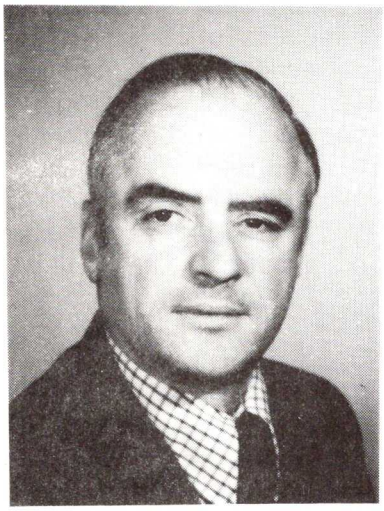
Teaching Metric Measurement



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Many teachers are apprehensive about teaching the metric system of measurement. Such worries are due, in large part, to two underlying causes: an unfamiliarity with the metric system, and a feeling that a whole new set of teaching techniques is required for teaching the metric system.

Eight recommendations for teaching the metric system are discussed in this article. Teachers will recognize that most, if not all, of these recommendations apply to the teaching of any system of measurement - not just the metric system. In other words, good methodology in the teaching of metric measurement is very similar to good methodology in the teaching of any system of measurement.

RECOMMENDATION 1: Let the Students Measure

The topic of measurement is unique among the various strands of the school mathematics curriculum. When teaching measurement, you have no choice but to make use of real objects from the real world. Most of us believe that we should utilize concrete examples whenever possible in our teaching and this decision is inescapable in the case of measurement. You cannot discuss measurement unless there is something to measure.

The classroom is filled with objects to be measured: doors, desks, tables, books, windows, chalkboards, pencils, paper clips, chalk, floor tiles and, of course, people. Students, particularly in the elementary grades, enjoy collecting data about themselves. Therefore, measurement activities might include finding one's height, weight (mass), armspan, volume, area of a foot, and so on. The important point in all of this is that the pupils are actively involved in measurement activities, and are thereby gaining familiarity with the units.

RECOMMENDATION 2: Use the Word "About"

A measurement is an approximation. Anyone who has ever built a cabinet, cut out a pattern, or baked a cake knows this. Companies that manufacture various types of moldings do a thriving business covering over the gaps in corners and edges that result from our best efforts to obtain an exact measurement. There is no such thing as an exact measurement. A measurement may be more or less accurate, or more or less precise. However, no measurement is ever exact.

So, John Doe is not 150 cm tall, nor is his mass 65 kg. John is 150 cm tall to the nearest centimetre. That means his true height may be anywhere between 149.5 cm and 150.5 cm. Similarly, his mass may be anywhere between 64.5 and 65.5 kg. In other words, John is *about* 150 cm tall and his mass is *about* 65 kg.

Teachers at all levels should discuss measurement as an approximation with their students. At the primary level, where students use rulers with centimetre markings but with no millimetre markings, children should learn to describe the length of objects in terms of intervals. For example, "The length of my comb is between 9 and 10 cm. It is closer to 10, so my comb is about 10 cm long." Textbooks at this level should show illustrations of objects whose lengths are not whole numbers of units.

At the intermediate grade level, teachers can show how measurements of area and volume are approximations. For example, students can be asked to find the area of one of their feet in cm^2. By drawing the outline of a foot on cm^2 paper, the pupils can obtain an approximation of the area. The smaller the squares on the paper, the better the approximation.

At the high school level, teachers can discuss measurement as approximation in the context of accuracy and precision. The precision of a measurement depends upon the unit of measure -- the smaller the unit, the more precise the measure. Thus, a measurement of 20 mm is more precise than a measurement of 2 cm. The accuracy of a measurement depends upon the number of significant digits used in expressing the measurement.

RECOMMENDATION 3: Have the Students "Guess-timate"

Many of your students will have had little or no previous exposure to the British system. Your objective is to have them "think metric." That is, when they look at an object they should think about it in terms of metres, kilograms, litres, and so on, rather than in terms of feet, pounds, and gallons. A very effective means toward attaining that objective is to have the students estimate a measurement before actually measuring.

Suppose that students are working at a station dealing with the lengths of several objects. Each student's worksheet should include three columns, headed: Object, My Guess, Length (see Figure 1). The student looks at an object, for example, the table top, and "guess-timates" that it is 85 cm long. He writes down

this guess in column 2 and then uses a tape measure to find the length of the table top is 143 cm. He enters this number in column 3. For students in the intermediate grades, you might decide to include a fourth column entitled "Difference." Under this heading, they would enter the size of their error and perhaps indicate whether their guess was too high or too low.

Figure 1

Object	*My Guess*	*Length*
table	85 cm	143 cm

RECOMMENDATION 4: Comparison - YES!

"A litre is about the same as a quart." (Actually, a litre is a little less than an imperial quart and a little more than an American quart.)

"A metre is about the same as a yard." (A metre is approximately 39 inches long.)

"21^0 Celsius is about the same as 70^0 Fahrenheit."

For older students and adults, comparisons such as these should be helpful in developing familiarity with the metric units. The students and ourselves have spent considerable time becoming adept at seeing the world in terms of feet, pounds, and quarts. We can make good use of this adeptness during the transitional period as we switch from the British to the metric system of measurement.

As the various units of the metric system are introduced, students should see examples of the use of each unit. Where possible, the new metric unit may be compared to the corresponding British unit which is familiar. Such an approach should assist students in learning the new units.

Most of the foregoing does not apply, in any great degree, to children in the primary grades. Children in the first two or three years of school have little or no grasp of techniques of measurement or systems of measurement. For that reason, any comparison of metric and British units with primary level children will likely result in confusion rather than in enhanced understanding.

RECOMMENDATION 5: Conversion - NO!

Most mathematics and science textbooks contain conversion tables such as the following:

1 cm = 0.4 in.
1 m = 39.37 in.
1 km = 0.6 mi.

These tables are intended to be used in solving exercises such as, "How many decimetres are there in 14.2 yards?".

There is no need whatsoever for teaching conversion between systems of measurement to our students. The metric system, including the interrelationships among the units of that system, should be learned as a system complete in itself. Our students, if they are to "think metric," must be capable of working in that system without recourse to the old. Analagously, bilingual persons can speak their second language fluently without having to translate back and forth between their second language and their mother tongue.

The distinction between comparison on the one hand and conversion on the other is an important one. Comparison of units should facilitate mastery of the new units and their interrelationships, whereas conversion of units from one system to the other serves no useful purpose in learning the new system.

RECOMMENDATION 6: Stress Place Value Concepts

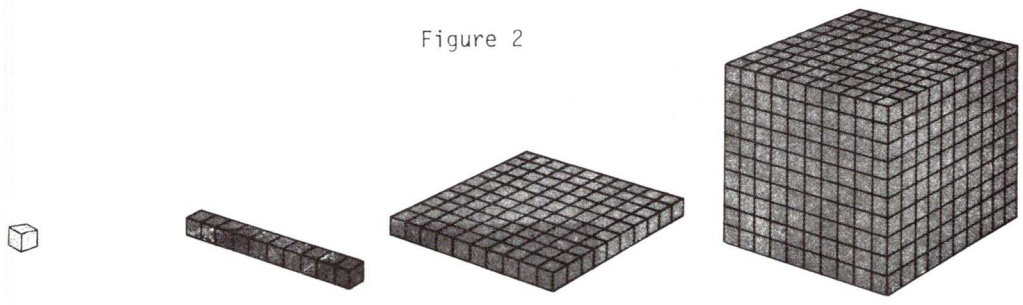
A surprisingly large proportion of students' difficulties with the fundamental operations of arithmetic are traceable to a lack of understanding of place value in our base ten system of numeration. For example, the majority of students' errors in addition and subtraction involve regrouping or renaming, which requires an understanding of place value concepts.

With the introduction of the metric system, decimal fractions and operations with decimals will be used more frequently than the corresponding operations with common fractions. For that reason, our students will need an even better understanding of place value concepts. Teachers, particularly in the intermediate grades, should not assume that their students have an adequate understanding of place value concepts such as regrouping, renaming, and recognizing "places." For many students, these ideas need to be taught, re-taught, and reviewed year after year.

Good teaching of place value requires extensive use of manipulative materials. Primary grade teachers can utilize counters, pocket charts, and various forms of the abacus, among others. Teachers of the intermediate grades cannot make too much use of counters because of the size of the numbers dealt with in those grades.

Perhaps the best teaching aid available for place value ideas with whole numbers is a set of blocks of various shapes and sizes called multi-base blocks

Figure 2



unit	long	flat	cube
1	10 x 1	10 x 10	10 x 10 x 10

or Dienes' blocks. The base-10 set of blocks comes with four types of blocks: units, longs, flats, and cubes (see Figure 2). The blocks can be used to give a simple and explicit representation of whole numbers and, simultaneously, to highlight place value concepts.

RECOMMENDATION 7: Teach Measurement as a 3-step Process

The process of measurement involves three discrete steps:

1. selecting the unit of measure,
2. matching the unit against the object,
3. counting the number of units used in step 2.

As each new unit of measure is introduced we should have students work through these three steps first with arbitrary, non-standard units and then with the standard metric units. Brief descriptions of two examples of this approach follow.

In the primary grades, an introduction to length might involve having students measure the width of their desktops in paper clips. Other non-standard units of length such as pencil lengths, pieces of chalk, edges of blocks, and so on could be used. In each case the 3 steps of the measurement process are made explicit. The non-standard units of length should be phased out gradually and replaced by a unit such as the centimetre. The children can make "centimetre trains" by placing a series of centimetre cubes end to end in order to find the length of an object.

An introduction to area concepts in the intermediate grades might involve the use of geo-boards. Using this aid students learn in a concrete way that area is a measure of the space enclosed by a plane figure. After experimenting with the geo-board and finding areas of various polygons on the geo-board, standard units of area, such as the centimetre square, may be introduced.

Only at the end of this 3-step procedure should formulas be introduced. We tend to introduce formulas for area, volume and the like too soon, before students have adequately grasped the meanings of the underlying concepts. Formulas provide unthinking, automatic responses. Until we are sure our students understand a new procedure or concept, we should avoid teaching them formulas.

RECOMMENDATION 8: Relax!

This eighth recommendation may well be the most important one of all. Hopefully, a reading of this paper has helped convince you that teaching the metric system will not be an onerous task. If anything, it should be easier to teach the metric system than the British system.