our annual meeting this year is a little later than usual, and will be held on November 7 and 8 at the Capri Hotel in Red Deer. Tell us if this is a better time for you when you see us in Red Deer. Further information is included in school mailings and in *The ATA News*, along with registration forms.

Ed Carriger
Editor

An Alternative Course for the "I Hate Math and I've Never Been Any Good At It" Student

by *Elaine V. Alton* and *Judith L. Gersting*
Indiana University - Purdue University at Indianapolis

We've all encountered this student. Probably his (or her) dislike of mathematics comes from his previous lack of success with mathematics courses. His understanding of what constitutes mathematics is usually limited to visions of very complex arithmetic manipulations, with perhaps some x's and y's scattered throughout.

A high school student such as this is one whose career goal probably does not include college, or, if it does, not in a discipline where any knowledge of algebra is required. This student is either unprepared for or uninterested in first-year algebra; perhaps even unprepared for or uninterested in a general mathematics course. Many states have a graduation requirement of one year of mathematics. What opportunities can we offer this student to meet such a requirement? Should he be "retreaded" in a course containing the type of mathematics with which he has already had difficulty and which aims to prepare him for a level of mathematics he will probably not use?

Some schools are trying an alternative approach by offering a mathematics course designed to awaken the student's appreciation of mathematics in his world. Facility with computation is not one of the objectives of such a course, but hopefully the student will have a better understanding of mathematical thinking in a wider sense and be aware of uses of mathematics which affect him as a citizen, regardless of his occupation.

At the college level, similar problems exist with a large number of students. Why should an English major learn how to solve a quadratic equation? Can't we offer something more appropriate to satisfy a graduation requirement? In this article, we will discuss an alternative mathematics course which we developed at Indiana University - Purdue University at Indianapolis (IUPUI). There is nothing in the course, either in content or prerequisites, which makes it necessarily a college-level course. In fact, almost the same course is offered in several local high schools. If you are interested in developing an alternative mathematics course for your own school, the following discussion may prove helpful.

In all phases of setting up our course at IUPUI, that is, in the formulation of objectives, selection of text and topics, choice of methods of presentation, et cetera, we attempted to keep in mind the special needs and attitudes of the group of students who would take the course. In particular, we anticipated that many students would dislike or fear mathematics due to past failures; would have little awareness that mathematics enters into aspects of life where, as educated citizens in a technological society, they should strive to make informed decisions; and would think of mathematics as pretty dry and uninteresting stuff. Many of our students did indeed fit this picture, but we were pleasantly surprised at the number who really did not dislike mathematics - they simply had no need for traditional mathematics in their course of study.

At the beginning of the course, we shared with the students three broad objectives which had been formulated, namely:

1. to give you an insight into mathematics as a way of thinking, as an area of human endeavor, an art and a science that has been both useful and interesting to mankind throughout history;
2. to help make you aware of the ways in which mathematics touches your everyday life;
3. to show you that mathematics can be fun.

As part of the course evaluation at the end of the semester, we gave the students another copy of the objectives and asked how well they thought each had been met. There were surprisingly positive comments; in fact, this was overall the most highly rated item in the course evaluation.

Choices that we made in each of the following four categories were influenced by our desire to achieve the course objectives.

1. Textbook

We used *Mathematics, A Human Endeavor*, by Harold Jacobs, W.H. Freeman and Company, 1970. This is a visually appealing book in an easy-to-read format. It does not overwhelm the student, but at the same time has a number of interesting problems which do require thinking. In addition, there is an excellent teacher's guide to accompany the text, which is filled with ideas for additional discussion, demonstration, et cetera. This guide, unlike many others, is a truly practical supplement.

2. Topics

We covered the following topics from the textbook: inductive and deductive reasoning, number sequences, counting, probability, statistics, topology. In addition, we included a unit on metric measurement and one on computer science. These were done in the same spirit as the material found in the textbook. The text contains enough material to be used for a one-year high school course.

3. Course Requirements

Grades in the course were based on homework problems, a series of short tests, a brief term paper and class participation. Often, the class broke into small groups and the members of each group worked together on homework problems. There was a test after each topic. The tests grew progressively harder during the course of the semester, but the students did not seem to notice, or at any rate did not object.

We provided three topics for the term paper - Fibonacci numbers, magic squares, and the four-color problem. Each of these is a topic which is easy to understand, interesting, and about which there is a lot to say; of course, there is more now to say about the four-color problem than there was when we first taught this course! We provided a short list of references for each topic, but a number of students found additional references and wrote quite good papers. A student could also write a paper on an approved topic of his own choice. Class participation was a component of our grading scheme because it was essential to the success of the method of presentation we used.

4. *Method of Presentation*

This was probably the most unique feature of the course. We decided that mathematics did not need to be presented as a spectator sport, and we attempted to involve each student in an active learning experience. We never gave a single lecture in the course. Instead, the students participated in activities or experiments designed to lead them to ask questions and formulate and test conclusions. Some of the activities were individual, some were done as demonstrations by volunteers from the class, but most were done within the small groups mentioned earlier. The membership of the groups developed quite naturally, and as the semester progressed there was a lot of mutual help and support going on in the individual groups.

We used a lot of instructional aids - posters, models, overhead transparencies, handouts, demonstrations, readings or pictures from other books - to stimulate discussions. The teacher's guide to the text provided many excellent suggestions, such as the "paper cutting race," to introduce the Moebius band and the topology unit. At the very least, it was impossible to sit passively in this class, and we certainly kept everyone awake!

There was one more unusual feature to this course. We submitted a course proposal, which was approved a year before the class was scheduled. The semester before the course was offered, both of us were involved in planning the course objectives, content, and requirements, as well as in developing and collecting instructional materials.

When the class actually began, we used what might be called "cooperative teaching." Each of us attended every class, and while one person was responsible for directing the class sessions during a given topic, the other person knew what was going to happen each day and could aid in guiding the discussion, setting up for a demonstration, or working with the groups. The short tests for each topic were designed jointly; we conferred on assignment of final grades. Because this is not a cost-effective way to teach any but a large class, we have not repeated this arrangement, but it was a good way to initiate a course of this nature and was an interesting experiment. You and another teacher might want to try this arrangement if you have the opportunity to combine several classes.

How successful has this course been? From all reports, the high school course has been well received and has apparently reached some previously turned-off students. Our own course at IUPUI has received high student evaluations and has grown slowly, in spite of the fact that mathematics is not a specific graduation requirement for many programs.

If you are interested in beginning such a course at your own school, you may encounter some opposition from faculty or administrators who feel the course is not sufficiently mathematical (read computational). One reply to this is that the student has not benefited much from his past computational courses; at least in an alternative course such as this he has a chance to learn some new mathematical ideas and develop a new and more positive attitude toward mathematics. One of our students said, while working with geometric sequences, "I was never any good at mathematics, but *this* is *fun*."

Introducing Calculus to High School Students

by *Ved P. Madan*
Red Deer College, Red Deer, Alberta

When you first took mathematics, the study was primarily concerned with the "arithmetic" - a subject dealing simply with such elementary operations in mathematics as addition, subtraction, multiplication and division. The arithmetical concepts were then explored further by introducing algebra, which provided answers to most everyday mathematical problems. After learning algebra, you almost became an independent person, who could handle the complexities of a shopping spree all alone!

The geometrical concepts probably were introudced along with the algebraic, and so you began to appreciate the beauty of nature. Geometry provided another dimension to the abstract mathematical knowledge. However, to meet the future challenges of the world of math, you had to pursue yet another investigation - the so-called study of "trigonometry." Trigonometry utilized the knowledge of algebra and geometry and made you a more matured teen-mathematician. All this because you were now studying higher math, or the advanced math, as some people put it.

You have thus studied arithmetic, algebra, geometry and perhaps trigonometry as well in this sequence; have you given any further thoughts as to what subject in math would be next, and why? Both algebra and geometry have provided valuable service in finding solutions to many problems, and they are undoubtedly still irreplaceable when it comes to specific solutions. But, with the progress of science and technology, mathematicians have had to look for yet other means that will account for the instant variations and/or accumulations of the factors influencing the problem. To give you an example, consider the problem of calculating interest. Algebra could be used for the problem if the interest was derived on an annual or even a monthly basis; how difficult would it be if the banks were to allow interest daily, hourly, or instantly? So, to catch on with the changing needs of the society, we must study yet another branch of mathematics, namely, calculus.

Luckily, this new subject has already been developed in great depth. The main objective of this article is to convince you that our studies in mathematics would not only be incomplete, but also incomparable, without the knowledge of calculus.

W. Leibniz (1646-1716) and Isaac Newton (1643-1727) independently invented two different phases of calculus. These are classified as differential calculus and integral calculus respectively. Differential calculus investigates functions and calculates certain limiting values. The central concept here is that of the derivative. The investigation of many problems is unthinkable without the concept of the derivative. Integral calculus, on the other hand, is a limiting process which determines the area bounded by a curve or the volume enclosed by a surface by approximation techniques. Newton recognized in 1665 that differentiation and integration are inverse problems to each other.

As mentioned earlier, the main reason for studying calculus is that differential calculus and integral calculus both have tremendous applications. Applying the theory of differential calculus, we can find the solutions to maxima or minima problems, study related rates, and sketch the graphs of given functions, while integral calculus can determine arc lengths, surface areas, and volumes. Differential and integral calculus are used jointly to describe some important relationships in mechanics and vector analysis. The applications in mechanics are concerned with the work, moment, centre of mass, et cetera. Vector analysis studies vector fields and flows of physical quantities via the important theorems of Gauss and Stokes.

The basics of calculus are not just useful to professionals in the mathematics area. Academics in many other disciplines, such as engineering, physics, chemistry, biology, economics and medicine, are also dependent upon calculus directly or indirectly.

A basic two-semester course in calculus generally begins with the study of topics such as the *function* and the *limit*. These are the concepts which have given birth to the subject of calculus. A function is a rule which expresses the relationship between two quantities called the variables (independent and dependent variable). Limit is the value which the function approaches as the independent variable "x" approaches a fixed value "a."

Once you realize that in actuality all problems of the world are one function or the other and their instantaneous response is a limit, you will find yourself in the realm of calculus, and having learned some basic rules of calculus which relate to the differentiation and integration techniques, you will find yourself surrounded by numerous applications of calculus as they unfold, one after the other!

MATH PUZZLES

(Primary grades)

- Parker

Two duplicating master books - Book 1: Addition and Subtraction to 10; Book 2: Addition and Subtraction to 20. Twenty duplicating pages in each book. Students do the math problems and then put the puzzle together. When the puzzle is completed it forms a picture of an animal. Cost is $6.25 for each book; 20 pages of masters plus two answer pages.

Available from:
Western Educational Activities Ltd.
Box 3806
Edmonton, Alberta
T5H 2S7

Publisher: Creative Teaching Press

Six New Publications from ERIC

The following publications are now available from ERIC Clearinghouse for Science, Mathematics, and Environmental Education, The Ohio State University, College of Education, Third Floor, 1200 Chambers Road, Columbus, Ohio 43212.

An Analysis of Mathematics Education in the Union of Soviet Socialist Republics (USSR). This publication was prepared at the invitation of the National Institute of Education to report on the current status of mathematics education in the USSR. The booklet discusses the curriculum in Soviet schools, instructional practices, research ideas and the general milieu of the students, teachers, parents and others in a system that has a different heritage, and thus different strengths and weaknesses, from the American system. 178 pages, $4.25

* * * * *

Mathematics Education Reports contains abstracts of all papers presented in the research reporting sessions of the NCTM 58th annual meeting in Seattle, Washington, April 16-19, 1980. 53 pages, $2.50

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Calculators: A Categorized Compilation of References will assist teachers, researchers, and others who need and want useful references on calulators which might be of immediate aid to them. 180 pages, $5.50

* * * * *

Applied Mathematical Problem-Solving is the result of a collection of papers on varied perspectives on applied problem-solving that was presented at a conference held at Northwestern University in 1978. The booklet contains a wealth of information on various related topics, as well as trends in research and models for applied problem-solving. 257 pages. $6.50

* * * * *

Some Theoretical Issues in Mathematics Education: Papers From a Research Presession. This booklet contains papers presented during the NCTM Research Advisory Committee and Special Interest Group for Research in Mathematics pre-session at the NCTM 58th annual meeting in Seattle. 74 pages, $2.50

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Understanding the Realities of Problem-Solving in Elementary School. As the title suggests, this booklet has practical pointers for "real" teachers to help "real" children as they consider the book's numerous ideas and put them to use in the classroom. 66 pages, $2.00

Calculator Information Center

The Calculator Information Center at The Ohio State University has received funding from the National Institute of Education for another year of operation. The NCTM has a subcontract with the Center to aid in the distribution of information about calculator uses in education. *Reference Bulletin No.25*, citing selected references on calculator activities and research at all levels, has been mailed to those on the Center's mailing list. If you would like a copy (and would like your name added to the mailing list to receive future reference bulletins), contact the Calculator Information Center, 1200 Chambers Road, Columbus, Ohio 43212.

Several annotated reference bulletins will be developed this year, and another is scheduled for mailing in January. The Center will also produce three information bulletins (in August, January, and February). Write to the Center or to NCTM for these bulletins, which are designed for readers with specific interests. The first one will contain secondary-level activities.

In early 1981, the Center will prepare an annotated bibliography containing references located since the June 1979 bibliography (available from ERIC/SMEAC at a cost of $5.50), and a set of critical abstracts of research with calculators. Finally, a state-of-the-art review was to be sent to all on the mailing list in August.

Previous materials produced by the Center are available from the ERIC Document Reproduction Service (Box 190, Arlington, Virginia 22210):

- Reference Bulletins from the Center - ED 167 426
- Information Bulletins from the Center - ED 171 574
- State-of-the-Art Reviews on the Use of Calculators - ED 171 573
- Investigations with Calculators: Abstracts and Critical Analyses of Research - ED 171 572
- Investigations with Calculators: Supplement - ED 171 585

If you want to continue to have your name on the Center's mailing list, you must inform them. If you have not done so, your name was removed from the mailing list as of July 1.

References on Instructional Activities, Research Reports, and Other Topics Related to Calculator Use

Excerpts from the Calculator Information Center *Reference Bulletin No.25*, May 1980.

References have been selected from those collected during the past year. They are grouped to aid you in locating materials which you might find particularly useful.

Activities for Students, K-12

Bitter, Gary. "Count on the Calculator!" *Teacher,* 96:67-68ff, February 1979.

Use of calculators for elementary students is recommended, so that they may concentrate on the sense of a problem. Activities on place value, estimation, and operations are suggested.

Dickson, T.R. *The Hand Calculator Handbook*. Aptos, California: Alchemy Press, 1978.

Calculator algorithms for problems ranging from root findings of equations to trigonometry, surveying, navigation and finances are included.

Elich, Joseph, and Carletta Elich. *Trigonometry Using Calculators*. Reading, Massachusetts: Addison-Wesley, 1980.

This book is designed for a one-semester or one-quarter course in trigonometry, with calculator use integrated.

King, Ronald S. "Concurrent Processing with Calculators." *MATYC Journal,* 14: 13-16, Winter 1980.

Two types of problems that could be used to develop the idea of concurrent processing with calculators are presented.

Maor, Eli. "A Summer Course with the TI 57 Programmable Calculator." *Mathematics Teacher,* 73:99-106, February 1980.

A six-week course for students aged 8-11 and 12-15 is outlined, and how some topics were explored is described.

McCarty, George. "Display Calculators Bring a New Dimension to Teaching." *Audio-Visual Instruction,* 24:20-21, September 1979.

A method of using a display calculator for communicating algorithms in classroom mathematics instruction is described.

Shields, Joseph J. "Mini-Calculators and Problem Solving." *School Science and Mathematics,* 80:211-217, March 1980.

How the calculator can facilitate the development of problem-solving skills is discussed.

Research Reports, K-6

Balka, Don S. "A Survey of Parents' Attitudes Toward Calculator Usage in Elementary Schools." South Bend, Indiana: University of Notre Dame, 1979.

Teachers in a workshop sent a 12-item questionnaire to parents and teachers of Grades K-9; 334 responses were received. Parents were skeptical about the use of calculators in elementary grades. They agreed that calculators could be used for motivation, and along with paper-and-pencil computation, but expressed moderate disagreement with the use of calculators for homework and were very negative about replacing paper-and-pencil computation.

Cohen, Martin P., and Robert F. Fliess. *Mini-Calculators and Instructional Impact: A Teacher Survey*. Pittsburgh: University of Pittsburgh, 1979. ERIC: ED 178 360.

Teacher attitudes, practices, and perceptions about school policies on calculator use were surveyed. Over 63 percent were strongly or mildly in favor of using calculators. The need for instructional materials using calculators was apparent.

Engelmeyer, William James. "The Effectiveness of Hand-Held Calculators for the Remediation of Basic Multiplication Facts." (University of Maryland, 1978.) *Dissertation Abstracts International*, 39A:5381, March 1979.

Three groups of underachieving seventh-graders (n=193) participated. One group received 15 minutes extra of practice on multiplication facts with calculator feedback. A second group had 15 minutes extra group instruction on the facts, while a third group had only "normal" mathematics instruction. No significant difference in achievement was found between the two extra practice groups.

Moser, James M. *The Effect of Calculator Supplemented Instruction Upon the Arithmetic Achievement of Second and Third Graders*. Technical Report No. 502. Madison: Wisconsin Research and Development Center for Individualized Schooling, September 1979. ERIC: ED 180 764.

Four classes in Grades 2 and 3 used calculators with the ongoing instructional program, while four classes did not have access to calculators. Significant differences favored the second-grade calculator group only on subtraction, and third-grade group only on place value and division; no other differences were significant.

Pederson, Dean Anthony. "The Effect of the Calculator on the Elementary Mathematics Student." (University of Northern Colorado, 1978.) *Dissertation Abstracts International*, 39A:4794, February 1979.

Students in Grades 2, 3, and 6 (n=309) were assigned to groups using or not using calculators for eight months. No significant difference in achievement was found.

Roesch, Carl J. "Reflecting the New Computation in Eleventh Year Mathematics." Buffalo: State University of New York at Buffalo, 1978.

This report presents comments and data from a teacher using the Math 11 programmable calculators materials by Rising et al.

Miscellaneous Concerns

Kiehl, Charles F. and Ann B. Harper. "My Child the Math Whiz! Or Buy Your Child a Calculator." *Education*, 100:18-19, Fall 1979.

An overview of advantages and disadvantages of using calculators is provided.

Moursund, David. "It's OK to Use Calculators (A Message to Elementary School Teachers)." *Computing Teacher,* 6:3-5, May 1979.

A clear rationale, encouraging teachers to accept and explore uses of calculators in elementary school classrooms, is presented.

Reiling, Mary J. and Gerald R. Boardman. "The Hand-Held Calculator Is Here: Where Are the Policy Guidelines?" *Elementary School Journal,* 79:293-296, May 1979.

A review of articles on the use of calculators is given, with an emphasis on research conclusions. The need for policy guidelines is discussed, and eight guidelines are suggested.

Werner, Marijane. "The Hand-Held Calculator and Its Impact on Mathematics Curricula." *School Science and Mathematics,* 80:29-36, January 1980.

Suggestions from reports on calculators are presented, including conference recommendations.

Post-Secondary Level References

Berg, Gary A. *Using Calculators for Business Problems.* Chicago: Science Research Associates, 1979.

Biondi, M., V. Midoro, and D. Pescetti. "Use of Programmable Pocket Calculators in Engineering Introductory Courses." *International Journal of Electrical Engineering Education,* 10:128, 1979.

DuRapau, V.J. and John Bernard. "From Games to Mathematical Concepts via the Hand-Held Programmable Calculator." *International Journal of Mathematical Education in Science and Technology,* 10:417-424, July-September 1979.

Three games involving functions and proof are presented, with the aim of stimulating creative thinking.

Hector, Judith H. *Using a Calculator to Teach Fraction Computation in Basic Arithmetic: Research and Observations.* Knoxville, Tennessee, June 1979. ERIC: ED 171 520.

Learning calculator-based algorithms produced no difference in computational skill, understanding, attitudes or length of time to learn when compared with conventional algorithms.

Koop, Janice B. "Calculators and the Community College Arithmetic Class." *MATYC Journal,* 14:113-120, Spring 1980.

The aims of remedial arithmetic courses for community college students are considered, with reasons for using calculators in such a course given.

McCarty, George. "Calculator-Demonstrated Math Instruction." *Two-Year College Journal,* 11:42-48, January 1980.

A demonstration for a calculus class on Newton's method is described, with general principles for planning demonstrations noted.

The Mathematics Curriculum and the Learner

by *Marlow Ediger*

Dr. Ediger is a professor of education at Northeast Missouri State University, Kirksville, Missouri 63501.

Teachers, principals, and supervisors seemingly emphasize the use of a single or multiple series textbook to provide major sequential learnings for pupils in the mathematics curriculum. Reasons given for a textbook-centred mathematics curriculum include:

1. The teacher cannot develop his/her own creative units of study in each busy day of teaching. A reputable textbook with a relevant accompanying manual may do a good job of assisting teachers to select vital objectives, learning activities, and appraisal techniques for pupils within the framework of teaching-learning situations.

2. Developers and writers of reputable mathematics texts have spent much time and money in their completed product. Sequential learnings may then be provided when content is presented to learners in the order contained in the adopted mathematics textbook.

3. The use of reputable mathematics texts has stood the test of time. These texts have been used for decades, and with needed revisions may be relied upon to provide significant learnings for pupils.

4. With today's emphasis on the basics, content within a reputable mathematics text might well provide essential learnings for pupils.

The Psychology of Teaching and Learning

Teachers, principals, and supervisors need to test their hypotheses on methods of teaching and learning against recommended criteria from the psychology of education. Which criteria in the educational psychology arena, based upon research findings, might assist pupils to achieve optimally if followed by educators in the school setting?

1. Pupils need to experience interesting learning activities to achieve desired ends. Effort put forth by pupils in the mathematics curriculum may then be sustained due to perceived interest.

2. Purpose needs to be developed in each unit of study. When purpose is involved in learning, learners accept reasons for participating in each activity and experience.

3. Meaning must be attached to that which is being learned. If pupils perceive meaning pertaining to facts, concepts, and generalizations being emphasized in each unit of study, they will better understand what is being learned. Learnings acquired meaningfully will also be retained for a longer period of time compared to content gained in a non-meaningful manner.

4. Adequate provision must be made for pupils with diverse capacities and achievement levels. Each pupil, then, is guided to achieve optimal development pertaining to understandings, skills, and attitudinal objectives in the mathematics curriculum.

Theories of Learning and the Mathematics Curriculum

Teachers, principals, and supervisors need to analyze and ultimately implement that which is desirable from the diverse theories of learning in the educational psychology arena. Implementing a theory or several theories may well assist in providing interesting, purposeful, and meaningful learnings to provide for individual differences in the mathematics curriculum.

Programmed learning emphasizes that pupils progress in very small sequential steps. Thus, for example, a pupil may view an illustration in a programmed textbook, read a sentence or more, and respond to a completion item or question. Immediately thereafter, a pupil may check the correctness of his/her response against the correct answer as given by the programmer. If the response was correct, reinforcement in learning is then in evidence. If the response was incorrect, the learner should carefully notice the correct answer and thus be ready for the next linear item in learning. This procedure may be followed again and again in programmed methods of teaching.

Assumptions inherent in programmed learning to guide optimal achievement of each pupil include the following:

1. Each pupil will be achieving at his/her optimal rate in learning regardless of the rate of progress of others in the class setting.
2. A pupil knows the right answer to a previous programmed item before approaching the next sequential step of learning. As a result, incorrect responses are not practiced.
3. The breadth of content covered in each sequential step of learning is small in scope. Otherwise, a learner may not be able to acquire needed subject matter in a specific interval of learning.
4. Specific items of content covered within the framework of programmed learning are generally field-tested and written so that pupils individually will make few or no errors in achieving sequential learnings.
5. Independently, each pupil may read, view a related illustration, respond and check his/her own response before attending to the next sequential item. The teacher, of course, gives assistance as needed.

Teachers, principals, and supervisors, in analyzing and appraising programmed learning, may ultimately wish to implement some or all of the above listed tenets.

Measurably stated objectives in the mathematics curriculum have become quite popular both inside and outside the framework of state and district approaches to accountability. Objectives in ongoing units of study in mathematics, such as the following, sound familiar:

- The pupil will correctly solve nine out of 10 word problems on page 70 in the adopted mathematics textbook.
- The pupil will correctly add 14 out of 15 problems, each containing three two-digit addends.
- The pupil will correctly multiply five of six problems, each factor having three digits.

The teacher generally determines which specific ends pupils are to achieve in each unit of mathematics study when measurably stated objectives are utilized in the instructional sequence. The teacher may also choose learning activities for learners to attain the desired ends. Ultimately, each pupil's progress is measured in terms of having attained the predetermined ordered measurable objective.

Assumptions inherent in utilizing measurably stated objectives in the mathematics curriculum include the following:

1. The teacher generally is in the best position, academically and educationally, to select objectives, learning activities, and appraisal techniques for pupils.

2. What is vital to learn by pupils is measurable.

3. Essential or basic learnings for pupils can be identified with considerable certainty in the mathematics curriculum.

4. Teachers need to be accountable in terms of relevant learnings acquired by pupils in the mathematics curriculum; pupil success in attaining precise ends may also reveal proficiency in teaching.

Humanism as a psychology of teaching and learning has also had strong supporters in education. Humanists believe that pupils with teacher guidance need to have ample opportunities to choose objectives as well as learning activities. Learning centers in the school-class setting may well assist in fulfilling these needs. Each pupil may choose which specific task to work on at any of several learning centers. The pupil then sequentially chooses activities and experiences in the mathematics curriculum. If a pupil is not actively involved in choosing and pursuing goals, the teacher is there as a stimulator and guide to assist. There are diverse choices which may be made by pupils in the mathematics curriculum, including the use of:

- programmed learning and measurably stated objectives;

- reputable mathematics textbooks to acquire sequential learnings;

- laboratory means of learning in the mathematics curriculum;

- activity-centred methods stressing projects and learning by doing approaches.

Assumptions involved in humanism as a psychology of learning to aid pupils in achieving optimally in mathematics include the following:

1. Within a flexible framework, the pupil is in the best position to determine what is vital to learn, as well as the sequence in learning. The psychological rather than a logical curriculum is then in evidence.

2. The learning environment becomes increasingly humane, as pupils are actively involved in determining the ends and means of learning. A teacher or programmer determining the curriculum in selecting measurably stated objectives, activities to attain these ends, and appraisal techniques would be frowned upon by humanists.

3. Trust and confidence between educators and pupils needs to be in evidence in the school-class environment. Thus, pupils may be choosers of their own experiences and destinies.

Selected References

Ediger, Marlow. *The Elementary Curriculum. A Handbook*. Kirksville, Missouri: Simpson Publishing Company, 1977.

Marks, John L. et al. *Teaching Elementary School Mathematics for Understanding*. New York: McGraw-Hill Book Company, 1975.

Riedesel, C. Alan. *Guiding Discovery in Elementary School Mathematics*. New York: Appleton-Century-Crofts, 1973.

Yelon, Stephen L., and Grace W. Weinstein. *A Teacher World*. New York: McGraw-Hill Book Company, 1977.

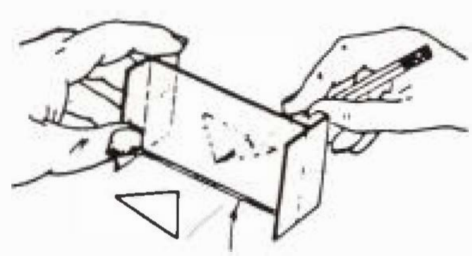
Mira Math for Grades 7-12

Reprinted from The Math Post.

Junior High and High School Teachers: Have you tried these activities with miras? The Mathematics Team has class sets of miras which can be borrowed for one-month intervals.

1. Investigate *images* of 3-D objects and of plane figures. For plane figures, draw the image and the reflection line. Practise with a variety of figures (points, segments, angles, triangles). Conjecture on the position, size, shape and sense of the image. Point to a part of the object and observe the corresponding part of the image. Draw the image when all or part of the object is behind the mira. Define reflection. Grades 7-10.

2. Conjecture on *properties of reflection*. Test each of these in a number of cases. Use the mira to draw the image and a variety of ways to test the property (paper folding,



cut-outs, acetate sheets, measuring instruments). Grades 7-10.

3. Investigate *line-symmetry* in a variety of figures (non-geometric and geometric), establish the meaning of line symmetry, relate plane symmetry in a 3-D object with line symmetry in a 2-D drawing of it.

Practise drawing lines of symmetry and creating figures and designs that have line symmetry. Grades 7-10.

4. Investigate the *line symmetries of various geometric figures:* triangles, quadrilaterals, regular polygons, others. Investigate properties associated with two or more lines of symmetry, and the images in a pair of hinged mirrors. Vary the angle, use the mira to draw diagrams to represent what you see, kaleidoscope, set the mirrors at right angles and look straight into the hinge. Examine what you see. Grades 8-12.

5. *Basic constructions related to line symmetry:* perpendicular lines, line through a point perpendicular to a line, perpendicular bisector, angle bisector, arc bisector, centre of a circle, test for parallel lines, draw parallel lines, mid-line et cetera. Application of these techniques to the study of altitudes, perpendicular bisectors, medians, angle bisectors of triangles. Investigate other construction problems. Draw various geometric figures: isosceles triangle, rectangle, rhombus, regular octagon. Grades 7-10.

6. Relate the mira to *paper folding* activities. Grades 7-12.

7. *Symmetry in the integer line.* Grades 7 and 8.

8. *Symmetry* in the *addition matrix* and the *multiplication matrix.* Grades 7 and 8.

9. *Reflection-congruent figures:* meaning of congruence, corresponding parts, draw the reflection line of two reflection-congruent figures, trace two congruent figures (points, circles, line segments, arcs, angles, triangles) and find the least number of reflections to map the one onto the other, direct congruence and opposite congruence, definition of congruence. Draw two triangles given SSS, SSA, SAS, ASA, SAA, AAA, HS and HA, and test for congruence, sufficient conditions for congruence. Grades 7-10.

10. *Properties of geometric figures:* Many of the properties stated in theorems and deductions of Euclidean geometry may be discovered (conjectured) by constructing the figures with a mira and/or testing with the mira for example, opposite angles of two intersecting lines, isosceles triangle theorem, properties of a rhombus, rectangle, parallelogram, equal chords of a circle. Grades 7-10.

11. *Applications to drafting,* 2-D representations of 3-D objects - drawing lines that meet at a vanishing point off the page. Grade 10 or later.

12. A formal study of *Euclidean geometry* can be based on reflections: reflection is defined, a few conjectures from number 2 are assumed as postulates and others are proved, then theorems and deductions follow. This approach is taken in *Geometry, A Transformation Approach,* Coxford and Usiskin, Laidlaw Publishing (Doubleday in Canada). The mira can be used to discover many properties, demonstrate many of the proofs and theorems, draw diagrams and stimulate ideas for proofs. Grade 10 or later.

13. *Composites of reflections.* The mira can be used to discover that rotation and translation are composites of two reflections in intersecting and parallel lines respectively. Glide reflection is the composite of three reflections. Given two congruent figures, the isometry by which they are related can be determined with the mira. Properties relating the reflections of these isometries can be discovered with the mira. Grade 8 or later.

14. Images under *dilations*, *stretches*, and *shears* can be drawn using the mira; some of their properties may then be conjectured. Grade 10 or later.

15. *Conics*. The envelope of a parabola, ellipse, and hyperbola can be drawn with the mira. These conics can be plotted point by point to specified dimensions revealing their locus laws. Tangents from a point, at a point, and with a given direction can be drawn accurately. Reflection and other properties of conics can be discovered. Common tangents can be drawn to any pair of conics (including circles). Grade 11 or later.

16. *Graphing on plain paper*. Draw the axes, scale the x-axis, reflect this onto the y-axis. Plot (a,b) by reflecting the y-axis perpendicular to the x-axis through (a,0). Investigate the image of (a,b) under reflection in y=0, x=0, y=x, y=-x, and the origin (composite of two reflections). Use the line symmetry of a function to assist in plotting it. Given functions f and g, using the mira graph f^{-1}, $\lfloor f \rfloor$, 1/f, f+g, f-g, and f∘g. Grades 8-12.

17. *Vectors*. Demonstrate a (geometric) vector as an equivalence class of directed line segments. Sum two or more vectors geometrically and by components. Solve force, navigation, and velocity problems geometrically. Grades 10-12.

18. *Trigonometry*. Plot sin, cos, and tan using a point-by-point technique. Graph their inverses and reciprocals. Graph the image of sin or cos under a translation. Demonstrate or discover identities related to reflection, for example, $\cos\theta=\cos(-\theta)$, $\sin(\frac{\pi}{2}-\theta)=\sin(\frac{\pi}{2}+\theta)$, $\sin(\frac{\pi}{2}-\theta)=\cos\theta$. For Grades 11 and 12.

19. *Optics*. Investigate i=r, a divergent pencil reflected from a mirror, a parallel beam reflected from a mirror, reflection of parallel rays striking a concave or convex spherical mirror (aberration). Draw diagrams for concave spherical mirror, convex spherical mirror, convex lenses, concave lenses. Investigate reflection of parallel rays from a concave and convex parabolic mirror. Grade 11 or later.

READING MATH

(Junior/Senior High)

- Cornett and Cornett

Topics include: Tune Up on Math; Word Power is Reading Power; Building Comprehension Skills; People and Careers in Math; Fine Tuning Reading Skills; Reading Math for Fun.

Students with reading difficulties need extra help. *Reading Math* gives them the practice they need to successfully read math texts, study, and take tests. This has been a long-awaited book. Cost is $5.35; 184 pages.

Available from:
Western Educational Activities Ltd.
Box 3806
Edmonton, Alberta T5H 2S7

Publisher: J. Weston Walch

PLUS +++

Pre-College Statistics for the '80s

John Del Grande, mathematics coordinator for North York, organized a committee of Ontario educators to develop guidelines and materials in statistics which could be used experimentally in Canadian secondary schools. Financed by the Samuel Beatty Fund, the group of 13 has produced two publications: *Pre-College Statistics for the 80s* (skeleton K-13 curriculum and topics for Grades 9-12), and *Statistics for Grade 13* (author Neil Walsh, North York).

These are copyrighted, but, while not available for commercial use, may be reproduced for experimental classroom use. For further information, write to Mr. J.J. Del Grande, Mathematics Coordinator, North York Board of Education, 5050 Yonge Street, Willowdale, Ontario M2N 5N8.

NCTM: An agenda for action

NCTM members have recently received a pamphlet detailing recommendations for school mathematics in the '80s. Entitled *An Agenda for Action,* it calls for a focus on problem-solving, for a broad approach to basic skills, evaluation, and curriculum, as well as for higher standards in the teaching of mathematics. For a copy, write to the National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091.

Call for Competition Information

The Canadian Mathematical Society Education Committee is anxious to compile a list of all school mathematical competitions held in Canada - information which it hopes to make available across the country. Please send Professor E.R. Williams, Department of Mathematics, Memorial University, St. John's, Nfld. A1C 5S7, the following information: name of competition, sponsor and local organizer, region of competition and regulations. Include, if possible, recent question papers.

Publication from Ontario Mathematics Coordinators

The Ontario Mathematics Coordinators' Association has produced a draft of a publication, *A Rationale for Elementary and Secondary School Mathematics.* For information, contact Mr. Brock Rachar, Mathematics Coordinator, London Board of Education, Oak Park School, 40 Hunt Club Drive, London, Ontario.

Problems for High School Students

The Canadian Mathematical Society has just published the fourth book in its series of problems for high school students. This volume contains 100 problems prepared by E. Barbeau, M. Klamkin, and W. Moser, and can be obtained for $2.50 from the Society's office at 577 King Edward, Ottawa, Ontario K1N 6N5.

Curriculum Revision

The Canadian Mathematical Society Education Committee is seeking information about proposals and initiatives for curriculum revision in all provinces. This should be sent to the chairman, Professor George Bluman, Department of Mathematics, University of British Columbia, Vancouver, B.C. V6T 1W5.

The Role of Applications in the Undergraduate Mathematics Curriculum

An ad hoc committee on applied mathematics training, chaired by Professor Peter Hilton, has come up with recommendations for a change in thrust to more applied experiences in university programs. The discussion of "themes" - attitudes, unification of the mathematical sciences, curriculum, applications (experience programs, societal aspects) - makes this a useful handbook for schoolteachers concerned with curriculum. The 26-page booklet, entitled as in the heading, can be obtained from the Office of Mathematical Sciences, U.S. National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418.

The Samuel Beatty Essay Contest

Two students were awarded first place in the 1980 Beatty Essay Contest:

- John Chew, Grade 12, University of Toronto Schools - "Limits to Areas in the Plane," and
- Kevin Jardine, Grade 12, West Humber C.I., Etobicoke, Ontario - "Surface Theory."

Each will receive $100. A third prize of $35 goes to Steve Meszaros, Grade 12, Blakelock H.S., Oakville, Ontario - "Newton vs. Einstein: Comparing the Newtonian Universe and the Universe of Special Relativity."

This contest, sponsored by the Samuel Beatty Fund, is open to all Canadian school students. Information for the 1981 contest will be available in October from E.J. Barbeau, B201, University College, University of Toronto, Toronto M5S 1A1.

Roving the Journals

The editor of *Plus + + +* receives mathematics teachers' journals from across the country. These indicate that the discussion of mathematical issues and classroom techniques is quite lively everywhere. Lack of space prohibits detailed discussion of contents, but the editor would like to draw attention to a recent issue of *Vector* (Vol.21, No.3), the B.C. journal, which contained some items of national interest. David Robitaille, Department of Mathematics Education, U.B.C., describes the Second International Study of Mathematics, and Bill Kokoskin of Handsworth S.S., North Vancouver, reviews the aftermath of a 1977 report to the B.C. Ministry of Education on women and mathematics. Walter Szetela, Department of Mathematics Education, U.B.C., discusses research on attitudes toward and effect of calculators in the classroom. The editor is Mr. Les Dukowski, 3821 - 202A Street, Langley, B.C. V3A 1T3.

A New International Journal in Canada

Professor David Wheeler of Concordia is the moving spirit behind and editor of a new educational journal. *For the Learning of Mathematics*, Volume 1, Number 1, was to appear in July, and issues will appear each July, November, and March. French and English are languages of publication. The subscription rate per volume is $24 (institutions, libraries) or $18 (private individuals). Apply to the Business Manager, *For the Learning of Mathematics*, Department of Mathematics, Concordia University, 7141 Sherbrooke St. W., Montreal, Quebec H4B 1R6.

HIGH SCHOOL ACTIVITIES

Crossfactor Puzzle

by *Terry A. Witczak*
Good Counsel High School
Chicago, Illinois

Reprinted from The Math Post.

Everyone likes crossword puzzles, so why not give your students a crossfactor puzzle? While covering factoring in first-year algebra, my students came to a point where they understood the concepts but needed some practice. To make their practice less painful, I gave it to them in the form of a crossword puzzle. The students enjoyed it and completed the needed drill.

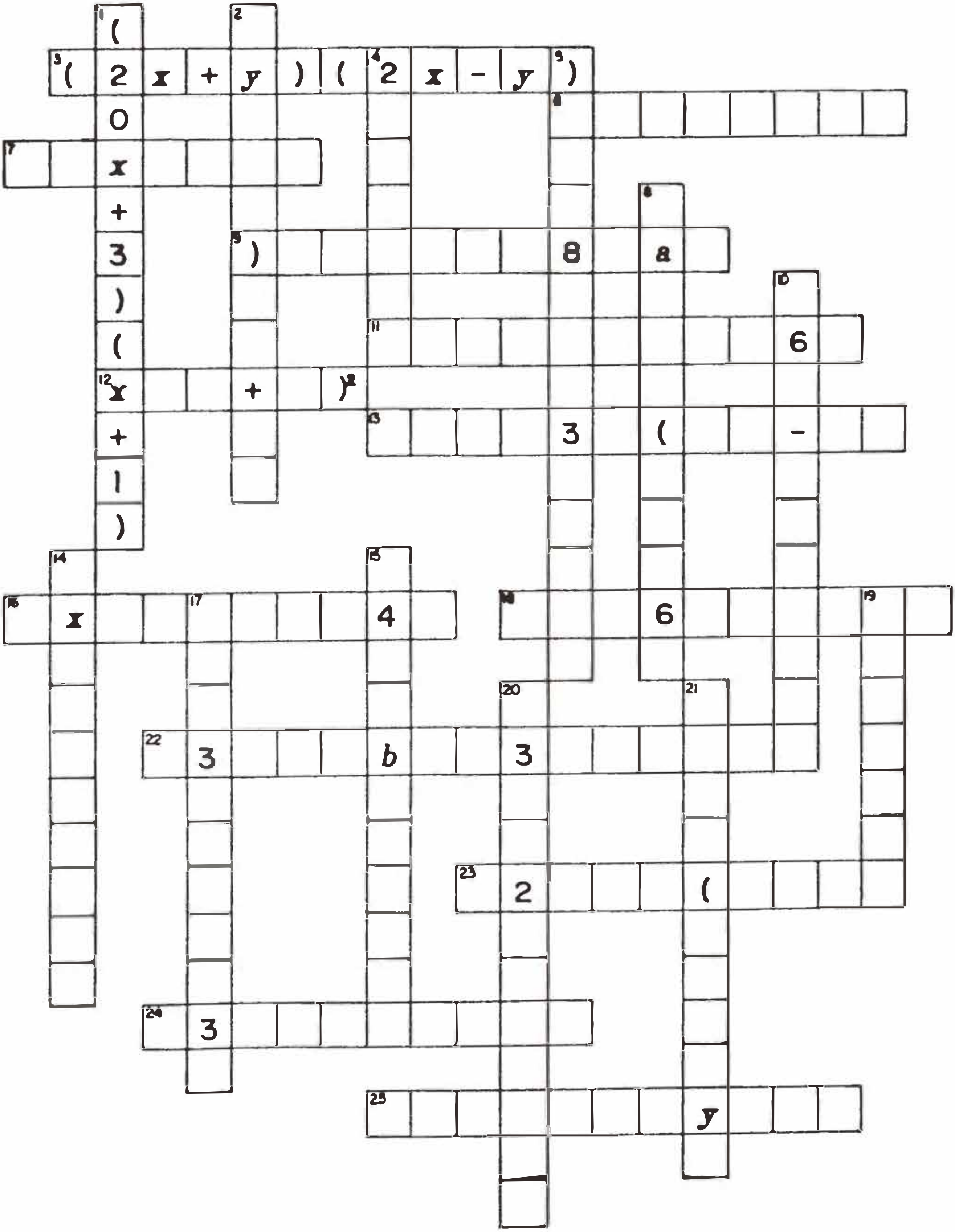
With a little imagination, the crossword format could be used with many other topics, including addition, subtraction, multiplication and division of polynomials, and for review as well as drill.

DIRECTIONS

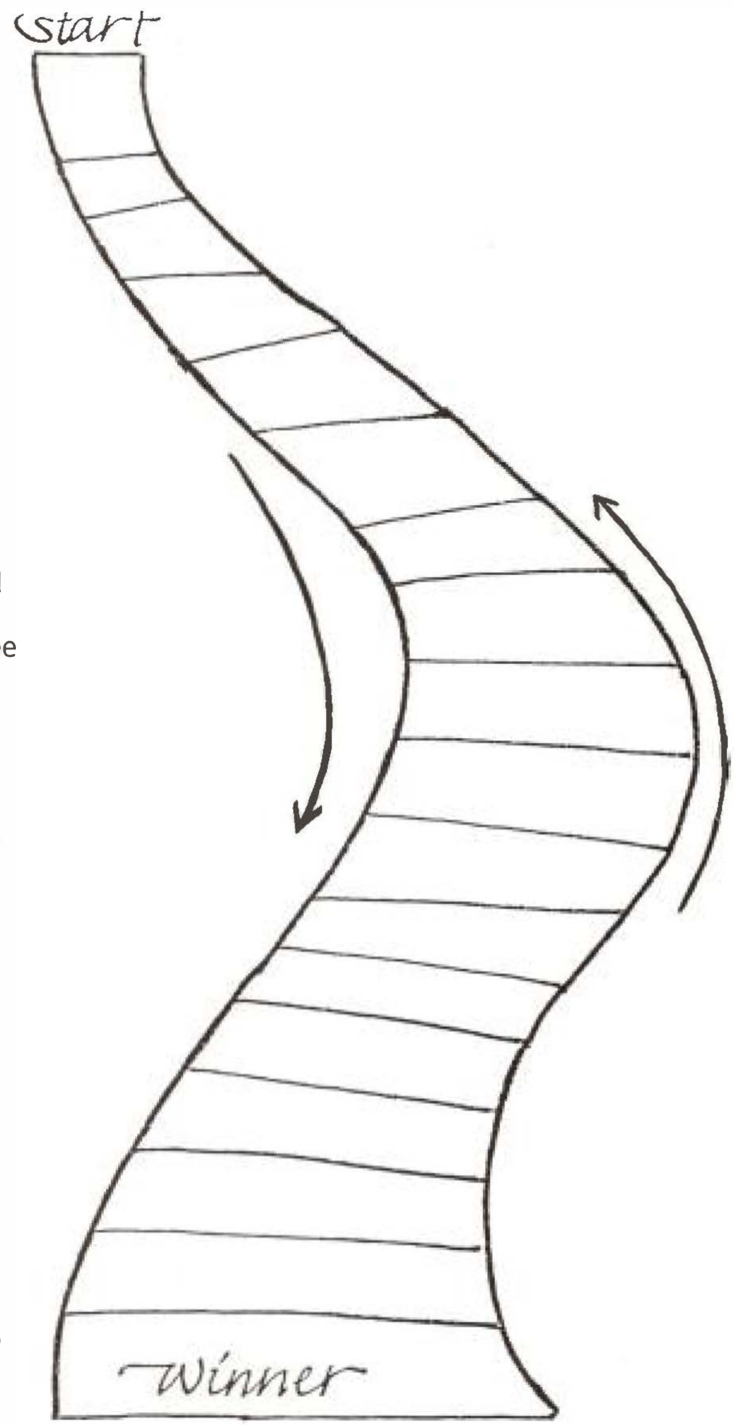
Factor the following polynomials and write their factors in the puzzle. Numbers 1 and 3 are completed to help you get started. There are also clues scattered throughout the puzzle. To simplify the puzzle, a parenthesis can be used in a given square to indicate both a left and a right parenthesis.

1. $20x^2 + 23x + 3$
2. $y^2 + 3yz + 2z^2$
3. $4x^2 - y^2$
4. $2x^2 + 4x$
5. $9x^2 - 64y^2$
6. $9yx - 15y$
7. $2x + 44$
8. $5a^2 + 31a + 30$
9. $2a^2 + 17a + 8$
10. $6y^2 + 19y - 20$
11. $5x^2 + 21x + 18$
12. $x^3 + 6x^2 + 9x$
13. $12a^2 - 25a + 12$
14. $x^2 - 16$
15. $12 - 13b + 3b^2$
16. $x^2 - 16$
17. $2y^2 + 9y + 9$
18. $y^2 - 36$
19. $24y + 18$
20. $18x^2 + 9x - 2$
21. $40x^2y - 60xy^2$
22. $9a^2 - 24ab - 20b^2$
23. $6 + 5x + x^2$
24. $18 + 9y + y^2$
25. $7y^2 + 37y - 30$

Answer on page 27.



Up and Down the Slide



Topic
Addition and Subtraction

Grade Level
K - 3

Time
10 - 15 minutes

Number of Players
2 or more

Materials Needed
Game Board.
Three counting cubes - two marked with numbers 4,5,6,7,8,9; one marked with three pluses and three minuses.
Different color marker for each player.

Object
To be the first person to land on the square marked "winner."

Rules
Each player takes a turn rolling the three counting cubes and making mathematical sentences with the numbers rolled. Example: 9 - 5 = 4.

Player then moves forward if he rolls an addition sentence, or backward if he rolls a subtraction sentence.

The winner is the first person to land <u>exactly</u> on the space marked "winner."

What's Covered Up?

Topic
Addition, Subtraction, Multiplication and Division

Grade Level
1 and up

Time
5 - 10 minutes

Number of Players
2

Materials Needed
Set of small cards with number sentences
Small square of card.
No game board necessary.

Object
To complete the number sentences.

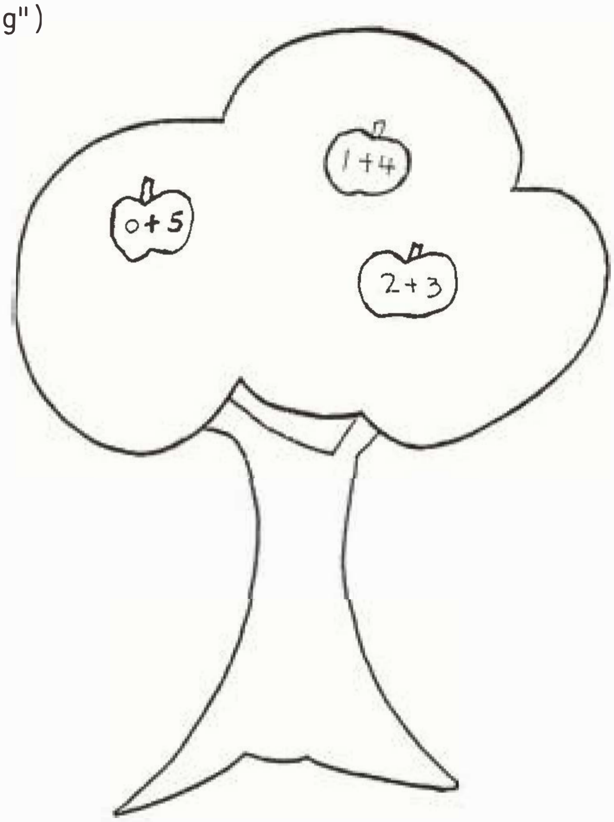
Rules
One child closes eyes while the other uses the card to cover one numeral or symbol.

Child with closed eyes must answer, "What's covered up?"

Number Tree

Skill: Number Facts

(*Tune:* "I'd Like to Teach the World to Sing")



I'd like to learn the sums for five
And build a number tree
0 plus 5, 5 plus 0
It's such simplicity.

Now I've learned the sums for five
And so I'm back home free.
Just remember the sums to five
Straight from the number tree.

Actions:

Show five fingers.
Build from floor.
Show first numeral with right hand, other with left. Reverse.
Hands out to side.

Five-in-a-Row

Topic
Addition

Grade Level
2 - 3

Time
10 minutes

Number of Players
2 - 3

Materials Needed
Game Board
Colored chips for each player
Two number cubes - first numbered 4-9; second numbered 5-10

Object
To place five markers in a row.

Rules
First player rolls the number cubes, computes the sum, and places one of his colored chips on a corresponding number on the game board.

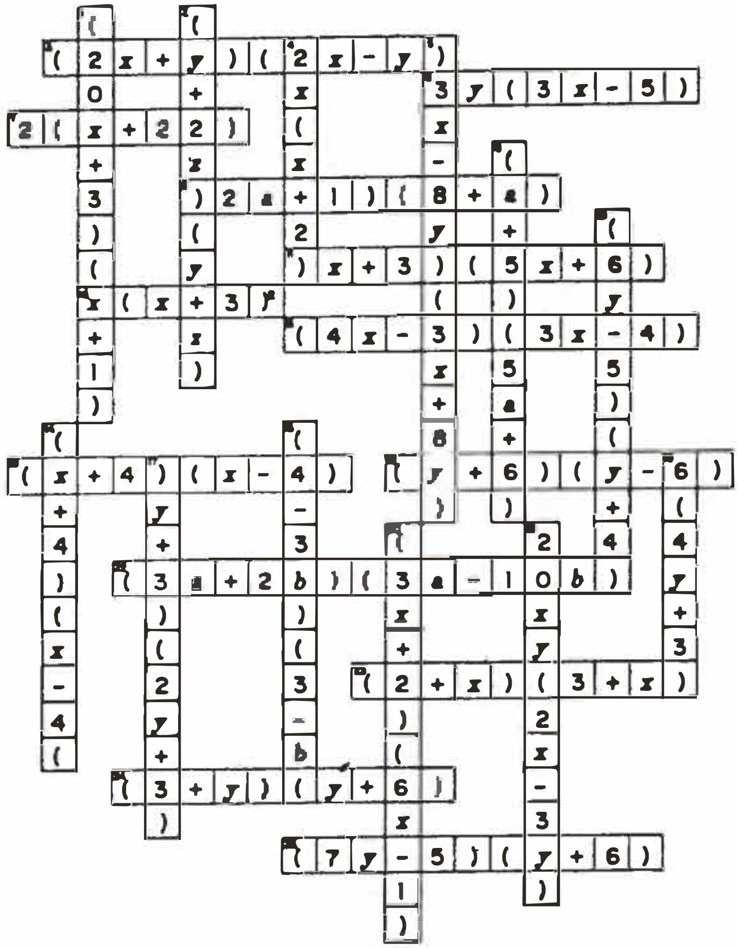
Players take turns, and the first player with five in a row wins.

The five may be horizontal, vertical, or diagonal.

12	11	13	12	11	10	13	9
14	13	11	9	15	12	10	14
16	15	12	17	10	14	18	19
13	19	10	14	16	15	17	11
18	16	14	19	17	12	9	13
14	11	19	15	13	18	16	12
15	13	17	11	16	10	14	9
17	10	18	14	13	19	12	15

Answer to Crossfactor Puzzle

(See page 22.)



CENTS-ABILITIES

(Grade 5 and up)

- Farnette, Forte, and Barris

An economic awareness activity book. The high interest (low vocabulary) format has been maintained to promote use of basic communication skills in the most positive and meaningful sense. Self-evaluative questionnaires, quizzes, puzzles, codes and functional reading and writing activities may be electively used to extend cognitive learning and reinforce affective development. Simple, easy-to-follow directions are self-explanatory, and are designed to encourage pupil independence.

Table of Contents: Making Money; Spending Money; Saving Money. Cost is $7.25; over 100 pages.

Available from:
Western Educational Activities Ltd.
Box 3806
Edmonton, Alberta T5H 2S7

Publisher: Incentive Publications

GOOD APPLE MATH BOOK

(Grades 1 to 6)

- Grim and Mitchell

This book is designed in an informal way to show that anyone can "think up" and develop math activities. The book contains many work pages for the students to use. These are shown with an apple in the corner. There are four game boards ready for you and your students to use.

The ideas here are designed to: (1) make math fun; (2) allow students the opportunity to use basic skills learned in basic materials in practical ways; (3) motivate students and teachers into discovering and developing additional activities - to look for math everywhere; (4) show that math is found everywhere, not just in schools, classrooms, desks and textbooks; (5) involve students in the higher thought processes, not just in the memorization of facts, but in divergent and evaluation thinking.

Contents: Create a Learning Centre; Math and Last Year's Calendar; The Garden - A Simulation; Math Can Leave a Good Taste in Your Mouth; Odds 'n' Ends; Math Art; Have a Happy Pumpkin Day; Mother Nature Can Help You Teach Math; Go! Go! Go! Metrics; Reviewing Math the Good Apple Way; Mapping Your Way Mathematically; Easy Math Games. Cost is $11.95; over 200 pages.

Available from:
Western Educational Activities Ltd.
Box 3806
Edmonton, Alberta T5H 2S7

Publisher: Good Apple, Inc.

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