Let's Do It: Measurement for the Times

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This is an article about measurement and multiplication. We chose this topic for three reasons. First, children need a variety of practice in multiplication. We hope that when children are working with problems in interesting, meaningful situations, they will be motivated to do the related computations thoughtfully and accurately. The individual activities do not contain a multitude of multiplication exercises—we are more interested in the quality than in the quantity of work done. Second, measurement is one of the main ways we use mathematics in everyday life. Thus, at the same time the children are practising multiplication, they are applying it. Third, mathematical skills often are taught separately and children do not see the relationships between them. Here we have provided ways to tie measurement and multiplication together.

The activities in this article are appropriate for children who need practice in multiplying numbers of any size. Although some are written for specific sizes of numbers, they can easily be modified for use with other numbers. Many of them can even be adapted to multiplication with decimals or common fractions. In these activities, we assume that the children know how to use rulers and scales, or how to compute the measure of the selected property—length, weight, area, volume or capacity. The activities are independent of each other and, hence, can be used in any way that suits you and your children.

The Latest Length

Lengths can be used to generate multiplication problems. We have suggested two activities, both of which ask the children to first measure and then multiply. In the first activity, the children measure something—the length of the classroom in decimetres, for example—and then find out how long the room would be if it grew to be 28 times as long as it is now. Tell the children that they are going to have a "megamare" and, in this dream, everything is 28 times as long, as high or as wide as it really is. Have the children measure different things and then find out how big those same things would be in their megamare. Provide a recording sheet for each child like the one in Table 1. Choose some appropriate objects and units of measure to get the children started, but leave a few choices of objects for the children to dream up.

Table 1

A Megamare **"It" grew 28 times as long or as tall.**		
"It"	Size "It" Is	Size in Dream
Your Height (cm)		
Room Length (dm)		
Pencil Length (cm)		
Width of Desk (dm)		
Length of Waist (cm)		
Length of Little Finger (mm)		
Thickness of Book (mm)		
Width of Doorway (dm)		

In the second activity, the children measure things in one unit (a chain) and then use multiplication to find the length of the object in a smaller unit (a paper clip). Give each child a chain of paper clips—say 13 paper clips—and a list of things to be measured. Have the children work in pairs to find the various lengths in paper clips. Since each pair of children has only a chain of 13 paper clips, they will need to find the lengths in chains and then multiply by 13 to find the lengths in paper clips. One list of distances that you might use is the following:

How high can each of you reach when you are

- lying on the floor,
- sitting on the floor,
- squatting on the floor,
- kneeling on the floor,
- sitting on a chair,
- standing with feet flat on the floor and
- standing on tiptoes?

If you wish to vary the multiplier, make chains of different lengths and label them *A*, *B*, *C* and so on. Then, place each chain with a direction card near the object to be measured. A direction card could read as follows: Use chain *C*. How many paper clips long is the cabinet door? The examples given here have involved multiplying by a two-digit number. They could easily be changed to require multiplying by only a one-digit number. In fact, if you choose the objects carefully, the same activities could provide practice for the multiplication facts.

Worldly Weight

Grams are grand for measurement/multiplication practice since small objects can weigh a large number of grams. You can pick the objects to be weighed to reflect the size of the numbers you want the children to use in multiplying: 1 digit × 1 digit (fact), 1 digit × 2 digits, 2 digits × 2 digits and so on. You will need a balance and gram weights or a scale that weighs in grams. Two suggestions for weighing activities that give multiplication practice follow.

The first activity is a game for two players called Gram Slam. Pick six objects to weigh and prepare a duplicating master of 12 cards similar to those shown in Table 2.

Table 2

36 rocks	25 jar lids	51 marbles
40 marbles	16 bolts	27 bolts
64 blocks	75 pencil erasers	50 jar lids
82 pencil erasers	23 blocks	18 rocks

Rules for Gram Slam

1. The two players cut out the cards, mix them up and deal them into two facedown piles.
2. Each player draws a card, weighs one of the objects listed on his or her drawn card and then multiplies to find the total weight.
3. The player whose card shows the larger total weight wins both cards.
4. Play continues until one player has won all the cards and has a "gram slam."

Encourage the children to weigh and multiply only when they need to. For example, if the two cards "36 rocks" and "16 bolts" are drawn, and it is clear that the rock weighs more than the bolt, 36 rocks will definitely weigh more than 16 bolts.

The other weight activity involves a story situation in connection with some objects to weigh. The Dress in Style Co. sends out shipments of different kinds of clothes. The clothes must be weighed and then the total weight for a shipment of a certain type of clothes is determined by multiplying. The information can be given in a table like Table 3.

Table 3

Dress in Style Co.			
Clothing	**Weight (g)**	**Number Ordered**	**Total Weight (g)**
Classy Coat		75	
Faddish Belt		29	
Trendy T-Shirts		80	
Posh Hat		66	
Super Socks		47	
Swanky Scarf		53	

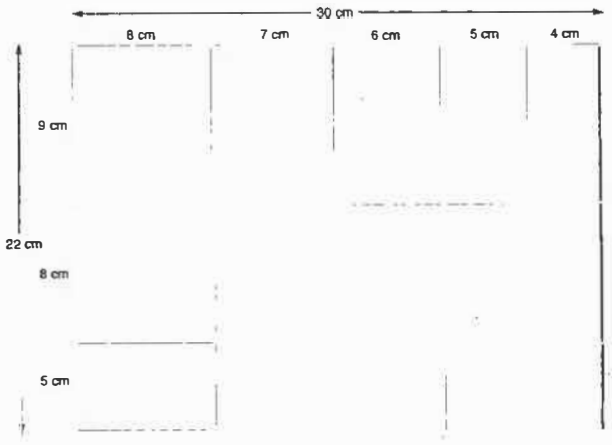
As before, you can choose the items to weigh and the numbers to multiply by to coincide with the type of multiplication problems the children need to practise. We have suggested a specific situation, but it would be easy to modify our suggestion to situations that use other objects. You can introduce the story situation to the class as a group or you can write it on a card; or you can put it on a duplicating master with a table on which the children can record their results.

Avant-Garde Area

Areas provide a natural way to practise multiplication. The first activity suggested here can be used to help develop the concept of the area of a rectangle while providing practice in multiplication. The next two activities depend on the children's knowing that the area of a rectangle can be found by multiplying.

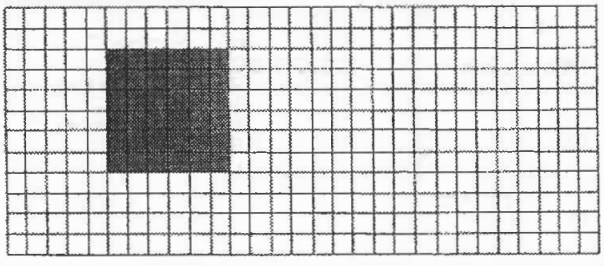
The first activity is a multiplication-fact game, Spaceship 79, designed for pairs of children. Each pair of children needs a transparent centimetre grid and a set of rectangular shapes. The centimetre grid can be made from centimetre graph paper and an overhead transparency. The set of rectangular shapes can be cut from a regular sheet of construction paper. (The pattern in Figure 1 is easy to cut and provides a variety of sizes.) Rectangles of other dimensions can also be used, if you want practice in other multiplication facts.

Figure 1



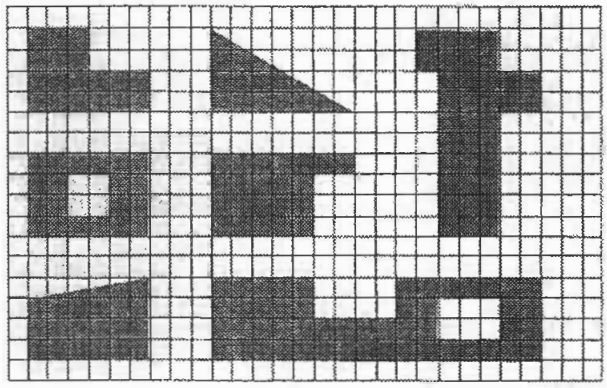
To play the game, each child picks a rectangle from out of the Space Treasury (a box, large envelope or the like), and then uses the transparent grid to find the area of his or her rectangle (Figure 2). The child with the larger area receives one point for each square centimetre of the difference between the two areas. The children continue the game, choosing two more rectangles, until one child has 79 points.

Figure 2



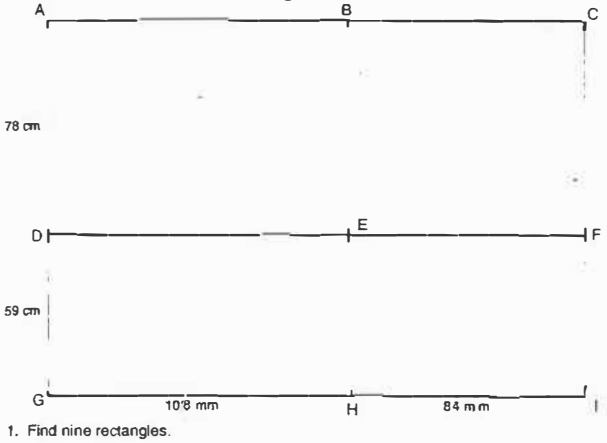
A few things can be noted about this game. First, the set of materials can be used in a variety of ways, such as having children put the rectangles in order by area, from the largest to the smallest. Second, children just beginning to use the grid may count all the squares instead of multiplying the length by the width. This is fine, but if your purpose is to have them practise multiplying, they will need to see how to use multiplication. Encourage them to look at the area of a rectangle, such as the one in Figure 2, as five rows of six squares; thus, $5 \times 6 = 30$. Third, the same game can be used for older children either by omitting the grid and using rulers, or by using the grid with shapes other than rectangles. The shapes in Figure 3, for example, require the children to break the figure into rectangular or triangular parts. (In making and cutting out shapes like those in Figure 3, make the vertical and horizontal sides a whole number of centimetres.)

Figure 3



The second activity has a puzzle to be solved before the task can be completed. It also requires measuring in millimetres, multiplying by three-digit numbers and knowing how to determine the area of a rectangle by multiplying. (You can alter the size of the numbers to be multiplied by making the rectangles whole numbers of centimetres and having the children measure them in centimetres.) This activity is designed for children to do individually. You could make a card, for only one child to do at a time, or a duplicating master, so many could be doing the activity. Figure 4 shows the instructions and the drawing. If you are making a duplicating master, leave space for answers. The dimensions are included for your reference only; do not include them on the children's copies. If children enjoy this activity, you might increase the number of rectangles (warning: adding two rectangles can increase the total number to 18), or you could use right triangles as in Figure 5.

Figure 4

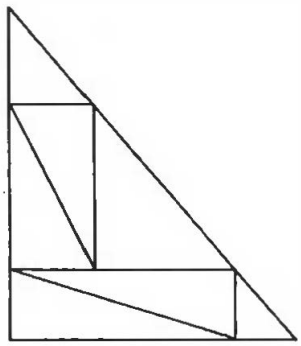


1. Find nine rectangles.
2. Just by looking at the rectangles, list them in order by area, from the smallest to the largest.

   smallest _____ _____

   _____ _____ _____ largest
3. Measure the rectangle in millimeters and find the areas in square millimeters. Check the areas against your list. Are you a good estimator of area?

Figure 5



For a third activity, you can have children use their ability to find areas of rectangles with real objects in the room—areas of bulletin boards, tabletops and desktops, and so on. Often we (teachers) limit finding areas to situations similar to the first two area activities; rectangles are drawn on paper, and only rectangles with sides a whole number of units are used. When children are finding areas of real objects, this is often not true. You can help children handle this by suggesting that they find an approximate area by rounding the lengths of the sides to the nearest unit, that they use a smaller unit or that they use decimals. The decision as to how to handle this will depend on the mathematics level of your children. Remember that measuring real objects is important. Children see how we really use measurement, and it helps develop the idea that all measures are approximate—we often mislead children about measurements when everything turns out "nice and even."

Another way to involve children in measuring areas of real things is to have a contest to see who can be the first to find four mystery objects. Choose and measure the areas of four rectangular things in your room—use things in a variety of sizes, such as a light-switch cover, a book, a desktop and a door. List the four areas without identifying the things themselves. Have the children, working in pairs, list 12 rectangular things that they think might be the mystery objects. When their lists are completed, they should measure the areas of the things on their lists to see if they have identified any of the mystery objects. The search also could be turned into a class project in which all cooperate to find the mystery objects.

Volume in Vogue

Once children are familiar with how to find the volume of a rectangular solid (box) by using its measurements, such problems can also be used for review or practice with multiplication. The first activity that we have suggested is an estimating game, The Cubic Question, which is played by one child. Collect and label—*A, B, C, . . ., G*—seven small boxes. (Each child playing the game will need a set of boxes.) Boxes for such things as pencils, pills, spices or other small things can be used. Make a worksheet like the one in Figure 6. This game gives children practice in estimating, measuring and multiplying, but not in competition with other children.

Figure 6

The Cubic Question

Look at boxes A-G. Without doing any measuring, just by looking at them, put them in order, from largest to smallest. Write the letters in order here:

____ ____ ____ ____ ____ ____ ____

Now measure and find the volume of each box in cubic centimeters. Do your multiplying in the spaces below:

A	B
C	D
E	F
G	Were your guesses about the order correct?

The size of the metric unit that you use can be varied to give practice with the numbers—one digit, two digits and so on—that are appropriate for your children. You can also vary the size of the boxes being measured. As with finding the areas of actual objects, the children will be confronted by boxes whose sides are not whole numbers of units. Possibly the easiest way to handle this in finding volume is to round off the dimensions to the nearest whole unit.

A second activity involves using larger boxes or even closets, cupboards or whole rooms. You will need to gear the metric units used to the size of the multiplication problem you want the children to practise. Very large boxes could be measured in cubic decimetres, for example, or even cubic metres. One way to get children to measure the volumes of large boxes is to begin with a guessing contest. Show the children a cardboard box and have them guess its volume in cubic centimetres. They can each record their own guess and need not share it with anyone. Ask for a volunteer to measure the length, width and height of the box. Then each child uses those measurements to find the volume. Check the answer together.

You could ask questions like these about the children's guesses:

- Whose guess was closer than 1,000 cm^3?
- Whose guess was closer than 500 cm^3?
- Who guessed too high?
- Who guessed too low?

Repeat the activity with another box. The children's guesses should be considerably more accurate this time since they can compare the second box to the one whose volume they already know. The activity can be done several times if the children enjoy it.

Another way to have children measure large solids is to separate the children into pairs. Then assign to each pair, or let them choose, large boxes or rectangular solids in the room, or even outside the room. The two children measure the lengths, widths and heights together, but each does the multiplication to serve as a check on the other.

Children can be very interested in how many cubic centimetres there are in a cupboard, a locker, a desk or even the classroom itself. A really ambitious project might consist of finding the volume of the whole school in cubic metres (or cubic decimetres if you want to get to *really* large numbers).

Contemporary Capacity

Activities in which children find the capacities of objects can be easily devised and provide much interesting multiplication practice. Again, you will want to choose units and containers to correspond with the sort of multiplication problem you want the children to practise.

The first activity involves some multiplication of very large numbers and will need to be modified if your children are not ready to handle them. Collect a cupful of as many of any of the following as you wish: lima beans, macaroni, popped popcorn, marshmallows, wrapped candy, marbles, crayons, pennies and so on. Place them at a math centre, with a large sign:

> **How Many in a Swimming Pool?**
>
> Pool your efforts with a friend. Dive right in and find out! Choose any kind of object at the math centre and follow the directions on the card.

Write a direction card with the following directions included:

1. Fill a cup with the objects you want to use.
2. Count how many of the objects are in the cup.
3. One pint holds two cups. How many objects would be in a pint?
4. One quart holds two pints. How many objects would be in a quart?
5. One gallon holds four quarts. How many objects would be in a gallon?
6. One bathtub holds about 70 gallons. How many objects would be in a bathtub?
7. A swimming pool might hold about 386 bathtubs. How many objects would be in a swimming pool?

The children can work in pairs (as the sign indicates), thus acting as a check for each other. If your children cannot handle such large numbers, you can stop the sequence at any step. Your final question could be, How many objects in a gallon? The children might be interested in comparing results for different objects: What is the difference between the number of lima beans in a swimming pool and the number of marshmallows in a swimming pool?

The second activity can be done at a centre by an individual child or by pairs of children, or with the whole class at one time, depending on how many materials are available. It requires a cylinder marked in millilitres and some small jars or bottles of a variety of sizes—spice bottles, mustard jars and pill bottles will all work. The children measure the capacities of the jars or bottles in millilitres, and then multiply each result by a given number. Label each bottle—*A*, *B*, *C*, . . .—and make a worksheet or card like that in Figure 7. (If you wish to see the children's computations, have them write them on a separate sheet.) Encourage children to use logic to avoid multiplication whenever reasonable.

Figure 7

Which Is Less?

Measure the capacity of each bottle in milliliters. Multiply to find out which of each of the following pairs holds the smaller number of milliliters, then circle it.

54 of bottle *A* 49 of bottle *B*	76 of bottle *B* 40 of bottle *C*
92 of bottle *A* 76 of bottle *C*	37 of bottle *D* 29 of bottle *A*
50 of bottle *B* 74 of bottle *D*	81 of bottle *C* 72 of bottle *C*
60 of bottle *E* 74 of bottle *D*	75 of bottle *B* 90 of bottle *E*

The activities in this article were built around the particular property in question. Many of them, however, could just as well be done with another property. For example, the game in the weight section could be played with length or capacity. You may even want to combine properties. Think what you could do with the ordering of boxes described in the volume section—they could be ordered by length, weight or surface area. Take the ideas and change them so they will *measure* up to what you need at that time.

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A pumpkin weighed 100 kg and was 99 per cent water. While the pumpkin was exposed to the sun, some of the water evaporated, so it was only 98 per cent water. How much did the pumpkin then weigh?