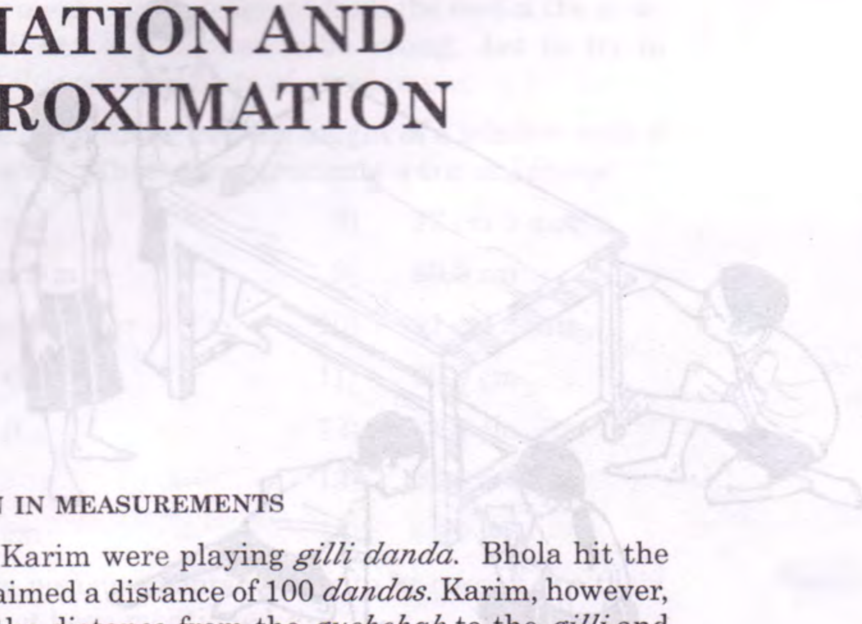
VARIATION AND APPROXIMATION

13



VARIATION IN MEASUREMENTS

Bhola and Karim were playing *gilli danda.* Bhola hit the *gilli* and claimed a distance of 100 *dandas.* Karim, however, measured the distance from the *guchchak* to the *gilli* and said it was only 98 *dandas.* The two got into an argument. So they decided to measure the distance together. On doing so, they got a distance of 101 *dandas.* Karim felt this just could not be possible. "Let us check once more," he said. This time they measured the distance as 100 *dandas.* They were both confused. What was happening? Even after taking so much care they kept ending up with a different number of *dandas.* Would such differences occur every time they carried out a measurement? How can we find out what the distance actually is? Would such variations occur even if we use a scale to measure the distance?

Let us measure and find out for ourselves.

PRECAUTIONS WHILE MEASURING

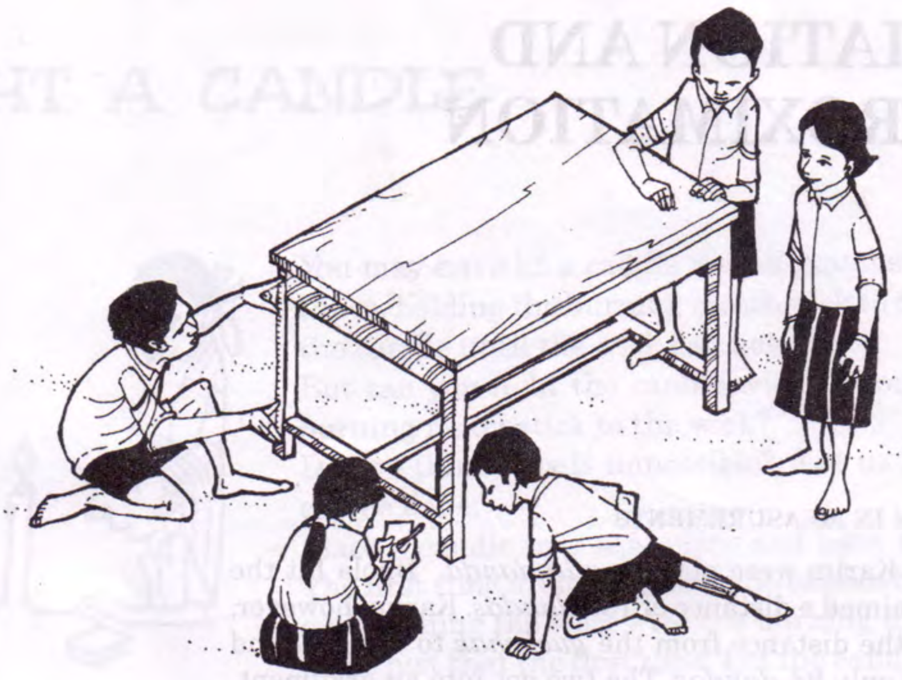
We had discussed some points in the chapter on measuring distances which, if not kept in mind, could lead to errors in measurement. Do you remember those precautions? For example, you must first note down the least count of the scale, then you must place the scale straight and read the measurement from the correct point.

EXPERIMENT 1

You have to measure the length of a table. Take a half metre scale.

What is the least count of the scale? (1)

Measure the length of the table carefully and note your



measurement on a piece of paper. Do not show what you have written to anyone else, otherwise they might copy your measurement. When we know what someone else has measured, we often tend to feel that our measurement should also be the same. Then we are not really able to measure independently.

After everyone has finished measuring, record all the measurements in you exercise book.

Are all the measurements the same? (2)

Even after everyone taking care there are still variations in the measurements.

Can you suggest any reason for such variation? (3)

Do you think all the measurements should have been the same?

Part of the variation could be because each person used his or her own scale. But even when a single person repeats a measurement several times with the same scale such variations can occur. Some differences can always creep in while placing or reading the scale for each measurement. If you like, you could try measuring the length of a table five times.

IDENTIFYING WRONG MEASUREMENTS

Do some of the measurements you have noted seem to be obviously wrong?

If a measurement is very different from the rest of the measurements, it can be assumed to be wrong. Let us try to understand this with the help of an example.

Fourteen children measured the height of a window with a half-metre scale. Their measurements were as follows:

1)	91.2 cm	8)	93 cm 5 mm
2)	93 cm 8 mm	9)	80.3 cm
3)	92 cm 5 mm	10)	91 cm 8 mm
4)	90.7 cm	11)	90.9 cm
5)	1.42 ft	12)	91.4 cm
6)	923	13)	92 cm 4 mm
7)	92.6 cm	14)	93.6

Two of these measurements appear to be correct but their units have not been mentioned.

Identify these measurements? Also write their units. (4)

Two measurements in the list are completely wrong. Identify them. (5)

Some mistake must have been made while taking these two measurements. So they can be safely removed. That leaves 12 measurements.

If we write all these measurements in centimetres our list will be as follows:

91.2 cm	93.5 cm
93.8 cm	91.8 cm
92.5 cm	90.9 cm
90.7 cm	91.4 cm
92.3 cm	92.4 cm
92.6 cm	93.6 cm

On the basis of these measurements can you say what is the height of the window? What do you suggest should be done?

All these measurements are not equal but they are close to each other. There is a small variation among these measurements.

What is the smallest measurement? (6)
What is the largest measurement? (7)

We can now make a good estimate of the height of the window. We can say that the height of the window lies somewhere between the smallest and the largest measurement. The average of all these readings is used as a measure of the length in such situations.

How does one obtain the average?

FINDING THE AVERAGE :

Add the 12 measurements:

91.2 cm
93.8 cm
92.5 cm
90.7 cm
92.3 cm
92.6 cm
93.5 cm
91.8 cm
90.9 cm
91.4 cm
92.4 cm
93.6 cm

Total : 1,106.7 cm

Since there are 12 measurements, we divide the total by 12. On doing so we get:

Average of measurement =
1106.7/12 = 92.225 cm

Look carefully at the average value. If we were to say that the average height of the window is 92.225 cm, it would create a lot of confusion. The first place after the decimal point denotes one-tenth of a centimetre. The height of the window was only measured up to the first decimal place. Now look at your scale. The second and third place after the decimal point denote one-hundredth and one-thousandth of a centimetre respectively. These cannot be measured with this scale. Therefore, it would be appropriate to write the average value up to the first decimal place only.

If we need to write 92.225 cm up to the first decimal place what should we do?

When we round off or approximate 92.225 cm to the first decimal place we get 92.2 cm. You will learn about how approximation is done at the end of this chapter. Therefore, we can state on the basis of these measurements that the average height of the window is 92.2 cm

Now look at the list again. It does not contain a single reading of 92.2 cm. Yet we accept this figure as the average height of the window. That means we cannot say that any of the 12 measurements is either correct or incorrect. We can, however, say that some of these measurements are closer to the average height than the others.

Food for thought

If we took 20 measurements instead of 12, could the average height of the window change?

Whenever we take a measurement, there is scope for some variation. Therefore each time the average of measurements could also be different.

Yet, the window is the same. It does not expand or contract. It is only that we cannot tell what its actual height is. All we can say is that on the basis of these measurements, the average height of the window is so much. Of course, the more accurately we measure, the more accurate would be the average height we obtain.

The length of your table

Let us now return to the length of the table. Look at the measurements written in your exercise book once again. You had measured the length of the table. Which of these measurements are completely wrong? Identify and mark them. What kind of mistakes might have been committed while taking these measurements?

Leaving out the wrong measurements, make a list of all the measurements in centimetres. (8)

Calculate the average of these measurements. (9)

Write the average length of the table in centimetres up to the first decimal place. (10)

To do this you will again have to round off or approximate the average value.

Rule for approximation

Suppose we have to round off 27.73 to the first decimal place.

Look at the digit in the second decimal place. If that digit is less than 5, we ignore it and write the remaining number as it is, up to the first decimal place. If, however, the digit is 5 or greater than 5, then we increase the digit in the first decimal place by 1.

The digit in the second decimal place in 27.73 is 3, which is less than 5. So we ignore it and write the number as 27.7 rounded to the first decimal place.

If the number, however, were 54.86, the digit in the second decimal place would have been 6, which is more than 5. So we add 1 to the 8 in the first decimal place to get 9. Therefore, 54.86 rounded off to the first decimal place would be 54.9.

The rule therefore is that if we have to round off to any digit, we should look at the digit immediately to the right. There may be more digits to the right of that point but there is no need to look at these remaining digits.

For example, if 7.847356 is to be rounded off to the second decimal place, we need only look at the digit in the third decimal place. The digit in the third place in this case is 7, which is greater than 5. So we add 1 to the digit in the second place which is 4. The rounded number would thus be 7.85.

Here are some more examples of rounding off to the second decimal place:

0.282 will become 0.28

8.1072 will become 8.11

66.06498 will become 66.06

2.0049 will become 2.00

If we round off to the first decimal place then:

57.87 becomes 57.9

0.052 becomes 0.1

3.4531 becomes 3.5

6.036 becomes 6.0

If we round off to the units place then:

8.8 becomes 9

99.64 becomes 100

0.5 becomes 1

6.2 becomes 6

SOME EXERCISES FOR REVISION

a) Round off the numbers below to the tens place:

878

10909

3635 **(11)**

b) Round off the numbers below to the units place:

9.9

503.28

0.6 **(12)**

c) Round off the numbers below to the first decimal place:

1.25

88.325

110.826 **(13)**

d) Round off the numbers below to the second decimal place:

0.995

77.3224

3.259 **(14)**

NEW WORDS

approximation average rounding off variation