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The ***TEXAS MATHEMATICS TEACHER***, the official journal of the Texas Council of Teachers of Mathematics, is published two times each year, in Fall, and in Spring. Authors are encouraged to submit articles that deal with the teaching and learning of mathematics at all levels. Editorial correspondence and manuscripts should be addressed to the Editor, Paul Kennedy. News bulletins for *Lone Star News* section should be sent to Associate Editor, Diane McGowan.

Potential authors should adhere to the following guidelines:

(1) Manuscripts should be word-processed, double-spaced with wide margins on $8^1/2$ x 11 paper meeting APA guidlelines. Tables and figures should likewise be computer generated. No author identification should appear on the manuscript.

(2) Submit the original and four copies. Include a Macintosh or IBM $3^1/2$ diskette containing the manuscript. On the disk label indicate the word processing program used.

(3) Include a cover letter containing the following information: author(s) name, address, affiliations, phone and fax numbers, email address and intended level of the article.

(4) An article for Voices From the Classroom should be relatively short, and contain a description of the activities sufficient in detail to allow readers to incorporate them into their teaching. A discussion of appropriate grade level and prerequisites for the lesson should be included.

As soon as possible after refereeing, authors will be notified of a publication decision. Originals of articles not accepted for publication will be returned to the authors. Two copies of the issue in which an author's manuscript appears will be sent to the author automatically.

We also need items for *Lone Star News*. These include reports, TCTM affiliated group announcements, and any other appropriate news postings. We would especially like to advertise upcoming professional meetings.

SUBSCRIPTION and **MEMBERSHIP** information is on the back cover.

TEXAS MATHEMATICS TEACHER

TEXAS COUNCIL OF TEACHERS OF MATHEMATICS

Affiliated with the National Council of Teachers of Mathematics

Fall 1996

TABLE OF CONTENTS

Change....A Continuing Process!

The words educational change have permeated the professional literature and the staff meetings of nearly every school faculty in the nation. These words are whispered at board of education meetings and in conversations with government officials. And they also punctuate the speeches of politicians, while business leaders link them to economic survival. A central task in creating educational change is to develop a more collaborative working relationship among teachers. Teachers now need to move beyond their own communities of fellow colleagues to seek more diverse views.

We know that good teaching is not just a matter of being efficient, developing competencies, mastering technique, and possessing the right kind of knowledge. Good teaching involves a great deal of emotional work to generate classroom relationships that feature interest, enthusiasm, inquiry, excitement, discovery, risk-taking, and fun. It is important that we structure our improvement efforts to create workplaces for teachers that promote positive, emotional relationships to teaching, learning, and improvement. And, we must protect ourselves from overextending ourselves through emotional labor, and from becoming burned out, or cynical.

How do we accomplish this? Openness, informality, attentiveness, care, lateral and reciprocal collaboration, candid and vibrant dialogue, and a willingness to face uncertainty together, are basic ingredients of positive educational change. Change is learning. We must create strong professional cultures so that we can support and learn from one another in our change efforts.

The Texas Council of Teachers of Mathematics (TCTM) is committed to aid in this collaborative change process. Our journal, The Texas Mathematics Teacher, continues to share elementary, middle, and high school classroom-ready activities that will help us implement the new Texas Essential Knowledge and Skills (TEKS). A TCTM-sponsored session at CAMT next summer is being designed to provide a forum for officers of local mathematics councils to discuss leadership issues. A two-day follow-up conference is planned for the January, 1998.

TCTM is also developing a web site! It will contain TCTM organizational and membership information, journal highlights, CAMT and staff development information, conference dates, links to TEA, the Texas SSI, and NCTM. We hope that all local math councils will affiliate with TCTM so we can share mathematics news and ideas from around the state. The projected online date is Summer, 1997.

Educational change has turned the world into a vast kaleidoscope of shifting patterns that increase the choices and decisions we can make for educating our young people. You can prepare for the coming changes by taking an active part in your local and state professional organizations!

Please do not forget to cast your vote for TCTM officers, and take an active role in making TCTM part of your change process!

Basia Rinesmith Hall

Mathematics Research Projects

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A worthy goal in Calculus class is to expose students to the historical side of mathematics. In addition to the mathematical information students obtain during the research, they also gain valuable knowledge from working with resource and reference materials in the library. In this article, two major projects will be discussed. The projects are both based on the same subject. Each student selects and researches a mathematician (from a pool of names that are posted) who has made a contribution to the world of mathematics.

In the first project,titled "Nobel Prize Speech", the student takes on the role of the mathematician who has just been notified that he/she has been awarded the "Nobel Prize for Mathematics". The student's assignment is to write an acceptance speech that includes biographical data and emphasizes the mathematician's major contribution to and/or impact on mathematics. The speech is to be written in first person, typed on clean white paper and be grammatically correct and clear.

The second project, titled "Hats Off to Mathematicians", is an extension of the first project. The student keeps the same mathematician researched during the first project. However, this project presents the research findings in a creative manner. Each student must create a mortarboard (like the ones they will wear at graduation) to display the research. On the top of the "board", the student is to list 10 facts about the mathematician; these should be numbered and in complete sentences. The mathematician's name should be written in large letters on the front of the "hat". On the back of the "hat", the student is to write or illustrate the mathematician's greatest contribution to his/her field (formulas are acceptable). A tassel finishes the mortarboard. The student may decorate the mortarboard with anything that is related to or an explanation of the mathematician and/or his/her contributions. Originality and creativity is taken into consideration during grading.

Culmination of the two projects comes when the students wear the mortarboards and orally present the "Nobel Prize" speeches. Most of the students are very proud of their work and ask to visit other classes to display their talents and explain their findings. After all speeches are given, hang the mortarboards from the ceiling in your classroom These not only decorate your classroom throughout the year, but also stimulate discussions and prompt questions from underclassmen.

Partial List of Mathematicians to Research:

Julia Bowman Robinson
Pythagoras
Leonardo Fibonacci
Francois Viete
Galileo Galilei
Bonaventura Cavalieri
Blaise Pascal
Gottfried Leibniz
Emilie du Chatelet
Mary Fairfox Somerville
Srinivasa Ramanujan
Amalie (Emmy) Noether
Wernher von Braun
Rosalind Elise Franklin
Shibasaburo Kitasato
Eratosthenes
Diophantus
Sonya Kovalevskaya
Grace Murray Hopper
Evelyn Boyd Granville
Niccolo Tartaglia
Simon Steven
Johannes Kepler
Pierre de Fermat
James Gregory
Marquis de L'Hospital
Karen Keskulla Uhlenbeck
Joseph Lagrange
Evariste Galois
Alan Turing
Annie Jump Cannon
Lillian Moller Gilbreth
Ada Byron Lovelace
Santiago Ramony Cajal
John Cunningham McLennan
Anna Johnson
Hypatia
Girolamo Cardano
John Napier
Rene Descartes
John Wallis
Sir Isaac Newton
Johann Bernoulli
Charlotte Angas Scott
Pierre de Laplace
Sophie Germain
Louise Arner Boyd
Andres Manuel del Rio
Perry Lavon Julian
Elijah McCoy
Thomas Harriet
Jean-Victor Poncelet
Maria Goetana Agnest
Pell Wheeler

Tangent Lines to Curves

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Introducing tangent lines to graphs of functions and relations can be done conveniently with the algebra and geometry of circles. Assuming knowledge of the "point-slope form for straight lines," exercises like "Write an equation for a line tangent to $x^2 + y^2 = 25$ at (3,4)" are considered. Further knowledge from plane geometry and relationships between perpendicular slant lines' slopes is sufficient to determine what slopes are for circles' tangent lines. Using the arithmetic of the given point here, it becomes a textbook exercise to write an equation for this tangent line.

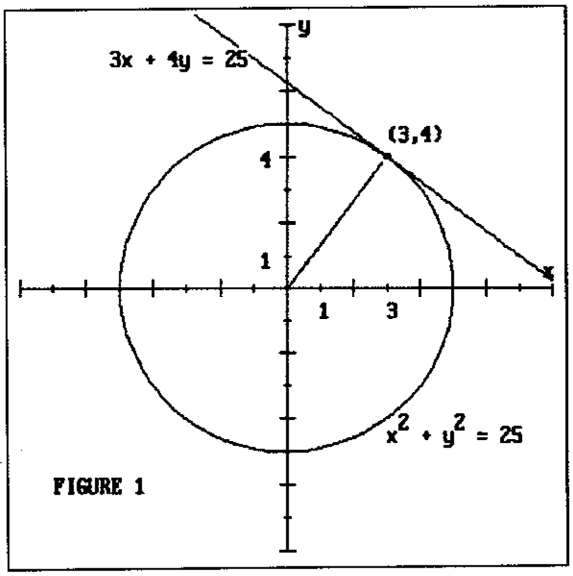

FIGURE 1

A radius constructed from (0,0) to (3,4) would have slope $\frac{4}{3}$. Therefore, the tangent line's slope would be $-\frac{4}{3}$, and the point-slope equation yields, in "general form," the line $3x + 4y = 25$.

Instead of moving to the "next topic" that introduces limits of Newton quotients, $\frac{f(x+h) - f(x)}{h}$, it is worthwhile to see if tangent lines to other relations and functions can be developed without these limits which produce "derivatives".

For example, what is an acceptable equation for a tangent line to a graph of $y = f(x) = x^2$ at $(c, f(c))$? The question can be decided geometrically with fair accuracy for $c=1$, say.

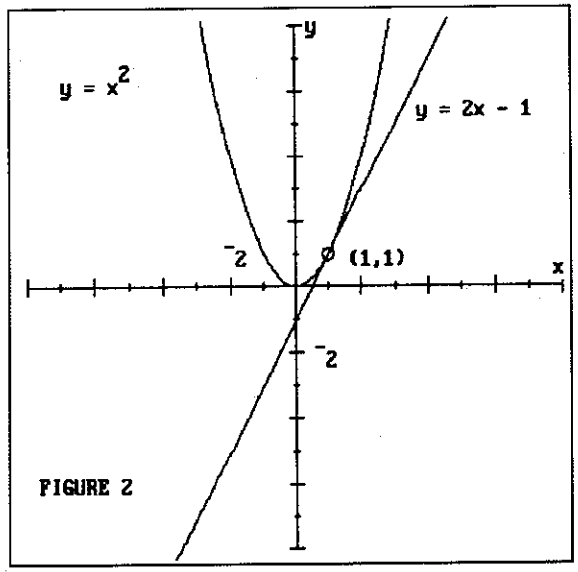

FIGURE 2

The geometry here suggests that a tangent line could be constructed and an algebraic representation could be expected to be fairly well approximated by $y = 2x - 1$.

After observing "geometrical existence," a way to determine slope is to simultaneously solve for the intersection of the given algebra of the parabola, $y = x^2$, with algebra for the line expressed in functional form: $y = mx + b$ where m and b are to be determined. It follows that for a "global" c:

$c^2 = mc + b$, or $c^2 - mc - b = 0$.

Looking at the geometry in Fig. 2, it can be seen that there is a "repeated root" at $(c, f(c))$. The quadratic is therefore a trinomial square and:

$-b = (\frac{1}{2}(-m))^2 =$. Then $c^2 - mc - b = 0$ becomes:

$c^2 - mc + (\frac{m}{2})^2 = 0$, or

$(c - \frac{m}{2})(c - \frac{m^2}{2}) = 0$ which implies $c = \frac{m}{2}$ as a repeated root.

Or, $\frac{m}{2} = c \Rightarrow m = 2c$ and for $c = 1$, $m = 2(1) = 2$.

(This was known to the instructor beforehand, but presumably not to the students.) To solve now for the other unknown, b , the slope intercept form for a straight line, $y = 2x + b$ yields, at $c = 1$, $f(c) = 1^2 = 1$, the equation: $1 = 2(1) + b$ which implies that $b = -1$.

Here the "slope" was determined in a "universal," or global form; that is, the algebraic expression $2c$ could have been applied at any domain choice associated with this function, the parabola $y = f(x) = x^2$; therefore, the slope could be expressed as $2x$.

Continuing with another example, $y = g(x) = x^3$, a somewhat similar attempt to determine an acceptable equation for a tangent line to a graph of this curve at (c, g(c)) will be made.

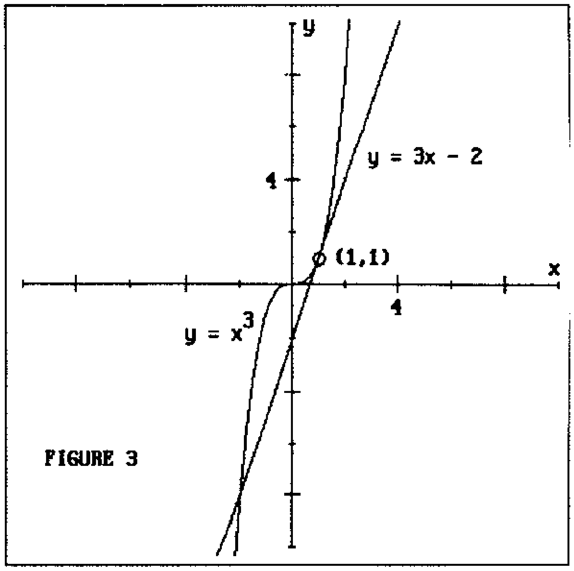

FIGURE 3

Selecting a convenient arithmetic point, say, (1, g(1)), geometry then suggests that a tangent line at (1,1) should exist (and at other arithmetic choices that could be selected.)

A way to determine an expression for the slope here involves some variations from the previous example but again with a simultaneous solution of $y = g(x) = x^3$ and $y = mx + b$, or $x^3 - mx - b = 0$.

By inspection of the convenient geometry in Figure 3, this third degree polynomial, $x^3 - mx - b$, exhibits one distinct root, say $x = k$, and a repeated root of "multiplicity two" at $x=c$.

Therefore, $(x - c) (x - c) (x - k) = x^3 - mx - b$, or, after multiplying the linear binomials in the left-hand expression and collecting like terms:

$$x^3 - (2c + k) x2 + (c^2 + 2ck) x - kc^2 = x^3 - mx - b.$$

For the two expressions to be equal we have

$-(2c + k) = 0$; $c^2 + 2ck = -m$; and, $-kc^2 = -b$.

It follows that $k = -2c$, and therefore $c^2 + 2c(-2c) = -m$, $\Rightarrow c^2 - 4c^2 = -m$, or, $-3c^2 = -m$, or, $m = 3c^2$ (*).

Also, $-kc^2 = -b \quad - (-2c)(c^2) = -b$, or $b = -2c^3$.

What is of main importance is equation (*): $m = 3c^2$. At the domain choice $c = 1$, the tangent line's slope is $3(1^2) = 3$, and the point- slope algebra for the tangent line at (1,1) could be written in slope intercept form as $y = 3x - 2$.

This appears acceptable by an inspection of figure 3, and, again, the instructor knew what to expect beforehand. The expression $3c^2$ is another global expression that exists for all real numbers x ; so, it could be written as $3x^2$ since all polynomial functions have domains of all real numbers.

These are just two "extensions" beyond tangent lines to circles that lead to non-calculus slope determinations of tangent lines to polynomial functions. These and others allow instructors in pre calculus and introductory calculus courses considerable activities with their students. Results are known beforehand to the instructor and mathematical reform movements stressing "symbolic, numeric and graphic" considerations can be emphasized as students are afforded more opportunities in drilling with geometrical and algebraic representations along with selected sampling among arithmetic representative points. These extend "excursions" will aide instructors in helping their students " to put it all together" and, later, appreciate a certain elegance when repeating the same problems but with benefits of limits of Newton quotients along with "short cut" procedures for derivatives of general functions and relations.

A Model for Teaching Mathematics

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For some, the beauty of mathematics lies within the intricacies of an irrefutable proof to an important theorem, or perhaps in the derivation of an unexpected result. For most adults, however, the beauty of mathematics is to be found in the width and the breadth of its service to people in their daily lives. This beauty is often lost in a curriculum which is an abstract maze of formulas, rules, and ideas to be memorized and recited at appropriate times. Romberg (1992) summarizes this situation by stating that if an equal access to an education is to become a reality then all groups of people must have "access to its (mathematics) concepts and to the wealth and power in its knowledge brings ... students need to study it in living contexts that are meaningful and relevant to them - contexts that include language, cultures, and everyday lives" (p.43). These remarks are echoed in the *Curriculum and Evaluation Standards for School Mathematics* (1989) published by the National Council of Teachers of Mathematics. Instructors should deemphasize the "rote memorization of facts" and limit" extended periods of practicing routine tasks"(p.129). Instead students should be provided with experiences which "develop the capability for their own lifelong learning" (p.128)

The shift away from a teacher-centered, textbook-driven, test-oriented environment to one which engages students in activities designed to promote the *meaningful* understanding of mathematics is not an easy task. The first step perhaps is to re-examine what it means to meaningfully understand mathematical concepts, principles and skills. Towards this end, Miller, Malone, and Kandl (1992) and Miller and Kandl (1991) have developed a four dimensional model for understanding mathematics which will be discussed in this manuscript. The model has been referred to as "The Miller Model for Understanding Mathematics".

The Miller Model for Understanding Mathematics

Knowing That - The First Dimension

The first dimension of the Miller Model for Understanding Mathematics is "knowing that" and refers to the knowledge that a fact, process, or concept exists. For instance, being aware that a procedure for bisecting an angle exists, or that there is a formula called the Pythagorean Theorem, are examples of knowledge in this dimension. If someone purchases an old house and wishes to determine if some of the corners in the rooms still form right angles that person will not think to use the Pythagorean Theorem unless the person "knows that" the theorem exists. Instructional settings should place students in a variety of situations in which they do not know what concepts, formulas, or skills will be needed. In the real life situation with the corners of the room of a house, no warning is sent that the Pythagorean Theorem may be of some use in the near future.

Knowing How - The Second Dimension

In the second dimension, "knowing how", the concern is with the student's ability to use acquired knowledge or skills. Using the definition of the concept of a prime number to determine the status of the numbers 13 and 14, or using the Pythagorean Theorem to determine the length of a side of a right triangle are examples of demonstrating knowledge in this dimension.

Knowing Why - The Third Dimension

In this dimension "knowing why" refers to knowledge that justifies the validity of the mathematics being used. Offering a formal or informal proof of the Pythagorean Theorem, or the ability to accurately paraphrase the definition of prime number would constitute an example of knowledge in this dimension. To simply state that there is such a concept as that of prime number, and this is how you determine if a given number is prime does not in itself constitute a thorough and meaningful understanding of this concept.

Knowing When - The Fourth Dimension

In the fourth and final dimension, "knowing when", the student would be expected to demonstrate some understanding of when to apply mathematical knowledge to the solution of a problem, and correspondingly, when that knowledge could not be applied. As Romberg (1992) stat ed, optimally the students would be presented with relevant real life situations to demonstrate knowledge in this dimension. A sheet of ten items in which a student is presented with the lengths of two sides of a right triangle with instructions to determine the length of the third side addresses this dimension in a narrow and abstract way. A more reasonable example of a problem addressing this dimension would be to present students with a situation such as maximizing the area of a garden given certain limitations regarding the amount of fencing materials available. The students would be expected to demonstrate the applicability of their knowledge of quadratic equations and the quadratic formula. When presented with a problem involving the blending of an inexpensive tea and an expensive tea to produce a moderately priced tea the use of the quadratic formula may not be as appropriate. This latter item might be useful as a means of introducing, developing and motivating the study of solving equations simultaneously.

Implementing the Model

When preparing instructional units instructors must make numerous decisions as to the individual emphasis each dimension will receive, the depth of understanding sought within each dimension, and the standards for determining acceptable levels of performance within each dimension. Is it sufficient that the student know that the quadratic formula exists or must it be memorized? Is it sufficient that a student can use the formula with the aid of notes or must the knowledge of how to use it be demonstrated without assistance? Will the student be required to provide a formal proof as to its validity or should the student be able to suggest its validity in some manner short of a formal proof such as deriving the same roots to an equation with another method such as factoring or completing the square? To demonstrate that a student "knows when" to employ the formula, is it necessary that the student recognize that the quadratic formula can be used to solve a limited class of fourth degree equations? An explicit awareness of the four dimensions of the Miller Model for Understanding Mathematics can assist an instructor in developing and organizing both instructional units and assessment strategies.

Teaching Mathematical Concepts

In dimension one the student must simply "know that" the concept exists. When faced with a large set of data to organize and summarize, the student will not consider the use of a bar graph unless he/she is familiar with the concept. In reality, to meaningfully consider the use of a bar graph the student has probably acquired the ability to paraphrase this concept using informal language meaningful to the student. According to Hendrix (1961) the process of concept formation involves a stage called "non-verbal" awareness in which the student may have acquired some ability regarding the concept but lacks the sophistication to express it verbally. Most people have probably experienced the situation in which they have been asked to explain a problem they have solved but are unable to communicate the method of solution meaningfully. Hendrix cautions against efforts to force students to verbalize too quickly, suggesting that students should be given many informal opportunities to discuss the concept prior to a formal evaluation of their knowledge.

In the second dimension the focus of instruction shifts to developing a student's ability to demonstrate how to use the concept. Naturally students must know of the existence of a concept before they begin to learn how to use it, but the development of an ability to meaningfully verbalize the concept can proceed at the same time students learn how to use it. As was the case with the importance of verbalization in the "knowing that" dimension, students who can informally and meaningfully verbalize the steps in constructing a bar graph probably possess a deeper understanding of the bar graph than students who can simply construct a bar graph but not discuss the steps involved.

In the third dimension instruction provides justification for the use of the concept. Curiously, a bar graph can be used both to enhance a reasonable interpretation of data sets or to distort or obscure trends in the data. Once again, as a measure of understanding, the students should be able to discuss the justification for using the concept.

"Knowing when" to employ the concept, the fourth dimension, will involve students in a wide variety of situations. For the bar graph these situations will contain occasions when a bar graph should be used, and when the decision should be to use another kind of graph or no graph at all. As much as is possible, the situations presented to students should be real life situations of interest and relevant to the students. This will help motivate the students to acquire an understanding of the concept. Because of this, appropriate instruction addressing the development of the concept should naturally begin with material addressing dimension four. A real life situation involving a problem whose solution can be effected in part through an understanding of the concept to be introduced should be the point at which the instruction begins.

Teaching Mathematical Generalizations

The first dimension for teaching generalizations is the same as that of teaching concepts. To be of any value the student must "know that" the formula or rule exists. Ideally the student will be able to do more than rotely recall the existence of a theorem, but also be able to informally gerneralize it.

In dimension two the students again exhibit their knowledge of how to use the formula. The final stage of work in this dimension is producing a correct solution, but a thorough evaluation of student performance goes far beyond checking the student's final solution.

In dimension three the student is involved with instruction focusing upon the validity of the theorem or formula. This may or may not involve a formal proof depending upon the student's level of sophistication. Instruction in this dimension would not involve a formal proof if students could not meaningfully understand the proof. In the case of the Pythagorean Theorem the students might use the theorem in cases in which the lengths of all three sides are known. Using the lengths of two of the sides to compute the length of a third side should produce a result which agrees with known values. While not a formal proof in any sense this activity may help students develop faith in the theorem when complete data is not known. A student's faith in the validity of a formula will no doubt affect the student's willingness to use it, and desire to master the steps involved in its use. An instructor can always rely on authority to assert the validity of a formula but this approach has many limitations. Cobb, Yackel, and Wood (1992) state that the act of telling "brings with it the danger that mathematics will become excessively algorithmatized at the expense of conceptual understanding" (p. 11).

In the fourth dimension students must 'know when" to apply the formula, and correspondingly, when not to apply it. Thus, items *possibly* involving an application of the Pythagorean Theorem should include acute and obtuse triangles. In some cases the Pythagorean Theorem might be used to estimate the lengths of sides of triangles other than right triangles, but the students should be aware that an estimate is produced.

Teaching Mathematical Skills

The teaching of mathematical skills, such as using a compass or protractor, plays an important role in some areas of the mathematics curriculum. An awareness of the Miller Model for Understanding Mathematics facilitates efforts to promote a meaningful understanding of a variety of mathematical skills such as triangle congruency constructions or bisecting angles. As was the case in teaching concepts and generalizations, when faced with a problem whose solution can be effected through the use of a mathematical skill the student must "know that" a skill exists. Traditional instruction has focused primarily on telling students how to perform the skill and this is an essential ingredient in a student's overall understanding of the skill. Additionally, "knowing why" the skill accomplishes what it purports to do does more than 'just add a feeling of comfort to the process. Understanding why the skill works undoubtedly helps students organize and remember the steps in using the skill. Dimension four, or "knowing when" to use the skill has also been neglected by traditional instruction. Suggestions as to why the acquisition of the skill might play a role in someone's life should play a significant role in all other dimensions including why the student may wish to remember that the skill exists.

The dimension of "knowing when" a concept, generalization, or skill can be used in daily life requires a great deal more emphasis than it typically has received. This is why students are often heard to inquire "What good is this stuff?". If students cannot be presented with the real life relevance of some components of the mathematics curriculum then perhaps it is time that these components be eliminated (Mitchell, 1990). Dewy (1959) further stated that the real life relevance of the curriculum must not be drawn from the student's distant future, but "must represent present life ... vital" (p. 22) to the student. Preliminary research efforts suggest that a focus on the real life value of the curriculum creates a more positive and equitable environment for minority students (Anderson, 1990; Delpit, 1988).

The use of the Miller Model for Understanding Mathematics should play an important role in the assessment of students' performance. Whether students are administered traditional examinations, or non-traditional experiences such as writing exercises or oral presentations the instructor who is aware of and considers all four dimensions of understanding can better insure that each dimension is measured. In fact, if the focus of classroom instruction shifts away from traditional paper/pencil examinations designed to determine if the student "knows how" to use the skill towards instruction with a focus upon the student's ability to verbalize his/her understandings in the other dimensions the Miller Model for Understanding Mathematics should facilitate the use of alternative assessment procedures. A focus upon the "knowing when" dimension has additional advantages as it encourages students to become more aware of and possibly involved in activities in their community involving mathematics.

Conclusion

If the *Curriculum and Evaluation Standards for School Mathematics* (1989) are to be implemented then instruction must focus upon students' meaningful acquisition and understanding of mathematical knowledge. The teacher-centered, textbook-driven, test-oriented curriculum must yield to one which is student-centered. It must yield to a curriculum which is supplemented by instruction geared toward the current interests of the students and to which uses a wide variety of assessment strategies to measure student performance. The use of the Miller Model for Understanding Mathematics will facilitate efforts to help students meaningfully understand mathematics and better appreciate this subject as one which will serve them throughout their lives. Traditional instruction has been dominated by efforts to have students memorize mathematical concepts, principles, and skills, and further memorize how to use this information. A consideration of all four dimensions of the model and the interrelationships of these dimensions will not only enhance the meaningful acquisition of mathematical knowledge, but will increase student performance.

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AFFILATED GROUP AND INSTITUTIONAL MEMBERSHIPS

Affiliated groups are encouraged to join TCTM to receive journal materials and information.

Complete the appropriate section on the membership form and keep your group informed about TCTM.

TCTM LEADERSHIP SESSION AT CAMT

Texas affilated groups are asked to send at least two officers or interested members to the special affiliated group session at CAMT in Houston. Please refer to the CAMT program to find the time and place. It will be an opportunity for affilated groups to share ideas and to have input into the state organization.

Estimating Square Roots: From Color Tiles To Graphics Calculator

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One of the objectives measured on the exit test for high school mathematics of the Texas Assessment of Academic Skills (TAAS) involves estimating the square root of a natural number, n by finding two consecutive natural numbers, n_1 and n_2 for which:

$$n_2 > \sqrt{n} > n_1, \text{ if n is not a perfect square.}$$

That is, the student is expected to know that the $\sqrt{18}$ is between four and five because the square of four is sixteen and the square of five is twenty-five. This method of estimating square roots is very limiting because many important mathematical concepts associated with extracting square roots are left out. Consequently, students do not gain a meaningful understanding of square roots. Meanwhile, immediate access to a calculator may be less beneficial if the students have not been shown mathematical connections. Reading the numbers off the calculator could be just another mindless activity unless a conceptual knowledge of square roots has been developed.

In this article, a teaching approach used with the middle and high school mathematics teachers to introduce estimation of square roots through developmental activities involving physical models is detailed. This approach was inspired by the work of Gary Tsuruda (1987) in which base-ten blocks were used to estimate the square root of a natural number. To simplify the model we suggest color tiles, preferably two colors only.

Building Squares with Color Tiles

The first part of the instruction involves building physical models of squares using color tiles. For each model of a square built the students identify the base or side and recognize that squaring the base would give the area which is also equal to the total number of color tiles forming the square. The mathematical terms "base", "exponent" and "square roots" are introduced while the students are building different squares with the tiles. At the same time, the students begin to visualize the "perfect squares" by associating these numbers to the squares they have built with the color tiles.

Estimating Squares Roots of Non-perfect Squares

Building on the idea of modeling squares using the tiles, the next phase of the instruction leads students to a procedure in estimating the square root of a number that is not a perfect square. For example, to estimate the $\sqrt{3}$, the student takes three color tiles (black) and tries to form a square using all three. Since it is not possible to form a square with all three black tiles, the student then picks a white tile to complete a 2x2 square - the next larger square. The $\sqrt{3}$ is then estimated by adding the base (i.e., one) of the smaller square to the fraction "2/3" which refers to the two black tiles (out of the three) in the additional row and column. We can say that the two black tiles are the "leftovers" of the original tiles. Figure 1 shows how to model estimating the $\sqrt{3}$ and $\sqrt{5}$, respectively.

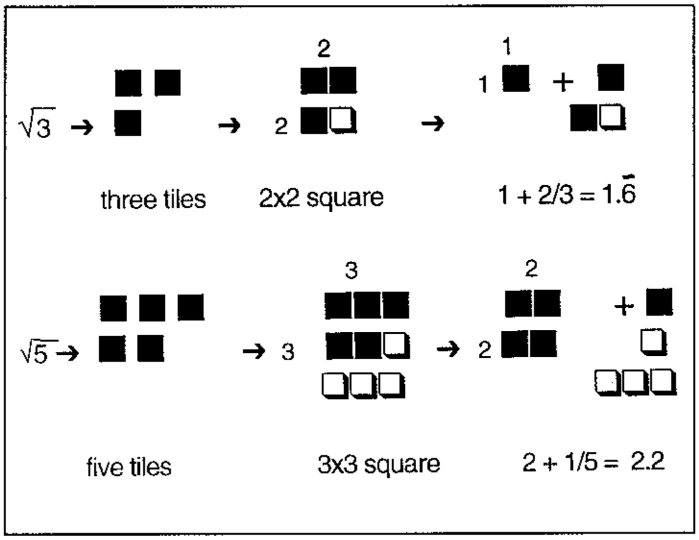

Figure 1. Modeling $\sqrt{3}$ and $\sqrt{5}$ using color tiles.

Using the tiles approach, we found that, when comparing the estimated value (2.20) for the square root of five with the calculator value (2.2360. . .), the percent error is only about four percent. Interestingly, a better square root approximation is obtained as the natural number becomes larger (Fig. 2, last column).

Emerging Patterns

While encouraging students to build squares of increasing base and recording their observations on a table (see Fig. 2), the teacher draws their attention to the number pattern (1, 3, 5, 7, 9, . . .) associated with the number of tiles needed to add a row and a column for building the

Number (a)	Original number of tiles (b)	Base of small square (c)	Base of larger square d)	Tiles in added row & column (e)	Estimated value[1] (f)	Calculator value[2] (g)	% error[3] (h)
$\sqrt{1}$	1	1	2	3	1 0/3=1.00	1.00	0
$\sqrt{2}$	2	1	2	3	1 1/3=1.33	1.41	6
$\sqrt{3}$	3	1	2	3	1 2/3=1.66	1.73	4
$\sqrt{4}$	4	2	3	5	2 0/5=2.00	2.00	0
$\sqrt{5}$	5	2	3	5	2 1/5=2.20	2.24	2
$\sqrt{6}$	6	2	3	5	2 2/5=2.40	2.45	2
$\sqrt{7}$	7	2	3	5	2 3/5=2.60	2.65	2
$\sqrt{8}$	8	2	3	5	2 4/5=2.80	2.83	1
$\sqrt{9}$	9	3	4	7	3 0/7=3.00	3.00	0
$\sqrt{10}$	10	3	4	7	3 1/7=3.14	3.16	.6
$\sqrt{11}$	11	3	4	7	3 2/7= 3.29	3.32	.9
.	.	.	.	.	.		
.	.	.	.	.	.		
.	.	.	.	.	.		
$\sqrt{16}$	16	4	5	9	4 0/9=4.00	4.00	0

[1] rounded off to two decimals. $(f) = (c) + \frac{\text{left-overs from original tiles}}{(e)}$

[2] rounded off to two decimals

[3] $\% \text{ error} = \frac{|\text{ estimated value - real value }|}{\text{real value}} \times 100\%$

Figure 2. Students' record-keeping to help see patterns.

next larger square. For instance, to change a 2x2 square into a 3x3 square, five more tiles are needed to add a row and a column; building from a 3x3 square to a 4x4 square, seven tiles (3+4) are added. The students should also observe that, for numbers between two consecutive squares such as 9 and 16, the denominator of the fractional part of the square root is the difference of the two numbers. They will also note that this difference is always odd (see Fig. 2, column e).

The patterns articulated during the exploratory phase of the lesson help students develop strong images which can facilitate estimating square roots of larger numbers without actually manipulating the color tiles. For example, a student successfully approximated the $\sqrt{125}$ using the reasoning below.

Student: "Well, the $\sqrt{125}$ is between 11 and 12. In my mind, I am changing an 11x11 square to a 12x12 square which has 23 (11+12) tiles in the added column and row. So, the fractional part has denominator 23 and the leftovers (125-121) tell me that the numerator is 4. I also know that the smaller square had a base of 11. Finally, the whole number part is 11, giving an estimated value of 11 4/23."

Extended Activities

When graphing calculators are available, the teacher can extend the lesson on estimating square roots by having students graph the function y= $\sqrt{x}$. The calculator shows a curve as shown in Fig. 3. Pressing the TRACER key, the coordinates (x, y) of any point appear on the screen. For instance, in Fig. 3, the "tracer" is at (5, 2.236. . .) where the y-coordinate is the calculator value of the $\sqrt{5}$. By adjusting the WINDOW, the students can explore or verify the square root of any positive number, x.

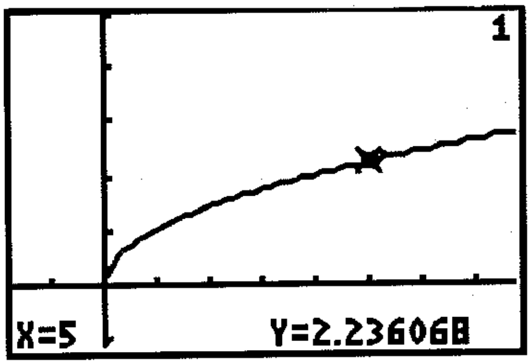

Figure 3. Graph of y=$\sqrt{x}$.

Another interesting problem that can be investigated involves inferring why the tiles method gives an estimated value less or equal to the calculator value. To answer this problem, the teacher might introduce the concept of "piece-wise linear approximation". The idea is to graph the family of lines connecting two points for which the x-coordinates are two consecutive perfect squares such as 1 and 4. The students will observe that the segment between the two points lies under the curve (see Fig. 4). How do we relate this phenomenon to the concrete model?

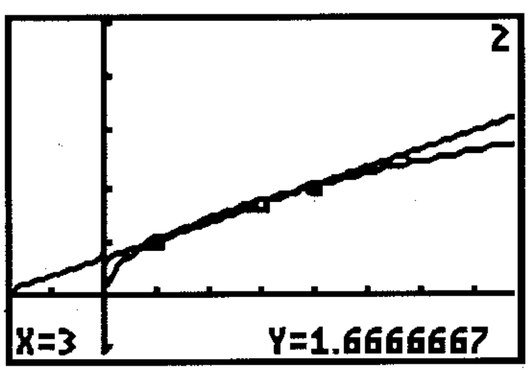

Figure 4. Graph of y= $\frac{1}{3}$ x + $\frac{2}{3}$

The equation of the line containing (1,1) and (4,2), contains the point (3, $1\frac{2}{3}$), which yields our concrete approximation for $\sqrt{3}$. Students can see how close their approximation is on the graph.

Benefits of the Approach

The Curriculum and Evaluation Standards for School Mathematics (NCTM 1989) strongly suggests that teachers provide mathematics experiences for students to connect mathematics to the real world and to use technology for verifying and reasoning. One of the standards outlined in this document specifically recognizes that "assessment of students' knowledge of procedures should provide evidence that the students can verify the results of procedures empirically (e.g., using models) or analytically" (p.228). The activities described above are aligned with the NCTM *Standards* which advocate mathematics activities that link procedural knowledge with conceptual knowledge.

In the real classroom, our high school students' reactions have been very positive after going through the activities described above. Students have no difficulty following the procedure to arrive at the estimated square root value after sufficient time is allotted for manipulating the square tiles. Similarly, pre-service elementary mathematics teachers found the tiles approach engaging and non-threatening. Moreover, the activities described here not only provide students with a better understanding of square roots but also the opportunity to: (a) strengthen their knowledge of fractions and decimals, (b) increase their understanding of area, (c) improve their ability to communicate about mathematics through the use of physical models, and (d) use technology in learning mathematics. Our students felt empowered upon realizing that they were able to estimate square roots of whole numbers without reaching for the "smart" calculator. Moreover, they saw the value of the graphic calculator in exploring patterns and relationships which strengthen their mathematical understanding.

References

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Elementary Students, Calculators, and Mathematical Meeting

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The calculator's role in everyday life is mainly that of a tool to free society from the drudgery of tedious computation. A view of the calculator's capabilities based only on its computational prowess leads to a limited, if not incongruous, vision of its use as an instructional tool. However, by juxtaposing the computational power and symbolic representations of the calculator with appropriate materials and meaningful questions, elementary teachers can use the calculator to engage students in critical aspects of mathematical thinking.

In Everybody Counts (National Research Council, 1989), mathematics is described as incorporating

> . . . distinctive modes of thought which are both versatile and powerful, including modeling, abstraction, optimization, logical analysis, inference from data, and use of symbols. Experience with mathematical modes of thought builds mathematical power—a capacity of mind of increasing value in this technological age that enables one to read critically, to identify fallacies, to detect bias, to assess risk, and to suggest alternatives. (p. 31)

Empowerment of students in the mathematics classroom must be addressed through shifts in the classroom environment toward classrooms as mathematical communities, toward logic and mathematical evidence as verification, toward mathematical reasoning, toward conjecturing, and toward making connections (National Council of Teachers of Mathematics [NCTM], 1991). Calculators are tools that both teachers and students can use to enhance activities and address probing questions that focus on modes of mathematical thinking: modeling (including symbolism), logical analysis, inference, optimization, and abstraction.

Mathematical Thinking

As teachers design or adapt mathematics activities to be worthwhile mathematical tasks, they can engage students in mathematical thinking in the following ways:

Are the students engaged in modeling? Does the activity encourage students to try to represent the situation in a diagram or a picture or a chart or table? Does the activity provide students with opportunities to communicate their results through the use of various representations, including appropriate symbolism?

Are the students engaged in logical analysis? Does the activity provide students with opportunities to discover why things work the way they do? Does it encourage students to look for the important characteristics of what is going on? Does it encourage students to compare likenesses and differences? Is the activity organized in such a way as to highlight important patterns?

Are students engaged in making inferences? Does the activity encourage students to make generalizations and conjectures? Does it give students the opportunity to test conjectures and transfer them to new situations?

Are students engaged in optimization? Does the activity encourage students to find the best or most efficient way to do something? Does it encourage them to use their imagination to explore many possibilities through "what if" questions?

Are students engaged in forming abstractions? Does the activity have a mathematical purpose? Is it designed to develop understanding of an idea/concept such as place value, patterns in evens and odds, or relationships between measurement units?

Using the Calculator to Support Mathematical Thinking

The following examples illustrate ways in which the use of a calculator can stimulate a student's mathematical thinking.

Exploring Place Value

As students work in pairs, one student displays an amount with place value blocks as the other student uses the constant-function capability of the calculator to "count" the value of the blocks.

Modeling. The first student places on the desk the following place-value blocks: three squares (hundreds), two long rods (tens), and four unit cubes (ones). As that student points to the hundreds, the second student enters + **100** = = = in the calculator and reads "100, 200 300." Pointing at the tens, then, and entering + **10** = = yields "310, 320," followed by + **1** = = = = and "321, 322, 323, 324" as the units are included.

Logical analysis. How is counting the hundreds with the calculator like counting the tens? The ones? What patterns do you see in the calculator display as you count the hundreds? The tens? The ones?

Inference. What would happen if you entered + **10** = = + **100** = = = + **1** = = = = and counted the tens first, then the hundred, then the ones? What would happen if you alternated between the different kinds of place-value blocks as you counted?

Optimization and abstraction. Complete the following chart from the examples you have tried:

Number of Hundreds	Number of Tens	Number of Ones	Total Value

What patterns do you see? What might you conclude about the relationship between the blocks and the values of the numbers they represent? What if one or more of the entries in the first three columns are "0"?

Investigating Remainders

Working in pairs, one student demonstrates the division process with counters while the other student uses a calculator with "Integer Divide" capability to record the process.

Modeling. The first student distributes 10 counters among four groups—two in each group with two left over—as the second student enters **10 Int÷ 4** = to display a quotient of 2 with a remainder of 2. More data is collected by investigating 11 counters divided between 4 groups, then 12 counters, then 13, and so on followed by various numbers of counters divided between 3 groups, 5 groups, and so on.

Inference. How will the remainders change if you use a different divisor with integer division on the calculator? What patterns do you expect to see if you organize the dividends according to this new set of remainders?

Optimization. If you're trying to share a bag of candies equally with a group of friends, and you get all the left-overs, how many friends might you want to share with? Why?

Abstraction. Given any number, N, divided by any non-zero number, d, what kinds of remainders could occur? Support your answer.

Predicting Fraction Sums, Differences, Products, and Quotients

Given four distinct, non-zero whole numbers—*a, b, c, d*—students place one number in each of the boxes in the template to generate the largest or smallest sum, difference, product, or quotient.

Logical Analysis. Place the four numbers in different arrangements in the template and find the sums using a calculator with fraction capabilities. Look at the sums that are greater (lesser) than most of the others. Why are they greater (lesser)? What kinds of fractions do they have for addends? (Similar questions could be addressed for other operations.)

Inference. To generate a greater (lesser) product, what do you do to a factor. How can you increase (decrease) the value of a fraction? What if one or more of the numbers were "0"? How can you use the calculator to test your conjectures?

Optimization. By looking back at the examples generated, do you see a pattern for placing the four numbers to make the greatest (or least) sum (difference, product, or quotient)? Have your partner choose four numbers, predict what you think the greatest product will be, and use the calculator to test your prediction.

Abstraction. Given four numbers *a, b, c, d,* where would you place them to obtain the greatest (least) sum (difference, product, quotient)? Support your answer.

Conclusion

By focusing on engaging students in mathematical thinking, teachers can expand their vision of the uses of the calculator in mathematics instruction. It becomes not only a tool for computation, but also a computational tool for modeling, analysis, and inference in order to make connections, generalizations, and predictions.

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Exploring Congruent Triangles at the Road-Kill Kafe

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This is an activity suitable for all levels of High School Geometry. Use it as an introduction to the triangle congruence postulates (SAS, SSS, ASA, AAS). Generally, classes have defined congruent polygons and have applied the definition to triangles. This means that in order to demonstrate that two triangles are congruent, one must show that all pairs of corresponding sides and all pairs of corresponding angles are congruent. The triangle congruence postulates are then usually introduced as "short-cut" methods for proving that 2 triangles are congruent.

The "Triangles Made to Order" activity provides students with some hands-on experience with the postulates in a way that is time-efficient and that makes sense from their point of view. It can be used as an in-class activity where students work in small groups to produce the triangles, or it can be introduced toward the end of a class period with the students making the triangles as a homework activity.

Introduce the activity simply as something fun to do— without making any mention of triangle congruence or "short-cuts." Emphasize the importance of following the directions and making the "triangle burgers" exactly according to specifications. Also show students what one should look like correctly cut out and labeled. Then let them get to work producing lots of "triangle-burgers"—the more, the better.

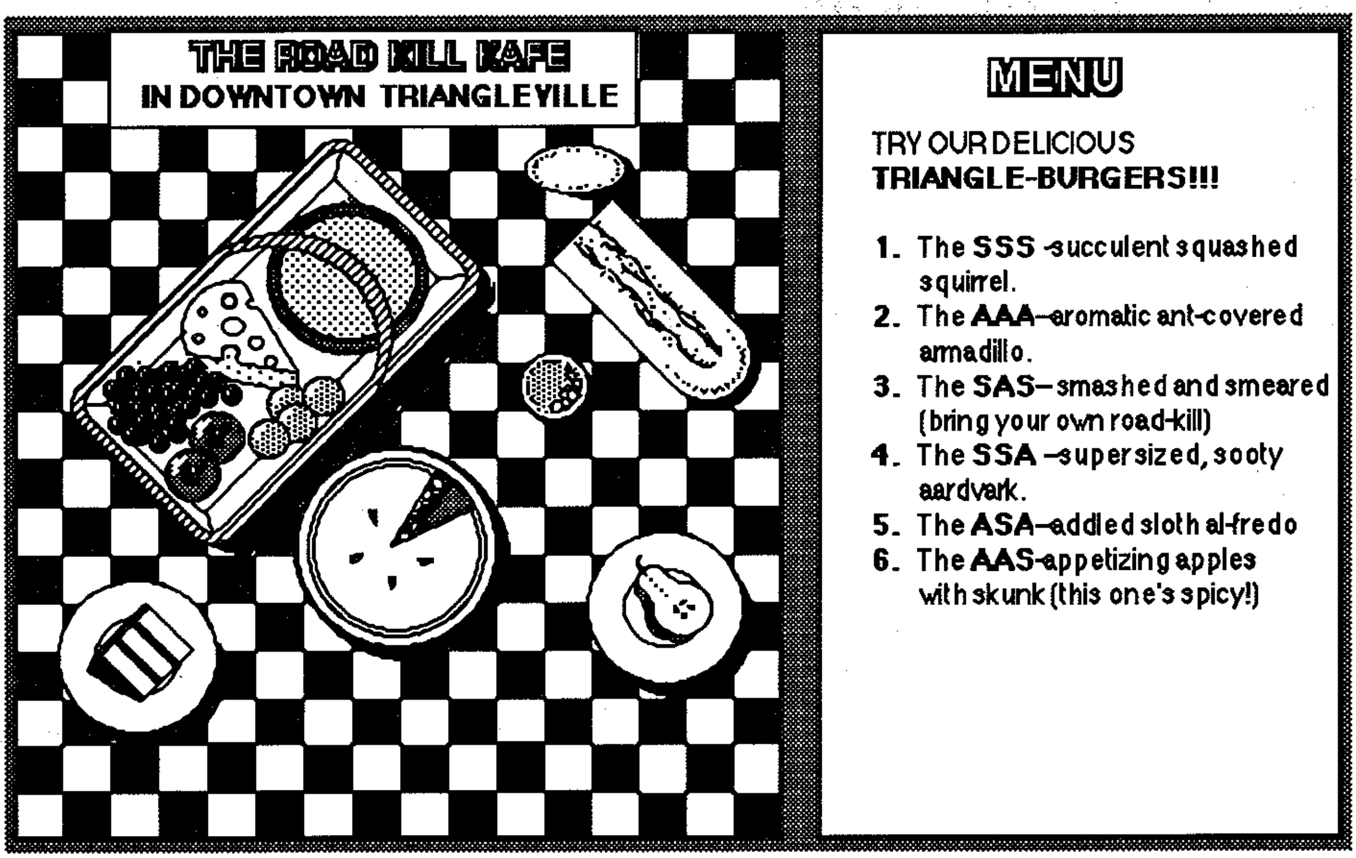
When students have finished making the triangles, partition the chalkboard into six areas labeled SSS, AAA, SAS, SSA, ASA, and AAS. Then ask them to tape their triangles up in the appropriate area. In a class of thirty students, this means that under ideal circumstances they should now have thirty congruent triangles taped up under the SSS label. Of course, the classroom rarely presents ideal circumstances, so talk about quality control and weed out the triangles that don't meet the cook's specifications.

At this point it should be obvious which sets of specifications produce congruent triangles and which ones don't. It's time to tie in the activity with the definition of congruent polygons and to talk about the triangle congruence postulates as "short cut" ways to establish that two triangles are congruent.

Bon Appetit!

TRIANGLES MADE TO ORDER

You have applied for a job as a short-order cook at the Road Kill Kafe in fabulous downtown Triangleville. As you can see, the menu is simple but satisfying. It consists of 6 different triangle-burgers—each with its own unique geometric "flavor."



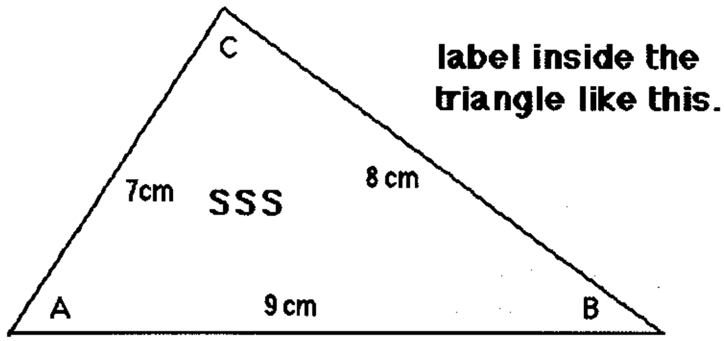
To get the job, you must demonstrate that you can make all six triangle burgers using the cook's precise specifications.

Make each of the 6 Road Kill Kafe triangle-burgers by reading the specifications, drawing and labeling the triangle on paper, and then cutting it out.

Each triangle you make must contain all the information given exactly as specified. If a particular length or and angle is not given, then you are free to make it as big or as little as you want—provided you can still come with the triangle-burger. You' ll understand what this means once you start making them.

Be sure to put your name on each of the triangles that you cut out.

One last note: make sure you put all your labels, lengths, and angle measurements inside the triangle so that they still



show up as part of the triangle once you cut it out.

Here are the triangles you have to make:

1. The SSS. Make ΔABC with:
   AB = 9 cm.
   BC = 8 cm
   AC = 7cm.

   (Hint: Draw segment AB first. Then use your compass set at 8 cm. to locate segment BC and your compass set at 7 cm. to locate segment AC.)

2. The AAA. Make ΔDEF with:
   m–D = 80
   m∠E = 30
   m∠F = 70

3. The SAS. Make ΔGHI with:
   GH = 8 cm
   m∠G = 50
   GI = 6 cm

4. The SSA. Make ΔJKL with:
   JK = 9 cm
   JL = 6 cm
   m∠K = 40

   (Hint: Draw ∠K then segment JK first. Use your compass set at 6 cm to locate segment JL.)

5. The ASA. Make Δ MNO with:
   MN = 8 cm.
   m∠M = 60
   m∠N = 40

6. The AAS. Make ΔPQR with:
   PQ = 8 cm.
   m∠P = 40
   m∠R = 60

   (Hint: You're the cook. You figure it out!!!!)

In Thin Air

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In 1992, the National Science Foundation (NSF) funded the Six Through Eight Mathematics (STEM) project at The University of Montana to develop a new middle school mathematics curriculum. The STEM curriculum was developed in thematic modules which last approximately four weeks each. The mathematics is taught in an integrated approach and applications are stressed. The modules have themes such as *Search and Rescue* and *Meet You at the Mall.* This activity originally appeared in the first module of *Amazing Feats, Facts, and Figures* of the eighth grade materials. It can be used to interest middle school students and challenge them to think about mathematics and problem solving.

In Thin Air

SETTING THE STAGE

At 29,028 ft, the summit of Mount Everest is considered the ultimate goal of many mountain climbers. Its incredible height is only one of the challenges it presents to those who would conquer it. Temperatures on the mountain can be as cold as -40° F or as hot as 100° F, with wind speeds sometimes reaching close to 100 miles per hour! More than 100 climbers have died attempting to reach the top of Everest.

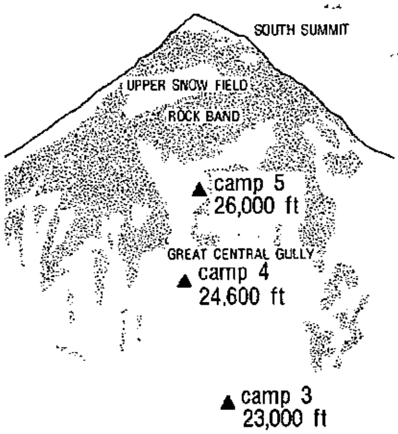
Scaling the world's highest peak is an incredible feat, and, without mathematics it would probably be impossible. In this investigation you will explore amazing feats, facts, and figures, and use mathematics to make sense of them.

Reflecting on the Reading

Use mental math to answer Exercises 1-2.

1. What is the range of temperatures on Mount Everest?

2. One mile is about 5280 feet. About how many miles high is Mount Everest?



EXPLORATION 1

Tenzing Norkay of Nepal and Sir Edmund Hillary of Britain became the first humans to scale Mount Everest. They accomplished this amazing feat in 1953.

I was greatly encouraged to find how, even at 28,700 feet and with no oxygen, I could work out slowly but clearly the problems of mental arithmetic that the oxygen supply demanded. A correct answer was imperative—any mistake could well mean a trip with no return.

[Edmund Hillary, High Adventure]

3. In making the ascent, the climbers in Hillary's expedition each depended on an 800-L (liter) tank of oxygen. Hillary estimated that at 3 L/min they had $4\frac{1}{2}$ h before the oxygen ran out. He then noted that they could cut down to 2 L/min if they had to. At 2 L/min, about how long would 800 L of oxygen last?

4. The amount of oxygen left in the 800-L tank is shown by a pressure gauge. At 3300 pounds pressure, the tank is full. At one point in the climb, Hillary checks the gauge. It shows 2550 pounds pressure. Assume he is using oxygen at a rate of 3 L/min.

   a. To determine how much time he has before the oxygen runs out, what sub problems does Hillary need to solve?
   b. Estimate how much time Hillary has before the oxygen runs out, by solving the sub-problems you found in Part (a).

5. In the following excerpt from High Adventure, Hillary explains how he used mental math and estimation to calculate how many liters of oxygen were left in the tank: "2550 from 3300 leaves 750. 750 over 3300 is about $\frac{2}{9}$ ths. $\frac{2}{9}$ ths off 800 liters leaves about 600 liters. 600 divided by 280 is nearly $3\frac{1}{2}$ ... Three and one-half hours to go."

a. Compare your method of estimation with Hillary's method. How are they different?
b. Calculate how much time Hillary actually had left. Was Hillary's estimate accurate? Explain.

To climb Everest, a mountain climber needs to consider not only the problem of oxygen, but also the problem of how to get supplies up the mountainside. In order to supply climbers at higher camps, supplies have to be carried from Base to Camp 3, from Camp 2 to Camp 4, and from Camp 4 to Camp 5.

When planning a 1975 ascent of Everest, Chris Bonington tried to predict what percentage of supplies would fail to reach their destination because of illness, weather, or other factors. He used a table to organize his data, a common problem-solving strategy.

Camp	**Percent of Failures**
Base to Camp 3	10%
Camp 2 to Camp 4	20%
Camp 4 to Camp 5	40%

6. a. What does 20% mean?
   b. Why do you think the percent of failures shown in the table increases as the climbers move to higher camps?
   c. Suppose 202 loads of supplies are to be moved from Camp 2 to Camp 4. About how many loads will not reach Camp 4?

Bonington's 1975 Everest expedition had 136 loads of supplies to move from Base Camp to Camp 3. To predict how many loads would fail to reach Camp 3, they needed to find 10% of 136. One way to find the percent of a number is to write an equation:

What number	is	10%	of	136?
↓	↓	↓	↓	↓
x	=	$\frac{10}{100}$	•	136
x	=	0.10	•	136
x	=	13.6		

7. How could you use mental math to find 10% of 136?

8. To predict how many loads would successfully reach Camp 3, Bonington calculated *136 less 10%.*

   a. What do you think *136 less 10%* means?

   b. Calculate *136 less 10%.*

   c. Bonington estimated that 123 loads of the 136 loads would reach Camp 3. Do you agree with his estimate? Explain.

9. If you know 10% of a number, how can you mentally find 40% of the number?

10. a. Suppose there are 86 loads to be carried from Base to Camp 3. Estimate how many loads will fail to reach Camp 3.
    b. Suppose there are 86 loads to be carried from Camp 4 to Camp 5. Estimate how many loads will fail to reach Camp 5.

PRACTICE AND APPLICATIONS

11. A climber needs to measure 5 c (cups) of water for making soup. Suppose there are two pots, one which holds exactly $3\frac{1}{2}$ pt (pints) and one which holds exactly $1\frac{1}{2}$ pt.

    a. Using only the two pots, and a large container with no measurements marked, explain how the climber can measure exactly 5 c of water. (1 pint = 2 cups)
    b. Explain how you solved the problem by describing your thinking for each step.

12. Bonington's team carried 1,934 lb of food and fuel up to Camp 2. He specified that $\frac{1}{3}$ of this amount was mountain rations (for future climbs) and $\frac{2}{3}$ of the amount was Camp 2 rations. About how many pounds of food and fuel were for Camp 2?

13. There is a 20% failure rate in loads to be carried from Camp 2 to Camp 4. If 110 loads are to be carried from Camp 2 to Camp 4, how many loads may not reach Camp 4?

14. John Hunt, the leader of the 1953 Everest expedition that conquered Everest, found that every 3 climbers needed 2 support members who would accompany the climbers and help carry the loads. You can write this comparison of climbers to support members as a ratio in three different ways:

    3 climbers to 2 support members
    3 climbers : 2 support members
    $\frac{\text{3 climbers}}{\text{2 support members}}$)

    a. Using this ratio, how many support members would be needed for 18 climbers?
    b. Hunt planned for the summit team to consist of 10 total members. How many were climbers?

15. The types of tents used on Hillary's expedition included 12-person, 6-person, 5-person, and 2-person tents. In planning for the trip, Hunt calculated the maximum capacity of one of the camps at 26 people. Find a possible combination of tents to accommodate exactly 26 people if:

    a. only one 12-person tent is used.
    b. the 12-person tent is not used.
    c. at least one 5-person tent is used.

16. The table below, from Hunt's book *Conquest of Everest*, shows a comparison of the rates of climb for different climbing groups. Use mental math to estimate answers for the questions about the table.

Comparative Climbing Rates
Between 25,800 Feet and 27,300 Feet

Party	Rate of Climb (feet per hour)	Climbing Conditions
Lambert and Tenzing, 1952	233	Step cutting and kicking in unbroken snow
Gregory, Lowe, and Ang Nyima	430	
First assault party, 1953	933	
Hunt and Da Namgyal	494	Steps already made
Second assault party, 1953	612	

[Source: John Hunt, *Conquest of Everest*]

a. At the rate listed in the table, about how far would the Second assault party, 1953 travel in $4\frac{1}{2}$ hours?

b. About how long would it take Hunt and Da Namgyal to travel 1400 feet?

c. At the rate reported in the table, could Lambert and Tenzing travel from 25,800 feet to 27,300 feet in 7 hours? Explain.

Communicating and Connecting With Resumes

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Why Resumes?

Students often view mathematics as disjointed groups of skills that have no use or meaning in the real world. They should be provided with the mental tools necessary for making connections. These tools include expertise in differentiating between whole and part, distinguishing between specific and general traits, and defining and elaborating on critical attributes of a situation. The vehicle to use to teach these skills is writing. The use of writing as a communicating skill in mathematics is well documented and widely used. Students' writing tasks can be structured specifically to elicit and sharpen these mental proficiencies. Writing resumes is an effective way for students to refine and demonstrate their knowledge.

Getting Started

What makes a good resume- one that catches the eye and conveys exactly the right amount of information? Students should brainstorm and research various resume formats and report back to the whole group. The resume should generally include the following information: job qualifications, education or training, specific skills, jobs previously held, and relational skills. Various ways of presenting this information along with the pros and cons of each method should be discussed. When students are comfortable with the writing skills involved, the real fun begins.

Students can be divided into groups and each group asked to pretend that they are a mathematical entity- for instance, a specific geometric solid. The group develops a list of qualities that they possess as this solid. The teacher can pose the question, "If you were a right hexagonal prism and were applying for a position as a hexagonal prism, what do you need to tell your prospective employer about yourself in order to get the job?". The students collaboratively develop a list of critical attributes which each group shares with the class. This activity emphasizes oral communication about mathematics as elaborated in the NCTM Curriculum Standards. Finally, students select a geometric solid and write a cover letter and resume as if they were this entity, applying for a position defined by these attributes. For example, they might write a a resume as a specific cube applying for employment as a cube.

On the surface this seems to be an easy task, but the skills involved are quite complex. Students are actually manipulating mental images. First, students must define the critical aspects of the mathematical entity. Then they must determine which of the characteristics they "possess" are general to all structures of this type and which are specific to them as this entity. They must then determine what specific things this structure does — a job description. The job description usually moves students from the cerebral halls of abstract thought to the real world, as they must find functions performed by these structures. The students must convince the employer (a group of their peers) that they are qualified to obtain employment on the basis of their attributes and skills. Students must furnish this information in a readable and presentable format, accompanied by a cover letter.

Assessing The Products

The student products are often quite amazing. Students may be as creative as they wish, and may submit letters of recommendation, videotapes, portfolios, and affidavits attesting to their qualifications. The minimum acceptable product is a concise well-written resume. The students evaluate each product as a class using a rubric they have developed. A sample rubric is provided below.

Writing Sample Assessment

__________ Clear communication

__________ Elaborates critical attributes

__________ Generates examples and non-examples

__________ Real world applications

__________ Total (4 points maximum)

The real pay-off for students is, of course, that when this activity is completed they have constructed a deep conceptual understanding of geometric solids and how they relate to the real world. This approach is consistent with current cognitive research, which asserts that students must construct knowledge for themselves through examples and non-examples.

This activity can be used at various levels in high school. Some of the topics developed include lines, linear systems, conic sections, geometric solids (See Figure 1), geometric figures, circles, triangles, and quadrilaterals specifically, coordinate representation, polar representation, and functions (See Figure 2). Resume writing provides opportunities for students to communicate about mathematical objects orally and in writing. Students like this activity, particularly when they understand the rationale. Resume writing is an appropriate activity for all students as it provides opportunities to construct knowledge through application and extension.

Figure 1.

Prism Job Resume

Personal Information:

Name:Polly Right Prism
Address: 90 Prism Lane
Montgomery TX 77356

Children:

Oblique Pentagonal (takes after her father)
Right Trapezoidal

Areas:

LA: 84 square centimeters
SA: 96 square centimeters

Professional Affiliations:

Roofing for Fellow Prisms
Attic Builders, Inc.
Assistant in Wedging
Prisms of America

Experience:

Two years apprenticeship in roofing and attic building
Eight months as an assistant in wedging and lifting objects
Four years as half of a table leg.

Why This Job?

I have been performing this job without the title for for four years. Since my base is a 3-4-5 right triangle, I have the proportions necessary to be named to the job. My personal qualifications are exhibited by my upright character.

Figure 2

Direct Function Resume

Name: David Direct Function

Relations: Linear Functions

Age: As the years increase, my age increases proportionally.

Previous Employment:

I was formerly employed as a graph plotter, I could use my equation to find the coordinates of any given point on my graph.

Skills

It is very easy for my job effectiveness to be evaluated because my equation is quite simple. I am extremely efficient and simplistic; I work like a machine. Any constant multuplied by my abscissa causes my ordinate to be increased proportionally. I am easily manipulated. I am useful in sales, construction, finance, and politics.So, you see, I am the perfect organization man: perfectly predictable, infinitely useful, and easily manipulated.

Birthday Data Collection Activity

Mano Barberena
High School of Medical Professions
2211 McKinnley Ave.
Fort Worth, TX 76106

This activity is adapted from an activity developed for the T^3 AC^2E program. It is appropriate for middle school and high school classes.

Objectives:

Students will collect data using the birthday of participants to develop box & whisker plots and histograms.

Students will develop an understanding of the vocabulary associated with one-variable data collection.

Skills Developed:

Transmitting and receiving programs (Linking)
- Executing a program
- Gathering data
- Using lists to enter data

Use Stat Plot to generate Box & Whisker Plots and Histograms

Materials Needed:

TI-83 with link cable for each participant
Day Program (see appendix)
Data collection form
TI-83 calculator and view screen
Markers to record data on board or overhead

Data Collection Activity

(a) Have participants send and receive the Day Program. Refer to TI-83 Guidebook for information on:
- 19-3 TI-83 Link
- 19-4 Selecting Items to Send
- 19-5 Receiving Items
- 19-6 Transmitting Items

(b) Have each participant complete a Data Collection Form.
For the Month use Jan. = 1, Feb. = 2, March = 3, ... , Dec. = 12
For the Day of the Month (DOM) use 1, 2, 3, ... , 31
For Day of the Year (DOY) useJan. 1st = 1, Feb. 1st = 32, etc.
A calendar or an overhead of number of days in each month may be useful. Remember February as 29 days in a leap year.
For Day of Week (DOW) Run Day Program

Sunday = 1, Monday = 2, ... , Saturday = 7

Birthday Data Collection
Month ________
Day of the Month (DOM) ________
Day of the Year (DOY) ________ Jan. 1st = 1, Feb. 1st = 32, ...
Day of the Week (DOW) ________ Sunday = 1, Monday = 2, ...

Box & Whisker Plot using Day of Year Data (DOY)

Have the participants arrange themselves in order from smallest to largest number. If the size of the group is large, move the activity outside or into the hall way. Determine the persons that represent the Xmax, Xmin, and 1st, 2nd, 3rd Quartiles. Pass out the appropriate signs.

(a) Xmax: The person on the end with the largest number for DOY.

(b) Xmin: The person on the other end with the smallest number for DOY.

(c) Median: Given an odd number of participants the median will be the person in the middle. Given an even number of participants the median will be the average of the two people in the middle. The median divides the group into an upper and lower half.

(d) 1st and 3rd Quartiles: to find the 1st quartile determine the person in the middle of the lower half. Given an odd number of participants, do not count the person representing the median to find the middle of the lower half. Given an even number of participants, the median is two people. The person representing the right half of the median is part of the lower half. In the case where the 1st Quartile is two people, the 1st Quartile is the average of two people.Repeat in the upper half to find the 3rd Quartile.

(e) Analysis of the grouping: Have the Xmax and Xmin step forward. The difference in these will be the range. Have the people holding the 1st & 3rd Quartile and Median signs step forward. There are four groups. The groups on the ends will represent the whiskers. Determine which whisker should be longer. The two groups in the middle will represent the boxes. Determine which box should be larger.
Discuss the relationship between Quartiles and Percentiles.
The 1st Quartile is also the 25th Percentile.
The median is the 2nd Quartile and the 50th Percentile.
The 3rd Quartile is the 75th percentile.

(f) Modes: Have the participants determine any modes. Given that February contains 29 days in a leap year, there could be modes where the same number appears but the participants have different birthdays.

For information on the mode refer to "The Birthday Problem Explained", *The Mathematics Teacher*, Vol. 90, No. 1, January 1997, pages 20 - 22.

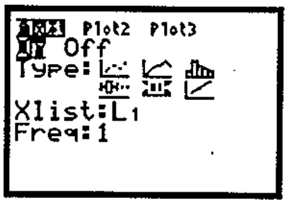
Box & Whisker Plot using Day of Year Data (DOY)

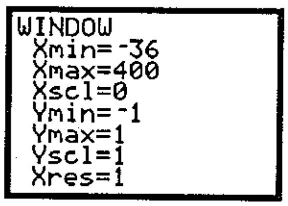
TI-83 - Box & whisker Plot and One Variable Analyses

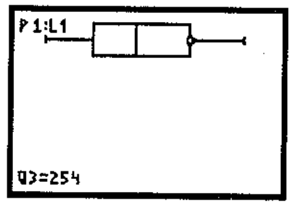
(a) Collect the data by writing the numbers either on the board or over-head.

(b) Enter the data into a List: Enter the data into a list from the home screen or into the list directly. A feature of the TI-83 is creating a list name.
Refer to TI-83 Guidebook
11-4 Storing and Displaying Lists
11-3 Naming Lists
12-11 Using the Stat List Editor

(c) Set up the Stat Plot: Select a box & whisker plot with the appropriate settings.
Refer to TI-83 Guidebook
12-33 Statistical plotting - (Boxplot)
[ZOOM] , [9] will set a window for the plot. The TI-83 calculates an appropriate Xmin and Xmax. Turn the axes off by [2nd] , [FORMAT] , [AxesOff]







(d) The Analysis of the Graph: Use TRACE to explore the graph and compare the lengths of the whiskers and the size of the boxes. The numbers and features should correspond to the expectations generated in the Activity.

(e) One-Variable Data Statistical Analysis: Compute the one-variable statistics [STAT] , [CALC] , [1-Var Stats] . The data will correspond to those generated in the graph. The analysis will generate the mean. Give the appropriate sign to the person closes to this number.

The day of the month (DOM) is available to repeat the activity in or out of class practice.

Histogram using Month Data

Have the participants group themselves by the month of the year in which they where born. If the size of the group is large, move the activity outside or into the hall way. Pass out the appropriate signs.

(a) Arrange the groups in appropriate order from January to December.

(b) Analysis of the grouping: Visually inspect for the group with the largest number, the smallest number, any months not represented, and group sizes repeated.

(c) Have the group line up parallel to each other forming a visual representation of the histogram.

TI-83 Histogram and One Variable Data Analysis:

(a) Collect the data: Method 1 - Have each participant write their initials on a class chart with the months as headings. This grouping allows the use of frequency. Method 2 - Collect the data by writing the numbers either on the board or over-head.

(b) Enter the data into a List: Enter the data into a list from the home screen or into the list directly. Method 1 of collecting data allows for the use of frequency. Assign the values 1 to 12 to List 1 and the corresponding frequency in List 2. A feature of the TI-83 is creating a list name

Refer to TI-83 Guidebook

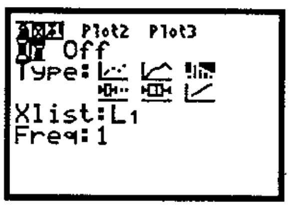
11-4 Storing and Displaying Lists
11- 3 Naming Lists
12-11 Using the Stat List Editor

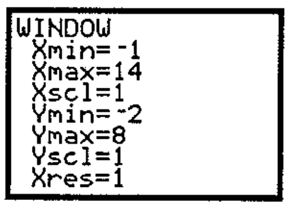
(c) Set up the Histogram: Set up a Stat Plot with the appropriate settings.

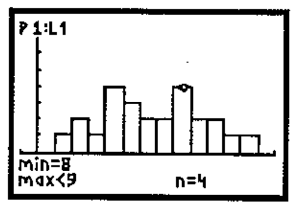
Refer to TI-83 Guidebook

12-32 Statistical plotting - (Histogram)

[ZOOM] , [9] will set a window for the plot. The TI-83 will calculate an appropriate Xmin and Xmax. The Ymin and Ymax may need adjusting for an appropriate viewing window. The Xscl value determines the width of each bar. Set the Xscl equal to 1.







(d) The Analysis of the Graph: Use TRACE to explore the graph and compare the heights of each bar. The numbers and features should correspond to the expectations generated in the Activity.

The day of the week (DOW) is available to repeat the activity or out of class practice.

DAY Program

```
:AxesOff
:ClrDraw
:PlotsOff
:FnOff
:Text(0,0,"ENTER THE MONTH, DAY, YEAR")
:Text(10,0,"ENTER MONTH AS NUMBER 1-12")
:Text(20,0,"ENTER FULL YEAR, I.E. 1953")
:Text(40,0,"PRESS ENTER TO CONTINUE"
:Pause
:Lbl 1
:ClrHome
:Prompt M,D,Y
:If M<3
:Then
:Y-1fY
:M+12fM
:End
:D+2M+iPart ((3M+3)/5)+Y+iPart (Y/4)-iPart (Y/100)+iPart
    (Y/400)+2fS
:7((S/7)-iPart (S/7))fW
:round(W,0)fW
:If W=0:Disp "SATURDAY"
:If W=1:Disp "SUNDAY"
:If W=2:Disp "MONDAY"
:If W=3:Disp "TUESDAY"
:If W=4:Disp "WEDNESDAY"
:If W=5:Disp "THURSDAY"
:If W=6:Disp "FRIDAY"
:Pause
:ClrHome
:Menu("DAY PROGRAM ","RUN AGAIN",1,"QUIT",2)
:Lbl 2
:AxesOn
:ClrHome
:Stop
```

TEXTEAM Update

Jackie Jimenez, TEXTEAM director has set up a new database that will allow her to share information on upcoming trainings with schools. Information on upcoming TEXTEAM presentations should be sent to Jackie Include the following:

Name of institute or module, presenters, dates, location, registration contact information and whether the training is open to the public or not the registration fee would be (if any).

TEXTEAM is developing an Algebra II/Precalculus Institute. Development will begin shortly, headed up by Dr. Susan Williams of the University of Houston. It is expected that training of trainers will occur in the summer and fall of 1998.

Work is underway on revisions to the Grades 6-8 Institute. This project will be led by Eva Gates. Training of Trainers will hopefully be ready in the spring of 1998. Registration preference will be given to the original 93 trainers with some slots for new trainers.

The SSI is in the planning stages of an institute on the new Math Models with Applications course in the TEKS which would also serve as a bridge to the Geometry Institute and touch on integrated algebra and geometry.

Presidential Awards

The Presidential Award Winners for 1996 were announced the first week in March, 1997. Congratualations to:

- Secondary Award Winner, Diane Reed, Hanks High School, Ysleta, Texas. Diane teaches AP Calculus and algebra.

- Elementary Award Winner, Judy S. Bishop, Saint Mary's Hall, San Antonio. Judy is an elementary mathematics specialist for grades 1 through 5.

The honored secondary and elementary teachers will be awarded with a week long trip to Washington, D.C. in the summer.

Profiles of Candidate

President-Elect

Pam Alexander

Pam has 21 years teaching experience, 19 of which were spent at Clear Lake High School in Clear Creek ISD. The last five years she also served there as Department Chairman. She currently teach mathematics content courses specially designed for preservice elementary teachers at Stephen F. Austin State University where she serves as a full time Lecturer. Honors include receiving the 1993 Presidential Award for Excellence in Science and Mathematics Teaching, recognition as Who's Who Among America's Teachers, nomination to the National Teachers Hall of Fame, and presenting at CAMT, NCTM Regional and National Conferences from 1991 to the present. Pam gives the following comments:

> My teaching philosophy is naturally centered in the importance of mathematics learning at all levels of education. How and what students learn evolves in how and what we teach . At the earliest grades, powerful problem solving strategies are established that are often cast aside as that the student enters the upper grades where crowded curricula become more the focus. As teachers of mathematics in a state the size and with the stature of Texas, we must embrace the diversity in our classrooms as a strength. With the support of strong professional development and good communication skills, we can continue to share successful strategies and activities where meaningful mathematics reinforce the powerful thinking skills we know children will need to succeed in the 21st century.

SE Regional Director

Dr. Pam Chandler

BS Mathematics- University of Houston 1965; MS Mathematics Education- Sam Houston State University 1980; Ed.D Mathematics Education- University of Houston 1992; 25 years as high school mathematics teacher Dallas ISD and Fort Bend ISD; 9 years mathematics department Head at Clements High School ; 5 years Mathematics Coordinator at Fort Bend ISD

Offices:

Co-founder Fort Bend Council of Teachers of Mathematics; Vice-president and President FBCTM;

Chairman Planned Meal Functions - Regional NCTM - Houston; Exhibits Chair CAMT 1997, 1998, 1999; Southern Regional Director- National Council of Supervisors of Mathematics

Honors, Awards, Grants

Teacher of the Year Clements 1986; University of Texas Excellence Award for Outstanding High School Teachers 1988; Rice University School Mathematics Project 1989; Master Teacher RUSMP 10090; Director FBISD/RUSMP Project 1991-1993; Calc Net Participant and Evaluator 1991; Transit Team Ohio State University 1991

Experience Writing Staff Development

Co-author Texas Staff Development Modules #28, #29, #30; Writing/Development Team for T-cubed modules for Algebra, Calculus, and Statistics; T-cubed Instructor

Cindy Schneider

Cindy received a B.A. from U.T. in History. She worked at various jobs including: the Certification Division at TEA, the City of Westiminister (CA) Fire Department, the Orange County (CA) Sheriff's Department, and the IRS in Austin.

She returned to school at Southwest Texas State University where she received Secondary Certification in 1987, with teaching fields in History and Mathematics. She complete her M.A. in Mathematics in December 1989 and taught remedial mathematics as a teaching assistant 2 1/2 years. In 1990, she began the Phd program in Mathematics Education at the University of Texas at Austin and taught for SWTSU, ACC, and Southwestern University in Georgetown. In 1993, she passed her qualifying exams for the Phd, and then moved to Germany. In Wiesbaden, Germany she served as a volunteer in many organizations encompassing such positions as president, treasurer, news letter editor, tutor and tour guide.

Since her return to the States, she have been employed by the Texas Statewide Systemic Initiative at the Charles A. Dana Center at U.T. Austin. Her position is Research Assistant . She aides Susan Hull, Cathy Seeley, and David Molina in their numerous endeavors. She has compiled the data from the second review process for the TEKS, and provided support for the Connected Mathematics Project (a middle school pilot project at seven sights in Texas using this NSF curriculum). She also teaches one class at Austin Community College.

Southwest Regional Director

Diane Reed

Diane has a BA from UNC Chapel Hill and an MA With Distinction from Cal St. Fresno (both in mathematics). She has been teaching for over 25 years, the last 13 of these at Hanks HS in the Ysleta ISD and has been department chair there for 10 years. Her main teaching areas are Calculus and Algebra at the high school level and mathematics courses for K-8 teacher candidates at the university level. She is a member of MAA, NCTM, TCTM and GEPCTM (past-president and also AWM. At the state level she is actively involved with the Algebra Action Team. At the local level, she has helped implement a lot of change in curriculum and instruction. Examples: member of the YISD K-8 Mathematics Framework Committee, spearheaded the revision of the Hanks HS Algebra program to reflect the NCTM Standards and TEKS.

Awards:

Secondary Presidential Award for Mathematics 1996, WWF Master Teacher (S88), Tandy Technology Scholar (1993) Her research interests are in mathematics education: Algebra, Problem Solving, Cooperative Learning and Assessment.

Margarita Gutierrez

Margarita is currently working in the Socorro Independent School District, a year-round education district, in El Paso, Texas. Working together with the El Paso Collaborative for Academic Excellence, other area districts, and the National Science Foundation on the Urban Systemic Initiative Project (USI Project) to improve mathematics and science education. As a USI Mentor of middle school mathematics, she has worked with each middle school to improve her district mathematics program. She has 12 years of experience in at the junior high (7,8,9) and middle school (6,7,8) level in mathematics.

Secondary VP Candidate

Sue Jackson Barnes

Sue Jackson Barnes taught mathematics in Arkansas for 25 years. She is currently in her second year of teaching at Texas High in Texarkana, TX. In Arkansas, she was a charter member of the Arkansas Math Crusades, a member of the state textbook adoption committee for secondary mathematics, and has worked on state education department committees for establishing the Arkansas curriculum frameworks, promoting standards of excellence of teaching mathematics, and constructing Arkansas's exit exam. She is a trainer for Equals, a nationally-known equity program in mathematics. A long-time NCTM member, Barnes has authored articles for The Mathematics Teacher and was a feature writer for the first eight issues of Mathematics Teaching in the Middle School. She has presented programs on state, regional, and national levels for NCTM or NCTM affiliate groups, at CAMT, and at Arkansas' Math Leadership Conference. She has acted as program chair of ACTM and worked on two STEAM Conferences held in Texarkana. She has served as ACTM vice president for secondary schools and as secretary of that organization. She was selected as Teacher of the Year by the DeQueen, AR Chamber of Commerce in 1982, and Outstanding Alumnus of the Year at East Texas State University-Texarkana in 1992.

Carolyn R. Lipton

Carolyn has 23 years of teaching experience at the elementary and secondary levels. She was a Master Teacher for National Teacher Training Institute for Math, Science, and Technology, 1993-94; ACE Calculator Group member, 1994-present; Teacher Advisory Panel Member, Editorial Panel, Mathematics Teacher, 1994-95; Mathematics Curriculum Writing Project for Volunteers, 1994; member of Delta Kappa Gamma sorority, recording secretary, vice-president; member of Phi Kelt Kappa Fraternity and Pi Lambda Theta; Active member of the Greater Dallas Council of Teachers of Mathematics and NCTM; Chairperson for registration and educational materials committee for the NCTM Southern Regional Conference in 1998, Who's Who Among America's Teachers, 1994. 1996, MMA member

Pam Summers

Pamela A. Summers, M.Ed., Coordinator for Secondary mathematics and Science supervises and works directly with over 300 secondary mathematics and science teachers in Lubbock ISD. She had 22 year of experience including six as an instructional administer and the remaining in teaching mathematics, Computer Literacy, Microcomputer Applications, and Computer Math. Mrs. Summers served as a member of the Texas Essential Knowledge and Skills writing team for Mathematics and is a member of the Algebra Task Force and a member of the Tenet Web Resources team. She is a frequent presenter at workshops, and state and national conferences in the area of mathematics and curriculum alignment.

Treasurer

Susan Cinque

Susan has been teaching math at Clements High School in Fort Bend ISD since 1983. She is currently teaching five sections of Advanced Placement Calculus. She has been a member of Fort Bend Council of Teachers of Mathematics, as well as NCTM, since 1985. Before becoming a teacher, she worked for several years at Fannin Bank, and part of her job duties included reconciling accounts.

She is an instructor for the Teachers Teaching with Technology, that provides summer workshops for teachers who want to incorporate graphing calculator technology in their classrooms. She has been a presenter at CAMT, and the pre-CAMT conference, as well as district inservices, and national conferences. She has also been trained as a TEXTEAM instructor for the new Algebra module. She has served three years on her Campus Leadership Team, and is currently a member of a district-wide Academic Advisory Council.

Gary Cosenza

Gary has been teaching for twenty-three years. His BS Degree was earned in 1972 from the State University of New York at Brockport and his Masters was earned in 1976 at Russel Sage College in Troy, New York.

He has taught fifth grade through high school. Subjects have included Algebra, Geometry, Accelerated Geometry, Accelerated Algebra, Science , Health and P.E. He has also coached and been class advisor as well as yearbook advisor. Currently He is employed at Alief Hastings High School where he teaches Accelerated Geometry and Algebra. He has served as yearbook advisor has served as president of the Taconic Hills Faculty Association, a member of the National Ski Patrol. He is a member of ATPE and active in my local civic club. He was nominated as building teacher of the year in 1996.

Calendar

July 30-August 1, 1997

Conference for the Advancement of Mathematics Teaching (CAMT) is the annual mathematics education conference for the state of Texas, sponsored by the Texas Education agency, The Texas Council of Teachers of Mathematics, The Texas Association of Supervisors of Mathematics and the Texas Section of the MAA. Programs and registration materials will be mailed to persons who attended last years conference in April. TCTM members may request a program using a coupon which will appear in next springs journal.

October 17-18, 1997

STEAM II
(Successfully Training Educators As Mathematicians)
Texas A&M University-Texarkan/ Texarkana College

February 12-14, 1998

Mathematics- Deep in the Heart of Teachers, NCTM Regional Conference, Dallas

Taylor High School Wins NCTM ToyotaAward

Taylor High School in Taylor, Texas has won a Toyota Time grant. Math Department Chair, Dixie Ross, led her department in creating a mathematics proposal which has been honored with the Toyota Time math grant. The announcement by the NCTM mathematics Education Trust awards the Taylor High School Mathematics Department $10,000 to support their new program. The proposal was one of 20 out of a field of 1,086 applications. The program will be designed by Dixie and the Taylor math teachers, Julie Downs, Gari Lord, Mary Kalbaugh, Tally McAfferty, Kaye Schaefer, James Ward, and Ken Cooper. Dixie will represent the school at the official recognition ceremony on April 19 at the NCTM national conference in Minneapolis, Minnesota.

The winning proposal includes a two year plan with the goal to provide several support activities to help all students succeed in algebra. A Homework Help Center will be staffed by peer tutors. A summer Algebra Camp will train students in how to serve as classroom leaders. The school plans to host six Family Algebra Nights to help parents and family members assist in a studentfs transition to high school mathematics.

Ballot

Please read the profiles of the candidates, circle your choice, and return your ballot to Basia Hall, 12306 Piping Rock, Houston, TX 77077 **by JUNE 10, 1997.**

President Elect:
Pam Alexander

SE Regional Director:
Vote only if you are in one of these Service Center Regions: 2, 3, 4, 5, 13
Pam Chandler
Cindy Schneider

SW Regional Director:
Vote only if you are in one of these Service Center Regions: 1, 15, 18, 19, 20
Diane Reed

VP for Secondary
Sue Jackson Barnes
Carol Lipton
Pam Summers

Treasurer:
Susan Cinque
Gary Cosenza

CAMTERSHIP APPLICATION

Six $100 "CAMT"erships will be awarded to first year teachers who are members of TCTM. The money is intended to help cover expenses associated with attending CAMT, and to encourage new teachers to attend CAMT. Two camterships each will be awarded to teachers in grades K - 4, 5 - 8, and 9 - 12. Winners will be determined by random drawing of names, and will be notified by July 1. Winners will be asked to work for two hours at registration or NCTM material sales will be TCTM's guest at our breakfast, where the checks will be presented. GOOD LUCK!!!

Name______________________________ Phone____________________

Home Address____________________________City, zip____________________

School______________________________ Grade(s) taught ________________

School Address______________________________ School Phone ____________

Principal's Name ____________________ Are you a member of TCTM ? __________

Note: If you are not a member of TCTM, you may enclose $8 with this application to apply for membership.

Are you completing your first full year of teaching?__________

What are your teaching responsibilities? ______________________________

____

Send your completed application by July 1 to
Basia Hall, 12306 Piping Rock, Houston, TX 77067

REQUEST FOR CAMT PROGRAM

If you have not received a CAMT program, by May 15 , you are a member of TCTM, and would like to receive a program, please complete this form, cut it out, send to the CAMT office, and a program will be mailed to you.

Name______________________________ Phone____________________

Home Address____________________________City, zip____________________

Mail to: CAMT
P.O. Box 200669
Austin, TX 78720-0669

TEXAS COUNCIL OF TEACHERS OF MATHEMATICS

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Cut out your membership card.
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Renew your membership before that date.
Use the form on the last page.

Texas Council

of Teachers of Mathematics

Member 1996-1997

NAME ______________________________

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