THE ALBERTA TEACHERS' ASSOCIATION

MATHEMATICS COUNCIL

NEWSLETTER

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Contents

Newsletter Editor: Mary Beaton
Faculty of Education, University of Calgary

AN EXPERIMENT IN LEARNING TECHNIQUES

J.P. Cronin

Head, Mathematics Department
Port Colborne High School
Port Colborne, Ontario

In the everyday presentation of lessons to their classes, teachers have often encountered the following difficulties.

1. Certain students tend to sit back, take no part in the lesson, and turn off their minds. Trying to involve them in the work by questioning them makes it virtually impossible to maintain a smooth continuity in the general questioning. For some students this withdrawal is not an entirely voluntary process but rather a protective device dictated by their shyness. They simply do not wish to stand up in front of the entire class and expose themselves to imagined, but for them quite real, humiliations. As well, many of the girls often wish to avoid appearing too "brainy" in front of their male classmates.

2. It is often impossible to properly answer a question posed by a student when the question is "off the track" of the lesson. To stop, and fully satisfy the questioner, would interrupt the flow of the lesson and leave the remainder of the class waiting with nothing to do.

The above difficulties are due, in part, to the static nature of the average classroom seating arrangement, wherein each student is largely isolated from his fellows. In an effort to overcome this situation in my Grade IX, X, and XIII mathematics classes, the ordinary desks have been removed from my classroom and replaced by six 4' x 2½' tables. These were arranged about the room in an irregular U-shape around an overhead projector. Students were then assigned to each table so that the average mark of the five or six people at any table was approximately 63. Of course, this distribution was entirely arbitrary. An alternate arrangement would have been to place the best students at one table, then the next best at another, and so on down the line. This latter approach would require a very large supply of programs suitable to the various table-levels. However, it would represent perhaps the ultimate arrangement, and would be, in effect, an ungraded classroom, with students at different tables doing different work, each at their own level of achievement.

At each table a captain is selected, who, in most cases, is the most able student at that table. The function of the captain is to oversee and guide the work of the others, and to answer as many of their questions as possible. It is the duty of everyone at a table to see that no one sits back and loafs, and to continuously check and compare each other's work. So many of the formerly shy and reticent students have really blossomed under this approach and have helped each other to an amazing degree. At one table the captain, every day, has been individually tutoring the slowest student at that table, a boy with a language problem who would never have asked a question under other circumstances. His work has shown a terrific improvement, and at the same time he is learning to communicate with others. There is a great deal more noise than normally, but most of the talk concerns mathematics.

More than one type of lesson is possible with this seating arrangement. From time to time, when the need dictates, the whole class stops and a short Socratic lesson can be presented to overcome a particular difficulty or to introduce a specific point. However, I spend most of our class time circulating around the room, sitting down at each table in turn, and discussing problems, as necessary, with one, two, three, four or all the people at the table. In this manner, I am regularly communicating, in a quiet, non-embarrassing way, with the students who are actually having the problems. In doing this, I believe I have come to know my students so much better than previously, and I feel that much more than before my students sense that I am a person with whom they are going to be able to learn - to explore and discover things together - and that I am personally interested in their problems and difficulties.

The method I use to create this circulating time is to prepare beforehand an overhead transparency projectual containing sufficient directional instructions to outline my lesson. The class then simply proceeds on their own to carry out the instructions given. As well, circulating time can be created by having students come up to the overhead to present and discuss their solutions to problems or to work out illustrative examples with the help of the rest of the class.

I should like to point out here to teachers not familiar with this approach that our experience indicates a world of difference between students' blackboard work and their work with an overhead projector. All to often working at the blackboard means taking one's notebook to the board, copying out a solution in absolute silence, with writing arm in a tiring and unfamiliar position, back to the class, body blocking off most of the solution, with the rest of the class paying little if any attention.

Working at the overhead is totally different. The student brings up no notebook, faces the class, writes in a normal, comfortable position, with all eyes following the step-by-step unfolding of the solution. The student may wish to obtain help from others and feels free to do so. Often a spirited dialogue develops, with continual comments from the class and a running discussion with the student doing the work.

This is a real learning situation, an involvement dialogue which is often not possible between teachers and students. We have found that many of the shyer students now actually want to go up and engage the class in this way - confident that the class will help them, that the teacher will not interfere and spotlight their difficulties, and that they will be able, in a constructive atmosphere, to really learn something. How amazing it is to hear them fighting over which one will go up and present the next solution! Another benefit of this approach is that even after a solution is finished, the plastic sheet containing the solution can be taken around the room for further reference or deeper inspection. This is just not possible with a blackboard solution. Furthermore, the students can be provided with plastic sheets and marker pens to take home overnight to more extensively prepare a particularly complex problem or illustrative example.

Another approach ideally suited to this kind of seating arrangement is the experimental lesson. So far this year, the students have performed a variation of Buffon's needle experiment to approximate the value of pi, have flipped three coins simultaneously to determine the probabilities of various upface combinations, and taken physical models of prisms, pyramids, cubes, parallelipipeds, and by actual measurement have calculated their total surface areas. In each case, follow-up reading is prescribed, and each table submits their results and conclusions. Many of the lead-ins to these experiments have arisen from our once-a-week "free" period wherein the students are free to play with dice, coins, and a roulette wheel, to read any book on mathematics from our classroom library, to go unsupervised to our school library to peruse their books on mathematics, to watch mathematics filmstrips of their own choice from the selection we have available, or to work on their mathematics project for that term. Every available inch of space in the classroom is filled with models they have built, curves they have stitched, and such other items as they have been interested in making. During the free period I bring a radio into the room and provide them with enjoyable music. After all, why shouldn't our classrooms be pleasant, stimulating, and enjoyable places in which to be and learn?

Reprinted, with permission, from
The Bulletin, published by the Ontario
Secondary Teachers' Federation,
December, 1968, pp.493, 494.

STATIC AND TRIANGLES

Brian Prior
President of CJHMCATA

The Calgary Public School Junior High Regional Mathematics Council (good grief!) held an open meeting on February 27, at which teachers were invited to make a set of aids. Those who were interested in this session met in a classroom where Lorne Sampson, the originator of the aids, demonstrated the use and construction. Following a short discussion, the group moved to the industrial arts shop to mark out and cut the raw material - a 4' x 2' x 1" sheet of expanded styrofoam.

To math teachers who also teach science, we can heartily recommend styrofoam dust as a material readily charged with static. Brushing has little effect.

A STIMULUS-RESPONSE METHOD FOR PRACTISING FACTS

A Report by Marshall Bye,
Consultant in Mathematics
for Calgary Public Secondary Schools

At the Northwest Mathematics Conference in Vancouver in October, 1967, Dr. Eric MacPherson suggested a method of drilling facts of the stimulus-response type. He indicated that this method appears to be one of the most efficient ways to drill on this type of material. Dr. MacPherson illustrated his talk by giving his audience a set of nonsense facts, three minutes to memorize them, followed by three tests. There was no time between tests for relearning. Most of the audience had a low mark on the first test, an improved mark on the second test and nearly a perfect paper on the third test. This method, I felt, had some merit. Therefore, I would like to pass it on to you.

I shall use the multiplication facts in my example. The student is provided with a sheet of paper marked as shown.

1. ____ ____
2. ____ ____
3. ____ ____

.
.
.

10. ____ ____

The teacher states the problem, pauses (while the student places his answer in the first space), gives the correct answer, pauses, then repeats the question and answer. If the student had the correct response, he places a check mark in the second space. If the student had an incorrect response, he listens while the teacher repeats the question and the answer; then he places the correct response in the second space.

<u>Example:</u>

Teacher:	5 x 6 (pauses)	Student writes in the first blank	1.	30	____
Teacher:	30	Student places check mark in second space	1.	30	✓
Teacher:	5 x 6 is 30 (pause)	Student listens			

Teacher:	7 x 8 (pause)	Student records response	2. 48 ______
Teacher:	56	Student listens since he is incorrect	
Teacher:	7 x 8 is 56 (pause)	Student records correct answer in second space.	2. 48 56

This procedure continues for 10 questions. If further drill is required on these facts, the same procedure is repeated the next day; otherwise the teacher goes on to new drill facts. Two essential items should be mentioned: (1) The pauses must be of proper length. Experience will assist the teacher in this. (2) Use frequent drills rather than long drills spaced weeks apart.

THIRTY-ONE ARTICLES OFFER IDEAS FOR TEACHING LOW ACHIEVERS

Aware of the increasing demand for information about how to teach low achievers, the editors of the NCTM journals have published numerous articles on the subject. In the past five years the *Mathematics Teacher* has averaged two articles a year from such notable authors as Sarah Greenholz, Florence Elder, Amelia Proctor, and Thomas Nagel. The *Arithmetic Teacher*, whose teacher-audience is so intimately responsible for giving low achievers a head start into academic life, has steadily enlarged its coverage from two articles in 1964 to seven lengthy reports in 1968. Authors Myron Rosskopf and Jerome Kaplan, Wilbur Dutton, John Cawley, and John Goodman are some who have dealt with all phases: the training of mathematics specialists for the disadvantaged; development of materials; evaluation of the slow learner; how to teach geometry, fractions, time concepts, and other topics.

Single copies of a cumulative index for these 31 journal articles are available upon request from the Washington office of the NCTM.

- *The Newsletter*, March, 1969
NCTM

WHAT IS ADDITION?

H.L. Larson

What makes *modern math* different from the *traditional*? In a nutshell, it is that we attempt to clarify simple concepts and then build around them.

One such example is addition. Many textbooks and many teachers are not at all clear as to what the concept of addition is. Is it a sort of "joining together", a "combining action"? Is it a physical kind of action, or is it purely mental abstract? If the teacher pushes two groups of objects together to form one group, is this really the operation of addition? The answer is a definite "no".

We should not mention this except for the fact that when we ask students to add, for example, "a" and "b", they are completely bewildered. It is at these points that we separate the Black Sheep from the White in junior or senior high, and largely because the Black Sheep really were never taught the concept properly. Let's illustrate.

Three men stood at the edge of a pond. They saw a group of four mallards swimming around, and in a distance was a group of three pintails.

The first man was a Biologist. His mind was conceptualizing the difference in the species. As the two groups swam around, at one time they actually intermingled. Did this joining action constitute addition? Not at all. The biologist may have been thinking something similar to this:

M = X X X X	P = 0 0 0
A set of mallards	A set of pintails

No mathematical operation was taking place in his mind.

The seond man was a Hunter. He was thinking of a delicious Sunday meal for his family. What mathematics may have been going on in his mind when the two groups intermingled?

If his mental vision consisted of a platter of four baked mallards and three baked pintails, then, of course, no mathematics was going on in his head beyond that which the biologist was thinking. It is more likely, however, that the hunter was thinking that there would be one duck per each member of the family. In this case, we can program his math thoughts as follows:

(1) $M = \{X\ X\ X\ X\}$,	$P = \{0\ 0\ 0\}$	Disjoint sets
(2) $M = \{\overset{d}{\cancel{X}}\ \overset{d}{\cancel{X}}\ \overset{d}{\cancel{X}}\ \overset{d}{\cancel{X}}\}$,	$P = \{\overset{d}{\cancel{0}}\ \overset{d}{\cancel{0}}\ \overset{d}{\cancel{0}}\}$	Mallards, Pintails $\longrightarrow$ ducks
(3) $MUP = \{d\ d\ d\ d\ d\ d\ d\}$		Union of disjoint sets
$\quad\quad\quad\ \ \updownarrow\ \updownarrow\ \updownarrow\ \updownarrow\ \updownarrow\ \updownarrow\ \updownarrow$		One-to-one corresondence
(4) $\quad = \{a\ b\ c\ d\ e\ f\ g\}$		with members of family

The third man was a Warden. His chief concern was to get a game count of water fowl in his district. He took out a little book and put down a mark. What math went on in his head?

The first three steps above were probably the same as for the hunter, but he likely went one step farther, omitting (4).

(5)	$MUP = \{1\ 1\ 1\ 1\ 1\ 1\ 1\}$	Physics to math, identity element of multiplication
(6)	$= 4 + 3$	Addition algorithm
(7)	$= 7$	Simplification (Arabic)

We should note well that the addition has really taken place in step (3) of the hunter's train of thought, except that he did not simplify as did the warden, because he did not need to simplify. It is important to understand that the two groups did not have to come together. The abstract idea of addition could have taken place regardless of the group placement.

The common fallacy in our teaching is to think that the physical combination was necessary and that addition is really step (7). This step is merely simplification. The algorithm 4 + 3 is the expression of addition as having taken place.

If children are clearly taught this concept of union of disjoint sets, they will not be bewildered by the algorithms "a + b". In other words, "a" add "b" is "a + b", period.

The implications for teaching addition in this manner will be, of course, that we need not waste page after page in textbooks and teacher's time in pictures of physical joining or separation. Hard to believe? Well, think about it.

"He who helps a child helps humanity with a distinctness, with an immediateness, which no other help given to human creatures in any other stage of their human life can possibly give again."

\- Phillips Brooks

STM 3 AND LOW-ABILITY STUDENTS

Ruby Anderson

My aim is to give these students a degree of success in mathematics and a feeling that it is not impossible to achieve. The mathematics they learn must be applicable to the basic necessities of everyday life.

To achieve the above, the following are uppermost in mind:

- Instill in the students that math is not impossible.
- Make math as simple and meaningful as possible.
- Teach and re-teach basic principles and operations and how and when to use them (for example, key words).
- Give praise and self-confidence constantly.
- Give individual help.
- Students must participate in math activities - attention span limited.
- Integrate students - must be part of a group.
- Success or failure depends on attitude, skill, and understanding of the teacher, plus empathy for this type of student.
- The teacher must have a plan for the year's course, but it must be flexible.
- Do not become textbook-bound.

Although I had only worked with this class for six weeks before they were confronted with a school exam, there were 6 C's and 7 D's on the normal school curve. In previous years they always scored the lowest of the low. At last, I do not hear the remark "I never could do math, I am dumb!"

Reprinted, with permission, from *The Math Post*, Volume 2, Number 12, p.1.

A COORDINATED REVIEW OF RECENT RESEARCH CONDUCTED
IN THE DEPARTMENT OF ELEMENTARY EDUCATION
UNIVERSITY OF ALBERTA
RELEVANT TO MATHEMATICS EDUCATION
Part II

W.G. Cathcart and W.W. Liedtke

Conservation is often used as a criterion in the assessment of concept acquisition. Investigators who use the concept of conservation in this manner are often criticized for the method they employ. The "clinical method" which consists of observing, interviewing, and recording is attacked frequently. However, few critics offer an alternative approach.

One alternative was developed by Sawada.[1] He conducted a study of length conservation in 62 kindergarten and Grade I children. The secondary purpose of his study was to ascertain whether or not an essentially non-verbal method of communicating the response criteria to the subjects would lower the age at which they gave evidence of possessing conservation of length. Sawada's non-verbal technique made use of calipers and a response apparatus to reward correct answers with a candy. The candy was placed behind one of three doors in a box. Over each door was a caliper with a model fit. That is, over one door a rod was inserted in the caliper so that it was too short, over the middle door the rod fitted exactly into the caliper, and over the last door the rod was too long for the caliper. The subject had another caliper that he could use to test the fit in the test situation. After a transformation was applied to the object, the subject was asked to open the door corresponding to the type of fit he thought there would be now without using his caliper after the transformation.

The results of this study showed that the threshold age at which 50 percent of the subjects conserved length was between five years and four months, and six years and two months. Thus, if the response criterion is essentially non-verbal, children are able to give conservation responses as much as two years earlier than they would if required to give verbal responses.

Sawada's major purpose was to explore the role of transformations (translations and rotations) in the child's conservation of length. He found that conservation of length cannot be solely explained in terms of the transformations applied to the objects exhibiting length. Neither could the factors extracted from the conservation test be defined solely in terms of the state properties of the objects to which the transformations were applied. Both state and transformation properties had to be used to interpret the factors extracted out of the test performance. Sawada also found that an illusion subtest was significantly more difficult than any of his other subtests. Age

[1]Sawada, D., "Transformations and Concept Attainment: A Study of Length Conservation in Children." Unpublished Master's Thesis, University of Alberta, Edmonton, 1966.

correlated significantly with performance on the test but intelligence, as given by the "Detroit Beginning First Grade Intelligence Test" (1937), did not.

Should conservation be induced in young children? If Piaget is correct when he claims that conservation is necessary for any rational activity, then certainly the acquisition of conservation should be of prime concern to teachers. But why not let it take its natural course of development? One major problem is that there is an increasing pressure being placed upon teachers and curriculum planners to introduce more sophisticated mathematical concepts at younger and younger ages. The Cambridge Report (1963) is an indication of such a trend. If the mathematical concepts outlined in the report are to be understood by the children rather than merely memorized, then conservation in related areas is important. Thus, the inducing of conservation becomes a relevant problem.

Sawada's finding (referred to earlier) that the concept of conservation is present on the non-verbal level at an earlier age than indicated by Piaget might have an important bearing on the problem of teaching conservation to children. This strongly suggests that the preliminary stages of inducing the concept of conservation and mathematical concepts should be approached from a level that is as free from verbalization as possible.

Towler[2], on the other hand, attempted to induce conservation by pointing out the important aspects of this concept in small groups. He used a sample of Grade I students. Forty non-conservers and 40 partial conservers were assigned randomly to an experimental group and a control group. His major hypothesis was that learning of conservation could take place if the crucial aspects of conservation could be isolated and presented to the students in such a way that they could understand them. He hypothesized that these relevant variables were (a) an understanding that a quantity retains its identity during transformation, (b) an understanding of compensatory relationships, and (c) an understanding of the principle of reversibility.

On the basis of this hypothesis, Towler designed a training session for the experimental group which he hoped would lead to the understandings mentioned above. To provide training in the identity relationship, Towler asked two types of questions. A drink was poured from a jug into a can and the subjects were asked, "Does pouring change the <u>kind</u> of drink?" The second type of question asked "Does pouring change <u>how much</u> (amount) there is to drink?"

Another aspect of the training session was designed to confront the subjects with the compensatory relations of height and width. Containers of various dimensions were used so that the levels of the liquids varied. Students were asked to predict where the levels would be and to explain why the level was higher or lower in a given container than in the original standard. A final aspect of the training session was concerned with the ability of the child to

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[2]Towler, J.O., "Training Effects and Concept Development: A study of the Conservation of Continuous Quantity in Children." Unpublished Doctoral Thesis, University of Alberta, Edmonton, 1967.

relate what he had just discussed to pictorial representations of similar situations.

It was thought necessary to describe Towler's training session somewhat since he claims that it was highly successful in inducing conservation in the experimental group. A significant number of non-conservers and partial conservers in the experimental group acquired conservation and, with the exception of one subject, were able to retain conservation over a two- to three-week period. They also were able to transfer their learning to a new situation using different materials (discontinuous quantity). While the experimental group showed this improvement, there was no change in the control group's understanding of conservation.

(To be continued)

MATHEMATICS MATERIALS

Address your request to

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402.

Ask to have your name placed on the notification list of new publications on the subject of mathematics.

State your name, address, city, province, and zip code.

Here are a number of interesting titles:

(1) Aids for Mathematics Education
(2) Mathematics, A Universal Language of Modern Civilization?
(3) Space-Oriented Mathematics for Early Elementary Grades
(4) Low Achiever in Mathematics
(5) Emerging 12th Grade Mathematics Programs
(6) Matrix Representation of Groups
(7) Course and Curriculum Improvement Projects

Cleveland Diocesan Mathematics Teachers
Newsletter, Fall, 1968

SIMPLE? YOU BET, BUT IT HELPS

Brian Prior, President of Calgary Junior
High Mathematics Regional Council

If you have seen the film *Crows, Sets and Infinity*, you will realize that these ideas are not original. However, there is adaptation to the class with overhead projector.

We cut a series of geometric shapes from colored acetate sheets, each shape being not more than 1" long or ½" wide. In our set we used all quadrilateral forms and some other odd polygons. The shapes were cut from blue, red, orange and green acetate.

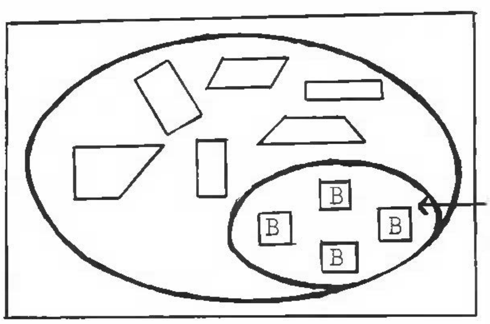
The first use we made of the shapes was to spill a variety on the overhead projector table and sort them out into sets by description. For example, the blue rectangles may be moved to one side and circled. Here we showed that the members of a set form "a definite collection of objects" (S.T.M.I., page 10).

Subsets may be developed in a similar manner when the set of quadrilaterals is placed on the table. The squares can be moved to one side and circled. A first idea of Venn diagrams will appear (see Sketch 1).

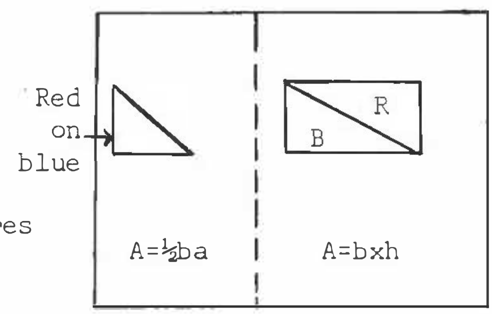
These geometric shapes can also be very useful in showing the relationships between types of quadrilateral.

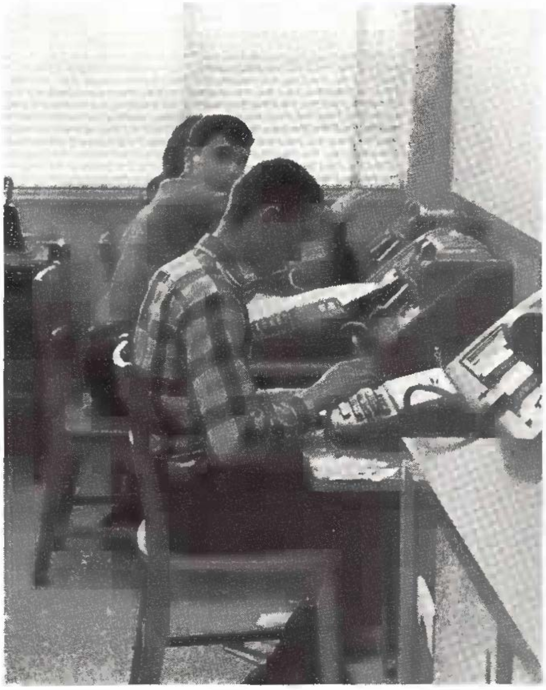
Furthermore, we found that slight care in cutting the original shapes will provide an aid in the development of formulae. An example would be the ½ (a) (b) for triangles by moving the blue on top of the red (Sketch 2).

Sketch 1



Sketch 2





A HIGH SCHOOL COMPUTER PROGRAMMING PROJECT

Kenneth N. Tusz, B.A., B.Ed.,
Ernest Manning High School, Calgary

A group of high school students at Ernest Manning High School in Calgary are learning computer programming as a pilot project supported by the University of Calgary Data Center.

Last September, a group of approximately 15 Grade XII students began the program. A number of these students left school before the new semester began in February. We then offered the program to Grade XI students and are now working with such a group. The course is offered as an extracurricular activity.

This project has several purposes:

1. to acquaint students with some of the things computers can and cannot do;
2. to prepare high school students who will be entering university with an "already" introduction to computers;
3. to encourage students to consider computer technology as a career after graduation from high school or university;
4. to study the feasibility of teaching computer programming in high school and to determine some of the real problems.

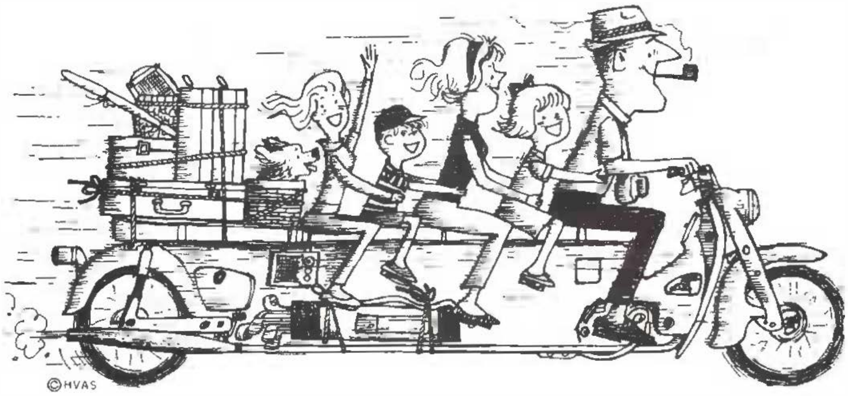
After a six-month operation of this course, a few observations have been made: Students have discovered, often to their surprise, that a computer is a "dumb" machine that must be controlled by man. This has invariably decreased their awe about the machine and computer science. I noticed that the students have become much more exact about their mathematical expression and have learned to think logically through a problem. One student of this course since September has found that some systems, of which he thinks all by himself and independently, actually work.

I would suggest to any other math teacher who is interested in a similar program to offer it to his students through a course. This is a very rewarding activity despite occasional temporary headaches.

ORGANIZATIONS OF INTEREST TO MATHEMATICS TEACHERS
KEY TO ABBREVIATED TITLES

Ray Cleveland
University of Calgary

SMSG	-	School Mathematics Study Group. - Has prepared materials for elementary, junior high and senior high courses. Director: Ed Begle
SSMCIS	-	Secondary School Mathematics Curriculum Improvement Study. - Will include materials for Grades VII through XII (presently includes material for Grades VII to IX). Director: Howard Fehr
CEEB	-	College Entrance Examination Board. - Commission on Mathematics sponsored by CEEB.
NSF	-	National Science Foundation. - Has sponsored retraining programs (Summer Institutes and Academic Year Institutes).
UICSM	-	University of Illinois Committee on School Mathematics Curriculum. - Has prepared materials for Grades IX through XII. Director: Max Beeberman
CUPM	-	Committee on Undergraduate Program in Mathematics. - Has made recommendations on college mathematics curricula (including teacher training).
CMC	-	Canadian Mathematical Congress.
MAA	-	Mathematical Association of America.
CAMT	-	Canadian Association of Mathematics Teachers.
CERA	-	Canadian Education Research Association.



BILLINGS, MONTANA: NAME-OF-SITE MEETING,
August 18-20, 1969

Plan your summer vacation in the "Big Sky Country" and attend the NCTM Name-of-Site Meeting in Billings, Montana, August 18-20. The Montana Council of Teachers of Mathematics will be your host on the Eastern Montana College campus.

With new trends in mathematics developing so rapidly, our attendance at these meetings is a must if we are to continue to enrich our teaching. The program will feature these nationally renowned speakers in both general sessions and section meetings:

Monday Evening General Session
Jack E. Forbes, Professor of Mathematics, Purdue University
Topic - "What Next for School Mathematics: Revolution? Evolution? Retreat?"

Senior High General Session
Calvin T. Long, Professor of Mathematics, Washington State
Topic - "The Ugly Duckling"

Junior High General Session
Charles E. Allen, Mathematics Consultant, Los Angeles City Schools
Topic - "Creative Teaching for the Low Achiever in Mathematics"

Elementary General Session I
R.B. Davis, The Madison Project, Syracuse University
Topic - "Where Does Elementary School Mathematics Stand Now?"

Elementary General Session II
David A. Page, University of Illinois Arithmetic Project, University of Illinois
Topic - "Some Illustrations of Different Kinds of Discovery"

Wednesday Evening Banquet
Howard F. Fehr, Director, SSMCIS, Teachers' College, Columbia University
Topic - "Mathematics as Intellectual Formation"

Over 70 outstanding section speakers will explain, illustrate and demonstrate a wide variety of topics for all teachers. Here are just a few:

Elementary Teachers

John W. Briggs - Team Presentation of Laboratory Materials
Robert B. Davis - Discussion of What Changes We Need to Make in Elementary School Mathematics
E. Glenadine Gibb - Diagnosing Learning Difficulties in Mathematics
Joseph Hashisaki - Geometry for the Elementary Teacher
Boyd H. Henry - Why Johnny Can't Cipher
M.L. Keedy - Long Division in Arithmetic and Algebra
L. Doyal Nelson - Mathematics Laboratory Ideas for Upper Elementary Grades
Raymond A. Ziebarth - Minnemast: A Coordinated Curriculum

Junior High Teachers

Charles E. Allen - From Ideas to Action
Carol A. Coughlin - Team Teaching in a Flexibility-scheduled Junior High School
John D. Hancock - Programmed Learning, Round 2
Douglas J. Potvin - Is the Pendulum Swinging Back?
David A. Page - The Multiplicity of Instructive Uses of the Greatest Integer Function
Ruth Putz - Learning Device Demonstrating Concepts of Junior High Math
Eugene P. Smith - Techniques for Teaching Meaningful Mathematics to All Students
Glen D. Vannata - ALARM, A Low Achiever Remedial Mathematics Project

Senior High Teachers

Myrl H. Ahrendt - Mathematics, Backbone of Space Technology: Some Applications for Your Classroom
Howard F. Fehr - A Modern Geometry Program for Secondary School
Clarence H. Heinke - Models: Use and Misuse
Calvin T. Long - Generalized Powers: A New Look at Positional Notation
Helen Kriegsman - Algebraic Systems
John B. Mueller - Finite Graphs: an Enrichment Topic for Geometry
Ernie M. Pletan - Our Experiences Under Flexible Scheduling
Jack E. Forbes - Geometry: Why? What? How?

Junior College Teachers

Louis C. Barrett - Variational and Applied Problems of Mathematics
J. Eldon Whitesitt - Calculus: the Problem Child

General Interest

Leroy Amunrud - Applications of Elementary Mathematics in Industry
Richard Andree - Simulation: a New Area of Mathematics Instruction
Irvine Brune - The 's in Mathematics
Joe W. Israel - Stonehenge Monolithic Computer
Sheldon Meyers - Content Domains of Contemporary Mathematics Examinations

Teacher Training

Lincoln G. Ekoman - Use of Video Tapes in the Training of Teachers in Elementary School Mathematics

In addition to the section meetings, there will be films and exhibits for viewing. A Western Barbecue for you and your family will provide an atmosphere of the Old West. Tours will be available for the family while you attend the meetings.

The Billings Meeting provides you with the opportunity to combine your summer vacation with a stimulating mathematics conference. With Yellowstone and Glacier National Parks, the Rocky Mountains, Beartooth Highway, Custer's Battlefield, Lewis and Clark Caverns, Virginia City, and many other historic attractions, the "Big Sky Country" offers fishing, camping, hiking, and sightseeing for a family holiday. Go to Montana and the Billings Name-of-Site!

For further information write:

William Stannard,
Mathematics Department,
Eastern Montana College,
Billings, Montana 59101.