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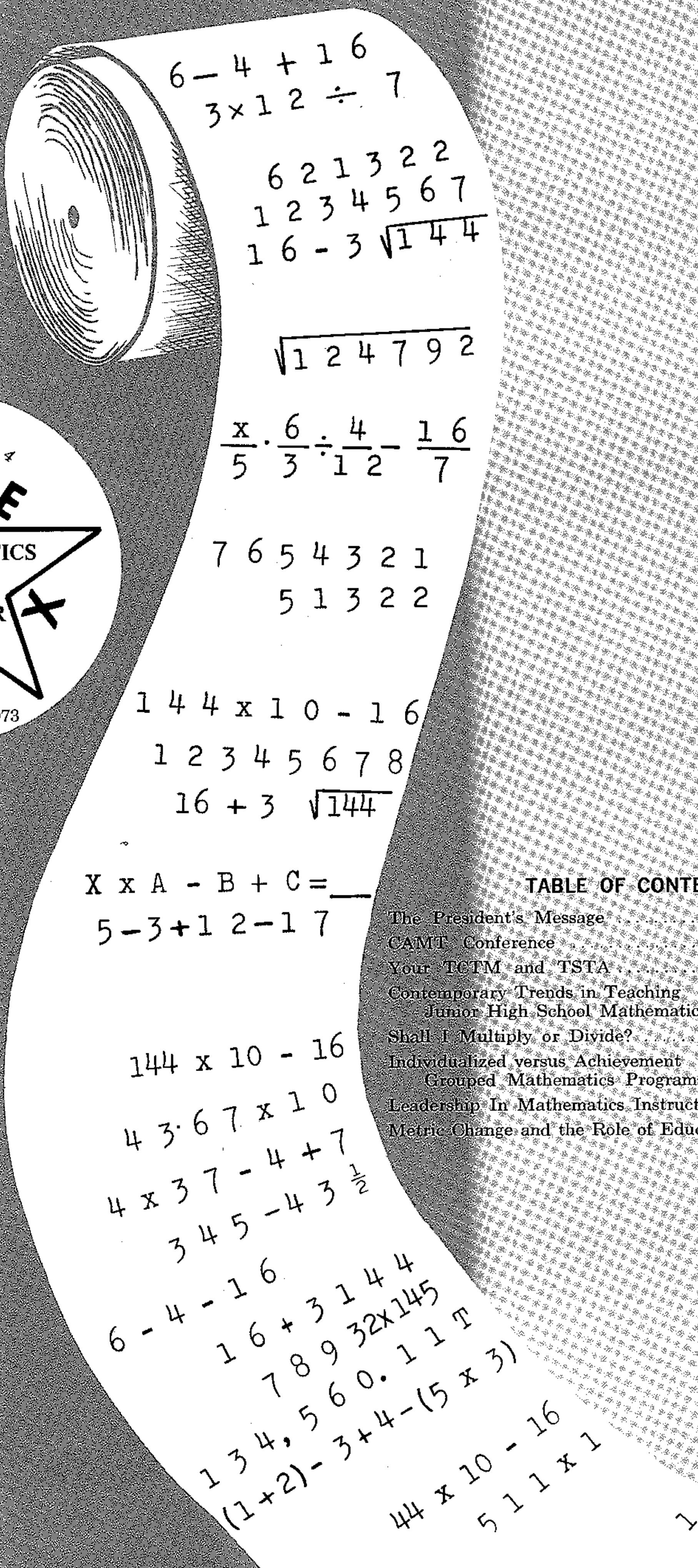
TEXAS MATHEMATICS TEACHER

September 1973



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

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President's Message

Mark November 1-3, 1973 on your calendar. This red-letter date is the annual mathematics conference to be held in Austin. As you know, the University of Texas was not planning a CASMT meeting for the school year 1973-74. Many of us felt that one should be held. A planning committee was named and arrangements have been made.

Some of us have been concerned for some time about the expenses involved with CASMT. The University has its guidelines, of course, but the expense of using the Joe Thompson Convention Center has caused quite an increase in the registration fee.

Representatives of the co-sponsoring organizations for both mathematics and science met last March with Bishop Pitts, chairman, and his University of Texas committee. As a result of that meeting, the CASMT organization was dissolved and the funds equally distributed to mathematics and science co-sponsors. The funds that mathematics received have been placed in a CAMT (Conference for the Advancement of Mathematics Teaching) account to be used as needed for the annual conference expenses.

The conference this year will be an excellent one. Many outstanding mathematics people will be present. Plan to attend and encourage teachers of all levels who are seeking new ideas for the advancement of mathematics teaching to attend.

The annual meeting of the Texas Council of Teacher of Mathematics will be held on Friday, November 2, during the CAMT conference. Yearly we have larger and larger groups who attend and share concerns and ideas for the betterment of mathematics.

There are many fine 7th and 8th grade mathematics textbooks up for adoption this year. Make every effort to see them and have a part in the selection for your district. The books listed for adoption by the state will be presented at the Mathematics Section meeting of TASCD in McAllen on October 31, 1973. If you have the opportunity to attend, you will hear an informative presentation by our Texas Education Agency representatives Dr. Irene St. Clair, Dr. Alice Kidd, and Mr. Marvin Veselka.

What's happening in mathematics where you are? We are all interested in Mathematics happenings across our state. Share your good things with us. Send ideas, events, and items of interest to our editor, J. William Brown.

Again, I urge you to conduct a workshop in your area this year. Mathematics teachers will love you for it! Call on Texas Council to assist you in planning one.

We are already underway with another year of mathematics for boys and girls and young people. Pledge with yourself and your co-workers to make this the most profitable "math" year these students have ever had.

NOMINATING COMMITTEE

At the annual meeting of the TCTM, Friday, November 2, during the CAMT Conference, the following nominating committee will present a slate of officers for the positions of president-elect and a vice-president:

Gillette Irby, Corpus Christi ISD
Charlene Stevens, San Angelo ISD
Maxine Shoemaker, Austin ISD

CONTEMPORARY TRENDS IN TEACHING JUNIOR HIGH SCHOOL MATHEMATICS

MAX A. SOBEL

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Montclair State College, New Jersey

Having taught at all levels from junior high school through graduate school, I have no hesitation in saying that the 15 years that I spent teaching junior high school mathematics was undoubtedly the most difficult assignment that I have ever faced . . . but also must stand as the most exciting and challenging of them all. I choose to call it the "Golden Age for the Teaching of Mathematics" and those fortunate enough to teach youngsters of this age can readily understand why.

Junior high school students are receptive to new ideas. They are imaginative and creative. They cry out for new opportunities and learning experiences. True, they can become a thorn in the teacher's side, but if and only if we do not provide them with a meaningful, interesting, and challenging curriculum . . . and teach with methods that take into account their basic characteristics and needs.

The basic characteristics and needs of junior high school youth are much the same as those for adults . . . and they are the same for youngsters of all levels of ability, differing only in degree.

They need security.

They need recognition, approval, status.

They need to experience success.

They want recognition by their peers as well as by their teachers.

They strive for personal independence.

They have rapidly changing interests.

As one educator so aptly summarized it, they are in need of the three A's: Acceptance, Affection, and Achievement.

During the decade of the 1960's we did much to stimulate the active imagination and creativity of these youngsters by a radical change in the curriculum. Much "new" mathematics was pushed into the junior high school, and we found ourselves teaching such topics as other number bases, modular arithmetic, non-metric geometry, and the like. Despite some shortcomings, such as a possible overemphasis on rigor, the 1960's did provide us with a junior high school curriculum that was far more exciting and dynamic than the old approach that featured such "relevant" topics as budgets, insurance, taxation, stocks and bonds, and other consumer oriented topics. Not that these topics are unimportant, but it's a non trivial task to get a typical 7th or 8th grader excited about installment buying and bank deposit slips!

What about the 1970's? The wave of curriculum revision seems to have passed, and indeed to have caught some subject matter in the undertow. Thus we now find decreased emphasis in such topics as number bases and modular arithmetic. This is not to imply that there will be no further changes in the curriculum, but rather that such changes will not approach the number that took place in the past decade. Indeed, contemporary curricula already reflect a number of new items that have only recently found their way into the junior high school program. Examples of new topics for the 1970's include an emphasis on flow charting throughout the mathematics course (not just an isolated unit on the topic), an introduction to BASIC, the language of the computer, an introduction to mappings, and attention to metrication.

It seems, however, that the major emphasis throughout the 1970's will not be in the area of additional subject matter changes, but rather in terms of pedagogy. The challenge seems to be that of finding ways to improve the teaching of mathematics. We need to find ways and means of motivating our students to learn mathematics, for motivation seems to be the key to the successful teaching of mathematics for students of all levels of ability. One may argue that capturing student interest may not be sufficient to teach them mathematics, but it certainly is most necessary. Therefore the remainder of this article will be devoted to a brief enumeration of suggested teaching techniques that are appropriate for motivating junior high school mathematics students, with just a few examples within each category.

1. Start the class with something interesting or exciting.

It is most worthwhile to spend the first few minutes of a period with some item that serves to create interest, even if unrelated to the subject under current discussion. For example, ask your students to try and express the numbers from 0 through 25 using the digits of the current year, in the order in which they appear, and any operations with which they are familiar. Here are a few examples for the year 1973:

$$0 = (1 + 9) - (7 + 3) \qquad 1 = 1^{973}$$
$$2 = 1 + \sqrt{9 + 7} - 3 \qquad 3 = [(1 + 9) - 7]! - 3$$
$$4 = 1^{97} + 3 \qquad 5 = [(1 \times 9) - 7] + 3$$

2. Get your students into the act.

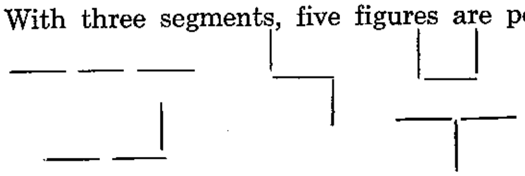
It has been said that mathematics is not a spectator sport. Junior high school students are especially in need of active involvement if they are to maintain interest. One way to accomplish this is by means of interesting questions that encourage student guesses, followed by the necessary computation to verify correct answers. Some examples of questions that generally prove to be of interest to youngsters of this age group follow: (a) How long will it take to count to one million at the rate of one number per second. (An answer of one million seconds is not acceptable!) (b) I snap my fingers now. One minute later I snap them again. Then I wait two minutes before the next snap. Then four minutes, eight minutes, and so forth . . . doubling the interval between each snap. At this rate, how many times will I snap my fingers in one year? (c) One million pennies are placed on top of one another. How high will the pile reach?

Be certain to encourage many guesses before resorting to computation to ascertain the correct answers to such questions.

3. Provide many opportunities for discovery.

All students enjoy making discoveries, at their level of ability. Appropriate problems can be presented, and together with teacher guidance, used to allow junior high school youngsters the great joy of making a mathematical discovery. A few problems that are suitable for this age group follow.
(a) Write all the multiples of 1/7 (from 1/7 to 6/7) in decimal form. See what you can discover about the repeating digits. Then look for other patterns in the multiples of 1/13.
(b) Line segments are to be placed so that they join at their endpoints to form a right angle or a straight line. With two segments, only two figures are possible:

With three segments, five figures are possible:

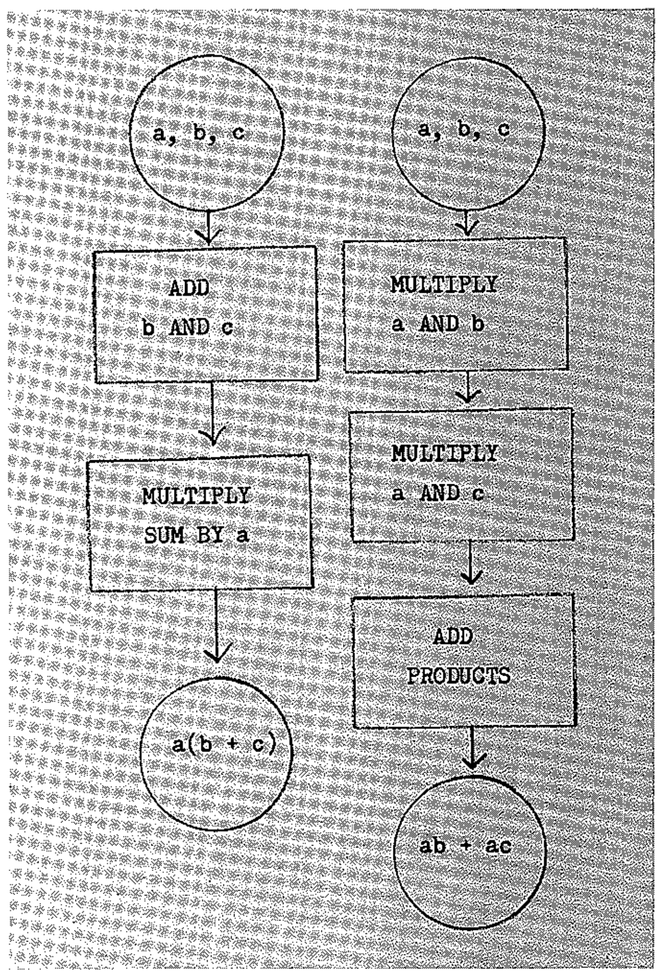


How many figures are possible using four segments?

4. Search for creative strategies to introduce a lesson.

Most students tire of routine approaches to the daily lesson, and respond with enthusiasm when the teacher begins the class in a unique manner. It takes time and imagination to invent such procedures, but it can be done. The following are a few possibilities.

(a) Use flow charts to indicate basic operations and illustrate important mathematical principles. Thus the distributive property can be introduced by means of these flow charts, followed by others using specific values for a, b, and c:

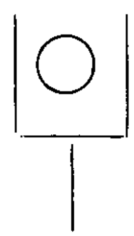


(b) Use classroom experiments to generate interest in a topic. For example, a unit on probability can best be taught by means of a series of experiments such as having students toss a coin 100 times to estimate the probability of a coin falling heads, or tossing tacks to estimate the probability of having one land with the point facing up. Such an approach is dynamic, and serves to generate considerable interest in the applications of mathematics.

5. Use mathematical recreations as a change of pace.

Almost everyone enjoys a good puzzle or trick, and junior high school students are especially interested in these. The range of possibilities here is almost unlimited, and the following are only suggestive in nature.

(a) A penny and four matchsticks are arranged to look like a cherry inside of a dessert glass. Move just two matchsticks to form a new figure that is congruent to the original one, but with the penny outside of the glass.



(b) Have your students write a three digit number so that the hundreds' digit is at least two greater than the units' digit. Reverse the digits and subtract. Now reverse the digits again and add. The sum will always be 1089!

This short list of items is by no means exhaustive, but only used to illustrate the main thesis of this article concerning the importance of motivation. Because of the shortage of space, further illustrations are not possible, but other considerations that one might add to the list are items such as the following:

6. Use topics from the history of mathematics to stimulate interest.

7. Make use of a variety of audio-visual aids besides blackboard and chalk.

8. Build lessons around current student fads and interests where possible.

9. Approach a topic from many different points of view.

10. End the period with something special! Save some item for the end of the period that will have students talking about their mathematics class as they walk out . . . a puzzle, a challenge, a mathematical anecdote, or the like.

The suggested list of items presented here is only a start; hopefully the reader will add to these ideas, and exchange ideas with other teachers for the benefit of their students. Above all else, however, we must place the item of enthusiasm. We must show our students by our own enthusiasm that we enjoy teaching mathematics, and then we will soon find that enthusiasm is contagious as these youngsters begin to reflect our excitement. There is nothing like an enthusiastic approach on the part of the teacher to provide the proper motivation for learning.

Although the source is no longer known, the job description of a mathematics teacher was once given in this way:

A teacher must know his stuff.

He must know the pupils he intends to stuff.

Above all, he must stuff them artistically.

This then is the challenge that we face in the 1970's: we must all strive to become artists in the job of "stuffing" our students with a sound program of mathematics, and in a way that they will enjoy as well!

SHALL I MULTIPLY OR DIVIDE?

When I attended school as a young girl (do not ask when), we were given a rule: If changing from a larger unit to a smaller one, multiply; (or was it divide?). Observing the students in my classes, I fear that we teachers (old and young, experienced and inexperienced) are still teaching rules, not concepts.

In considering the multiplicative axiom of one, very young students understand that

$$\text{if} \quad 12 \text{ inches} = 1 \text{ foot},$$

$$\text{then } \frac{12 \text{ inches}}{1 \text{ foot}} = 1 \text{ or } \frac{1 \text{ foot}}{12 \text{ inches}} = 1.$$

Older students require more precision:

$$12 \text{ inches}\left(\frac{1}{1 \text{ foot}}\right) = 1 \text{ or } 1 \text{ foot}\left(\frac{1}{12 \text{ inches}}\right) = 1.$$

PROBLEM: 48 inches is the same as how many feet?

$$\begin{aligned} 48 \text{ inches} &= 48 \text{ inches } (1) \\ &= 48 \text{ inches}\left(\frac{1 \text{ foot}}{12 \text{ inches}}\right) \\ &= 4\left(\frac{12 \text{ inches}}{12 \text{ inches}}\right)(1 \text{ foot}) \\ &= 4(1)\ (1 \text{ foot}) \\ &= 4 \text{ feet} \end{aligned}$$

$$\therefore 48 \text{ inches} = 4 \text{ feet}$$

PROBLEM: Find the length(s) of the arc intercepted by a central angle of 150° in a circle with a radius of 3 units.

Definitions:

1^R (central angle) = 1 radius (on arc), and $\pi^R = 180°$

The problem now becomes a matter of changing the name of 150° to a number of units.

$$
\begin{aligned}
s &= s \\
&= 150°(1)(1) \\
&= 150°\left[\left(\frac{1}{180°}\right)(\pi^R)\right]\left[\left(\frac{1}{1^R}\right)(3 \text{ units})\right] \\
&= \frac{5}{6}\left[(30°)\left(\frac{1}{30°}\right)\right](\pi)\left[(1^R)\left(\frac{1}{1^R}\right)\right](3 \text{ units}) \\
&= \frac{5}{6}(1)(\pi)(1)(3 \text{ units}) \\
&= \frac{5}{2}\left[\left(\frac{1}{3}\right)(3)\right]\pi \text{ units} \\
&= \frac{5}{2}\pi \text{ units} \\
\therefore s &= \frac{5}{2}\pi \text{ units}.
\end{aligned}
$$

This method may be used for all dimensional questions. Our physics teacher tells me that it works effectively and saves memorizing many formulas. (I insist upon having the equality sign written in a column. One can make the work as rigorous as desired, depending upon the maturity of the students.)

PROBLEM: If pete travels 50 mph, how fast does madge travel?

Definitions:

2 madge = 3 nutz

5 nutz = 4 pete.

The students thoroughly enjoy "fun and games" like this, and they *do* understand the principle better after several non-sense examples. The seniors are required to show a minimum of 25 steps and state the axioms.

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Individualized versus Achievement Grouped Mathematics Programs

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OLD DOMINION UNIVERSITY

For years educators have been searching for school programs in which children, through a reasonable use of their capacities, can succeed. A major concern of mathematics education is the development of mathematics programs that are meaningful and productive as well as related to the needs, interests, and abilities of children. Two instructional methods that many believe are meaningful and productive as well as related to the needs, interests, and abilities of children are homogenous grouping and individualized instruction. Unfortunately, there appears to be no conclusive evidence as to what type of instructional program is the most productive in increasing mathematics achievement in elementary school children. The results of some studies favor either individualized instruction or homogeneous grouping, whereas the results of other studies find no significant evidence favoring individualized instruction or homogenous grouping.

The purpose of this study was to determine whether students in an Individualized Mathematics Program would make significantly greater gains than students in an Achievement Grouped Mathematics Program. The subjects were fifth grade students in two elementary schools located in a metropolitan area of Virginia. The study was conducted during the school year 1971-72. Both schools were designated as Title I schools, so the same basic social class may be assumed to populate each. Twenty students from each school were matched on the following relevant variables: sex, race, age, and intelligence quotient. Each group contained five white males, five black males, five white females, and five black females. The students were ten, eleven, or twelve years old. In no instances did the intelligence quotient of two matched students differ by more than three points. The Lorge-Thorndike Intelligence Test, Level III (Form B) was used to determine intelligence quotient.

In the spring of 1972 following intensive study in the two programs, the Metropolitan Achievement Test, Intermediate Level (Form F) was administered. The mathematics battery is made up of three tests — computation, concepts, and problem solving. The mean for each group was calculated on each of the three mathematics tests —computation, concepts, and problem solving. The null hypothesis that there was no significant difference between the two groups of pupils in mathematics achievement was assumed. The t test was employed. Pupils in the Individualized Mathematics Program had a slightly higher mean on concepts and problem solving. Pupils in the Achievement Grouped Mathematics Program had a higher mean on computation. None of the differences, however, was found to be significant at the .05 level of confidence. Please note table 1.

From this study one may draw many implications. Possibly the good teacher does individualize her teaching to meet the needs of her students. It is also possible that individualization of work is more profitable with certain groups than others. The question arises of how individualized can a commercially produced program be?

These and other questions will continue to haunt teachers and no doubt continue to drive researchers that one extra mile to try and determine the best method to use in trying to develop programs that are meaningful and productive as well as related to the needs, interests, and abilities of children.

Table 1

The Means and the Results of the Significant Test for the Computation, Concepts, and Problem Solving Scores

	Computation	Concepts	Problem Solving
AGMP	82.6	78.2	80.1
IMP	81.9	81.0	82.3
t	.27	—1.08	—.92
d.f. = 38	—Required for .05 level, 2.03		

Note—AGMP = Achievement Grouped Mathematics Program
IMP = Individualized Mathematics Program

Leadership In Mathematics Instruction

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A side effect of the Watergate incident has been to leave some foreign diplomats with a sense that there has been a loss of leadership in American policy. This fact has been a concern to many people, and a source of frustration to the diplomats. The final and far reaching results of this may not be known for a long time. Perhaps we as educators have not given the stress to leadership development that industry and government have. We should. One person who is doing something about developing leadership in the schools is Dr. E. Allan Davis, Professor of Mathematics at the University of Utah. Over a year ago Professor Davis started a program that had as a primary objective the building of leadership among junior high school classroom teachers.

The program, which was supported by the National Science Foundation, involved a staff of six professors and two public school teachers. Different members of the staff were used at different times. The first phase of the program was an In-Service Institute held during the academic year 1972-73. This was followed in 1973 by a Summer Institute. The In-Service Institute ran for 32 weeks, while the summer program was six weeks long. As with most institutes, this one had as an objective the building of increased competency in subject matter among the teacher participants, but as stated, it had an additional and fundamental dimension of developing leadership among classroom teachers.

Basically, the participants attended in teams, of two teachers each, from 27 junior high schools within commuting distance of the University in Salt Lake City. The teachers received instruction in the SMSG materials produced for junior high schools, in probability and statistics, calculus, computer programming, and in some of the new developments in mathematics instruction going on across the country. The teams of teachers were encouraged to assess new materials and the possibility of applying them to local circumstances. Each team described and examined carefully the mathematics programs at its home school and new developments under way or proposed.

During the Summer Institute, participants used approximately one third of their eight hour day in curriculum writing. Curriculum units were produced by teams of five people. New teams were constituted weekly, with new team leaders. In all, each teacher served on five different teams during the summer, and served once as a team leader. Teachers also had a further chance during the summer to survey some of the newer mathematics programs available. Dr. Howard Fehr was a visitor describing the Unified Mathematics Program. Professor Jean J. Pedersen, University of Santa Clara, and Mr. Donald Clark, Utah State Mathematics Specialist, also gave presentations on recent developments in mathematics instruction, and there was input in this area from the staff and the participants themselves.

One unusual feature of the summer phase of the program was that each participant wrote what was termed a "gem". That is, each participant chose one concept that he felt he taught exceptionally well, or had a unique way of presenting, and wrote a description of how he taught this concept. The "gems" are being compiled into a publication to be sent to all major high schools of the State.

Following is a quotation from the announcement that was distributed at the inception of the program stating one of its goals:

> The project would begin with good teachers, and help them to become really quite expert in the mathematics of the junior high schools; sufficiently expert so that they can and will assume a leadership role in their schools in helping to bring about a general improvement in the school mathematics program.

The total and final contribution that the teams of teachers, instructed through the program, will make to the school community is, of course, not yet known. One thing that is expected, however, is that the abundance of ideas and teaching methods that the participants now have will be exploited. The exploitation will come from teachers in their schools, looking to them for help. It will be fostered by the participants themselves, who apprehend that improvements do not come automatically but do come through someone leading out in an intelligent direction.

Perhaps leadership of the type that this program worked to develop is a kind that the schools have been derelict in building. We as classroom teachers should look around us and decide how we can develop leadership in our ranks. Whether it be by programs similar to that described above or something totally different, we should constantly be searching for ways to develop trained leadership in mathematics instruction. One approach might be for us to encourage more public school teachers to write textbooks of the kind they believe they need. Also we should push for more ways for teachers to get together and exchange ideas. Maybe we should take more seriously the opportunities for training in leadership provided through colleges and universities, or work to develop more teacher led in-service programs for other teachers in our districts, or create more mathematics clubs for teachers, or encourage our fellow teachers to prepare and present scholarly talks at meetings of our mathematics organizations—or maybe the best way for us to build leadership in classroom teaching has not yet been discovered.

Duane M. Young

METRIC CHANGE AND THE ROLE OF EDUCATION

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Background

Way back in 1821, John Quincy Adams, in a report to the Congress, stated that "weights and measures may be ranked among the necessaries of life to every individual of human society. They enter into the economical arrangements and daily concerns of every family."

As you are aware, the "necessary" weights and measures which we commonly use in the United States are based on the yard and the pound, parts of the so-called customary system of weights and measures.

What about the rest of the world? They are almost exclusively using another system — one called the metric system. In fact, the situation is such that the U.S. is the only country of any size not either using or at least committed to this metric system.

You may have heard something recently about the increasing use of this metric system here in the United States. The primary reason for this is the increasing use of metric in our industry, which finds it feasible and necessary to change to international metric standards for two reasons: first as an aid to maintaining and expanding our exports and, secondly, as a means of avoiding the inefficiency and inconvenience in operations of U.S. plants at home and abroad, manufacturing the same products, to different standards.

Concurrently with our industry's expansion of metric usage, the National Bureau of Standards conducted the U.S. Metric Study for a Congress that was concerned about the effects of this increasing worldwide domestic metric usage. I don't intend to bore you with the details of the study. If I did, I think you would agree that it was a very comprehensive study. It was also very complex, but its findings were fairly straight-forward, and I would like to share the three main ones with you now.

U.S. Metric Study Findings and Recommendations

First, the U.S. already makes some use of the metric system and metric use in the United States is increasing. Examples are easy to find. Metric is the only system used in the olympics. Our astronauts use it on the moon. We have all heard of 35 mm film; and what about 100 mm cigarettes? In addition, many of our canned foods have supplementary metric units on their labels. Even an American car—Ford's Pinto has a metric engine and transmission. These trends are so pronounced that it is apparent that we will eventually become a metric country even without any further Government action.

Second finding: a great majority of businessmen, educators and other informed participants in the study believe that increased metric use is in the best interests of the U.S. and an even larger majority believe it is better for the nation to increase its metric use by plan rather than by no plan.

Third finding: this concerns the costs and benefits of metrication. An attempt to determine such figures was made primarily because what everyone wants to know is "what will it cost?" Such costs and benefits are extremely difficult, if not impossible, to evaluate in dollars and cents. This is verified by the British experience that such estimates cannot be made, even after conversion, because the metrication costs are hard to identify. The point to be made, however, is that whatever the cost, it will be less if we go metric by plan. Remember that we are already slowly drifting to metric, thus our metric costs, whatever they are, are going to occur. We realistically do not have the alternative of *not* spending the money, *not* going metric. Therefore, it is not fair to speak of the cost of metrication and stop there; we must consider that a planned program although it may cost "x" dollars, will lead to a net savings for us in the long run. The reason, of course, is the obvious savings that come with careful planning and coordination.

With these findings in hand the study's final report was written, and transmitted to the Congress with a series of recommendations by the Secretary of Commerce in July, 1971. The major recommendations were:

- that the United States change to the International metric system deliberately and carefully;
- that this be done through a national program, coordinated by an official body;
- that a target date be set 10 years ahead;
- that changeover costs "lie where they fall";
- that early priority be given to educating school children and the public at large;
- that immediate steps be taken to strengthen U.S. participation in international standards activities.

Just what does this mean? It means we would essentially continue the metric changes we are now making, only with more coordination and with a definite goal in sight. More specifically:

1) In 10 years we would switch the roles of metric and customary units;
   - the U.S. would become predominantly metric, but not exclusively so;
   - some sectors of the economy would take less time, others more; but all could be accommodated;
2) Rule of reason would guide the change:
   - most things would be changed only when worn out or obsolete;
   - some change early, some slowly, some never for metric reasons alone
3) A central metric coordinating board should be established to:
   - help all sectors work out their own plans and timetables;
   - ensure all these plans are meshed;
   - work out a program of public education.

So, the Congress has the report of the U.S. Metric Study and the Secretary's recommendations. They are also aware that industry is increasing its metric usage. The next step is up to them. Legislation was introduced in both the house and the Senate last year and the Senate acted favorably. The House didn't have time and the issue died. Metric legislation has already been reintroduced this year and the outlook, though hard to predict, is good for favorable action. There is much interest and not much opposition.

Educational Impact

Regardless of what does happen officially—and most persons feel it's just a matter of time—what are the metric implications for education? Education is an important part of metric change, and it is generally acknowledged—including one of the Secretary's recommendations — that the present situation (rapidly increasing metric usage plus the likelihood of Congressional action in the future) is such that attention *must* be paid *now* to the question of improving both the quality of metric education. Admittedly, as long as we do not officially "go metric," we can't consider phasing out customary measurement learning; but, even until we do go metric, we need to be teaching metric more thoroughly in our schools.

Another reason for early movement in metric education—aside from the present use of metric—is that we need to be sure that every child now in school is adequately equipped for the future. There is really no question but that those students starting school this year will be graduating into a metric world. If they don't adequately learn metric, they certainly will be ill equipped for the world they will inherit.

There's even one more reason for prompt action —one that maybe the students will enjoy. Their parents are eventually going to need to learn metric—so they can shop in metric stores, cook with metric recipes. Our children—if they have already learned metric in the classroom—will likely prove invaluable in helping their parents learn metric.

Thus it is apparent that education must begin now to plan for its responsibilities in the metric world of the future—and I mean the near future.

Advantages and Disadvantages of Metrication

Educators in general have long been in favor of metrication. For example, the National Education Association is on record as saying (1970 resolution):

"The NEA believes that a carefully planned effort to convert to the metric system is essential to the future of American industrial and technological development and to the evolution of effective world communication. It supports federal legislation that would facilitate such a conversion."
The National Council of Teachers of Mathematics has stated last year that it continues to support the adoption of the metric system and encourages that this be a system to be taught by teachers of all grades, along with other systems of measurement beginning in the 1973-74 school year. The Council even devoted its 1948 yearbook to the metric system.

Why is it that education, or at least the key education associations, are so inclined? Its easy to understand when you look at the advantages and disadvantages of metric education—as compared to customary measurement education.

The chief educational advantage of using the metric system lies in the simplification of teaching and learning how to measure. This advantage arises from the simple interrelations of units mainly based on multiplication by 10 and from the ease of computing with decimal fractions and whole numbers.

Another advantage would be that the educational system would no longer be burdened with teaching two systems of measurement, and would be able to concentrate on the one which is simpler and more easily understood. Time saved due to teaching a simpler system could be used for the introduction of valuable new materials. At the same time, much of the customary drill in fractions could be reduced, although we would of course need to retain an easy familiarity with halves, thirds, quarters, and fifths; but even so we would be able to gain even more time that would be available for other work.

What's the major advantage of the customary system? That it's familiar to most people—and of course that the metric system is not.

With these facts in mind, its easy to see why metric is favored by educators in general (I'm not pretending that all of you are pro-metric). But there's even another advantage of going metric, perhaps one that outweighs all the others.

I'm speaking about the opportunity during the change of what some educators feel are certain much needed curriculum changes — they are referring to things such as:

—early introduction of decimal fractions, with corresponding reinforcement of the place value system

—a considerable downplay of inessential skills in manipulation of fractions

—an upgrading of effort in teaching measurement in the schools

Whether or not such reform is needed I leave to you and other educators to decide. The important point is that metrication would provide an ideal time for such changes should they be desired.

Areas of Metric Impact

So, it seems to be generally agreed that metrication is coming and it would indeed be good for education. The question then becomes where will the change impact education and how can this impact best be handled.

I will briefly consider three broad areas: curricula and associated text books; teacher training; and other educational materials, including library books and lab and shop equipment. Of course, I can't speak as an expert in any of these areas. But let me give you a few words of how a metric expert views these impacts. Perhaps they will help you—the educators — assess these impacts for yourselves.

Curricula/Textbooks

The important areas of curricula change is probably quite complex, especially in light of any of the above proposed changes that might take place. It seems apparent that what we're talking about is not merely a mechanical conversion from customary to metric units in existing curricula, but substantive changes of some kind. Certainly we have the expertise available to properly revise curricula. I only hope that, once a national metric program is enacted, national organizations will support such new curriculum developments.

Once they are ready, then of course, we need revised texts. The process of getting revised books into the schools should not prove to be a big problem. A key point is that at present most books are only used for about five years.

Textbook editors indicate that in the course of normal reprinting and revision practice, many textbooks could undergo metric conversion in a period of 5 years or less. If a lead time of 2 or 3 years were provided for changes, and if the people who select and buy textbooks were advised that changes were in process, and if they adjusted their replacement and renewal schedules accordingly, then new materials would be available and would reach students promptly after the beginning of a metric conversion period.

The cost? If this method is followed, it would easily be absorbed in the usual replacement cost.

It is only fair to indicate that this is the ideal way of making the change, and certainly it won't apply to *all* cases. The problem, of course, are those schools who do not change books every five years. They *will* have an added cost, and it is probably they who can least afford it.

Teacher Training

Certainly, some training will be necessary for you to be able to properly teach metric. It should be mentioned that this need is not for just math and science teachers. In a general conversion to metric, teachers in all classes that use measurement units should be expected to begin using metric units — and that's really most teachers: English, geography, shop, home economics, etc. These teachers will need to develop at least a working familiarity with metric units. Certainly, the retraining necessary for these teachers will not approach the amount needed for math and science teachers, who will have to teach—not just use—the system.

For these, most educators agree that 8 to 15 hours of inservice training would suffice to prepare mathematics and science teachers for going metric. Most schools have inservice training programs which could easily accommodate the needed training.

However, there will be a problem for the small percentage of teachers with no such inservice training available. Special efforts will have to be made to ensure these are reached, espcially those who are geographically isolated. There's another possible side benefit here, by the way. Perhaps the need for training for metric conversion may prompt the formation of a regular program. How should the training be done? It should be tightly structured, well organized and preferably condensed into a short time span, ideally just before new metric materials are used.

Other Educational Materials

This area is quite complex, but let me say just a few words.

First, printed and other "software" — films, maps, etc. — replacement of library books and encyclopedias would not be an obstacle, in light of usual replacement cycles and given a 5 to 10 year conversion period. Many of the other materials turn over with a typical lifetime of less than a decade, and as such pose no special problems.

But what about "hardware"—the lab and shop equipment, including things in office and home economics training. Without a census of all schools, its impossible to know the magnitude of change needed. But we can say it is considerable and could be costly—although such costs would likely be small compared to total education budgets. The necessary modifications to existing equipment could likely correspond to a year's depreciation; and that this cost would not have to be taken all at once but could be spread over several years.

Differences in cost may rise due to the way the change is viewed. It's interesting to compare two responses in our Education Study to a question concerning the changes:

(1) One technical school reported: "It is not worthwhile to modify an old machine if modification should cost as much as 10% of the price of a new one; we would have to buy new machinery." and

(2) One Vocational School said: "We would modify our own machines — it would give the students some meaningful projects to work on."

So, in all areas metric conversion will have a great deal of impact, but generally speaking, let me emphasize a well-planned program, given proper time to make the changes, need not be overly expensive or overly hard to do. The key is the proper planning and proper timing.

Incidentally, this is just another reason why a planned metric conversion program is desirable. Too long a conversion period or a long drawn out drift toward metric might dilute or sacrifice the sense of purpose and change and it would of course continue the need to teach two measurement languages, and delay any needed or desired curriculum changes.

How to Teach Metric

I've said about all I can related to changes needed in education and how they will impact your operations. I'd like to briefly switch gears and give you a few ideas about how—and how not to—teach metric. Please remember—these are from a non-educator who knows a little about the metric system. I think, though, you probably will agree with their validity.

—It is best if both students and teachers learn to use metric units by measuring familiar things in metric units *only*. I would warn against a general attempt to teach metric equivalents and conversion factors from customary to metric and vice versa. Nothing can turn off a person's interest more than requiring the memorization of a series of lengthy conversion factors. An engineer may need to know that 1 cm = 0.3937 but *not* the average person.

—Let me emphasize the idea of learning by doing. It is of course possible to learn metric units by study only. But the familiarity with metric units that is needed can only come with actually measuring things plus using the new measurement language in meaningful, everyday expressions.

—Finally, it would seem wise to avoid — in most —supplementary metric workbooks or pamphlets *along with* existing texts. The books and curricula should be revised to achieve all of the possible benefits.

Conclusion

At that, let me end my remarks. I hope I have given you at least an idea of what will be happening in education as metrication comes about.

I hope its been enough to get you thinking about what the impacts would be on your positions and that perhaps you will begin to prepare yourselves soon for the challenge ahead.

It is really important that you our educators begin to plan now for metrication. Let me stress once again: we are going metric in this country—there is no way to avoid it. And it's imperative that education, which is an important part of the process, be ready to aid in the change.

Let me close with an offer: if you would like any additional metric information, let me know after the discussion and I'll be glad to send it to you.

Thank you for your attention.

"Accept with graciousness the pupil as you find him. When he leaves you, you should be assured that he will be a happier individual because of his contact with you and with your subject."

"In teaching mathematics, let us always use correct English and correct mathematical language!"

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