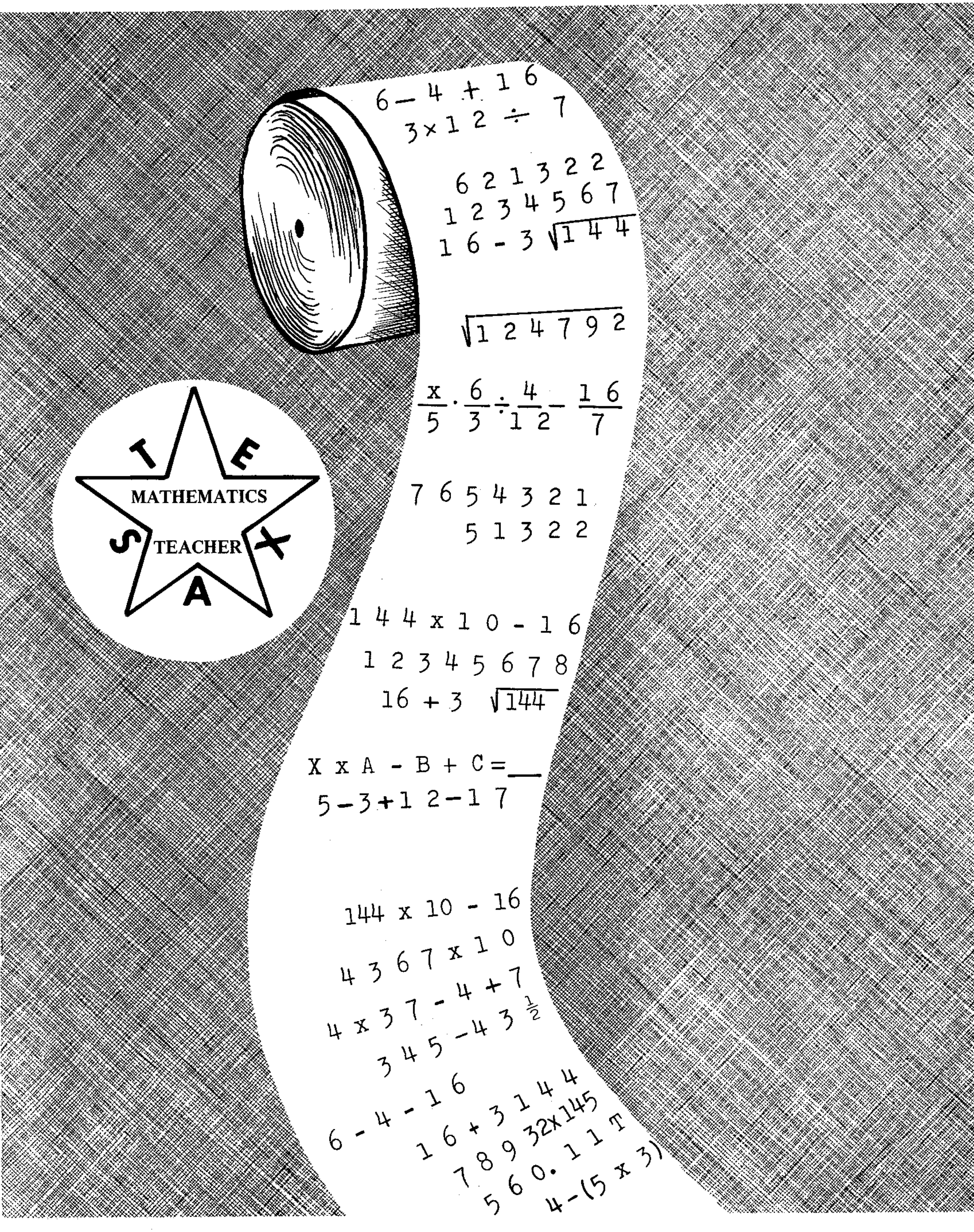
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TEXAS MATHEMATICS TEACHER is the official journal of the Texas Council of Teachers of Mathematics. The views expressed are the contributor's own and are not necessarily those of the publisher or the editor. All manuscripts and correspondence about this publication should be addressed to Mr. J. William Brown, *Texas Mathematics Teacher*, 100 So. Glasgow Drive, Dallas, Texas 75214.

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TEXAS MATHEMATICS TEACHER

Texas Council of Teachers of Mathematics

Vol. XXXI May, 1984 No. 3

PRESIDENT'S MESSAGE

It's unbelievable that another school year is closing. I hope all of you have had a successful and productive year and are making plans for a fun-filled summer.

You will probably want to plan now for the school year 1984-1985. The CAMT Conference will be October 11-13 in Austin; The Algebra Conference (former FOM Conference) will be early January 1985 in Huntsville; and, of course, the Annual Meeting of the National Council of Teachers of Mathematics will be April 17-20, 1985 in San Antonio. Plan now to attend!

You can expect also some exciting changes in our journal format beginning next fall. Be sure and look for the new issues.

In June 1984 NCTM will increase its dues - yet you can take advantage of the lower rates and re-new for two years, as long as you do so before June 1 , 1984. If you have doubts concerning the expieration date of your TCTM Membership, you can find that date on your mailing label. If your Membership has expired, please re-new today. We need your support!

The week of April 22-28 was designated as Mathematics Education Week in Texas by a Proclamation signed by Governor White. A copy of that official memorandum is printed in the journal. Since the annual meeting of NCTM will be in Texas next year, let's being now to make the public aware of Mathematics Education and the activities and professional meetings that are planned.

See you in the Fall.

Sincerely,

Betty Travis

COMMENTARY

I agree with Joe Allison's statement in his article "Some Logic of Induction" in the March, 1984, TEXAS MATHEMATICS TEACHER that the proof by induction usually presented in texts leaves the student unsatisfied. I admit to usually following that form because students are so dependent on the texts and they can use the examples in the texts as additional examples.

His proof shows that the statement to be proven true for all natural numbers is true for infinitely many natural numbers, but falls short, without further discussion, of proving that the statement is true for all natural numbers since he contradicted the particular assumption that the statement was true for only finitely many natural numbers.

A more logically correct argument would be to suppose that there is some counting number n for which the statement S(n) is not true. Let M be the set of all counting numbers n for which S(n) is not true. Now assume that it can be shown that S(1) is true. Since M is a set of natural numbers, there is an element k in M that exceeds no element in M. Since S(1) is true, 1 k and k - 1 is a natural number. Since k - 1 does not belong toM, S (k - 1) is true.

Now, assuming that one could proceed to use the fact that S (k - 1) is true to argue that S(K - 1) = S(k) is true, one has a contradiction to the statement that there exists a natural number n for which S(n) is not true. Therefore, S(n) is true for all natural numbers, which was to be proven true.

Dr. Katherine L. Woerner
Westlake High School
Eanes I.S.D
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TCTM Journal needs articles for all levels of Mathematics.

TARGETS AND TRIGONOMETRY: APPLICATIONS OF THE TANGENT RATIO

David R. Duncan and Bonnie H. Litwiller
Professors of Mathematics
University of Northern Iowa
Cedar Falls, Iowa

Trigonometry teachers are always looking for real world applications of their subject. We shall demonstrate our such application.

Suppose that Peter is target shooting with his rifle. His target is a can with a radius of 2 inches and height of h inches. Peter is standing 50 feet from his target and he tries to aim directly at the "center" of the can. By how many degrees can his shot be "off center"--to theleft or right of the center--and still hit the can? Call the maximum number of degrees that Peter can be "off" to the left or right the allowable angular deviation (AAD).

Figure I. (not drawn to scale) depicts the situations.

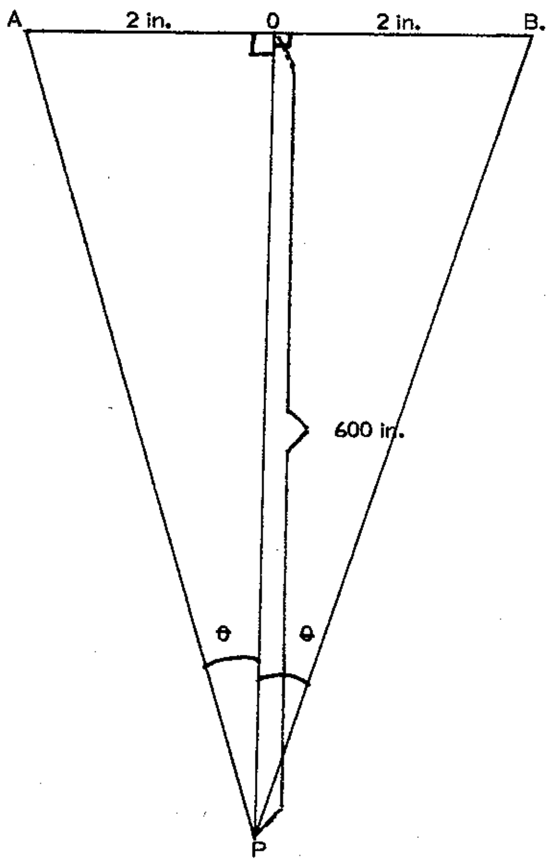

Figure I

Peter is standing at point P. The diameter of the can is AB and O is the center of the can at which Peter is aiming. θ represents the largest angle (the AAD) by which Peter's shot can be off target and still hit the can.

To find the value of θ, the tangent function can be used.

$$\tan\theta = \frac{2}{600}$$

$$= .0033$$

Therefore $\theta = 0.19°$ or 11.5 minutes.

A slight tremor of Peter's hand would cause this AAD to be exceeded.

Suppose that Peter is a poor shot and decides to double the radius of the target. Peter reasons that doubling the radius of the targent should double the AAD to .38°. We investigate this conjecture by Peter.

This new conjecture specififes that AO = OB = 4 in Figure I.

$$\tan\theta = \frac{4}{600}$$

$$= .0067$$

$$\theta = .38°$$

Peter's prediction seems correct. To further test the sort of reasoning implicit in his conjecture, we next vary the original problem by making the target very large in width. In particular, let 4 = 20 feet, or AO = OB = 20 feet.

Peter predicts that since the original value of AO has been multiplied by 120, the AAD should also be multiplied by 120. This would yield an AAD of .19(120) = 23°.

$$\tan\theta = \frac{240}{600}$$

$$= .4$$

Therefore $\theta = 21.8°$.

Why was Peter wrong? His error lay in assuming that the tangent function was linear.

This notion of allowable angular deviation is of great interest in the military. A standard unit used in the military for measuring angles is the mil. A mil is the measure of a very small angle; 6400 mils = 360 degrees. The use of a mil as the AAD of Figure I yields the following result:

Suppose that Peter is 1 mile from a target; PO = 1 mile. If θ = 1 mil, then

$$\frac{AO}{5280} = \tan(1 \text{ mil})$$

$$AO = 5280\ [\tan(1 \text{ mil})]$$

$$= 5.18 \text{ feet}$$

Since adjustments in military gun-signts are commonly calibrated inmils, this provides a way of setting sights properly. If a shot is off by 5 feet at a distance of one mile, an adjustment of one mil in the gun-sight should be performed.

Challenge: This article considered horizontal angle deviations. If vertical angle deviations are considered, the trigonometry would be identical, except that one of the conditions of the problem has changed. Specifically, the angular deviation of a shot is affected by the gravitational pull on the bullet which follows a parabolic path. Compute the vertical AAD for this new situation.

CALCULATING SLOPE AND DISTANCE--A DIFFERENT APPROACH

Barbara Zimmanck Krueger
Ursuline Academy
Cincinnati, Ohio

One routine topic in the Algebra 1 class room is slope of a line. We are all familiar with the formula

$$m = \frac{y^2 - y^1}{x_2 - x_1}$$

to calculate the slope of the line containing the points

(x_1, y_1) and (x_2, y_2).

I found that students being introduced to the concept of slope had difficulty substituting the appropriate values into the formula because they were confused by the notation.

I calculate slope using a different approach to the formula. I follow the order of operations, plus subtract the ordered pair values vertically. The order of operations for the formula is to subtract the x and y values, then divide.

Example 1: Find the slope of the line containing the points (2, - 1) and (-4, 2).

$$\begin{array}{r} (\ 2, -1) \\ \underline{-(-4,\ 2)} \end{array}$$

$$\frac{-3}{6} = \boxed{-\frac{1}{2}}$$

The example above also illustrates how it is easier for the student to remember that slope is change in y over change in x because students are used to working from left to right.

Following the order of operations and subtracting vertically can also be extended to the distance formula. Substituting values into $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ means to subtract, square, add, and then take the square root.

Example 2: Find the distance between (3,-2) and (-3,1).

$$\begin{array}{r} (\ 3, -2) \\ \underline{-(-3, 1)} \\ 6\ \ -3 \end{array}$$

$$\sqrt{6^2 + (-3)^2} = \sqrt{36 + 9} = \sqrt{45} = 3\sqrt{5}$$

This different approach has been used with much success. After students can calculate slope and distance correctly, then they can look at the formulas with more understanding.

— The Illinois Mathematics Teacher, January, 1984

GOALS IN THE MATHEMATICS CURRICULUM

by Marlow Ediger
Northeast Missouri State University

There is considerable debate pertaining to which objectives learners are to attain. The mathematics curriculum is no exception. One hears much about a return to the basics. The basics generally are perceived as emphasizing the three R's (reading, writing, and arithmetic). Thus, the third R--arithmatic-- has essential content for all learners to master. Within the framework of essentialism, which objectives, methods of teaching, and appraisal procedures need to be in evidence?

Instructional Management Systems

Instructional Management Systems (IMS) advocate the utilization of precise, measurable ends. Vagueness and ambiguity need to be eliminated from goals of instruction according to IMS tenants. With clarity of intent in objectives, the teacher knows precisely which sequential ends students are to attain. Thus, learning activities may be selected by the teacher to guide pupils to achieve each objective on an individual basis. An objective needs to be attained by the student before progressing to the next sequential end. The teacher can then measure if a learner has/has not achieved a specific goal. Uncertainty on the teacher's part is not in evidence to determine if a student has mastered content necessary in goal attainment.

The Missouri Department of Elementary and Secondary Education[1] listed the following characteristics of IMS:

1. High expectations for learning. Teachers and administrators expect a high level of achievement by all students and communicate their expectations to students and parents. No students are expected to fail, and the school assumes responsibility for seeing that they don't.

2. Strong leadership by building principals. The building principal is an instructional leader who participates in all phases of instruction. The principal is a visible leader of instruction, not just an office-bound administrator.

3. Emphasis on instruction in the basic skills. Since mastery of the basic skills is essential to learning in all other subjects, the effective schools make sure students at least master the basic skills.

4. Clear-cut instructional objectives. Each teacher has specific instructional objectives within the overall curriculum which are communicated to students, parents and the general public. In effective schools, teachers and administrators--not textbooks--are clearly in charge of the curriculum and teaching activities.

5. Mastery learning and testing for mastery. Students are taught, tested, retaught and retested to the extent necessary to assure mastery of important objectives.

6. School Discipline and climate. The effective schools may not be shiny and modern, but they are at least safe, orderly and free of distractions. All teachers and students, as well as parents, know the school's expectations about behavior and discipline.

The following are definitely not emphasized by IMS:

1. open-ended general objectives in the mathematics curriculum.

2. leaway in interpretation as to which subject matter should be taught so that students may choose sequential goals to achieve in a flexible mathematics curriculum.

3. pupil-teacher planning in selecting objectives.

4. learners in a classroom achieving at a similar/same level of progress. Each student progresses as rapidly as possible in achieving objectives.

Learning Centers and Mathematics

Educators, advocating humanism as a psychology of learning, believe that students should be involved in decision-making. Thus, the mathematics teacher, alone, does not select objectives, learning activities, and evaluation procedures for students. Rather, within a flexible framework developed by the teacher, the learner may select from among alternatives which sequential activities to pursue. A learning centers approach might then be in evidence. An adequate number of centers and tasks needs to be available so that the involved student may truly choose which activities to pursue and which to omit. Continuous progress must be made by the learner in completing personal suitable tasks. Each student may then achieve at a unique optimal rate of progress. Diverse objectives in mathematics may be achieved when comparing one student with another.

Choices made by learners in tasks pursued depend upon personal interests, abilities, capacity, and motivation. The kinds of tasks chosen may emphasize individual or committee endeavors, an activity centered or subject matter emphasis, inductive or deductive methods, as well as concrete or abstract experiences.

Morris and Pai[2] wrote the following pertaining to the thinking of Carl Rogers:

> But what are the conditions for such learning, and what must the teacher do to facilitate them? Like other humanistic educators, Rogers assumes that human beings have a natural potentiality for learning and curiosity. John Holt argues that this potentiality and desire for knowledge develops spontaneously unless smothered by a repressive and punitive climate. Consequently, humanistic educators seek to remove restrictions from our schools so that the child's capacity for learning can be cultivated. They attempt to provide the child with a more supportive, understanding, and nonthreatening environment for self--discovered learning. For example, if Jimmy is having serious difficulty in reading, he should not be forced to recite or read aloud in front of his peers, whose reactions may strengthen his own perception of himself as a failure. Rogers believes that significant learning can be promoted by allowing children to confront various problematic situations directly. If students choose their own direction, discover their own resources, formulate their own problems, decide their own course of action, and accept the consequences of their choice, significant learning can be maximized. This suggests that significant learning is not possible unless the learner's feelings and the intellect are both involved in the learning process.

Advocates of learning centers do not emphasize:

1. precise, measurable objectives for student attainment. What is specific to measure in pupil progress may not be relevant. Interests and purposes of learners are significant, but can not by any means be precisely measured.

2. teachers selecting objectives, learning activities, and evaluation techniques for students.

3. a rigid, formal curriculum. Rather, input for students in curriculum development is important.

4. each pupil being assigned the same/similar tasks as compared to other learners in the classroom.

Structure of Knowledge and the Mathematics Curriculum

Mathematics may be perceived as having considerable structure. There are selected concepts and generalizations which hold true consistently. Thus, concepts, such as the following may be stressed in teaching and learning:

1. The commutative property of addition and multiplication.
2. The associative property of addition and multiplication.
3. The distributive property of multiplication over addition.
4. The identity elements for addition and multiplication.
5. The property of closure for addition and multiplication.

Key concepts and generalizations, as advocated by mathematicians on the higher education level, then become objectives for students to attain on the elementary, junior high school or middle school, and senior high school years.

To achieve these structural ideas, the teacher of mathematics needs to have students utilize inductive methods of learning. Lecture and heavy use of explanations is not recommended. Rather, the teacher identifies problems and questions. To secure content in answer to the questions and problems, a variety of reference sources need to be utilized. Answers to problematic situations come from students. Methods of learning used by students should be similar to those emphasized by professional mathematicians.

Woofolk and Nicolich[3] wrote:

> Jerome Bruner is a well-known modern cognitive theorist .... Bruner has been especially interested in instruction based upon a cognitive learning perspective. He believes that teachers should provide problem situations that stimulate students to discover for themselves the structure of the subject matter. Structure is made up of the fundamental ideas, relationships, or patterns of the subject matter, that is, the essential information. Specific facts and details are not part of the basic structure. However, if students really understand the basic structure they should be able to figure out many of these details on their own. Thus Bruner believes that classroom learning should take place inductively, moving from specific examples presented by the teacher to generalizations, about the structure of the subject, that are discovered by the students.

Structure of knowledge advocates in mathematics do not believe in:

1. student-teacher planning as to objective the former is to attain. Rather, structural ideas need to be achieved as identified by subject matter specialists.

2. teachers presenting subject matter deductively for learners to acquire.

3. content for student attainment being chosen by others than professionals in the mathematics curriculum.

4. emphasizing abstract experiences for students as compared to the concrete and semi-concrete. Sequence in lerning activities must progress from manipulative (real objects and items), to the iconic (pictures, films, filmstrips, slides, and transparencies), to the symbolic (abstract words, letters, and numerals).

The Mathematics Laboratory

Mathematics laboratories philosophy in teaching and learning believe that students are active, not passive beings. Learners need to choose and select, rather than to listen to lectures and lengthy explanations of subject matter. Concrete experiences need to be at the heart of the mathematics curriculum. An adequate number of real objects need to be in the offing to stimulate student achievement. Thus, for example, objects and materials need to be in evidence from which learners may select to weigh, measure lengths and widths, determine the volume, as well as find areas, perimeters, and circumferences.

Within the framework of concrete experiences, students use abstract learnings to record weights, measurements, areas, and circumferences.

Involving the mathematics laboratory concept, Ediger[4] wrote:

> Pupils should have ample opportunities to experience the mathematics laboratory concept of working. The mathematics laboratory emphasizes tenets of teaching and learning such as the following:
>
> (a) Pupils are actively involved in ongoing learning activities.
>
> (b) A variety of experiences is in evidence so that pupils may select materials and aids necessary for problem solving.
>
> (c) Practical experiences are emphasized for learners in that they actually measure the length, width, and/or height of selected people and things; weigh real objects and record their findings; find the volume of important containers; as well as determine areas of selected geometric figures.
>
> (d) Pupils become interested in mathematics due to reality being involved in ongoing learning activities.
>
> (e) Provision is made for individual differences since there is a variety of learning opportunities for pupils from which to select on an individual basis.
>
> (f) Meaning is attached to what is being learned since pupils individually and in committees work on tasks adjusted to their present achievement levels.

A mathematics laboratory philosophy does not advocate:

1. a textbook methodology in teaching and learning situations.

2. students being recipients of facts, concepts, and generalizations from teachers.

3. lecture and extensive explanation approaches in teaching mathematics.

4. abstract, symbolic learnings to the exclusion of using realia in the mathematics curriculum.

A Miniature Society Concept in the mathematics Curriculum

There are selected mathematics educators who believe strongly in guiding students to acquire and apply facts, concepts, and generalizations useful in society. The community becomes an ideal place then in having learners attain understandings, skills, and attitudinal goals. Thus, for example, students with appropriate readiness experiences and with teacher stimulation might engage in finding unit prices for soap, cereal, flour, and cake mixes. How much then does each brand name and generic brand cost per ounce or gram? Other factors also need to be evaluated, in addition to unit pricing, and that is quality within each item.

Students in a miniature society context, might determine the cost of:

1. a given number of items from a supermarket.

2. selected items purchased from a hardware store.

3. items of clothing from a clothing store.

4. cost of gasoline, after buying a certain number of liters or gallons.

A miniature supermarket may be developed in the classroom. Empty cereal, fruit and vegetable, as well as other containers may be placed on shelves in the classroom setting. Appropriate clearly labeled prices need to be attached to each food item. Play money may be used by learners in shopping for needed items. Paper and pencil, as well as the hand held calculator may be used to determine cost of a given set of items purchased, as well as change to be received from money given in payment.

John Dewey[5] wrote:

> The development within the young of the attitudes and dispositions necessary to the continuous and progressive life of a society cannot take place by direct conveyance of beliefs, emotions, and knowledge. It takes place through the intermediary of the environment. The environment consists of the sum total of conditions which are concerned in the execution of the activity characteristic of a living being. The social environment consists of all the activities of fellow beings that are bound up in the carrying on of the activities of any one of its members. It is truly educative in its effect in the degree in which an individual shares or participates in some conjoint activity. By doing his share in the associated activity, the individual appropriates the purpose which actuates it, becomes familiar with its methods and subject matters, acquires needed skill, and is saturated with its emotional spirit.
>
> The deeper and more intimate educative formation of disposition comes, without conscious intent, as the young gradually partake of the activities of the various groups to which they belong. As a society becomes more complex, however, it is found necessary to provide a special social environment which shall especially look after nurturing the capacities of the immature. Three of the more important functions of this special environment are: simplifying and ordering the factors of the disposition it is wished to develop; purifying and idealizing the existing social customs; creating a wider and better balanced environment than that by which the young would be likely, if left to themselves, to be influenced.

A miniature society mathematics curriculum does not emphasize:

1. a textbook centered method of teaching mathematics.

2. a teacher initiated curriculum whereby the instructor selects objectives, learning activities, and appraisal procedures for pupils.

3. minimizing concrete, life-like experiences for students.

4. students being recipients of content in a highly structured mathematics curriculum.

In Closing

Numerous philosophies are in evidence pertaining to goals in mathematics for learners to attain. These include:

1. IMS with its emphasis upon precise, measurable ends for learner attainment.

2. Learning centers with its stress placed on students becoming quality decision makers in ongoing experiences.

3. Structure of knowledge with its advocacy of students acquiring major concepts and generalizations as identified by professional mathematicians.

4. A mathematics laboratory with emphasis placed on students using concrete materials in mathematics achievement.

5. A miniature society philosophy in which learners use mathematics in the functional real world.

Teachers and supervisors need to study and evaluate each philosophy. Ultimately, those philosophies which guide each pupil to achieve optimally should be emphasized in the mathematics curriculum.

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FOOTNOTES

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ANOTHER LOOK AT THE SIEVE OF ERATOSTHENES

by Sister M. Geralda Schaefer

All through the ages mathematicians, no matter what their special interests, have devoted much time and energy to the study of relationships among numbers. A favorite topic for study is the classification of numbers as prime or composite. The term "prime" or "primitive" was given by the ancient Greeks to any number p with exactly two divisors, 1 and p. The primes are the building blocks from which all composite numbers are built. A composite number, then, is a number that has at least three divisors. So the unit 1 is neither prime nor composite.

The Greek Eratosthenes (circa 230 b.c.) is accredited with the invention of the Sieve, a device to sort out prime numbers by successively crossing out multiples of the primes. Figure 1 shows that this method produces 25 prime numbers less than 100. The famous Greek mathematician Euclid (circa 365 b.c.--275 b.c.) proved that the set of primes is infinite.

When we examine the Sieve, we find that the primes are irregularly positioned. We note that 2 and 3 are the only consecutive prime numbers since 2 is the only even prime. There are, however, many examples of twin primes, primes that differ by 2. Some examples are 5 and 7, 11 and 13, 17 and 19, 29 and 31. With the advent of calculators and computers some very large pairs have been found such as 1,000,000,009,649 and 1,000,000,009,651. An unproved conjecture states that there are infinitely many twin primes. It is surprising that, to date, no one has proved that the set of twin primes is infinite since the problem seems on the surface not very much more complicated than the one involving the infinitude of primes solved so elegantly by Euclid over 20 centuries ago.

Further investigation of the distribution of primes reveals that there are primes separated by a number of consecutive composite numbers. For example, between 7 and 11, there appear three composites, 8, 9, and 10. Between 31 and 37, there are five consecutive composite numbers. Between 89 and 97, there are seven consecutive composite numbers. Now the question arises: Is it possible to find eleven consecutive composite numbers?

Before we explore that possibility, let us review some facts from number theory. First, factorial notation, such as 12! is defined as $12 \cdot 11 \cdot 10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$. Also, if $n = 4 \cdot 3 \cdot 2$, then $4 \mid n$, $3 \mid n$, and $2 \mid n$. If $2 \mid a$ and $2 \mid b$, then $2 \mid (a + b)$. Now since $2 \mid 12!$ and $2 \mid 2$, then $2 \mid (12! + 2)$. Likewise $3 \mid 12!$ and $3 \mid 3$, so $3 \mid (12! + 3)$. We can continue this pattern through $12 \mid 12!$ and $12 \mid 12$, so $12 \mid (12! + 12)$. So the numbers $(12! + 2)$ through $(12! + 12)$ are all composite numbers since each has at least three divisors, and they are consecutive numbers, so we have found eleven consecutive composite numbers. We make no claim that these are the smallest such numbers. We do know that they exist and that they are large numbers.

Following this pattern we have a scheme for finding any number of consecutive composite numbers. For example, to find 500 consecutive composite numbers, we can use $(501! + 2)$ through $(501! + 501)$. These are huge numbers but they do exist!

Despite the presence of all primes greater than 3 in the first and fifth columns of the Sieve, composite numbers appear there as well. So we surmise that there is no very nice and predictable pattern in which primes display themselves. History attests to the fruitless search by mathematicians for a formula by which to generate all primes. It is particularly fascinating, then, to see a clustering of primes on a computer display discovered by S. M. Ulam and his associates at the University of California and an associated spiral grid indicating the distribution of primes which appeared on the cover of the March 1964 issue of Scientific American. So the search for patterns for the distribution of primes continues.

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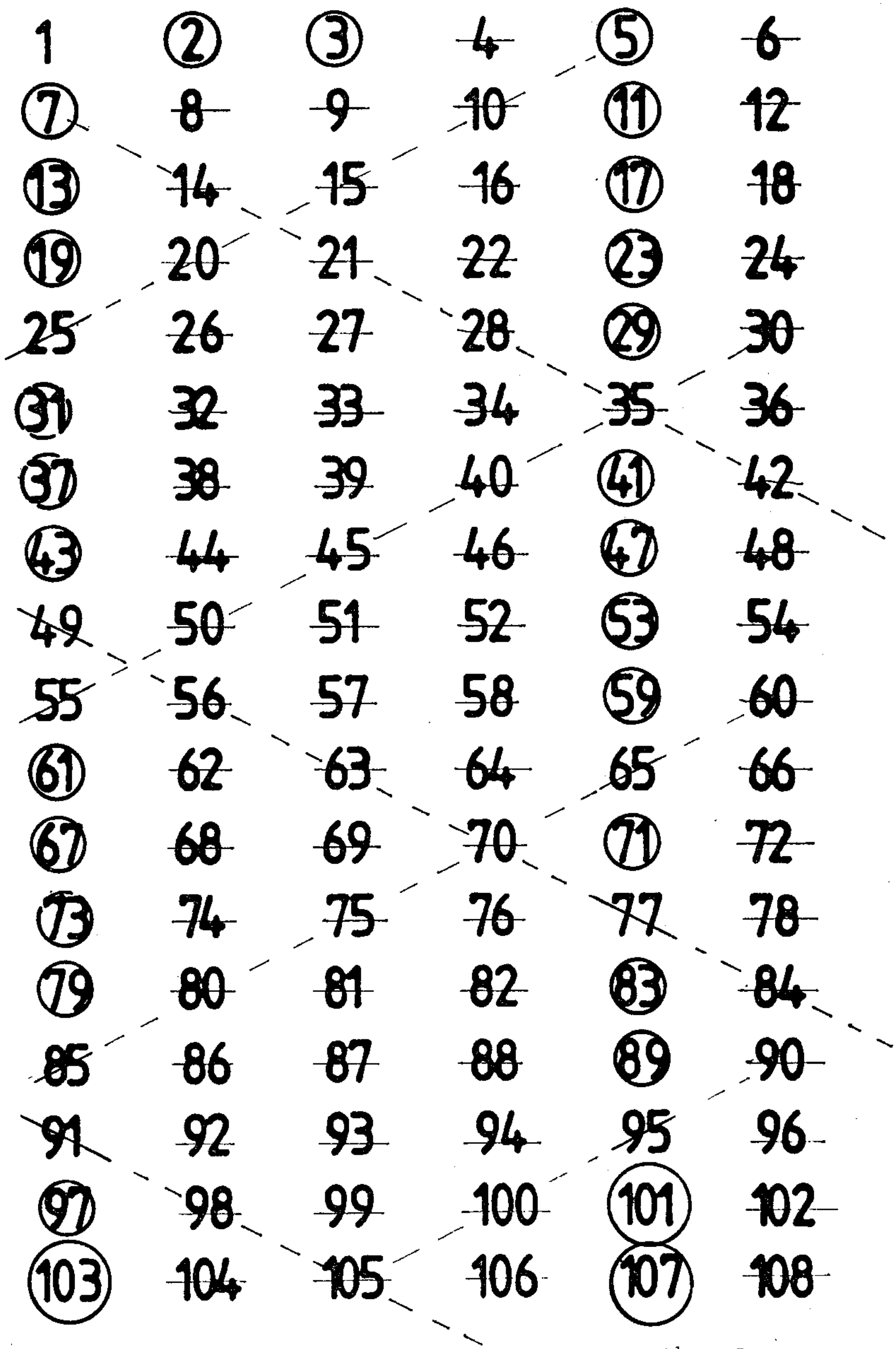

Figure 1 - Sieve of Eratosthenes

Official Memorandum

By

MARK WHITE

Governor of Texas

GREETINGS: **AUSTIN, TEXAS**

Various programs and activities aimed at encouraging students, teachers, parents, and the general public to become knowledgeable in the field of mathematics are being sponsored by the Texas Council of Teachers of Mathematics during the week of April 22-28, 1984.

Mathematics is the language of science and engineering and it paves the way for advances in modern technology. To maintain our state's forward momentum, it is necessary to depend upon advances made in science and engineering.

To remain economically competitive as a state, public and private business in Texas will need a clear understanding of mathematics and the proper use of mathematical models in their economic endeavors.

Mathematics is a valuable intellectual endeavor and can provide a firm foundation for the future success of the state. Our children must become familiar with the language and application of mathematics if they are to cope with the pressures of our technologically based economy.

THEREFORE, I, as Governor of Texas, do hereby designate the week of April 22-28, 1984, as

MATHEMATICS EDUCATION WEEK

in Texas.

In official recognition whereof, I hereby affix my signature this 26th **day of** April **19**84

Mark White

Governor of Texas

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