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TEACHING
Data Handling

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**At
Right
Angles**
A Resource for School Mathematics

INTRODUCTION

All mathematical topics that are taught in the primary school are born out of the need of children to understand their world. In the process of acquiring and growing in this understanding children encounter various types of numerical data. Often this data acquires significant meaning when seen in relation to other numerical data of a similar kind. When this data is organised into a meaningful form and presented graphically it highlights similarities and differences. Comparisons can be made and patterns observed leading to useful conclusions.

In today's world there is an explosion of data and much of this data is presented to us in the form of graphs. Graphs have become a form of communication. The skill of representing data graphically, reading and interpreting graphs accurately, and learning their limitations has acquired significance.

While teaching this topic it is important to ensure that representation of data in the form of a graph is not perceived as an end in itself. Ideally a graph should lead to important observations. Once the graph is made the crucial question to be raised and discussed in the classes is 'what does the graph say?' It has an open ended aspect to it. Also data used needs to be realistic, meaningful and should provide an opportunity for useful graph work.

What does data handling at the primary level involve?

It involves raising questions (preferably organically), collection of data or working with a given data set, representation (graphs ranging from physical object graphs, pictographs to bar graphs and Venn diagrams) and interpretation. Interpretation at this level would take the form of reading of facts from the graph, making comparative statements, pattern recognition and understanding causes and implications of the data.

Data handling and graphing skills progress through various levels of increasing complexity in terms of collection, organisation, representation, interpretation finally leading to conjecture and analysis. It is the context where children apply their numerical skills.

What should be the order or the progression of graphic skills?

In all areas of mathematics, while teaching young children one introduces concepts through concrete materials followed by semi-concrete, i.e., drawings, and then we make the transition to the abstract. In a similar manner, even in the teaching of data handling there should be a developmental sequence starting with physical object graphs, pictographs, bar graphs, leading finally to the abstract graphical forms.

What is the place of a data survey or enquiry?

A survey project needs to emerge organically from the questions that children ask. What is the most favourite game of the class? Which is the month with maximum number of birthdays in our class?

Once the question is framed, children can figure out the kind of data they need to collect to seek the answer to that question. Identifying the data needed to answer a question is one of the learning objectives of data handling. Children can now go through the process of collecting data. Collection of data can happen through various forms. It may be as simple as asking their classmates to raise their hands or making a questionnaire to be filled in. Recording of this data can also take various forms from making pictures to tally marks to summing and recording.

The next challenge is organising it in a readable form and representing the data through various means.

Interpretation of the data can be done at three levels. Firstly, reading the numerical values of the graph, answering the 'which is the highest/lowest?' kind of question. Secondly, reading relationships, that is, comparative statements, how much less, how many times more, etc. Thirdly, noticing patterns and seeing connections, understanding causes and implications of the data.

So the whole task of conducting a survey involves several objectives: identifying the data needed, working out the format of collecting data, finding a good way of recording the data, choosing an appropriate form for presenting the data, answering the basic questions as well as noticing other patterns in the data and interpreting the data.

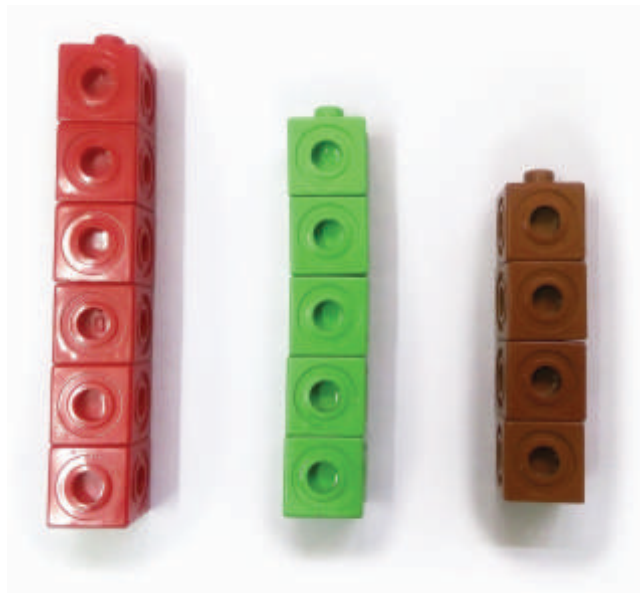
However, carrying out a survey is a very time-consuming process, and sometimes it is necessary to present the children with structured pre-determined data sets. These need to be connected to their life and their immediate experiences, and they must be meaningful to the children.

Expectations: Children build graphs of real objects.

Introduction to graphs is generally initiated by the teacher through play activities which children enjoy. At this stage teacher can help the children to build graphs of real objects. They can then count and compare quantities using number words. Since the graphs are made of real objects which can be placed on the floor or affixed on a bulletin board, the floor or the base of the board acts as the x-axis. Labelling and uniformity of scale arise naturally from the situations. Children should not be obviously exposed to terms like axis, base and scale.

ACTIVITY 1

Material: Unifix cubes or big wooden blocks of different colours

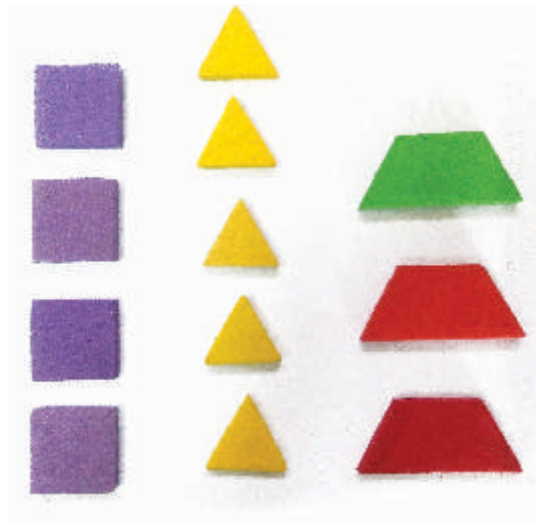


Children love to build trains. They would be quite excited to build coloured cube trains with Unifix cubes (cubes which fit together). The cube train becomes a graph of real objects. Once the graph is built children can talk about the graph. The number of cubes in the red train is more than the number of cubes in the brown train. If we have one more cube in the green train it will be the same as the number of cubes in the red train. The teacher can raise further questions about the graph and the different possibilities. What will happen if three cubes of the red train are left behind at the station? Which train would be the smallest? What if we attach 4 more cubes to the brown train?

If cubes are not available, children can make towers of wooden blocks and compare these towers. However, the blocks should be of uniform size.

ACTIVITY 2

Material: Shapes of different colours



Give each group of children around 20 shapes (different shapes in different colours). Let children sort the shapes into different sets (say by shape) and build a graph with them.

Raise questions: Why do these belong together? Which has the most? Which has the least? How many more? Can these shapes be sorted in another way?

Children can also sort the same set by colour. They may sort them by the number of edges or on the basis of number of corners. They may sort them as shapes with edges of same length, edges of different lengths and shapes with no straight edges.

3-D shapes can also be sorted in different ways (by number of faces, shapes of the faces, number of edges).

ACTIVITY 3

Material: Chess Kit



Once upon a time there was a king and a queen. ... The story can be the starting point for a graph built with chess pieces.

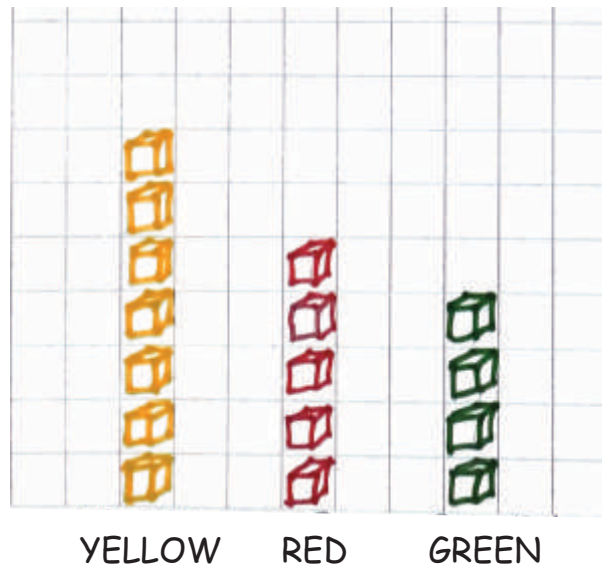
Children can sort and line up the pieces. The teacher can label the columns to familiarise the children with the names of the various pieces.

Expectations: Children will be able to construct pictographs.

They will begin to learn to collect, display and interpret data for seeking an answer to their question. They will also be able to read and interpret teacher generated pictographs. They will be able to use simple Venn diagrams.

Teachers can use questions which arise naturally in a classroom situation to initiate graph making. Often children express their likes and dislikes about food items. It may be about vegetables, fruits, biscuits or chocolates. They have their favourite games. 'I wonder what the favourite fruit of our class is!' This can become the starting point for a lot of chatter which can be skilfully used to create a pictograph.

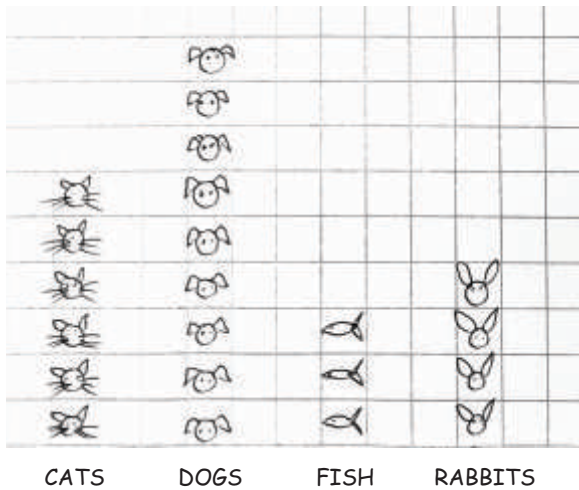
ACTIVITY 4



Children can now draw pictographs by mapping real objects to pictures. They are also in a position to make pictographs for given data. Square grid paper can be used to facilitate the drawing. It serves the need for uniform scaling. Vertical columns can be easily filled in by children. The square acts as a frame for children to fill in. Labelling can be done at the base. Since each unit square stands for one entry it facilitates counting.

Drawings made in these squares need not be realistic and are generally symbolic. Children can now interpret this graph by comparing quantities: more, fewer, less than, greater than, together, etc.

ACTIVITY 5



Pets or favourite animals are an attractive theme for children. 'Which is the most popular pet?' may be the starting point.

Once the graph is built, children can be encouraged to make their observations:

- Which pet is the least popular?
- Which animals are equally popular in our class?
- If _____ more students choose 'cat' then it will be as popular as 'dog'.
- _____ and _____ together are more popular than _____.

Teacher can draw attention to other aspects: If we add up all the numbers in the graph, does the total match the total number of students in our class? Why? Why not?

It is important to present graphs both in vertical and horizontal form. Children should be able to read data from different forms.

ACTIVITY 6: Horizontal graph

Modes of travel to school are closely linked with children's lives. This topic provides opportunities for discussion about traffic, safety, overcrowding, etc.



The teacher can create a chart as shown in the picture for children to fill in. Once the chart is ready, the teacher can at first encourage children to make their observations. Numerical figures can be read and recorded. Comparative statements can be made.

Some possible questions which can lead to general discussion: Why are more students coming by the auto than by the bus? How are some students able to come walking? Why don't we have students come by train? Are there some students who use a vehicle as well as walk? Why does that happen?

ACTIVITY 7



SUNNY WINDY RAINY CLOUDY

Weather calendar and chart: Weather can be categorised as 'sunny', 'windy', 'rainy', and 'cloudy'. Children can create symbols to depict these four categories of weather. Each day an entry is made into the calendar according to the weather. At the end of the month, a pictograph can be prepared based on the information from the calendar.

Why do we have so many rainy days this month? Is it possible to guess what kind of a day tomorrow will be? If we make a weather chart for March, will it look like this? What would be different? Are there some days when it is both rainy and windy? How did we mark those days?

ACTIVITY 8

Stickers are a great favourite with children. As homework they can be asked to create a graph using stickers. They can bring the graph to the class room and talk about it.

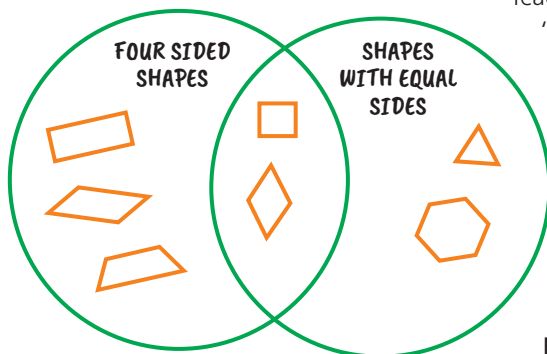
The question "which is the favourite cartoon programme of the class?" will interest the children immensely!



SUN BEES FROGS APPLES MOON

ACTIVITY 9: Venn diagrams with two circles

Expectations: Children build graphs of real objects.



Teacher can draw two separate circles labelled as 'four sided shapes' and 'shapes with equal sides' on the floor. Let children pick up the various shapes one at a time and work out where the different pieces go. However when they pick up a square or a rhombus they will be unclear as to where to place them. Through discussion between students and teacher, students will see that square belongs to both the sets. Teacher can now redraw the two circles as intersecting circles and shapes can be placed in the right places. Children will need help in learning to describe a shape in terms of two different attributes. At this stage, they do not need to know the names of all the shapes.

Raise questions: Why is this shape part of both the sets? Why are these shapes not part of any set? When will a shape be only in one of the circles?

Expectations: At this stage children are able to create data tables and make tally charts.

They will be able to draw bar graphs using square paper. They will be able to read and interpret teacher generated bar graphs. They will be able to use pictographs where each picture represents more than one (e.g., 1 face may stand for 5 people). However, such pictographs have a built-in limitation. For instance, if a face represents 5 people, it is possible to represent all multiples of 5. But there would be a difficulty in representing in-between numbers, e.g., from 21 to 24. Half-multiples may be possible, say by drawing half of the symbol; but fractions such as a third or a quarter would clearly be difficult to represent. The teacher should help children understand the limitations of such pictographs. Also, the teacher can show students that it is easier to represent larger numbers with a tally chart or a data table than to make a pictograph. They will be able to use simple Venn diagrams (two circles) with subsets.

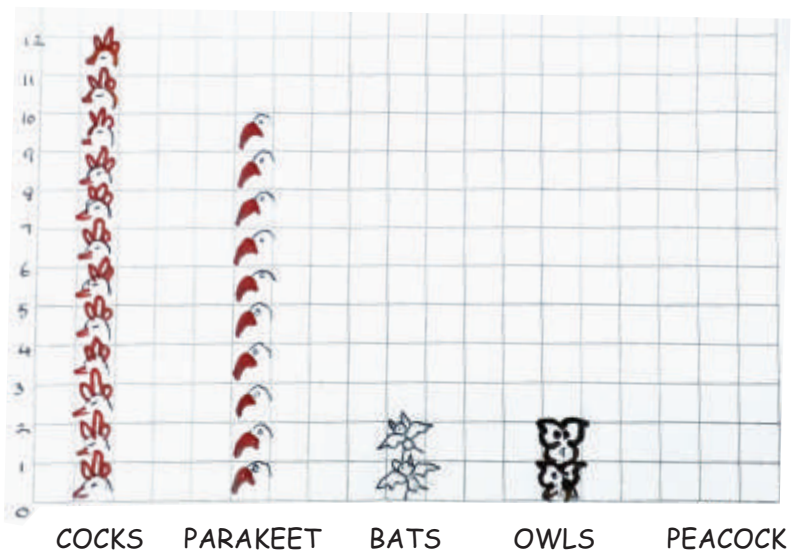
Transition from pictographs to bar graphs: This is the next challenge that children face. Usage of the square grid as a framework facilitates this process. Instead of drawing the pictures in the grid, they will now fill the squares with colour and outline the bars.

ACTIVITY 10

Material: Chess Kit

Use the tally chart to answer the questions.

BIRD	TALLY	TOTAL
COCKS	### ## II	12
PARAKEET	### ##	10
BATS	IIII	4
OWLS	II	2
PEACOCK		0



Data to be represented in these graphs is taken from tables or tally charts. Children will need demonstration of the usage of tally charts and data tables as a means of recording information. As a second step, they need to be shown the transference of this data from the tally chart or the data table to the graph. Also at this stage they number the vertical line (Y-axis). Special attention needs to be given to the placement of 0 and 1. They need to understand the need for placing 0 at the base line or the lower end of the first square and 1 at the upper end of the first square.

ACTIVITY 11

DATA ON WEIGHT	
NAME	WEIGHT(KILOGRAMS)
1. SAMRUDDHI	26
2. SHREYA	24
3. AMUDHA	27
4. ANIKET	30
5.	
6.	
7.	

WEIGHT CHART		
KILOGRAMS	TALLY	TOTAL
20 - 22		4
22 - 24		6
24 - 26		
26 - 28		
28 - 30		
30 - 32		
32 - 34		

Children at this level are aware of concepts like 'height' and 'weight'. These can be measured in the class. They also like to measure their capabilities? – number of times they can bounce a ball, time taken to run 100 metres, etc. Plenty of activities can be conducted to generate data. Children can be actively involved in measuring and recording data. Tally charts can be designed by them with the help of the teacher. Such data carry a personal touch and interest them greatly.

ACTIVITY 12

TIME SPENT			
NAME:	FROM	HOURS	MINS
SLEEP	-TO-	—	—
EAT	-TO-	—	—
PLAY	-TO-	—	—
WATCH TV	-TO-	—	—
READ	-TO-	—	—

At this stage children learn to read time in hours and minutes. They can make a study of how they spend their time on some major activities in the day.

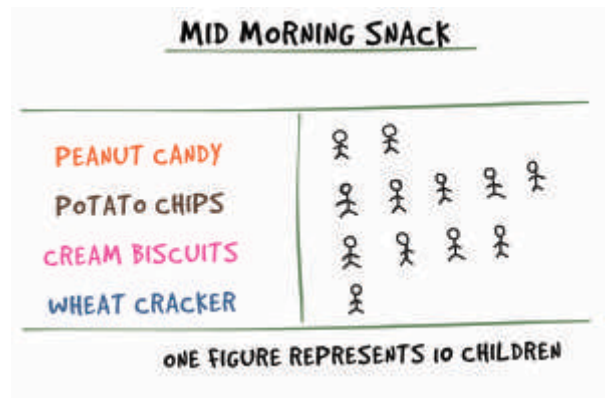
How long do I sleep? Eat? Play? Watch TV? Read books with my parents' help?

There should be a discussion on such questions before plunging into the task of collecting data. What do I need to draw this graph? What type of graph should I make (bar graph or pictograph)? After making their individual time graphs, children can sit together in pairs and compare their graphs.

Raise questions: Are there differences in the number of hours you sleep? Do some of you feel sleepy during class? Are you sleeping for less time than the others? Discuss the number of hours of sleep children need. Discuss the time at which they should go to bed. Discuss the need for having a reading time towards the end of the day. This can be followed up by creating a time planner for a Sunday.

ACTIVITY 13

The teacher can provide students with a graph which increases awareness of healthy foods and junk foods. Initially, questions can be raised about the information that can be obtained from the graph. Subsequently, the discussion can be about foods eaten at snack time in the school. What do you have at snack time? Sandwiches, chaklis, biscuits, chips, milk, cold drinks, fruits, etc. Which of the items that we eat are healthy? If the class were to make a graph of the items that are consumed at snack time, how would the graph look? Will the healthy items be more or less than the junk food?



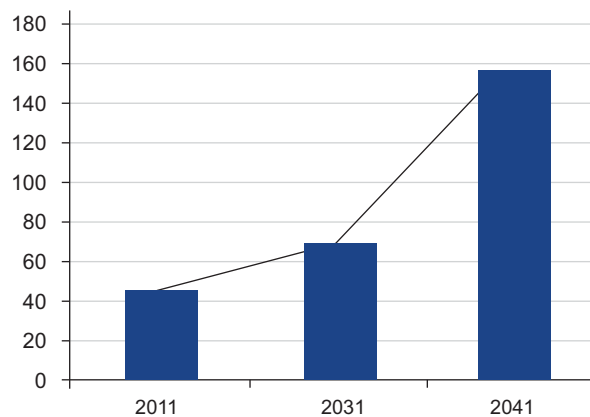
Children will now be able to read and create graphs where one unit stands for many objects. Discuss the usage of one unit square representing 2, 5 or 10. How should the unit squares be shaded if we have to represent numbers like 3 or 5? Would the graph be easily readable if we do this?

If each unit represents 5, is there a way of showing 6, 7, 8 or 9? Can we devise a way of showing such numbers on such a graph? (Children may suggest dividing the unit square into 5 equal parts and shading the required number.) Does the graph look easily readable now?

Children can be taken to the primary section of the library. They can categorise books as picture books, fairy tales, animal stories, comics, etc. They can count and record the total numbers in each category. Now pose the question: How do we show this information in a graph? Will it be possible to show numbers like 20 and 25 on this square paper? Slowly lead them to the idea of one unit representing 5 or 10 units. They can now draw a graph to represent books in the library.

ACTIVITY 13A

WASTE GENERATED IN THOUSAND TONS / YEAR

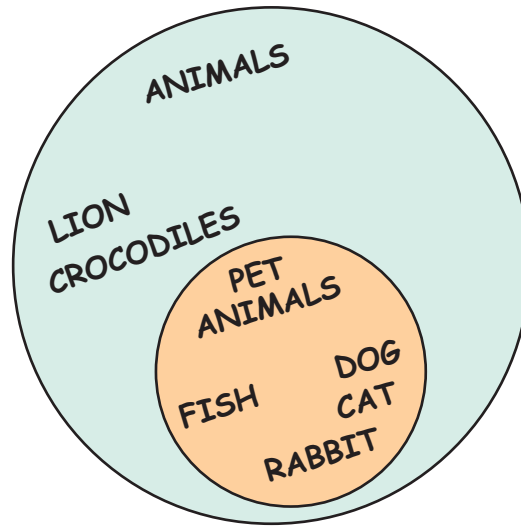


The teacher can expose children to simple bar graphs or tables that are found in newspapers or magazines. Children can share their observations and discuss the data presented in these graphs.

At this point, help the children to evaluate the use of graphs, their readability, etc.

Ask the questions: Which graph is easy to read? Which graph is easy to count?

ACTIVITY 14: Venn diagrams with subsets



Children can use Venn diagrams which depict relationships between sets that contain other sets. Let them come up with more such examples, where one set is contained in another. They can be asked to show multiples of 2 and 4 in such a form.

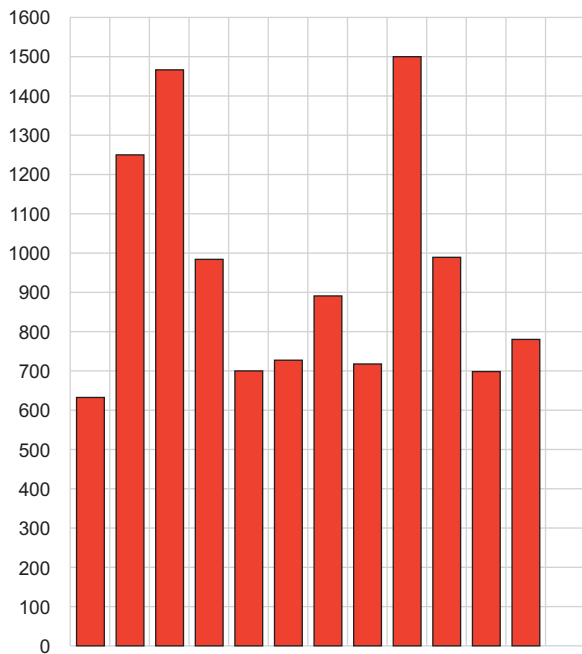
Questions for discussion: What is the relationship between these two sets? What smaller set does the larger set contain? What else does the larger set contain which is not in the smaller set?

Expectations: Children can design a survey with the support of the teacher. They can collect data, process it, display it as a bar graph and interpret it.

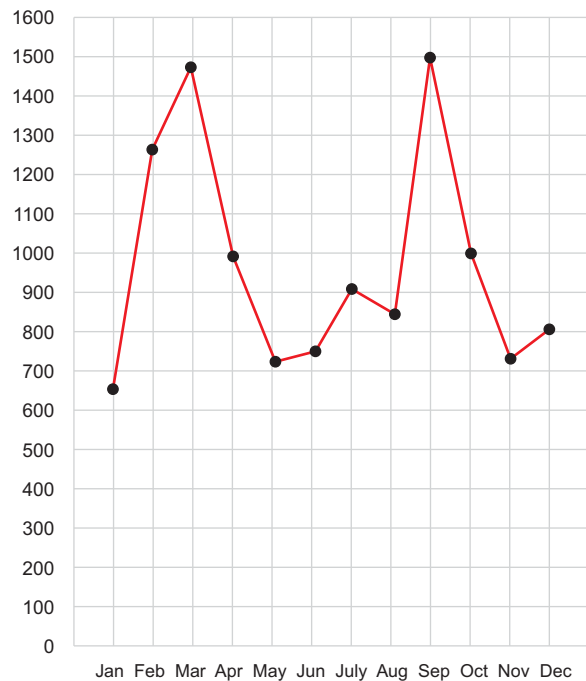
They can create bar graphs on plain paper using an L-shaped tool or a set square, and make the necessary markings to create a uniform scale. They can represent large data. They can draw a line graph for non-discrete data. They can create a simple survey which involves ratings. They can create and read Venn diagrams with three sets.

It is good to integrate graphs with different subject areas at this level. EVS which includes sciences and social studies and other topics in mathematics can become the source of the data.

ACTIVITY 15



ELECTRICITY CONSUMPTION (KWH) 2015



Large data: The teacher can provide students with data tables containing large numbers. It could be the size of the classes in the school. Data can be restricted to numbers up to 10,000.

Discuss the challenge of presenting this data in the form of the graph. Slowly lead them to the usage of scale and the selection of a suitable scale.

Children can now be exposed to the construction of line graphs which lend themselves well to certain kinds of non-discrete data.

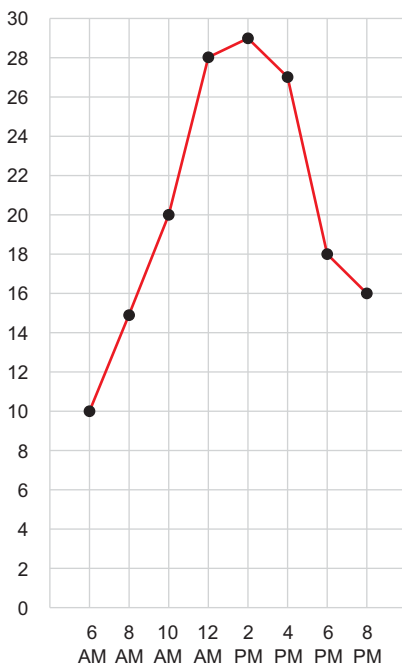
ACTIVITY 16

TEMPERATURE								
<u>Time</u>	6 AM	8 AM	10 AM	12 PM	2 PM	4 PM	6 PM	8 PM
<u>Temperature</u> (degrees)	10°C	15°C	20°C	28°C	29°C	27°C	18°C	16°C

Comparing different representations: Make 4 groups in the class. Give all the groups the same structured data; e.g., temperatures at different times of the day. Tell them to discuss and come up with a way of representing that data. Different groups may use different scales for the vertical axis as well as different forms (tally charts, bar graph, line graph).

ACTIVITY 16A

TEMPERATURE ON 12.6.2016



Raise questions about the information which requires a deeper study of the graph:

- What is the change in temperature from _____ AM to _____ PM?
- Was the temperature between 2 PM and 4 PM rising or falling or did it stay the same?
- During which interval was the change in temperature the largest?
- During which interval was the change in temperature the least? Why?
- How high can the temperature get? In which season does that happen?
- How low does the temperature get?
- What do you think will happen on a rainy day?

Raise questions on the organisational aspects:

- How do we know that these diagrams represent the same data?
- Which is a better way of representing the data?
- How is the graph different from a tally chart?
- How is the bar graph like a pictograph? How are they different?

Trees: As part of science children learn about different trees. They can measure the girth of different trees in their surroundings. They can make a graph based on their girth: trees with girth between 50 and 75 cm, trees with girth between 75 and 100 cm, etc. The teacher must observe how far up the tree trunk the children measure the girth. Should it always be in the same place on each tree? (Typically girth is measured about one metre up.)

Graphs can also be made on the type of leaves a tree has: simple or compound leaves, leaves with smooth edges or jagged edges, etc.

ACTIVITY 17

TELEVISION SURVEY		
How do you rate the _____ ?		
RATING SCALE		
5 EXCELLENT		4 VERY GOOD
3 GOOD		2 FAIR
1 POOR		
NO	PERSON	RATING

Ratings in surveys: Many surveys use rating on a scale from 1 to 5. This is a way of evaluating the success or failure of a product or idea. Explain to the children how each number on the rating scale stands for a different response (poor, fair, good, very good, excellent).

Home work: Family survey – help children to create a questionnaire to find information from their family members. ‘How do they rate the quality of a particular show (say a music channel or a film channel) on television?’ The rating scale can be prepared ranging from 1 to 5.

ACTIVITY 18: Venn diagrams with three intersecting sets

Let children write multiples of 2, 3 and 4 (up to 36) in the labelled circles in appropriate places.

What numbers are part of all the three circles? Why are there no numbers in some parts? They should be able to justify their answer.

In a similar way, they can write factors of 36, 48 and 64.

Some interesting themes for graphs:

- Monitor the growth of a suitable plant (example: sunflower) on a graph for a month.

What is the height at the end of the first week? Did the plant double its height at the end of the second week? What do you think will happen in the third week?

- Litter found in the school: This is a real problem everywhere in India. The teacher can go with the children for a litter picking session along a path. Record the type of litter (toffee wrappers, biscuit wrappers, chips packet wrappers, juice cartons) found and the amount found in a tally chart. Litter can also be analysed as bio-degradable and non-bio-degradable.

- Sports day data: Method of scoring and ways of scoring data, timings of events

- Put up some graphs from magazines and raise questions.

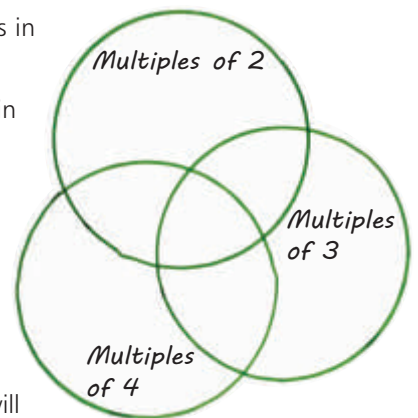
How will you describe this graph? Is it at the same level every day? Is it increasing? Is it decreasing? Is it going up and down?

- Graph detectives: Draw a graph with numbers on the Y-axis but without any labels on the X-axis.

What could this graph be about?

What numbers are seen? What is the maximum number? What is the minimum number? How are they changing?

Could this graph be about _____? or _____?





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