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ABSTRACT

In this set of six booklets on simplifying data, intermediate grade students learn how to tell what data show, find the median/mean/mode from sets of data, find different kinds of ranges, and use key numbers to compare two sets of data. The major emphasis in all Unified Sciences and Mathematics for Elementary Schools (USMES) units is on open-ended, long-range investigations of real problems. In most instances students learn through observing results of their own and their classmates' experiments. However, students may recognize the need for certain facts and/or skills during their investigations. Although some children prefer to work things out for themselves, others may ask for help. USMES "How To Sets" are designed to provide such assistance. Each booklet in a set contains several examples of children using a skill being taught, each example emphasizing a different aspect of the skill or a potential pitfall. The first page tells why or when students may need the skill covered in the booklet and includes a table of contents. There is no sequence to the sets (or booklets within sets) and they should not be used out of the context of childrens' open investigation of a practical problem. (Author/JN)

HOW TO SET

TELL WHAT YOUR DATA SHOW

FIND THE MEDIAN

FIND THE MEAN

FIND THE MODE

FIND DIFFERENT KINDS OF RANGES

USE KEY NUMBERS TO COMPARE TWO SETS OF DATA

SIMPLIFYING DATA

WHAT IS USMES?

USMES challenges students to solve real problems within their school and community. Students tackle problems like a busy or unsafe intersection near their school, classroom furniture that doesn't fit them, or playgrounds that are crowded or uninteresting. These problems have immediate and practical impact on students. They have no established, correct solutions--students take or recommend action based upon whatever data they collect and analyze. Furthermore, the students themselves, not the teacher, direct the problem-solving process.

Solving real problems is interdisciplinary: skills, processes, and concepts from science, mathematics, social science, and language arts all play a part. For example, students conduct opinion surveys, build measuring devices, write letters, and make and use graphs. They also make decisions, work productively in small groups, and develop and clarify values.

The USMES curriculum is organized into twenty-six problems, or units, that have been developed in the classroom by teachers and students in a wide variety of schools. Most units can be used in grades K-8 although the level at which students approach a problem and develop a solution will vary according to age, ability, and interest.

RESOURCES FOR AN USMES PROGRAM

In addition to the USMES "How To" Series, there are--

The USMES Guide: This book describes the USMES project, real problem solving, classroom strategies, the Design Lab, the units, and the support materials as well as ways that USMES helps students learn basic skills. A section in the guide correlates the twenty-six USMES units with topics in Science, Mathematics, Social Science, Language Arts, Career Education, and Consumer Education.

Teacher Resource Books (one per unit): Each of these guides to using USMES units describes a broad problem, explains how students might narrow that problem to meet their particular needs, recommends classroom strategies, and presents logs from teachers whose classes have worked on the unit.

Design Lab Manual: This guide helps teachers and administrators set up, run, and use a Design Lab--a place with tools and materials where students can build things they need for their work on USMES units. A Design Lab may be a corner of a classroom, a portable cart, or a separate room.

Background Papers: These papers provide teachers with information and hints that do not appear in the student materials.

The "How To" Series is a resource developed by the USMES project. Earle L. Lomon, Project Director, Betty M. Beck, Associate Director for Development, Thomas L. Brown, Associate Director for Utilization Studies, Quinton E. Baker, Associate Director for Administration.

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Complete USMES Library ISBN: 0-89292-033-5
Intermediate "How To" Series ISBN: 0-89292-030-0

THE USMES INTERMEDIATE *HOW TO* SERIES

USMES and Skills

USMES students often see a need to learn new skills to help them get a problem-solving job done. Students seeking to improve a street crossing may want to learn how to use a stopwatch or how to make a trundle wheel. Students comparing different brands of paper towels may want to learn how to design an experiment and how to make a bar graph. The list can go on and on, but the pattern is clear; solving a real problem requires skills.

Purpose of 'How To' Series

Materials that help students learn skills like designing an opinion survey and choosing the appropriate measuring tool are not readily available for intermediate grade students. The USMES Intermediate "How To" Series fills this gap. Its magazine-style format helps students acquire the skills and knowledge they need to do things like redesign their classroom, find the best buy in potato chips, or run a school store.

How to Use the 'How To' Series

Wait for a need. When a student asks for help, refer him or her to the appropriate booklet. Having a student read a booklet before there is a need to do so will not only result in less effective learning but will defeat the USMES purpose of allowing students to decide what needs to be done.

When necessary, use the "How To" Series as a teaching aid. Most of the time students will be able to go through a booklet by themselves and learn the skills they need to learn. However, some material in some sets is difficult and somewhat abstract. When the booklet by itself is not doing the job, feel free to step in and help the student go through it.

Knowing how the contents of the booklets are organized may help in using the series effectively.

- The first page tells why or when a student may need the skill covered in the booklet, and includes a table of contents.
- Each booklet contains several examples or stories about students using the skill or process being taught. Each example emphasizes a different aspect of the skill or a potential pitfall.
- When information in other booklets may help the student, the titles of the booklets are included in the text.
- The last pages of each booklet contain a summary of the points covered in the booklet.

OTHER USMES *HOW TO* SERIES

Beginning "How To" Series: This cartoon-style series covers in less detail much of the same material as the Intermediate Series. Its cartoon-style format helps younger children and those with reading difficulties acquire the skills needed to work on a real problem.

Design Lab "How To" Series: These illustrated cards help children learn how to use tools safely and effectively.

"How To" Cards: This series is printed on colored card stock rather than paper. They contain fewer words than the Intermediate "How To" Series and utilize the American system of units (ft./lb./sec.) rather than the metric system. The Collecting Data set, however, is not available in the "How To" Cards.

INTERMEDIATE *HOW TO* SERIES

COLLECTING DATA

Collect Good Data
Round Off Data
Record Data
Do an Experiment
Make an Opinion Survey
Choose a Sample

GRAPHING

Choose Which Graph to Make
Make a Bar Graph
Make a Histogram
Make a Line Graph
Make a Conversion Graph
Use Graphs to Compare Two Sets of Data

MEASURING

Use a Stopwatch
Choose the Right Tool to Measure Distance
Use a Trundle Wheel
Make a Scale Drawing
Find the Speed of Things

SIMPLIFYING DATA

Tell What Your Data Show
Find the Median
Find the Mean
Find the Mode
Find Different Kinds of Ranges
Use Key Numbers to Compare Two Sets of Data

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Production:
Paula Lakeberg, John Saalfield

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"HOW TO"

TELL WHAT YOUR DATA SHOW

Maybe you have collected one set of data. Now you have a bunch of numbers. Numbers can be confusing. Especially when you have a lot of them. You may be wondering how your data can help you solve your problem.

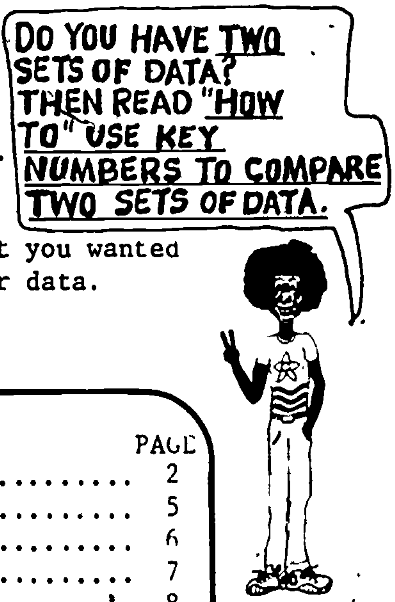
You can use your data to find KEY NUMBERS. KEY NUMBERS will make the data easy to understand. They will help you solve your problem.

Different keys work for different doors. And different KEY NUMBERS work for different kinds of data. You need to choose the right KEY NUMBER or NUMBERS for YOUR data. You need to choose the right KEY NUMBER for what you need to know.

The stories inside tell about four different KEY NUMBERS, the MODE, the MEDIAN, the MEAN, and the RANGE. They tell how students use a KEY NUMBER to solve their problem.

READ THE STORIES.

They will help you decide which KEY NUMBER to use with your data.



REMEMBER: You should know why you collected your data....and what you wanted to find out. Then you can decide what to do with your data. You can decide which KEY NUMBER to use.

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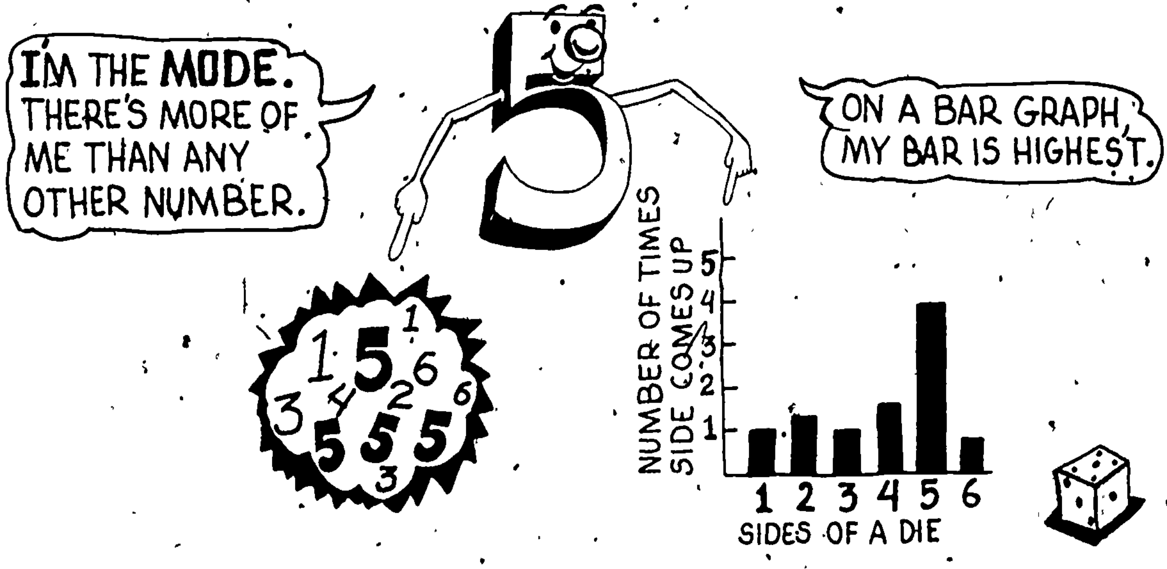
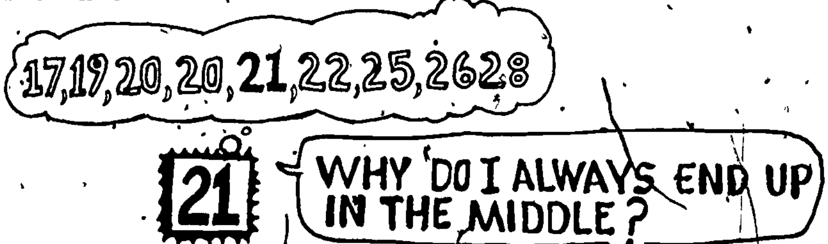
DEFINITIONS OF KEY NUMBERS

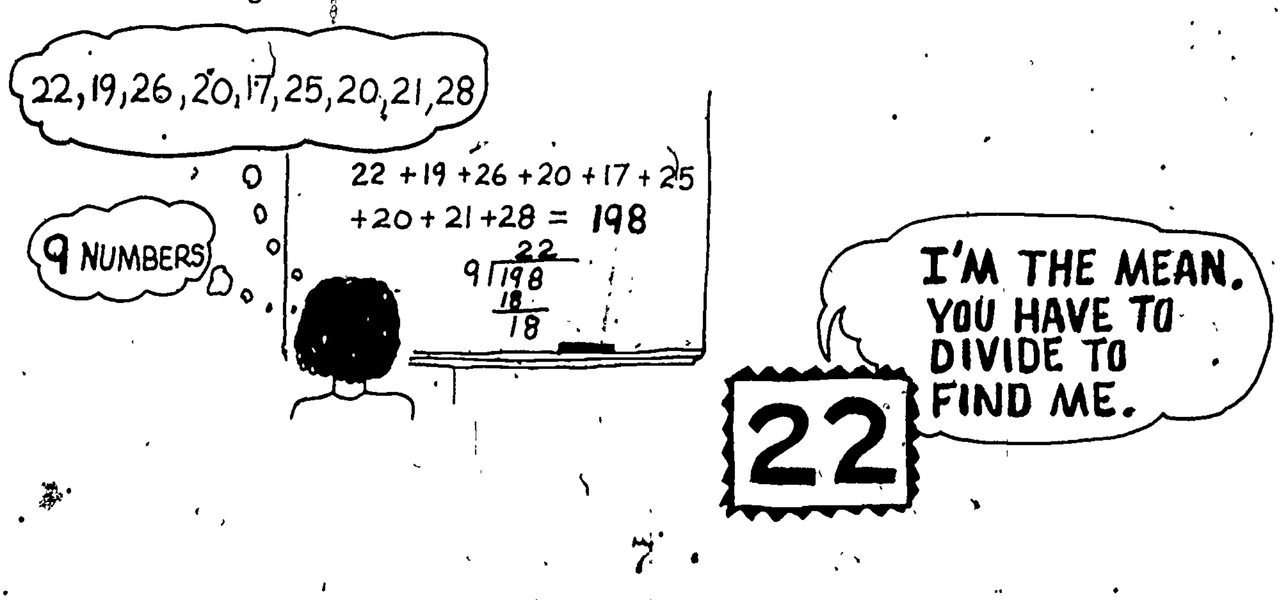
MODE: The number or thing that is listed the most times in a set of data. If you make a bar graph, the mode is shown by the highest bar.



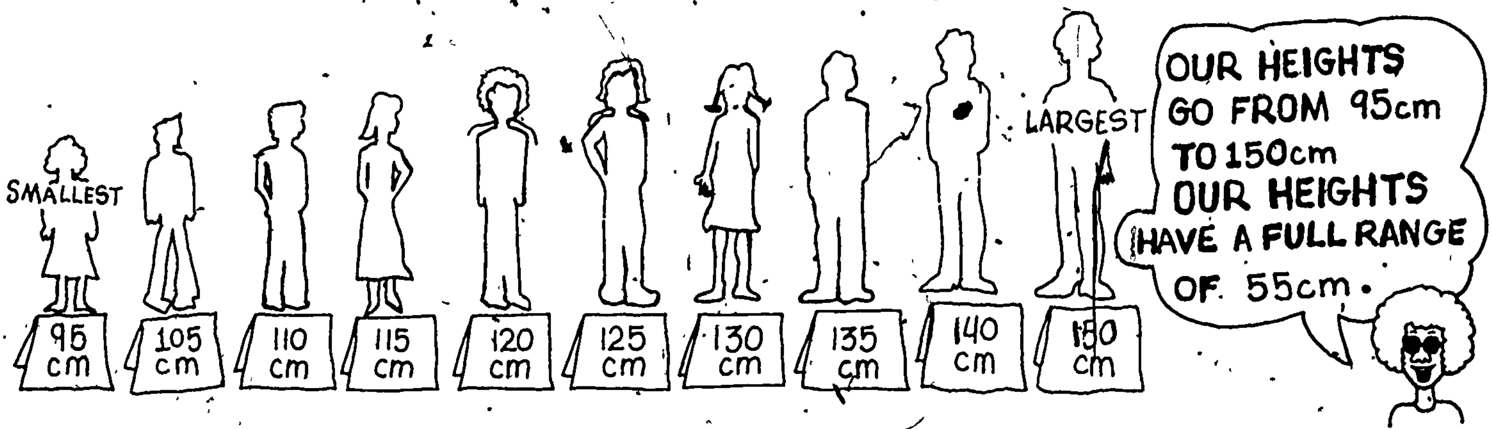
MEDIAN: The middle number in a set of data that has been put in order from smallest to largest. There are just as many numbers smaller than the median as there are numbers larger than the median.

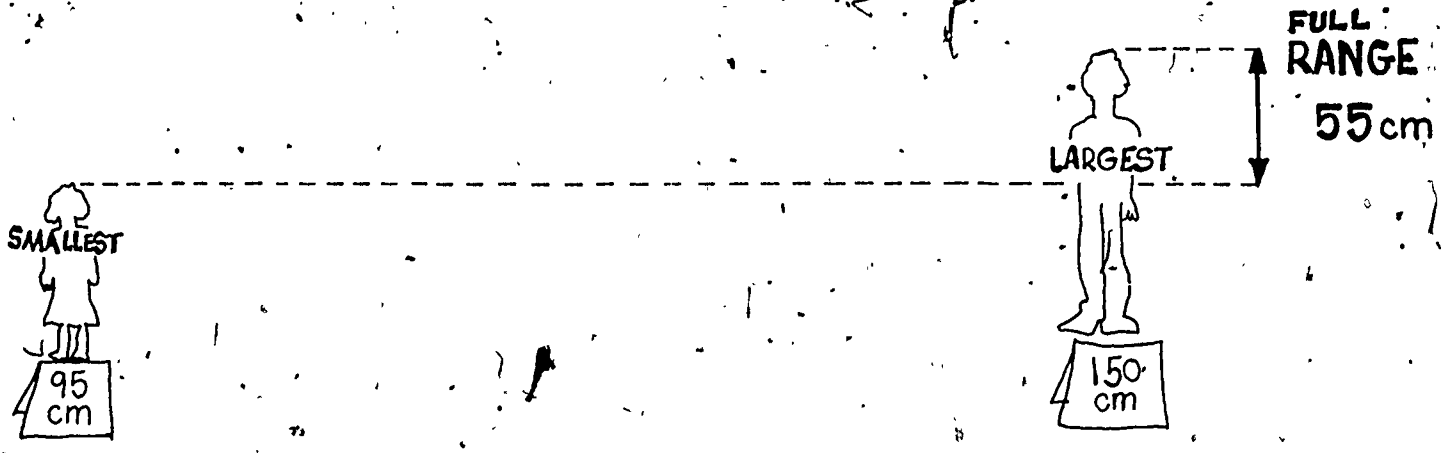


MEAN: The number that shows the amount per week, per person, per meter. You can find the mean by dividing the sum of the numbers in your set of data by the number of numbers in your set of data. The mean is often called the average.

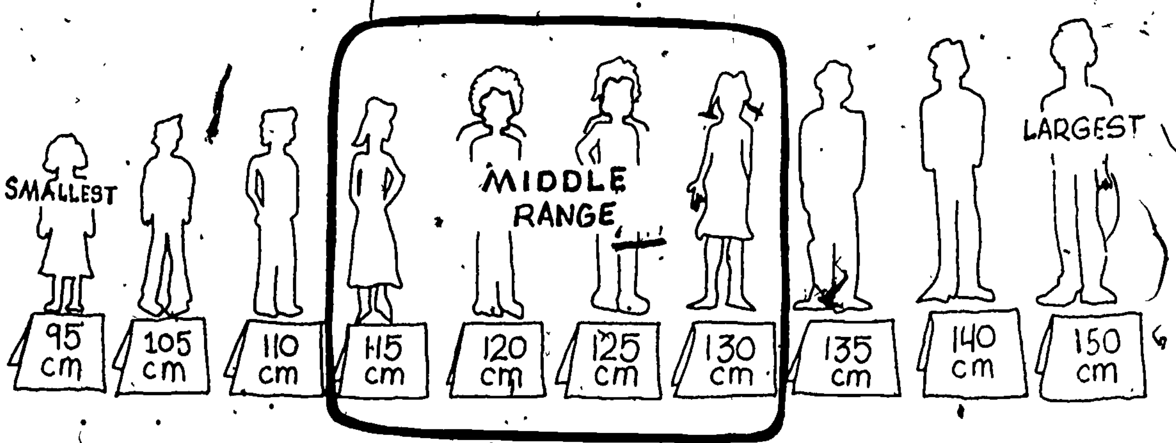


FULL RANGE: The full range is the difference between the largest and smallest numbers in a set of data. It shows how much the data changes or varies.

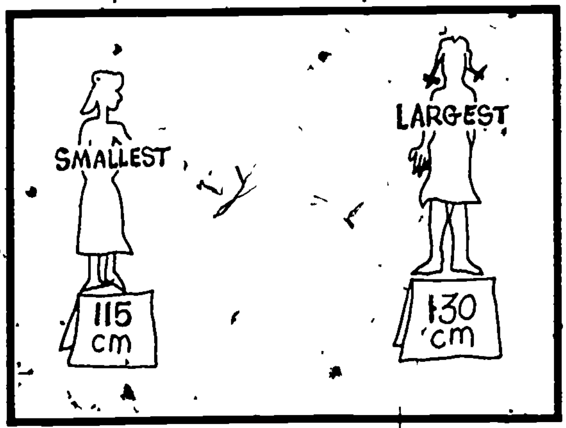


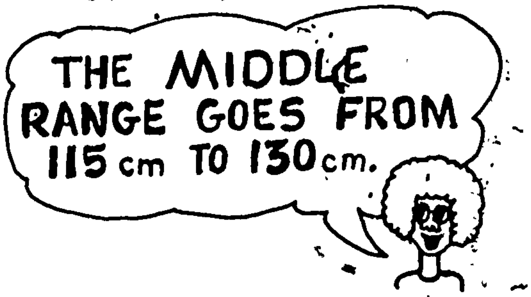


MIDDLE RANGE: This range goes from the smallest to the largest number in the middle half of the data.

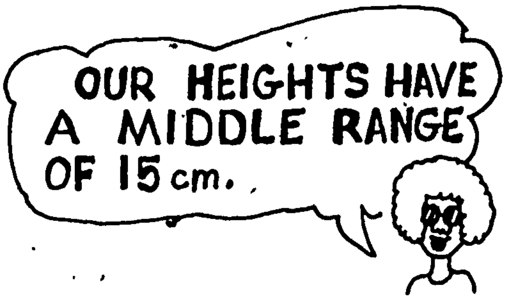


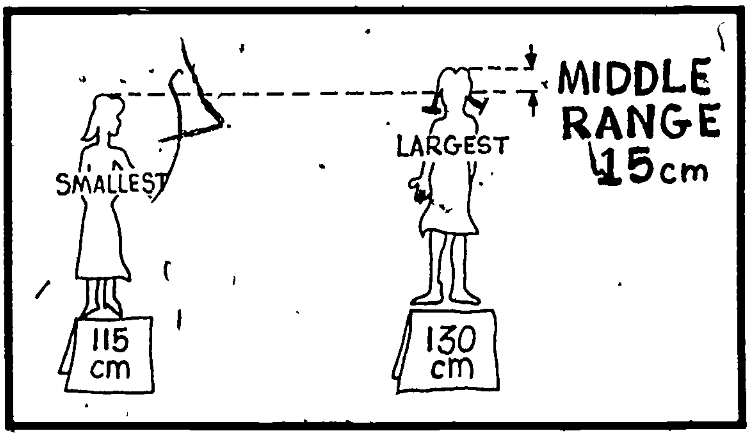
Sometimes you may want to use the smallest and largest numbers in the middle range.





Sometimes you may want to find the difference between the largest and smallest numbers in the middle range.

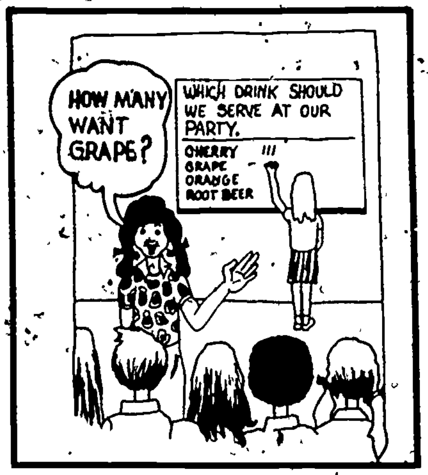




THE MODE: FINDING OUT WHAT THE MOST PEOPLE WANT

You may want to decide:

- *What is the most important problem to work on?*
- *Which soft drink should we serve at our party?*
- *What type of games should we make to play during our free time?*



Or you may want to decide something else.

You may have made an opinion survey to help you decide. Now you need to use the survey data. The MODE is good to use for this. The MODE is the number or thing that is listed the most times in a set of data.

This example shows how two students use the MODE to make a decision.

Terry and Hal want to know which drink to serve at their class party. They survey their class to find out. The data from their survey look like this.

Hal and Terry look at the survey data. They want to pick the most popular drink. They want to pick the drink that got the most votes.

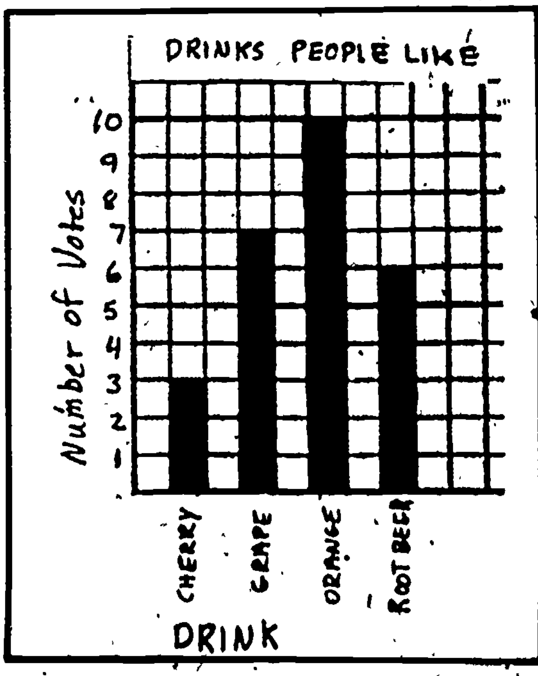
ORANGE got the most votes. It was listed the most times in the survey. It is the MODE.

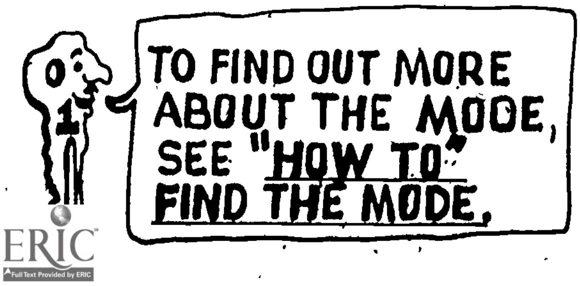
DRINKS PEOPLE LIKE			OCT. 26
DRINK		NUMBER OF VOTES	
DRINK #1:	CHERRY	|||	3
DRINK #2:	GRAPE	~~||||~~ ||	7
DRINK #3:	ORANGE	~~||||~~ ~~||||~~	10
DRINK #4:	ROOT BEER	~~||||~~ |	6

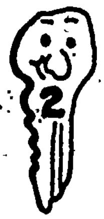
Hal and Terry want to serve orange drink at the party. They make a bar graph and show it to the class.

It looks like this.

Everyone agrees that orange drink should be served at the party.







THE MEDIAN: FINDING THE BEST MEASUREMENT TO USE

You may want to find out the best height for a poster or table, or the best size to make something. It should be a height or size that is close to what most people will like. Or you may have measured something several times and now you want to pick the best measurement.

The MEDIAN is a good number to use for this. The MEDIAN is the middle number in a set of data.

Sue, Bill, and Randy are trying to decide on the best height for a work table in their classroom. They have made up a test to find out the heights that students in the classroom like.

After the test, they make a list of the heights that the students like. Their list looks like this.

71 cm, 67 cm, 74 cm, 70 cm, 67 cm, 65 cm, 73 cm, 68 cm, 71 cm, 69 cm, 66 cm,
67 cm, 72 cm, 70 cm, 73 cm, 65 cm, 69 cm, 71 cm, 72 cm, 66 cm, 73 cm.

They want to use the numbers that they have collected to find out the best height for most people in the classroom. They are looking for a typical number. They decide to find the median of their set of data.

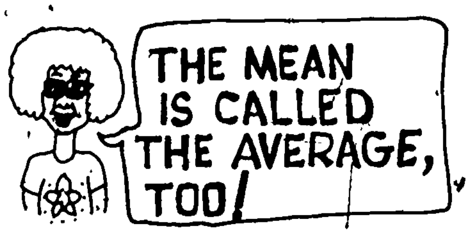
They read "How To" Find the Median. First, they put the heights in order from smallest to largest:

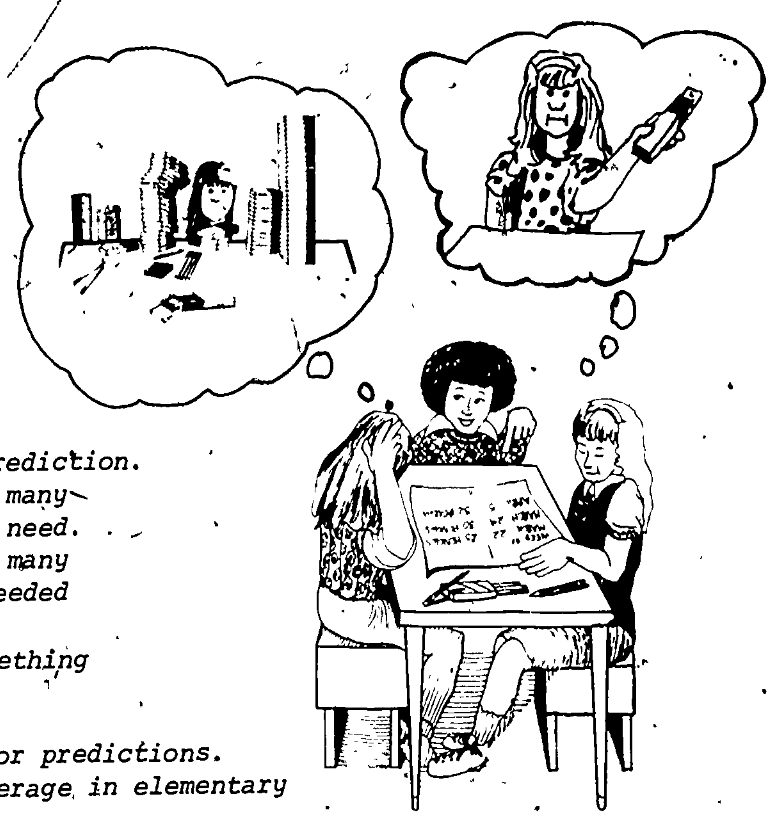
65, 65, 66, 66, 67, 67, 67, 68, 69, 69, 70, 70, 71, 71, 71, 72, 72, 73, 73, 73, 74.

Then they find the middle number by crossing off as many numbers from one end as from the other end.

~~65~~, ~~65~~, ~~66~~, ~~66~~, ~~67~~, ~~67~~, ~~67~~, ~~68~~, ~~69~~, ~~69~~, 70, ~~70~~, ~~71~~, ~~71~~, ~~71~~, ~~72~~, ~~72~~, ~~73~~, ~~73~~, ~~73~~, ~~74~~. MEDIAN

They decide to make the table 70 centimeters high. Seventy centimeters is the number that is closest to the height that most people like.





THE MEAN: MAKING A PREDICTION

Sometimes you may need to make a prediction.

- *Maybe you want to predict how many pencils the school store will need.*
- *Maybe you want to predict how many cans of soft drinks will be needed for your class picnic.*
- *Maybe you want to predict something else.*

The MEAN is a good number to use for predictions. (The MEAN is usually called the average in elementary school.)

In the next example, three students solve their problem by using the MEAN to make a prediction.

Anna, Louise, and Kathy are running the school store. They want to find out how many pencils to order for the rest of the school year. But they don't want to guess. Louise has recorded how many pencils students have bought for the last twelve weeks. The data look like this.

PENCILS BOUGHT BY STUDENTS

WEEK OF	NUMBER OF PENCILS	WEEK OF	NUMBER OF PENCILS
Jan. 18	54	Mar. 1	37
Jan. 25	30	Mar. 8	29
Feb. 1	23	Mar. 15	32
Feb. 8	19	Mar. 22	25
Feb. 15	34	Mar. 29	33
Feb. 22	0	Apr. 5	32

They decide to find the mean number of pencils bought by the students per week. They read "How To" Find the Mean.

First, they add up the number of pencils:

54 + 30 + 23 + 19 + 34 + 0 + 37 + 29 + 32 + 25 + 33 + 32 = 348

Second, they count the number of weeks: 12

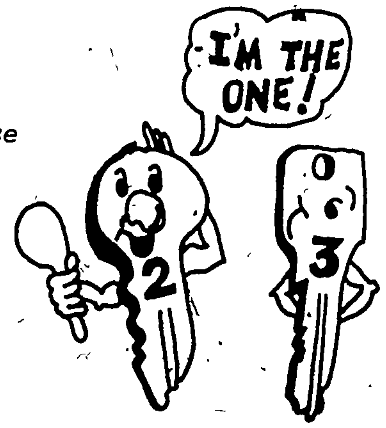
<u>Third</u>, they divide the sum of the number of pencils by the number of weeks:

$$\frac{\text{SUM OF PENCILS}}{\text{NUMBER OF WEEKS}} = \frac{348}{12} = 29 \text{ pencils per week}$$

Now they know that students usually buy about 29 pencils a week. They also know that there are 10 weeks of school left. They multiply 29 x 10 to find out how many pencils to order. They need to order about 290 pencils.

<u>MEDIAN OR MEAN?</u>

Sometimes it is hard to decide whether to use the median or the mean. These stories tell about some things that can help you decide.



A MEDIAN STORY

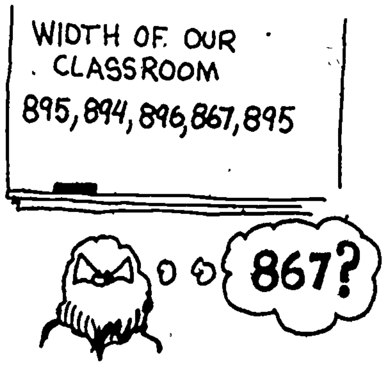
Tony and Sam have measured the width of their classroom five times. Their data look like this.

WIDTH OF OUR CLASSROOM (cm)
895, 894, 896, 867, 895

They want to use the data to find the best measurement of the width.

WHICH SHOULD THEY USE, THE MEDIAN OR THE MEAN?

Tony looks at the data. He notices that one of the measurements is much smaller than the others. But he can't figure out why. Sam thinks that is is just a mistake. He can't think of any other reason that it is so different from the other numbers either.



WHEN THE DATA ARE LIKE THIS, YOU SHOULD USE THE MEDIAN.

WHY IS THE MEDIAN BETTER TO USE?

The median is the middle number in the set of data. When you find the median, it does not matter how big or how small the biggest and smallest numbers in the set of data are. The median will not change if a few of the numbers happen to be mistakes.

THE MEDIAN WINS AGAIN!

Charlene and Linda want to find out how long it will take their class to make 500 belts. They decide to count how many belts the class makes each day. They count the number of belts made by the class on 10 different days. Their data look like this.

They want to use the data to find out how many belts the class makes on a typical day.

BELTS MADE	
DATE	NUMBER OF BELTS
Nov. 2	17
Nov. 3	19
Nov. 4	24
Nov. 6	1
Nov. 9	22
Nov. 10	21
Nov. 12	23
Nov. 16	16
Nov. 17	21
Nov. 20	23

WHICH SHOULD THEY USE, THE MEDIAN OR THE MEAN?

They look at the data. Linda says, "There's only one thing strange about <u>these</u> numbers. That's the 1 for November 6."

"Yes," says Charlene, "The blade for the leather cutter snapped that day right after we cut the first belt, and there were no spare blades. But we keep them on hand now. So that won't happen again."

WHEN THE DATA ARE LIKE THIS, YOU SHOULD USE THE MEDIAN.

WHY IS THE MEDIAN BETTER TO USE?

In this case, the 1 is an unusual number that won't happen again. You shouldn't let the 1 change the answer. The median will not change if the 1 is included in the data. But the mean will. That's why it's better to use the median.

MEAN NUMBER OF BELTS PER DAY = 18.7

MEDIAN NUMBER OF BELTS PER DAY= 21

A MEAN STORY

Ginny and Marie are recording the amount of food wasted in the lunchroom. They count the portions of food that the children throw out each day. They have made a data chart. It looks like this.

FOOD WASTED			
WEEK OF	NUMBER OF PORTIONS	WEEK OF	NUMBER OF PORTIONS
MAR. 3	102	APRIL 6	89
MAR. 10	47	APRIL 13	58
MAR. 17	23	APRIL 20	53
MAR. 31	55	APRIL 27	49

Ginny and Marie want to find one number that tells the typical amount of food wasted. They want to predict how much food will be wasted during the rest of the year.

WHICH SHOULD THEY USE, THE MEDIAN OR THE MEAN?

First they look at the data. They find both the median and the mean. The median is 54 while the mean is 59.5. Then they notice that some of the numbers are very different from the others. They look unusually large or small.

Ginny says that the amount of food wasted during a week might be very small if there are many students absent that week. Or it might be small if the weekly menu is popular with the students. And the amount of food wasted during a week might be large if several unpopular meals are served.

These things make some of the numbers <u>unusually large or small</u>, but they are not <u>mistakes</u>. These things will probably happen again. They must be considered in making a prediction.

WHEN THE DATA ARE LIKE THIS, YOU SHOULD USE THE MEAN.

Ginny and Marie use the mean of 59.5 portions of food wasted per week to predict how much food will be wasted during the last 8 weeks of school. They report that about 476 portions of food will be wasted before school ends.

WHY IS THE MEAN BETTER TO USE?

When you find the mean, you add up <u>all</u> the numbers as a first step. Numbers that are very different but show an unusual happening will be taken into account. Leaving out some will give a wrong answer when you want to predict a total amount of something for a long period of time.

MEDIAN OR MEAN: HOW TO DECIDE WITH YOUR SET OF DATA

1. Look at your data. Are there some numbers that are very different from the others?

2. Is it hard to tell whether some numbers are very different from the others? If so, make a graph or chart of your data.

3. If some numbers are very different, you will have to decide why they are different.

   - Are the numbers likely to be mistakes? USE THE MEDIAN.
   - Are the numbers due to something unusual that will probably not happen again? USE THE MEDIAN.
   - Are the numbers due to something unusual that may happen again and must be considered in the future? USE THE MEAN.

4. If you are not sure, then you can find either the median or the mean. Or you can find both of them. To find out more about medians and means, read "How To" Find the Median and "How To" Find the Mean.

THE MIDDLE RANGE: ANOTHER WAY TO MAKE A PREDICTION

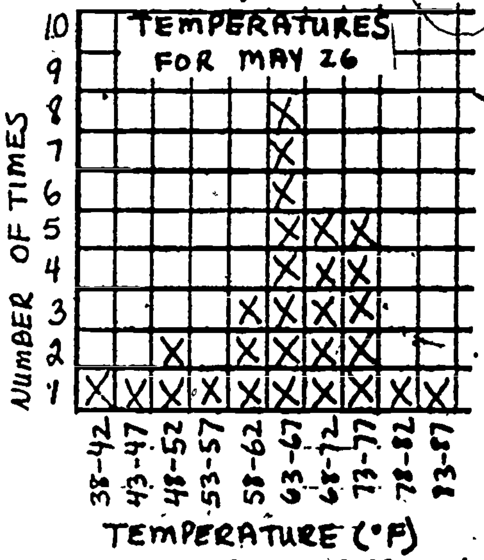
Maybe you are planning a picnic or a bicycle trip. If you can predict what the temperature will be during the picnic or bike trip, then you can plan better. The MIDDLE RANGE is good for this. It uses the highest and lowest numbers in the middle half of the data.

In the next example, some children predict the most likely temperature range for their class picnic.

Denise and Jason want to predict what the temperature will be for their class picnic. It will be held on May 26.

They go to the library and find a book that lists temperatures. It tells the highest temperature on May 26 for 1976, for 1975, and all the way back to 1900. Denise and Jason want to use the highest temperatures because the picnic will be held during the hottest part of the day.

Denise and Jason decide that they will list the highest temperatures on May 26 from 1976 back to 1949. They will have 28 numbers. They think that is enough numbers to make a prediction.



Jason says, "Let's make a histogram of our data." They review by reading "How To Make a Histogram". They decide to group the temperatures by fives. Then they make a histogram. It looks like this.

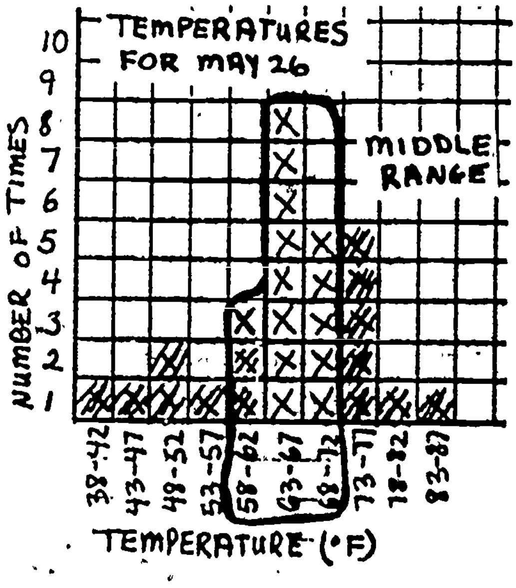
Denise looks at the highest column on the histogram. It shows the temperatures from 63 to 67 degrees. She counts the Xs. There are 8 Xs in it. "It will probably be from 63 to 67 degrees for the picnic," she says. "That column has the most Xs."

Jason looks at the graph. "There are 28 Xs all together. 8 out of 28 isn't very much. There are 8 chances out of 28 that the temperature will be between 63° and 67°. But there are 20 chances out of 28 that it won't be because 28 - 8 = 20."

"How can we predict, then?" asks Denise.

Jason has an idea. "Look," he says, "there are more Xs in the middle of the graph than on the sides. Let's find the middle half of the data. There are 28 Xs all together so half of that would be 14. There will be 14 Xs in the middle half of the data and 14 Xs outside. If we use the middle half, we will have 14 chances of being right and 14 chances of being wrong. That's a 50% chance of being right."

Denise isn't sure how to do that, but Jason shows her how. "All we have to do is cross off 7 Xs from each end. There are 14 Xs left in the middle. Jason draws a loop around them. Now the graph looks like this.

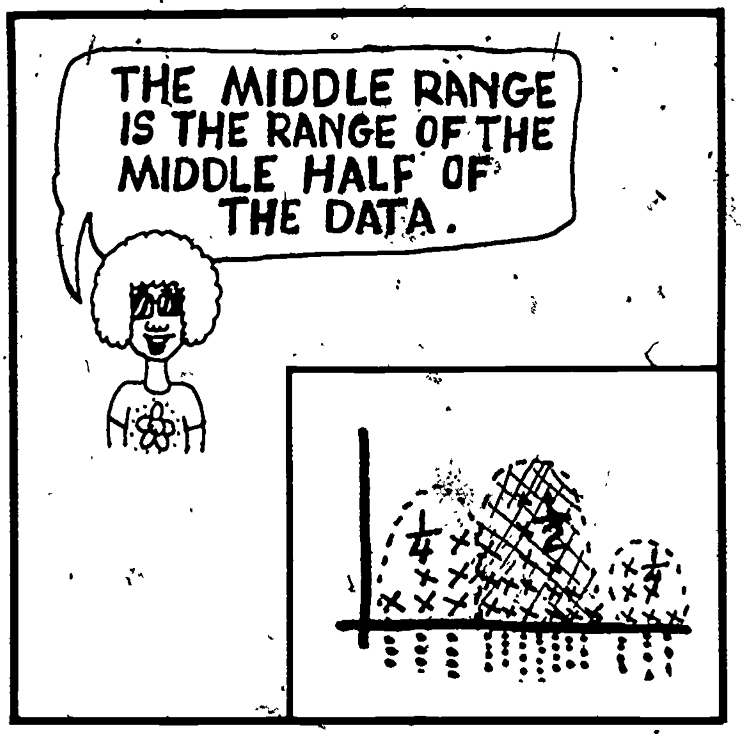


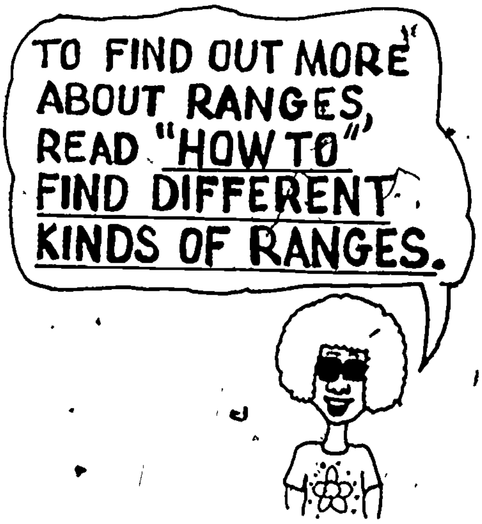
Jason points to the numbers inside the loop. "The range of the middle half of the temperatures goes from 58° to 72°F. If we predict the temperature will be 58° - 72°F., we'll have a 50% chance of being right."

Denise looks at the graph again. She asks Jason about the other Xs between 58° and 72° that aren't inside the loop.

Jason is happy. "There are 2 extra Xs. That means that our chances of predicting the right temperature are even better. We have more than a 50% chance of being right."

"That's a good prediction," Denise says. "We can tell the rest of the class that the temperature will probably be between 58° and 72°F. for the picnic. That's a range of 14° but it will help some."





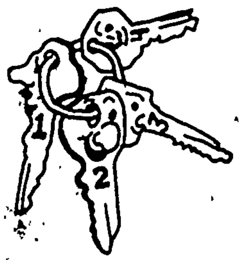
WHAT SHOULD YOU DO WITH YOUR DATA?

Before you do anything with your data, check your numbers.

- Do your numbers make sense?
- Did you measure what you wanted to measure?

If your data look wrong, you may have to collect new data.

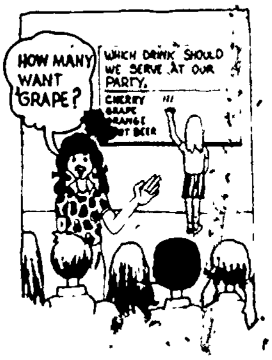
- If you have survey data, read "How To" Make An Opinion Survey.
- If your data are measurements, read "How To" Collect Good Data.



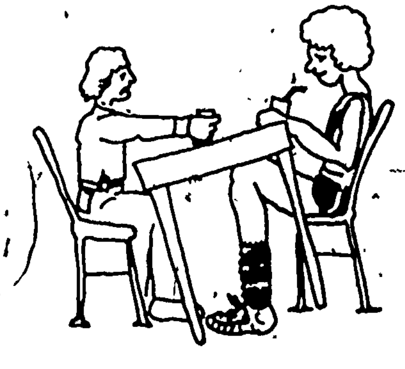
Suppose you have checked your numbers. They look O.K. What should you do with your data? Which KEY NUMBER should you find? You can follow this checklist. It will help you decide.

1. Know why you collected your data. Talk with your group about what you want to find out.

2. Do you want to find out what got the most votes or was listed the most times on a survey? It might be the most votes for a soft drink or for a game to play. You are looking for the thing that occurs the most often. You want to find the MODE.



3. Are you looking for a typical number like the best height for a table or the best size for an apron? Do you want to find the best measurement of a room or a table after measuring it several times? If you are looking for something like one of these things, find the MEDIAN of your data.



4. You may want to use your data to make a prediction over a long period of time. You may want to predict how many pencils are needed for the school store. If so, find the MEAN of your data.

5. If you are not sure about whether to use the MEDIAN or the MEAN, then use the one you like best. They will both describe your data well.

6. Maybe you want to predict something but just one number is not a good prediction. It might be a prediction of the most likely temperature range at noon on a certain day. If so, then use the MIDDLE RANGE of your data.

7. Are you still confused about what to do with your data? Maybe doing one of these things will help:

   A. Look at the stories in this booklet again.

   B. Look at other booklets in this set:

      "How To" Find the Mode
      "How To" Find the Median
      "How To" Find the Mean
      "How To" Find Different Kinds of Ranges

   C. Make a graph of your data. If you are not sure about what kind of graph to make for your data, you can read "How To" Choose Which Graph To Make for One Set of Data to find out.

   D. Then look at your data again to decide what you want to do.

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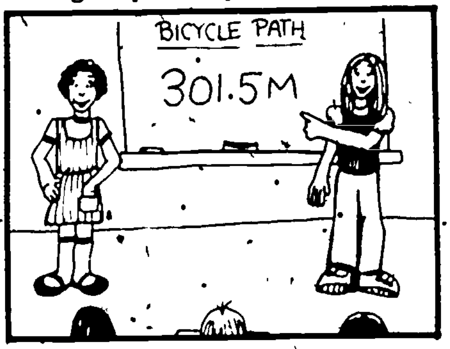
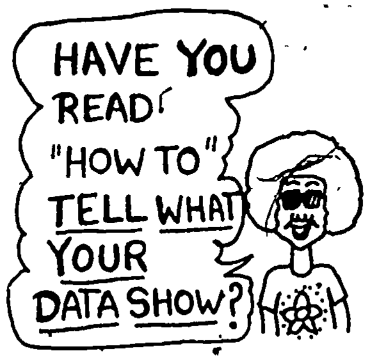
"HOW TO"

FIND THE MEDIAN

Do you want to make sure you have a good measurement of something? You may be measuring the height of a table or the length of a bicycle path and want to be sure your measurement isn't way off. Do you want to compare the numbers or measurements for two groups of things? You may want to compare the heights of two groups of plants or the strengths of two kinds of string.





THE MEDIAN IS GOOD TO USE FOR THESE THINGS AND MANY OTHERS.

WHAT IS THE MEDIAN?

The median is the middle number or measurement in a set of data. Half of the numbers in the set of data are above the median and half are below the median.

HOW DO YOU FIND THE MEDIAN?

It is easy to find the median. There are three different ways you can use: the Crossing-Off Way, the Counting Way, and the Histogram Way. This booklet will help you learn how and when to use each way. And you will find out how to decide which way is best for your data.

WHEN CAN YOU USE THE MEDIAN?

You should use the median when some of your data are unusually large or small and are likely to be mistakes or are due to something that won't happen again. You can also use the median when none of your data are unusual. The stories in this booklet will show you ways to use the median.

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THE CROSSING-OFF WAY: MEASURING A BICYCLE PATH.......... 6
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THE HISTOGRAM WAY: FINDING THE BEST HEIGHT FOR A POSTER.......... 11
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FINDING OUT HOW WELL SOME PLANTS GREW.......... 16
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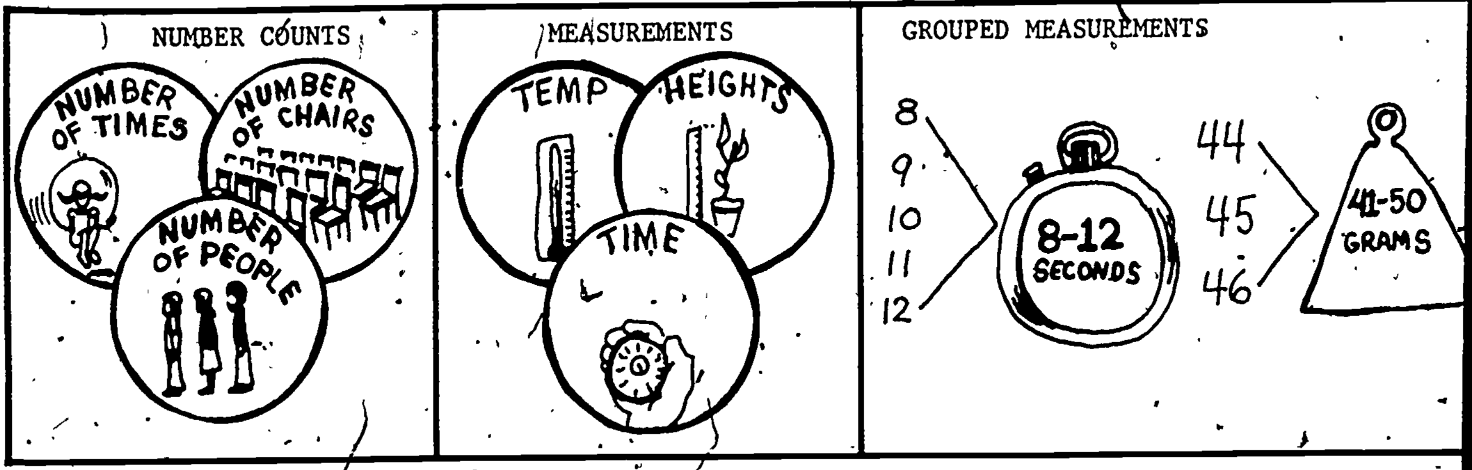
WAYS TO FIND THE MEDIAN

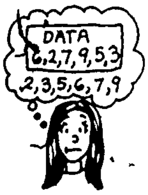
LOOK TO SEE WHAT YOUR DATA ARE. YOUR DATA MAY BE



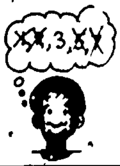
There are three ways to find the median. Use the first two ways if your data are NUMBER COUNTS or MEASUREMENTS. Use the third way if your data are GROUPED MEASUREMENTS.

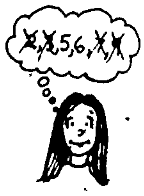
*1. The Crossing-Off Way

Put your data in order from smallest to largest.

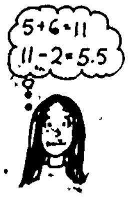


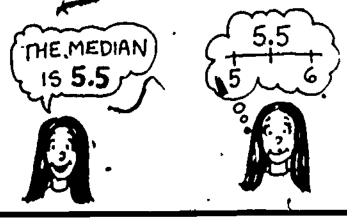
Cross off numbers from each end of your list of data until there are only <u>one</u> or <u>two</u> numbers left. You should cross off as many numbers from one end as from the other end.





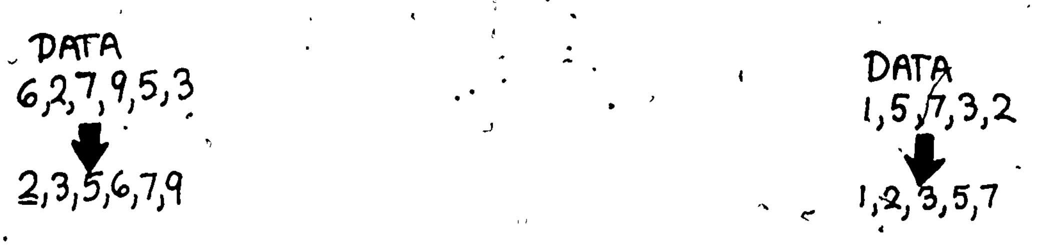
If you have <u>one</u> number, you are finished. If you have <u>two</u> numbers, then you must find the number halfway between the two numbers. You can do this in your head or by drawing a number line. Or you can add the two numbers together and then divide by 2.



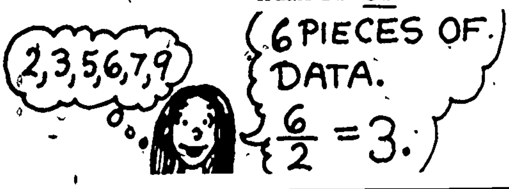


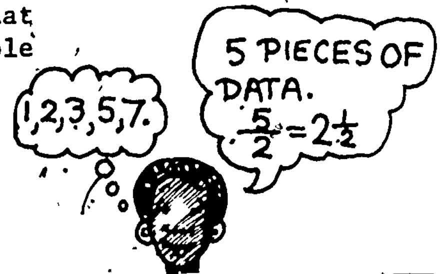
*2. The Counting Way

Put your data in order from smallest to largest.

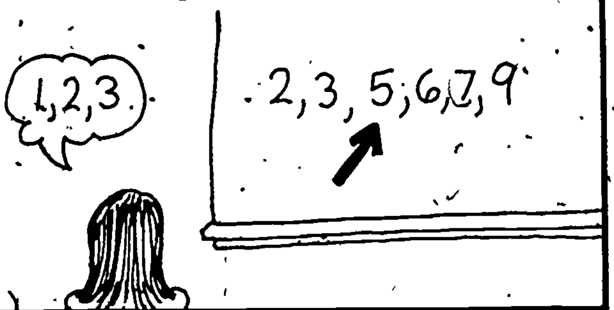


Count your pieces of data and divide that number by 2. You will get either a whole number or a whole number plus a half.

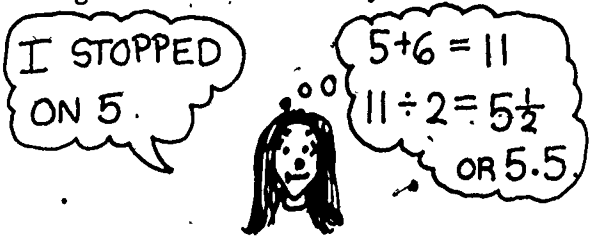




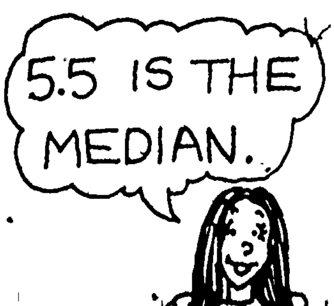
If your answer is a WHOLE NUMBER, count that many pieces of data starting with the smallest number.



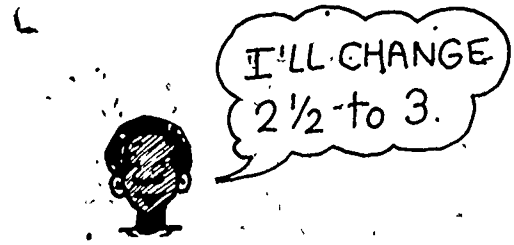
Look at the number you stopped on. Look at the next number in the data. Add these two numbers together and divide by 2.



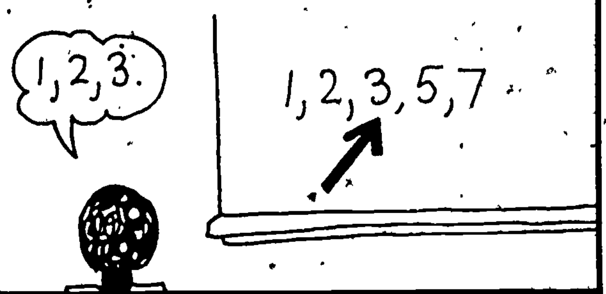
Your answer is the MEDIAN.



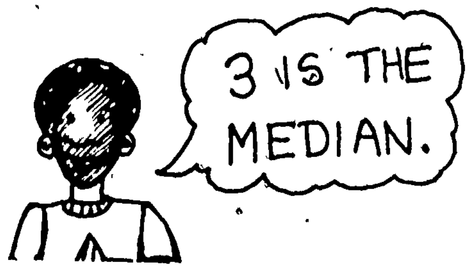
If your answer is a WHOLE NUMBER PLUS A HALF, change it to the next higher whole number.



Count that many pieces of data starting with the smallest number.

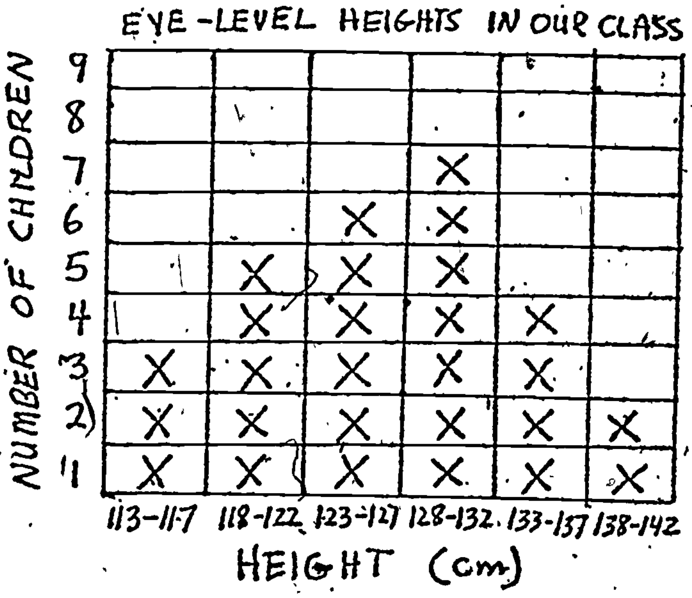


Look at the number you stopped on. It is the MEDIAN.



*3. The Histogram Way

If you have a lot of measurements, you can put them in groups and make a HISTOGRAM to find the MEDIAN. The story called "FINDING THE BEST HEIGHT FOR A POSTER" will help you do this. If you don't know how to make a histogram, read "How To" Make a Histogram.



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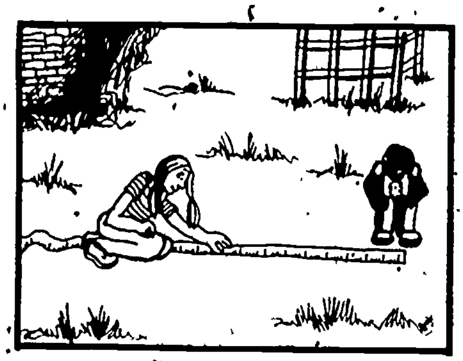
THE CROSSING-OFF WAY: MEASURING THE PLAYGROUND

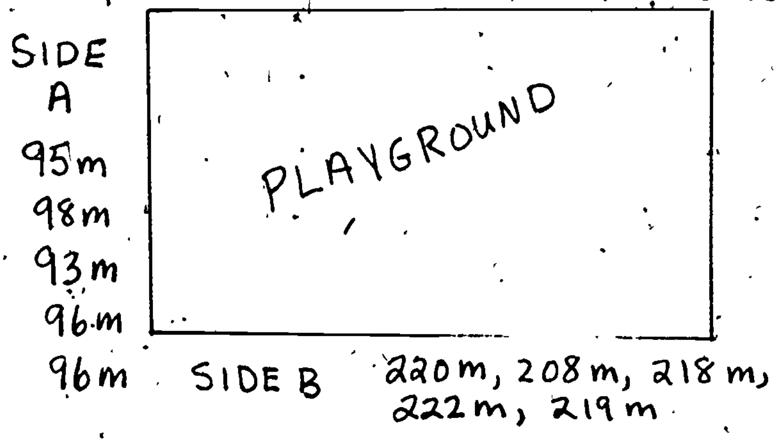
You should use the MEDIAN when you want to be sure that you have a good measurement. You can find the MEDIAN by measuring several times and then using the CROSSING-OFF WAY. That's what the children in the next two stories find out.

Gene, Carol, and Paula want to measure their school playground. They have a tape measure that is 10 meters long to measure with. The playground is big. They will have to move the tape measure many times. It will be easy to make a mistake.



Gene thinks about all the work they must do to measure. It would be too bad if their measurements are off by a lot. "I think we should measure the sides of the playground more than once," he tells the others. "We should measure the sides five times. We can use the middle measurement. That's the median. The median is the measurement that's most likely to be close to the actual distance."

Carol and Paula decide that Gene's idea is good. They measure the playground the next day. They measure to the nearest meter each time. Then they record their measurements on a sketch of the playground.



"What do we do with these measurements now?" asks Paula.

"First," says Gene, "we put them in order from smallest to largest." And he does.

<u>Distance in Meters</u>

Side A	93, 95, 96, 96, 98
Side B	208, 218, 219, 220, 222

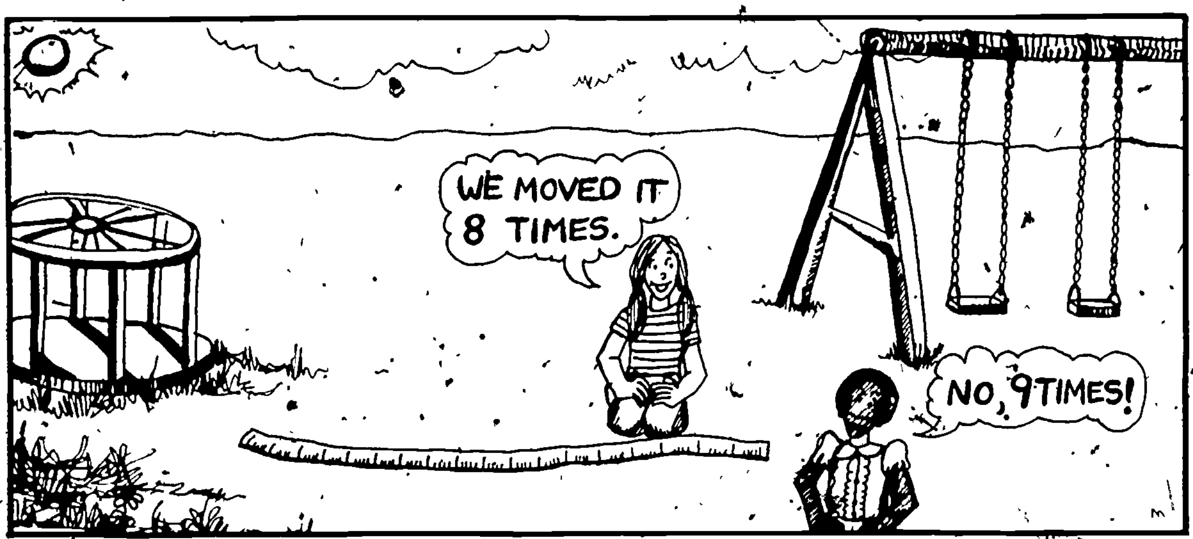
"Then we cross off numbers from each end until there are only one or two numbers left." Gene crosses off numbers from each end until only one number is left for each side:

Side A	Side B
~~93~~, 95, 96, 96, ~~98~~	~~208~~, 218, 219, 220, ~~222~~
~~93~~, ~~95~~, 96, ~~96~~, ~~98~~	~~208~~, ~~218~~, 219, ~~220~~, ~~222~~

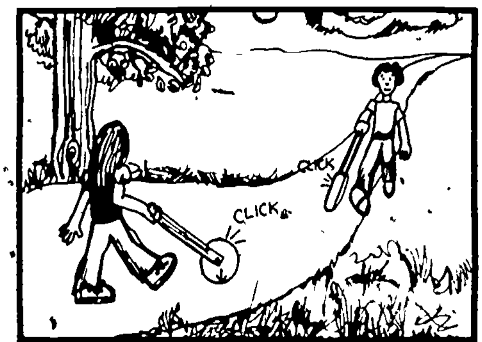
"Now," he says, "we know that the median measurement for Side A is 96 meters and the median measurement for Side B is 219 meters."

Paula notices the 208 meters for Side B. "It's a good thing we took the time to measure more than once because there's quite a difference between 208 meters and 219 meters."

"Yes," Carol says, "we must have miscounted as we were moving the tape measure. But measuring a few times has helped us avoid a mistake like that."



THE CROSSING-OFF WAY: MEASURING A BICYCLE PATH



Rosa, Sandy, and Delores are laying out a bicycle path near their school. They are using a trundle wheel to measure the bicycle path. They want to be sure that they have a good measurement of the distance. They know that it's easy to make mistakes when measuring.

Rosa has an idea. "Why don't we each measure the bicycle path two times? We will have six measurements in all. Then we can find the median of the six measurements. The median is more likely to be close to the actual distance than any one of our measurements."

Sandy and Delores think that Rosa's idea is good. The group measures the bicycle path. They round off each measurement that they make to the nearest meter. Then they record their measurements. The data look like this.

BICYCLE PATH FROM SCHOOL TO MILL ST.
302 m
299 m
301 m
296 m
302 m
303 m

Sandy asks, "Now what do we do?"

Delores explains. "The median is the middle number in the set of data. First, put the data in order from smallest to largest. Then cross off numbers from top and bottom until only one or two are left."

While Delores is talking, she is putting her work on the board so that Rosa and Sandy can see. It looks like this.

302		296 smallest		~~296~~		~~296~~
299		299		299		~~299~~
301	→	301	→	301	→	301
296		302		302		302
302		302		302		~~302~~
303		303 largest		~~303~~		~~303~~

Delores says, "Now there are two numbers left. The median is halfway between these two numbers."

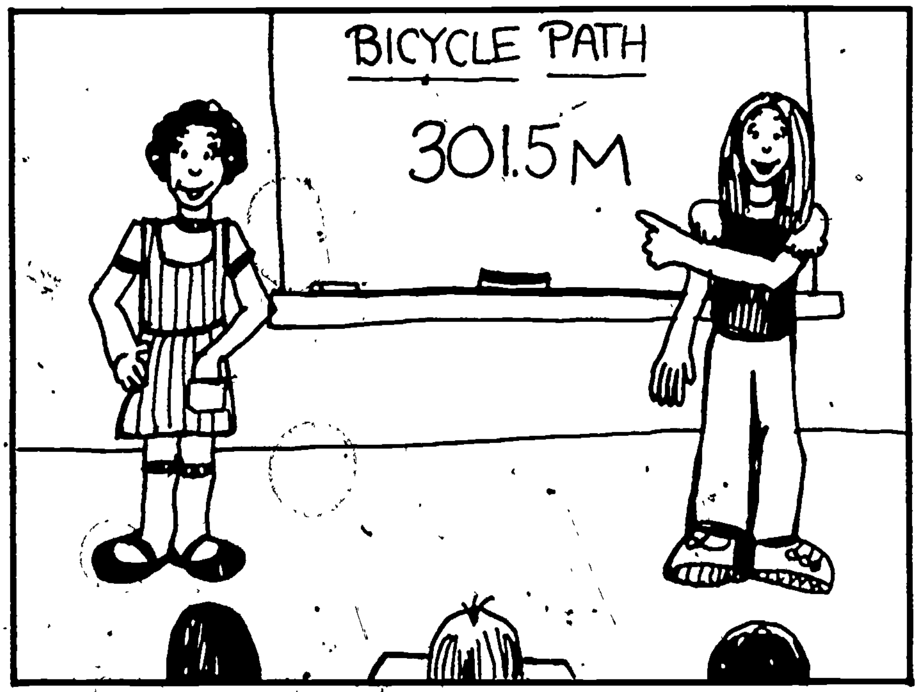
Rosa says," There's no number between 301 and 302." She is thinking of whole numbers.

Sandy is excited. "Yes, there is. It's a number with a fraction. It's $301\frac{1}{2}$."

"Yes," says Delores. "But let's write it as 301.5 meters. We are using the metric system. We should use decimals with the metric system."

"Well," says Rosa, "now we're finished. We can use 301.5 meters as our measurement of the bicycle path. We took six measurements; so we can be sure that 301.5 meters is a good measurement.

So the three girls use 301.5 meters as the measurement of the bicycle path. "When we report to the class," Delores says, "we can tell them we used the median."



THE COUNTING WAY: A FEW STRANGE NUMBERS

In the last two stories, the children used the MEDIAN to make sure they had a good measurement. They used the CROSSING-OFF WAY to do this. In this story, three children find out that their numbers are unusually large or small because of mistakes and fooling around by the children who answered their survey. They, too, find that the MEDIAN is a good number to know about, but they use the COUNTING WAY to find it. They find that the COUNTING WAY is a better way to use when there are a lot of numbers in the data.

Susanna, Tricia, and Franco are preparing for their soft drink sale. They already know that it will cost them 4¢ to make one cup of their soft drink. Now they want to find out how much to charge for it. So they have made up a survey to find out. It looks like this.

SURVEY

How much would you pay for our WONDERFUL soft drink? Comes in 3 FANTASTIC FLAVORS!

Put an X beside only one price.

5¢	______	20¢	______
10¢	______	25¢	______
15¢	______	Other	____

They hand out the survey to everyone in their grade. When they get all the surveys back, they tally the votes. Their tally looks like this.

Price	Number of Votes
5¢	36
10¢	34
15¢	33
20¢	11
25¢	2
other 0¢	6
7¢	3
12¢	3
50¢	2
$1.00	1

Now they aren't sure how to use the data to decide what price to charge. "We should pick the price that most children voted for," says Tricia.

Franco objects. "But the votes for 5¢ are only two more than the votes for 10¢ and only three more than the votes for 15¢."

Tricia changes her mind after hearing Franco. "I guess picking the price that got the most votes isn't such a good idea. The votes are practically tied for 5¢, 10¢, and 15¢. But how can we decide then?"

Then Franco remembers. He remembers that the median is good to use when some of the numbers are unusually large or small and are likely to be mistakes or due to something that won't happen again. "We can find the median. We have a lot of numbers that are really big or small like 0¢ and $1.00 in our data. And I know they are just mistakes or someone fooling around."

Susanna and Tricia listen to Franco. They decide that finding the median may help. They look at the tally chart again.

Franco says, "This table is a short way of writing 5¢ 36 times, 10¢ 34 times, and so forth. To find the median, first we have to put the price column in order from smallest to largest."

Susanna wonders why Franco uses the price column. Tricia says, "That's because we want to find the MEDIAN PRICE, not the median number of votes."

There were 36 5¢s listed.

Price	Number of Votes
5¢	36
10¢	34
15¢	33
20¢	11
25¢	2
other 0¢	6
7¢	3
12¢	3
50¢	2
$1.00	1

The group puts the data in order from the smallest price to the largest price. Now the data look like this.

Price	Number of Votes
0¢	6
5¢	36
7¢	3
10¢	34
12¢	3
15¢	33
20¢	11
25¢	2
50¢	2
$1.00	1

The Price column is put in order from smallest to largest.

Franco knows how to find the median using the counting way. "Next, we need to count up how many pieces of data we have. The number of votes column tells how many times the price 5¢ was listed in the survey, how many times the price 10¢ was listed, and so forth. It tells the number of votes (or the number of pieces of data) for each price. We need to add up all the votes to get the total number of pieces of data."

Price	Number of Votes
0¢	6
5¢	36
7¢	3
10¢	34
12¢	3
15¢	33
20¢	11
25¢	2
50¢	2
$1.00	1
	131

Susanna adds up the numbers in the number of votes column. They add up to 131. There are 131 pieces of data in all.

Franco divides 131 by 2. The answer is 65½. Franco changes 65½ to 66.

Price	Number of Votes	
~~0¢~~	~~6~~	45 votes so far
~~5¢~~	~~36~~	
~~7¢~~	~~3~~	
10¢	34	MEDIAN is 10¢
12¢	3	
15¢	33	
20¢	11	
25¢	2	
50¢	2	
$1.00	1	

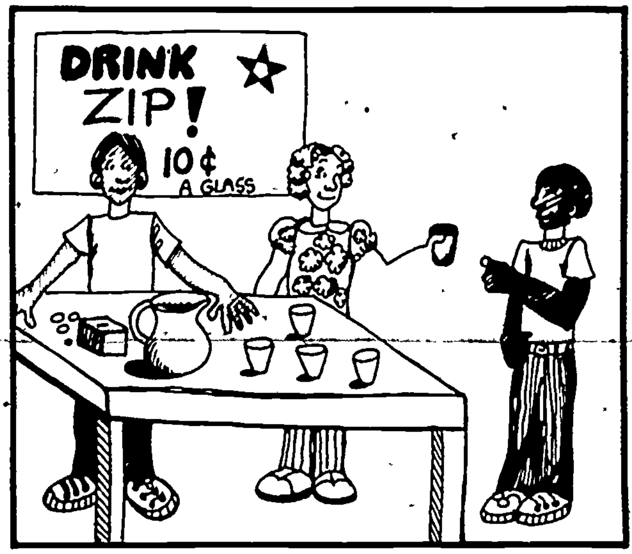
"Now we must count 66 pieces of data, starting with the smallest," says Franco. First, they count the 6 votes for 0¢. Then they count the 36 votes for 5¢.

"So far," says Tricia, "we've counted 42 votes." Then they count the 3 votes for 7¢. They are up to 45.

"Well," says Tricia, "we've only got 21 more to count and there are 34 pieces in the 10¢ row."

"That settles it," says Franco. "The median price is 10¢."

"I don't believe how easy it was," says Susanna. "Now we know. We can charge 10¢ for our soft drink. That's the price that's closest to what most people want to pay, and it will let us make a profit."



THE HISTOGRAM WAY: FINDING THE BEST HEIGHT FOR A POSTER

The MEDIAN is a good number to use when you want a number that is exactly in the middle of your data. And grouping measurements to make a histogram is an easy way to find the MEDIAN when there are many measurements in the data. That's what Ramona's class finds out in the next story.

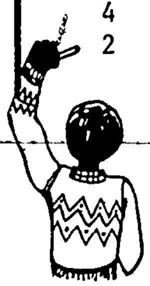
Ramona's class can't agree on the best height to hang posters in the classroom. Some of the children want the posters low and some want them high. Ramona and two of her friends, Greg and Paul, decide to solve the problem. They think that the posters should be at a height where as many children have to look up at them as have to look down at them. So they first measure the eye-level heights of everyone in the class. Their data look like this.

OUR EYE-LEVEL HEIGHTS			MAR. 3
NAME	HEIGHT (cm)	NAME	HEIGHT (cm)
Chuck	132	Joanne	129
Sue	126	Serena	131
Maria	124	Otis	116
Jill	137	Marlene	120
Herbert	135	James	131
Alfie	119	Natasha	127
Brian	138	Francis	123
Hugh	125	Patrick	115
Nancy	114	Samuel	134
Lynn	126	Dianne	128
Joyce	120	Eunice	121
Chris	138	Bill	140
Karen	129	Sandy	118
Anna	128		

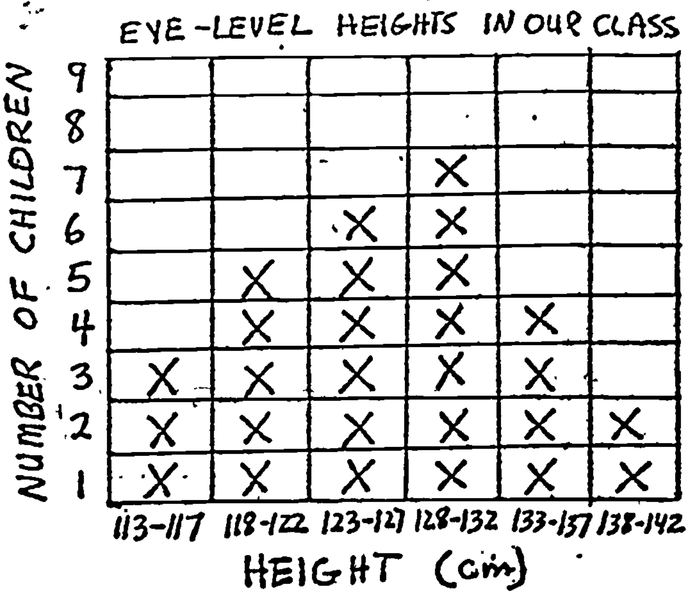
There are a lot of kids in the class. There are too many numbers. Otis, another boy in the class, makes a suggestion. "Put the data into groups. Then you can show all the data on a histogram and find the median. It's easy."

Otis makes up a new data table for Ramona, Greg, and Paul. It has grouped measurements on it. It looks like this.

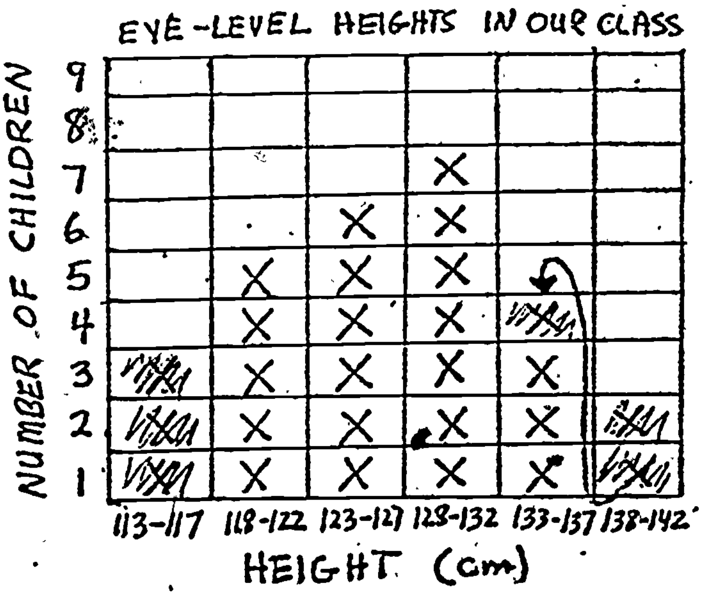
OUR EYE-LEVEL HEIGHTS	MAR. 4
HEIGHT (cm)	NUMBER OF CHILDREN
113-117	3
118-122	5
123-127	6
128-132	7
133-137	4
138-142	2



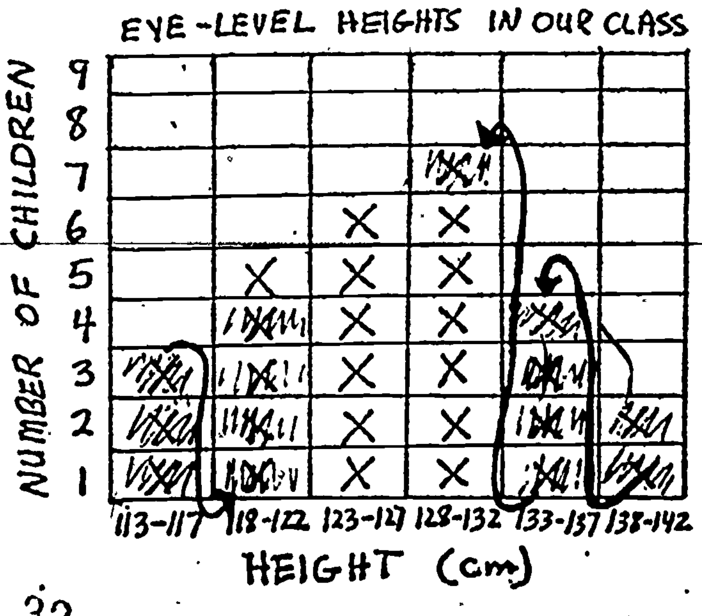
Then Otis makes a histogram from the new data table. It looks like this.



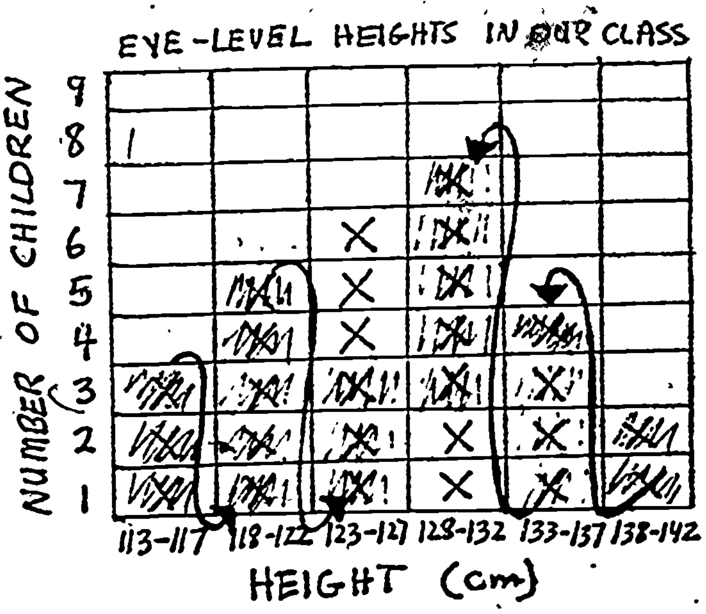
Ramona knows how to find the median. She starts crossing off Xs on the histogram. She crosses off the same number of Xs from each end, but she crosses off the Xs on the lower end starting at the bottom of each column, and crosses off the Xs on the higher end starting at the top of each column. When she has crossed off 3 Xs from each end, the histogram looks like this.



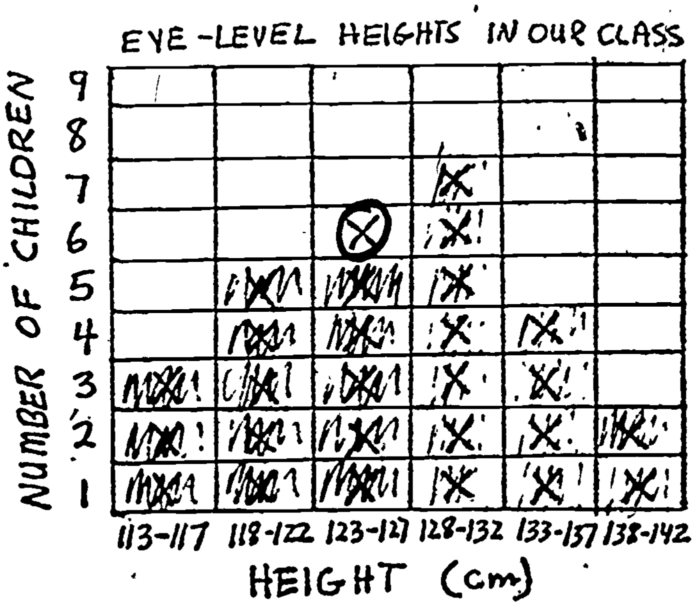
When she has crossed off 7 Xs from each end, the histogram looks like this.



When she has crossed off 11 Xs from each end, the histogram looks like this.



Now she crosses off two more Xs from each end. That leaves on X. It is the middle X. She puts a circle around it. It is the MEDIAN. The graph looks like this.



The median is from 123 to 127 centimeters. So Ramona tells the class that the posters should be hung so that the middle of each poster is between 123 and 127 centimeters high.

One boy isn't satisfied. "I want just one number for the median," he says. "I know that a 4 centimeter difference is not very much, but I'd like to know what the median is exactly."

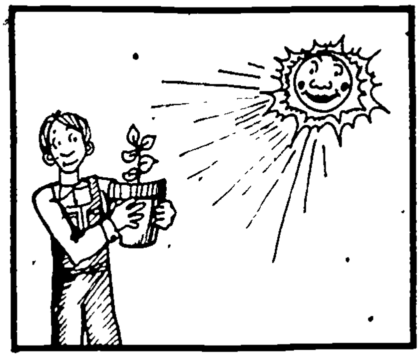
He looks at how Ramona has crossed off the Xs. "The X that is circled is the top X in that column. All the others were crossed off," he adds.

"We can go back to our data and find out what the measurements in the 123-127 centimeter column are," says Otis. "Because the last X is at the top of the column, the crossed-off Xs are the smaller measurements in that column. The last X is the biggest measurement." Otis goes back to the data chart and writes down the six measurements that were tallied in the 123-127 centimeter column. They are:

126 cm, 124 cm, 125 cm, 126 cm, 123 cm, 127 cm.

"The biggest measurement is 127 centimeters," says Otis. "Let's use that as the median and hang the posters 127 centimeters high."

A PLANT EXPERIMENT



Maybe you have collected two or three sets of data and you want to compare the sets of data to see which group of things is bigger, or stronger, or takes longer. You may have made many measurements or tests. Now you have several bunches of numbers to compare. It's hard to compare several big bunches of numbers, but it's easy to compare several MEDIANS. That's what the boys in this story find out.

Sean, Casey, and Julio have decided to do an experiment to see if light will make their plants grow taller. They have planted three boxes of seeds. They give each box a different amount of light.

After several weeks, they measure the heights of the plants in each box. Their data look like this.

LOTS OF LIGHT 6/12	
PLANT	HEIGHT (cm)
#1	5
#2	12
#3	6
#4	9
#5	8
#6	8
#7	11
#8	7
#9	9
#10	7

SOME LIGHT 6/12	
PLANT	HEIGHT (cm)
#11	10
#12	6
#13	11
#14	6
#15	7
#16	4
#17	5
#18	5
#19	4
#20	5

LITTLE LIGHT 6/12	
PLANT	HEIGHT (cm)
#21	3
#22	2
#23	1
#24	4
#25	6
#26	4
#27	5
#28	3
#29	7
#30	3

They want to compare the heights for different amounts of light, but there are a lot of plants in each box. Looking at all the measurements is confusing.

Casey says, "I wish that I could wave a magic wand and make all these numbers be just one number."

"Yes," says Sean, "but you wouldn't want just any number. That won't help. Anyway, it should be three magic numbers because we want to compare the three groups to see how much light is best. And the number for each group should be a number that is close to all of the measurements for that group."

"Oh!" says Julio. "Let's use the MEDIAN. The median is a number that is close to all of the other numbers in a set of data. It is the number that is exactly in the middle of the data."

"Great!" says Casey. "We just thought of three magic numbers. We can find the median for each group."

And so they do. First they put the measurements for each group in order from smallest to largest. The data look like this.

AMOUNT OF LIGHT	HEIGHT (cm)
LOTS OF LIGHT:	5, 6, 7, 7, 8, 8, 9, 9, 11, 12
SOME LIGHT:	4, 4, 5, 5, 5, 6, 6, 7, 10, 11
LITTLE LIGHT:	1, 2, 3, 3, 3, 4, 4, 5, 6, 7

There are ten numbers in each set of data. Ten is an even number. So when the numbers are crossed off from both ends, two numbers are left in each set of data. Now the data look like this.

AMOUNT OF LIGHT	HEIGHT (cm)
LOTS OF LIGHT:	~~5~~, ~~6~~, ~~7~~, ~~7~~, 8, 8, ~~9~~, ~~9~~, ~~11~~, ~~12~~
SOME LIGHT:	~~4~~, ~~4~~, ~~5~~, ~~5~~, 5, 6, ~~6~~, ~~7~~, ~~10~~, ~~11~~
LITTLE LIGHT:	~~1~~, ~~2~~, ~~3~~, ~~3~~, 3, 4, ~~4~~, ~~5~~, ~~6~~, ~~7~~

Casey figures out the median by finding the number that is halfway between the two middle numbers in each set of data. The median for LOTS OF LIGHT is easy to find. Halfway between 8 centimeters and 8 centimeters is 8 centimeters. The median for SOME LIGHT is 5.5 centimeters and the median for LITTLE LIGHT is 3.5 centimeters. Casey makes a table of his results.

Sean says, "I want to show this to the rest of the class."

AMOUNT OF LIGHT	MEDIAN HEIGHT (cm)
LOTS OF LIGHT	8
SOME LIGHT	5.5
LITTLE LIGHT	3.5

Sean looks at the table. He figures out the differences between the median heights. The difference in median height between plants that got LOTS OF LIGHT and plants that got SOME LIGHT is 8 cm - 5.5 cm or 2.5 centimeters. The difference in median heights between plants that got SOME LIGHT and plants that got LITTLE LIGHT is 5.5 - 3.5 cm or 2 centimeters.

"Look," he tells Julio and Casey. "The differences are small. Two centimeters and 2.5 centimeters aren't much. Does a little difference like this prove that more light makes plants grow taller?"

The group asks the teacher. She tells them that they should compare the differences in the medians with the middle ranges of their sets of data. "If the differences in the medians is about as large or larger than the largest middle range, you can say that more light makes plants grow taller," the teacher says.

Sean, Casey, and Julio read "How To" Find Different Kinds of Ranges. They calculate the middle ranges of their sets of data and are happy to find out that the differences in the medians are as large or larger than the largest middle range.

"Well," says Julio, "I guess that proves it."

FINDING OUT HOW WELL SOME PLANTS GREW

The MEDIAN is good to use when you want to be able to compare the numbers in your set of data with a typical number in the data. The boys in this story use the MEDIAN to decide whether the plants they have grown are as tall as the plants grown by the whole class.

Aldo, Harold, and Mohamed wonder if their plants have grown as well as the others in the classroom. Some of their plants seem tall, but most of them seem shorter than the others in the classroom. So Aldo, Harold, and Mohamed decide to find out how their plants compare to the others in their room. This is what they do.

First they measure all of the plants in the classroom, including their own. Next they decide to find the median height for all of the plants. After putting the measurements in order from smallest to largest and crossing off the same number of measurements from each end, they find that the median height for all of the plants is 10 centimeters.

PLANT HEIGHT IN CENTIMETERS

~~4~~ ~~4~~ ~~5~~ ~~5~~ ~~6~~ ~~6~~ ~~7~~ ~~7~~ ~~8~~ ~~8~~ ~~9~~ ~~9~~ ~~10~~ ~~10~~ 10 ~~10~~ ~~11~~ ~~12~~ ~~12~~ ~~13~~ ~~14~~ ~~15~~ ~~16~~ ~~16~~ ~~16~~ ~~17~~ ~~17~~ ~~18~~ ~~19~~

Now Aldo, Harold, and Mohamed look at the measurements of just their group of plants. They are:

6 cm, 7 cm, 9 cm, 8 cm, 4 cm.

They put the heights in order from smallest to largest.

4 cm, 6 cm, 7 cm, 8 cm, 9 cm

They compare the heights of their plants with the median height and they are very disappointed. All of their plants are shorter than the median height. They think about how they have been growing their plants. They decide that they will put the plants in a sunnier place and measure them every week to see if they grow better.

WHEN CAN YOU USE THE MEDIAN?

USE THE MEDIAN

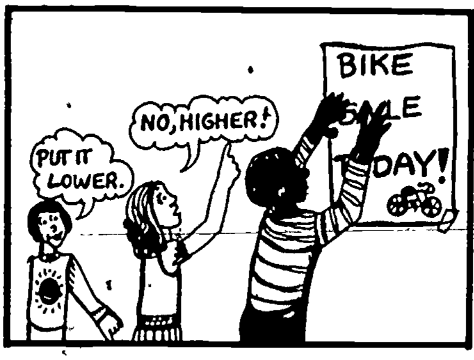
- when none of the numbers or measurements are unusually large or small.
- when some of the numbers or measurements are unusually large or small and are likely to be mistakes or are due to something that won't happen again. The story called "A Few Strange Numbers" tells about this.

FOR ONE SET OF DATA:

The median is good to use when you want to find out--

- the best measurement for the height of a table, the time of a walk light, or the length of a bicycle path. The stories called "Measuring the Playground" and "Measuring a Bicycle Path" tell about this.

- a number or measurement that is typical for a whole group of people or things, such as the best height for a table or the best price to charge for a soft drink. See the story called "Finding the Best Height for a Poster."



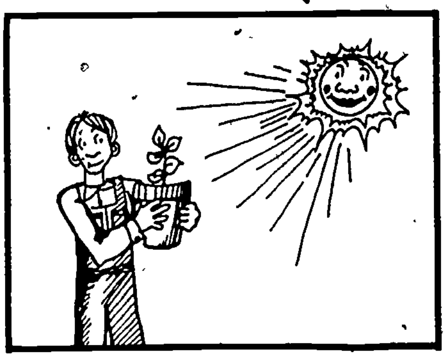
- how your other data compare with a typical number or measurement, such as how tall your chair is compared to the median height of chairs in your class or how big your plants have grown compared to the median height of the plants in your room. See the story called "Finding Out How Well Some Plants Grew."

FOR TWO OR MORE SETS OF DATA:

The median is good to use to compare sets of data. You may want to find out--

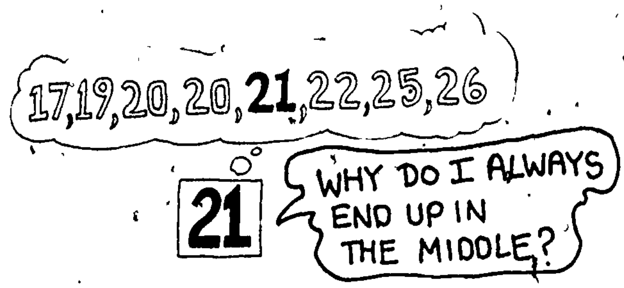
- whether sets of data collected before and after a change has been made are almost the same or different. You may want to compare sets of test scores from before and after when you are trying a new method of learning something, or you may want to compare sets of data to see if putting up signs has made a change in the time it takes for children to find the library.

- which thing is bigger or stronger or takes longer when you are comparing the heights of groups of plants, the strengths of two brands of paper towels, or times for two different grades to cross a street. See the story called "A Plant Experiment."

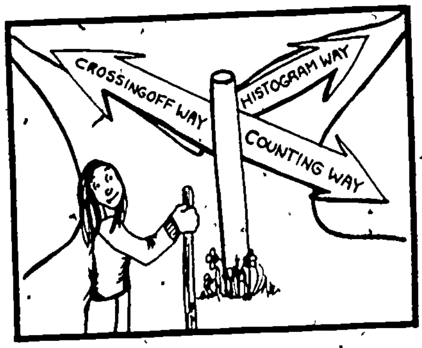


THINGS TO KEEP IN MIND

1. The MEDIAN is the middle number in a set of data. Half of the numbers are above the median and half are below the median.



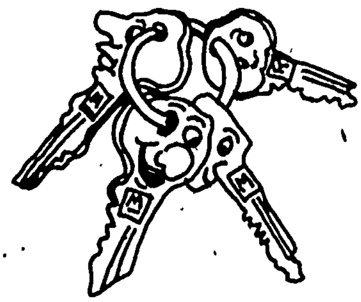
2. There are three ways to find the MEDIAN. Which way you use depends on the kind of data you have.



- If you have NUMBER COUNTS or MEASUREMENTS, you can use either the CROSSING-OFF WAY or the COUNTING WAY.

- If you have many measurements, you can put them in groups and use the HISTOGRAM WAY.

3. The MEDIAN, the MODE, and the MEAN are all KEY NUMBERS. Each of them tells something about a whole set of numbers or measurements. Each of them tells what a typical number or measurement may be for a whole set of data.



Maybe the MODE or the MEAN would be better to use than the MEDIAN for your data. If you are not sure about which KEY NUMBER to use, you can look at "How To" Tell What Your Data Show and "How To" Use Key Numbers to Compare Two Sets of Data.

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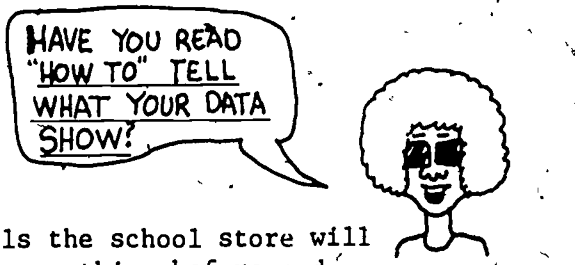
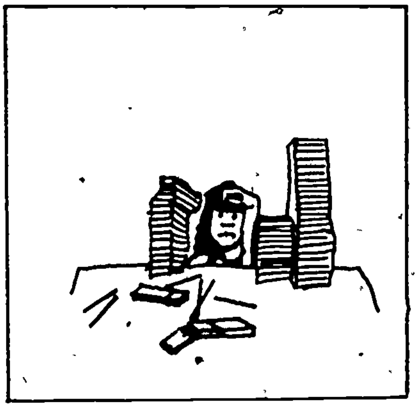
"HOW TO"

FIND THE MEAN



Do you need to predict something, like how many pencils the school store will need for the next two months? Do you want to compare something before and after changes have been made?. You may want to compare the time it takes to find the library before and after signs have been put up. You can use the MEAN to find out these things. And the MEAN is good to use for many other things too.



WHAT IS THE MEAN?

The MEAN is the number or measurement that you get when the total of your data is split into equal pieces. The MEAN is often called the AVERAGE.

HOW DO YOU FIND THE MEAN?

You can find the MEAN by dividing the sum of the numbers in your set of data by the number of numbers in your set of data. This booklet will show you how to find the MEAN of your data.

WHEN CAN YOU USE THE MEAN?

You should use the MEAN when some of the numbers or measurements are unusually large or small but need to be considered because they show something that will probably happen again. You can use the MEAN for many other things too. You can use the MEAN when your data are not unusual. Each story in this booklet shows a different way to use the MEAN.

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HOW LONG MUST WE WAIT?.................... 7
WHEN CAN YOU USE THE MEAN?.................... 9
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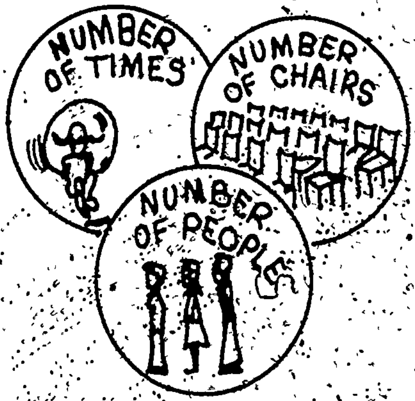
FINDING THE MEAN

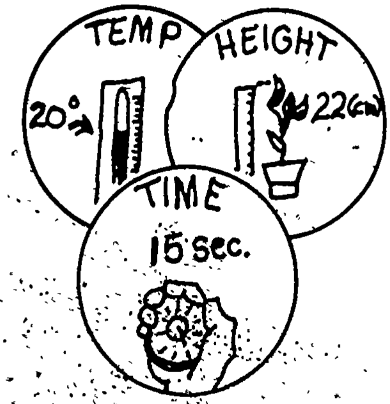
LOOK TO SEE WHAT YOUR DATA ARE. YOUR DATA MAY BE

NUMBER COUNTS



OR

MEASUREMENTS



You can follow these steps to find the MEAN.

1. Add up all the numbers in your set of data. This is the TOTAL of your data.

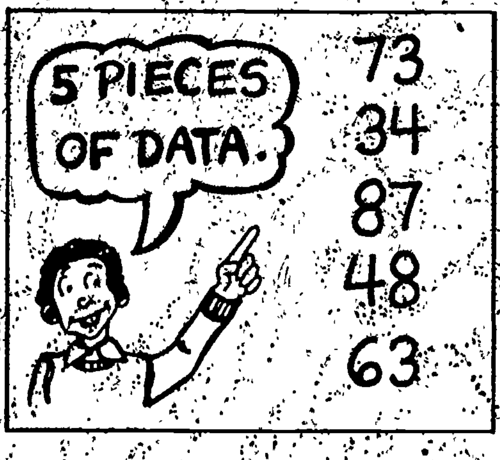
THE DATA

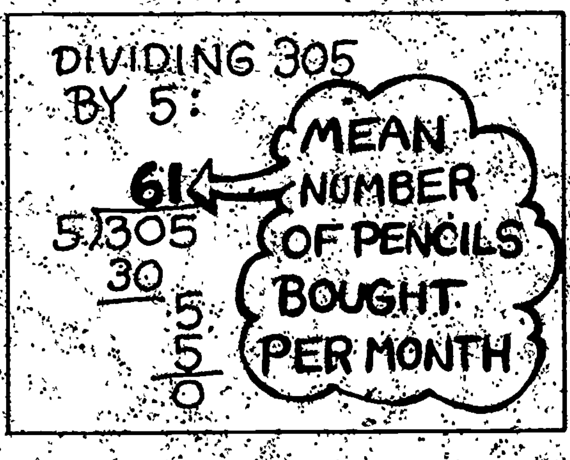
PENCIL SALES DEC. 1	
MONTH	NUMBER OF PENCILS
NOV.	73
DEC.	34
JAN.	87
FEB.	48
MAR.	63

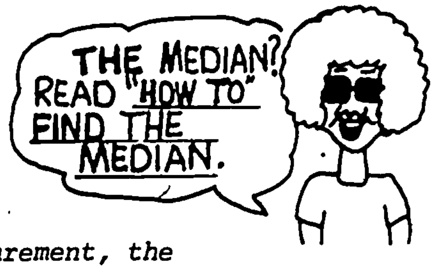
$$\begin{array}{r} 73 \\ 34 \\ 87 \\ 48 \\ +\ 63 \\ \hline 305 \end{array} \leftarrow \text{TOTAL OF THE DATA}$$

2. Count how many pieces of data you have.

3. Divide the TOTAL by the number of pieces of data. Your answer is the MEAN.

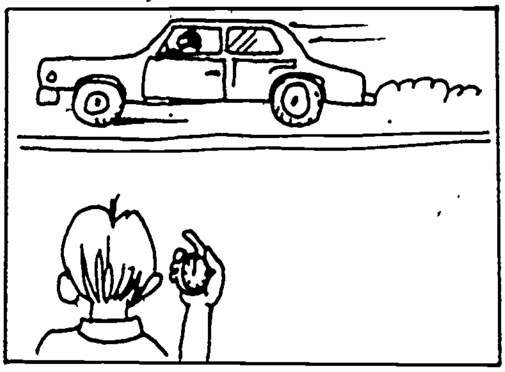






MEASURING TIMES

When you want to find a good measurement, the MEDIAN is usually the best KEY NUMBER to use. But when you have only two measurements of something, the MEDIAN and the MEAN are the same. When that happens, you find the MEAN. That is what this story is about.



Kay's class is measuring the speeds of cars near their school. They want to be sure that their measurements are accurate. So they pick two teams to measure the time for each car.

Each team has a timer, a person who tells the timer when to start, and a person who tells the timer when to stop. Each team times the same five cars for a distance of 100 meters. When the teams are finished, the data look like this.

CAR TIMES (TEAM I)	
CAR	TIME (seconds)
A	6.2
B	8.4
C	10.0
D	7.6
E	6.8

CAR TIMES (TEAM II)	
CAR	TIME (seconds)
A	6.0
B	8.4
C	9.8
D	7.2
E	7.0

Both teams look at the data. Frances says, "I know how to find the speed: just divide the distance by the time." She has read "How To" Find the Speed of Things.

"Which time?" asks Toby. "We have two times for each car. We only need one time to find the speed."

Gino replies, "We should first find the MEAN of the two times, then we can use the MEAN TIME for each car to figure out the speed."

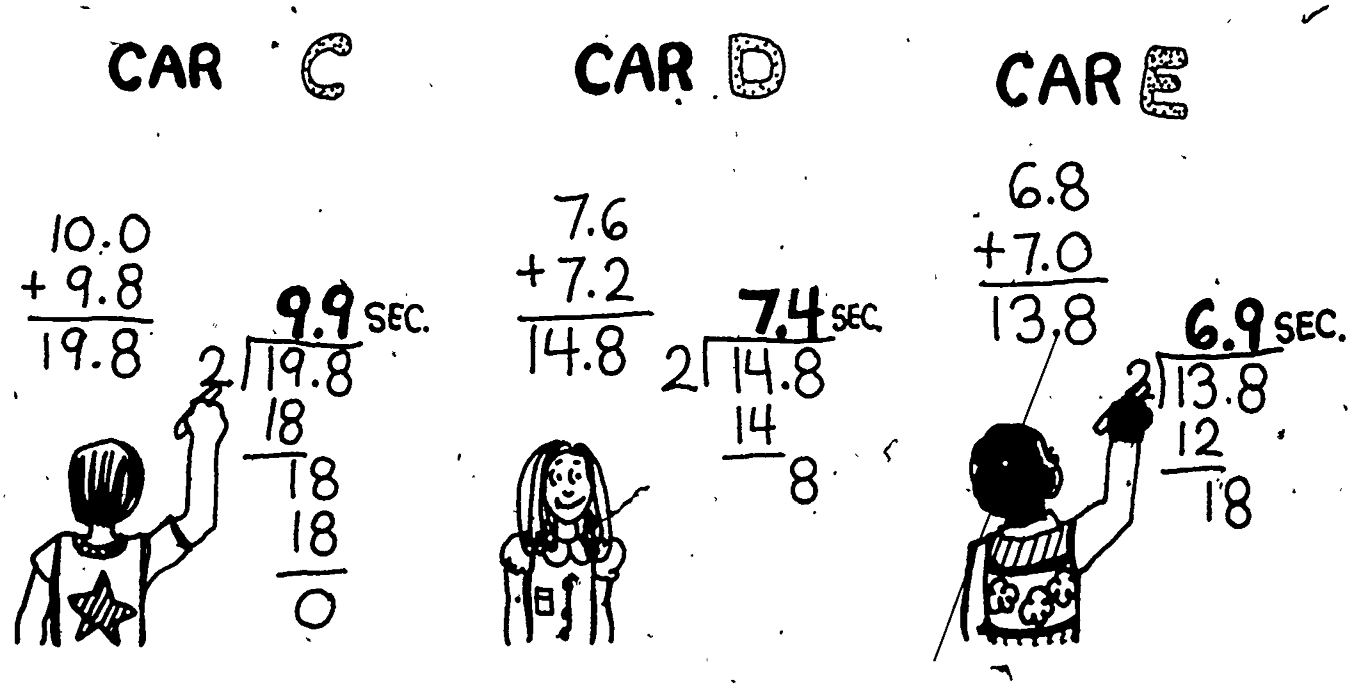
"Yes," says Frances. "Finding the mean with two numbers is easy. Just add the two numbers together and divide by two. I'll bet if we each take the times for one car and do the figuring, we will be finished in 5 minutes. I'll check everyone's answers."

Everyone is very busy for a few minutes. Then they are done.

Frances makes a new data table showing the MEAN TIME for each car. It looks like this. "Great!" says Frances. "Now we are ready to find the speeds of these cars."

MEAN CAR TIMES

CAR	MEAN TIME (seconds)
A	6.1
B	8.4
C	9.9
D	7.4
E	6.9



MAKING A PREDICTION

Sometimes you may need to make a prediction.
- *Maybe you want to predict how many pencils the school store will need.*
- *Maybe you want to predict how much soft drink to make for a party.*

The MEAN is good to use when you need to make a prediction. That's what the students in this story discover when they predict how many pencils they need to order for the rest of the school year.

Anna, Louise, and Kathy are in charge of ordering supplies for the school store. The store has run out of pencils. They want to order enough pencils so that they don't run out of pencils again before school ends for the year. They need to decide how many pencils they should order.

They decide that they should first find out how many pencils students usually buy during a week. Anna and Louise look at the store records. They find information on how many pencils the students have bought each week at the school store. Anna suggests that they just copy the number of pencils for the last 12 weeks. Louise agrees that that would be enough. She makes a data chart showing the number of pencils that students have bought for the last 12 weeks. The chart looks like this.

PENCILS BOUGHT BY STUDENTS

WEEK OF	NUMBER OF PENCILS	WEEK OF	NUMBER OF PENCILS
Jan. 18	54	Mar. 1	37
Jan. 25	30	Mar. 8	29
Feb. 1	23	Mar. 15	32
Feb. 8	19	Mar. 22	25
Feb. 15	34	Mar. 29	33
Feb. 22	0	Apr. 5	32

Kathy looks at the chart. "It's hard to tell how many to order from these numbers," she says. "One week the students bought more than 50 pencils. Another week they didn't buy any."

Anna says, "We can find the mean. We can decide how many to order by finding the mean number of pencils bought per week. Then we can multiply the mean by the number of weeks that are left in the school year."

Kathy knows how to find the mean. First she adds up the number of pencils.

$$54 + 30 + 23 + 19 + 34 + 0 + 37 + 29 + 32 + 25 + 33 + 32 = 348$$

She gets a total of 348 pencils. Then she counts the number of weeks. There are 12 weeks listed in the data chart.

Next she divides the total of the pencils by the number of weeks:

$$\frac{\text{SUM OF PENCILS}}{\text{NUMBER OF WEEKS}} = \frac{348}{12} = 29 \text{ pencils per week.}$$

The mean is 29 pencils per week. Students usually buy about 29 pencils per week.

Louise figures that there are 10 weeks of school left. She multiplies 29 x 10 to find out how many pencils to order. They need to order about 290 pencils.

HOW MUCH SOFT DRINK DO WE NEED?

Maybe you want to make a prediction, and you only have a little information. You may think that you don't have enough data to find out what you need to know. But, to find the MEAN, you don't need much information. All you need to know is the total amount of something and the number of items. That's what the students in this story find out.

Maureen, Karen, and Cory are in charge of buying soft drink for the annual picnic. They need to figure out how many quarts of soft drink they will need for the picnic. Alisa, who worked on the picnic planning last year, has given them some information:

Total quarts bought	96
Number of children at picnic	240

Alisa tells the group that last year there was enough soft drink for everyone, and if the same number of children will be at the picnic this year, they can just buy the same number of quarts.

Karen has a count of how many children want to go to the picnic. 330 children have signed up. More children will be at the picnic this year.

"How can we figure out from these numbers how many quarts to buy?" asks Maureen.

Cory looks at the information. "We can use Alisa's data to figure out the number of quarts per child. That's the MEAN NUMBER OF QUARTS. Then we can multiply the mean number of quarts by 330 to find out how many quarts to buy this year."

Karen says, "To find the mean number of quarts, we should divide the total quarts by the number of children." Karen figures out the number of quarts per child:

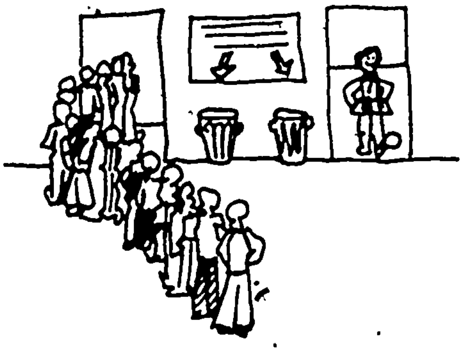
$$\frac{\text{TOTAL QUARTS}}{\text{NUMBER OF CHILDREN}} = \frac{96}{240} = \frac{2}{5} \text{ QUART PER CHILD}$$

"Each child got about 2/5 of a quart. Now we can find out how many quarts to buy this year," says Maureen. "We have to multiply 2/5 by 330.

Maureen finds that the number of quarts needed for 330 children will be 132 quarts. Cory, Maureen, and Karen check the figures again. They still get 132 quarts. They report to the class that they will need enough money to buy 132 quarts of soft drink.

HOW LONG MUST WE WAIT?

When some of your numbers or measurements are unusually large or small but need to be considered because they show something that will probably happen again, you should use the MEAN. The time spent waiting in line for lunch is like that. There are many things that could cause the time spent in line to be long or short, and these things will probably happen again. That's what this story is about.



Melinda's class wants to shorten the time spent waiting in line for lunch. They are changing different things to find out what will make the line go faster.

First they time how long it takes to get lunch before any changes have been made. They time every fifth person. They do their timing on five different days. Their data for one day look like this.

TIME IN LUNCH LINE ON OCT. 3 (Minutes)

11, 14, 16, 19, 15, 14, 13, 12, 17, 10, 16, 12, 11, 19, 10, 18, 11, 14

Melinda and Tina look at the data for Oct. 3. They notice that some of the times are short. It took some students only 10 or 11 minutes to go through the lunch line. Other times are long. Some students took 18 or 19 minutes to go through the line. Tina and Melinda decide that they should find the mean of the times in line. They want to use the mean because waiting times on any day could be long or short depending on many things that will probably happen again:

- Some students buy only milk or dessert. They go through the line fast. Others buy the whole lunch. They take longer.
- Some students have the correct change. Others need to have bills changed.
- Some students fool around.
- Some students forget their forks and napkins and have to go back to get them.

Melinda and Tina compute the mean time for Oct. 3. They add up all the times and get a total of 252 minutes. Then they divide by 18--the number of students. The mean time for Oct. 3 is 14 minutes. Other students in the class find the mean times for the other four days. Then they make a chart of the five mean times. It looks like this.

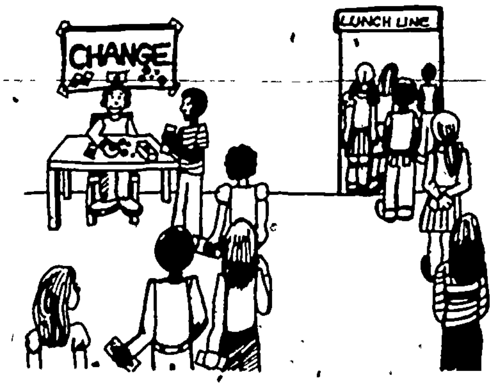
LUNCH LINE TIMES	
DATE	MEAN TIME IN LINE FOR EACH DAY (Minutes)
Oct. 3	14
5	12
6	11
9	12
10	13

They aren't finished yet. Now they need to find the mean time in line for all five days. They must find the mean for all 5 days because many things such as the menu and the number of students change from day to day.

So they do. They add up the five times and get 62 minutes. Then they divide by 5. The mean time in line for all five days is 12 2/5 minutes. They round this off to 12 minutes.

Melinda looks at the figuring. "We didn't find just the MEAN," she says. "We found the MEAN OF THE MEAN. And we are still not through. Now we have to see whether changing the lunchroom around will make the time waiting in line shorter."

The class wants to change things to that the mean time spent waiting in line is cut by five minutes. The next week they rearrange the lunchroom layout. They wait a few days until the students are used to the new layout and then they do the timing again on five different days. Each day they time every fifth student. Then they find the mean times for each day again and make a chart. It looks like this.



LUNCH LINE TIMES	
DATE	MEAN TIME IN LINE FOR EACH DAY (Minutes)
Oct. 24	9
25	10
27	8
30	10
Nov. 1	9

They find the mean time in line for all five days. It is 9 1/5 minutes. They round that off to 9 minutes. They compare the two mean times. They have made the mean waiting time shorter by 3 minutes.

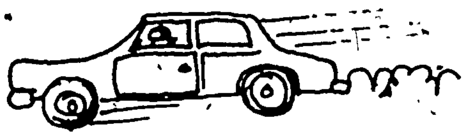
They decide to try making a different sort of change. They plan to rearrange the schedule so that the classes come into the lunchroom 5 minutes apart instead of all at once. They need to get permission from the principal to do this. They collect the data they have so far to show to the principal. They are happy that they used the MEAN because it makes their results much easier to see.

WHEN CAN YOU USE THE MEAN?

USE THE MEAN

- when none of the numbers or measurements are unusually large or small.
- when some of the numbers or measurements are unusually large or small but need to be considered because they show something that will probably happen again. The story called "How Long Must We Wait?" tells about this.

FOR ONE SET OF DATA, USE THE MEAN



- to get a typical count or measurement of something when you have only two numbers or measurements. See the story called "Measuring Times."

- to predict how much or how many of something will be needed in the future. The story called "Making a Prediction" tells about this.

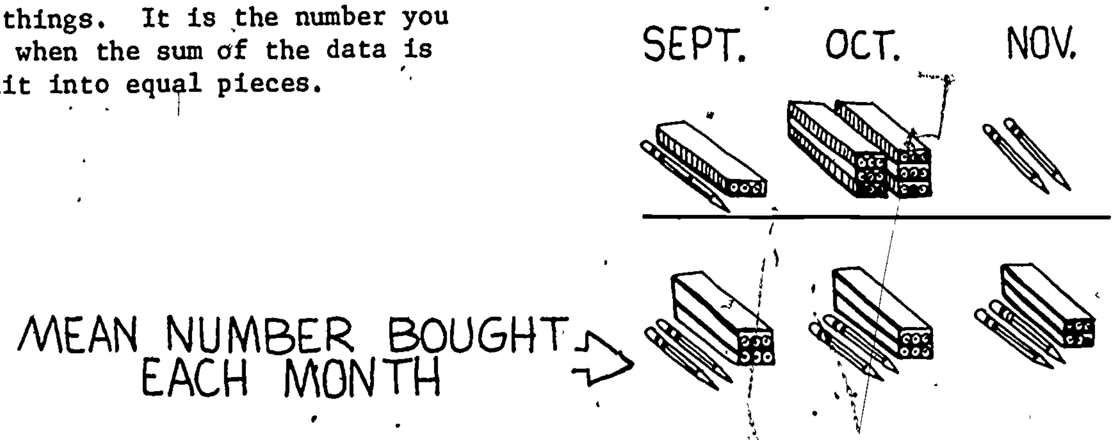
• to get a typical number for something when you know only the total amount and the number of items. See the story called "How Much Soft Drink Do We Need?"

FOR TWO OR MORE SETS OF DATA, USE THE MEAN

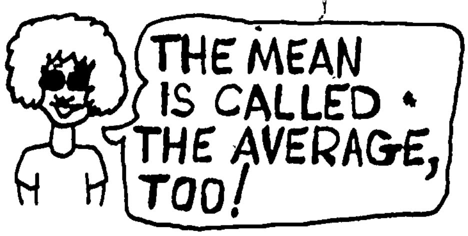
• to compare something before and after changes have been made. The story called "How Long Must We Wait?" tells about this.

THINGS TO KEEP IN MIND

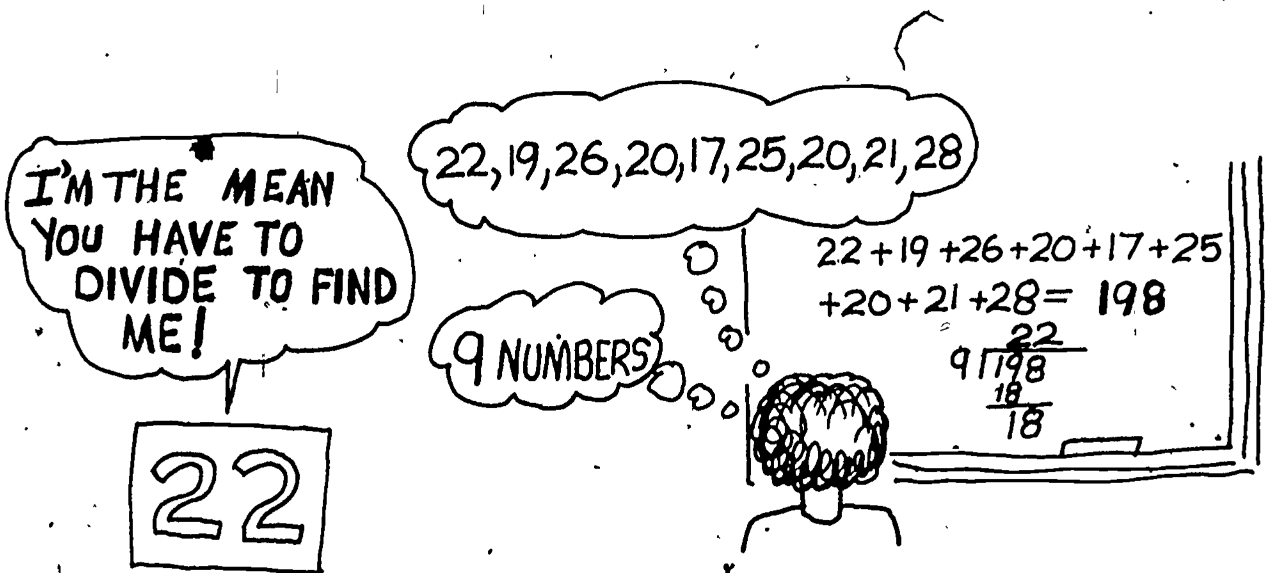
1. The MEAN is a typical number or measurement for a group of people or things. It is the number you get when the sum of the data is split into equal pieces.



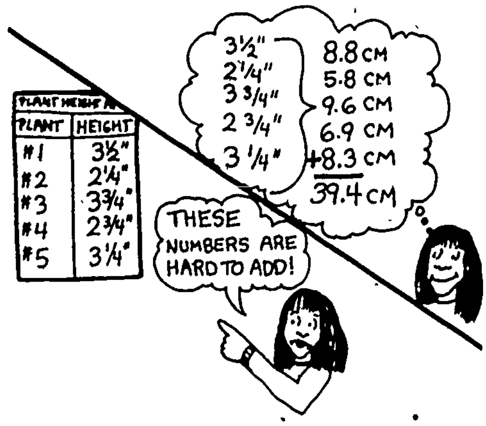
2. The MEAN is often called the AVERAGE. You can call it the AVERAGE if you want to.



3. It's easy to find the MEAN. Just DIVIDE the SUM of your data by the NUMBER of pieces in your data.

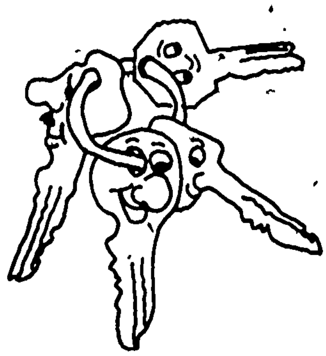


4. When you find the MEAN, use DECIMALS rather than FRACTIONS. Decimals are easier to add. They are easier to divide. And if you are using the metric system, decimals are the proper way to write your measurements.



5. The MEDIAN, the MODE, and the MEAN are all KEY NUMBERS. Each of them tells something about a whole set of numbers or measurements. Each of them tells what a typical number or measurement may be for a whole set of data.

Maybe the MEDIAN or the MODE would be better to use than the MEAN for your data. If you are not sure about which KEY NUMBER to use, you can look at "How To" Tell What Your Data Show and "How To" Use Key Numbers to Compare Two Sets of Data.



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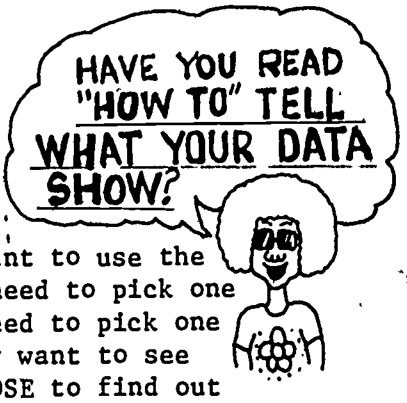
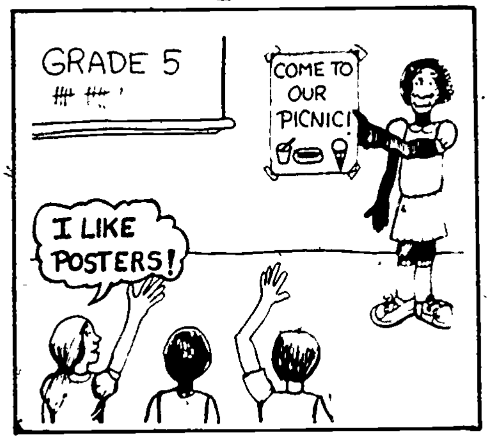
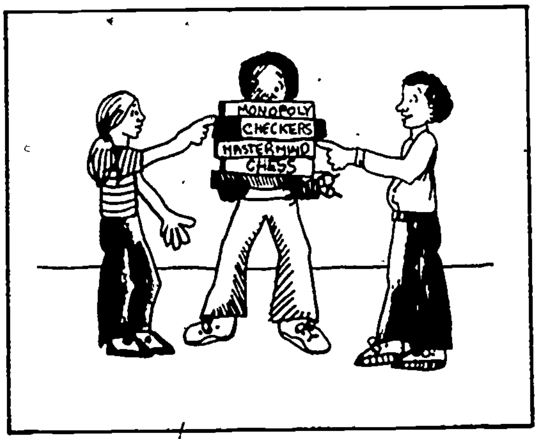
"HOW TO"

FIND THE MODE



Do you want to find out what most people like best? You may want to use the results of a vote or a survey to choose one thing. Maybe you need to pick one flavor of soft drink to serve at a class party, or maybe you need to pick one game to buy that most of the class will enjoy playing. You may want to see what things two groups of people like best. You can use the MOSE to find out these things.





WHAT IS THE MODE?

The MODE is the number or thing that is listed the most times in a set of data. When you pick the winner of a vote or a survey, you pick the number or thing that is listed the most often. You pick the MODE.

HOW DO YOU FIND THE MODE

It is easy to find the MODE. You don't have to do any figuring. All you have to do is look at your data and find the number or thing that is listed the most times.

WHEN CAN YOU USE THE MODE?

The stories in this booklet will help you decide whether the mode is the best number to use to tell about your data.

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FINDING THE MODE	2
PUTTING A DISPLAY IN THE BEST LOCATION	3
DECIDING WHAT TO MAKE FOR THE CRAFTS SALE	6
WHICH METHOD OF ADVERTISING DID YOU LIKE BEST?	7
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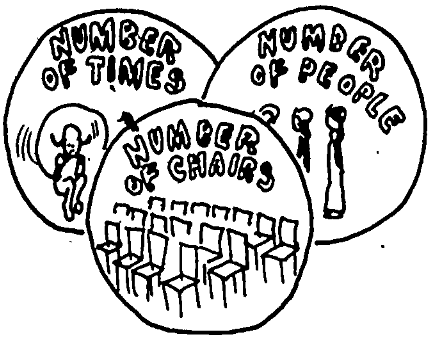
THINGS TO KEEP IN MIND	10

FINDING THE MODE

LOOK TO SEE WHAT YOUR DATA ARE. TO FIND THE MODE, YOUR DATA SHOULD BE

CATEGORIES AND NUMBER COUNTS



THE MODE IS THE THING THAT HAS THE HIGHEST NUMBER COUNT.

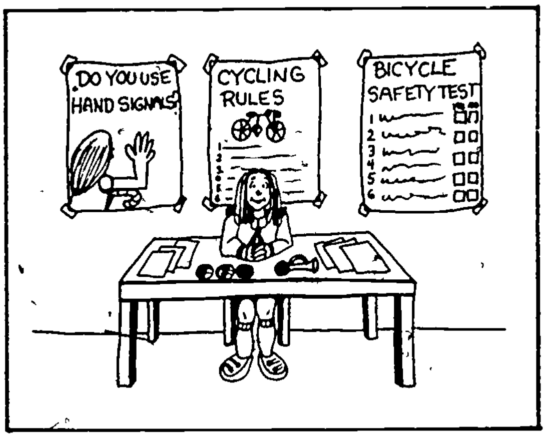
FAVORITE FLAVORS	
FLAVOR	NUMBER WHO LIKE IT
Cola	4
Orange	6
Grape	2
Root Beer	1

NUMBER COUNT

Orange got the most votes.
Orange is the MODE.

PUTTING A DISPLAY IN THE BEST LOCATION

The mode is good to use when you want to find the most frequent count or measurement of something. In this story, the students use the mode to find out the place that the most children walk by.



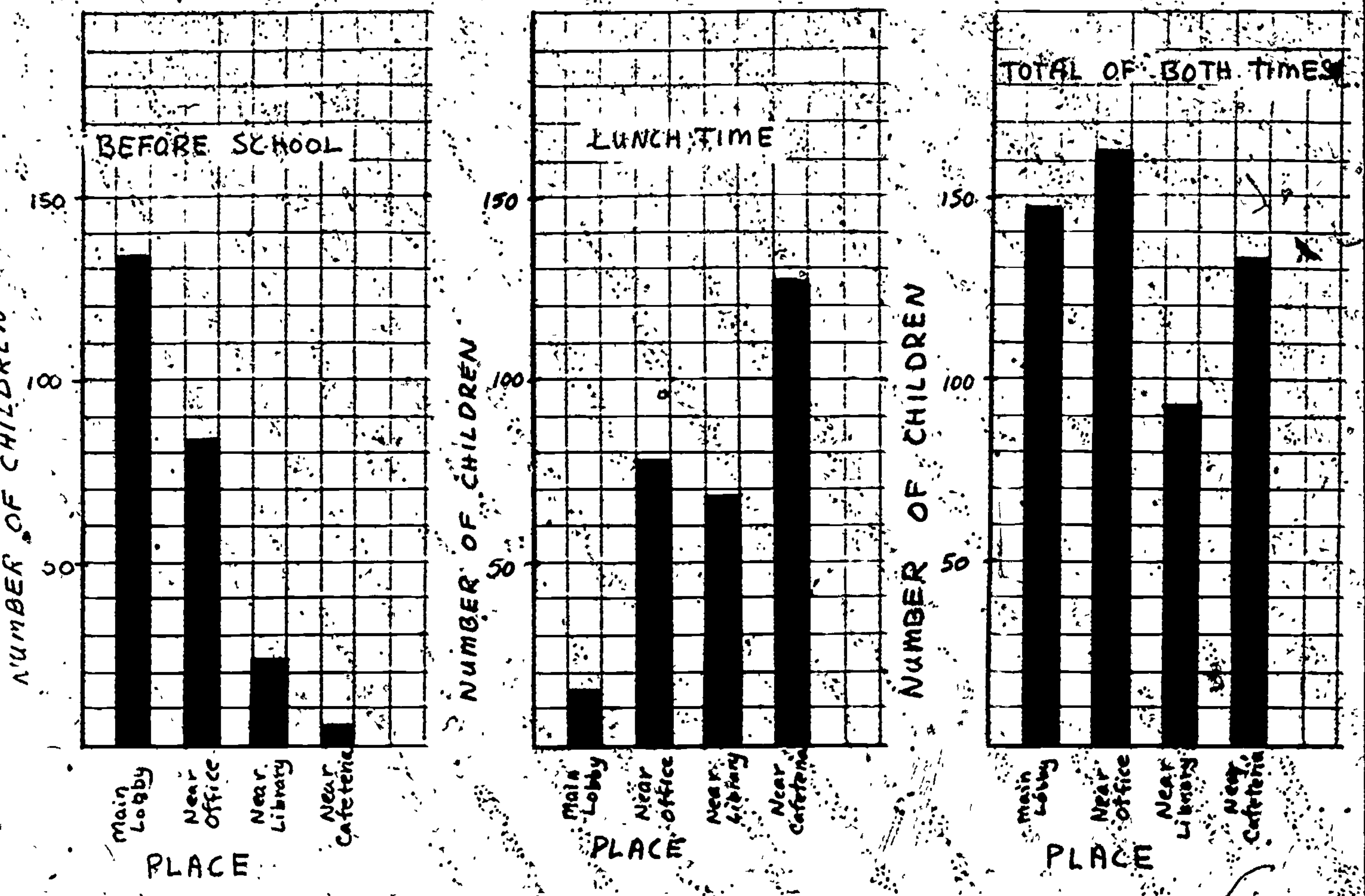
Penny's class has created a display to show the other children in the school some rules for bike safety. Now the class wants to put the display in a place where the most children will see it. They have found four possible locations for the display. They decide to count how many children pass by each location at two different times during the school day. Penny, George, Andy, and Katrin each go to one of the locations before school and at lunch time and take a count of how many children pass by in 5 minutes.

Then they make a chart of their tallies. It looks like this:

NUMBER OF CHILDREN PASSING DIFFERENT PLACES			
	Number of Children		
Place	Before School	Lunch Time	Total
Main Lobby	132	15	147
Next to Office	83	79	162
Next to Library	23	69	92
Next to Cafeteria	5	127	132

Andy says, "Looking at all these numbers is confusing. And the whole class needs to see our data to decide. Let's make some bar graphs to show them. The bar graphs will make our results easier to see."

So Penny, George, and Andy make three bar graphs. The bar graphs look like this.



The whole class looks at the bar graphs. Felicia points to the bar graph showing the TOTAL NUMBER OF CHILDREN FOR BOTH TIMES. "The tallest bar shows where the most children passed by," she says. "It is the mode. The most children passed by the office."

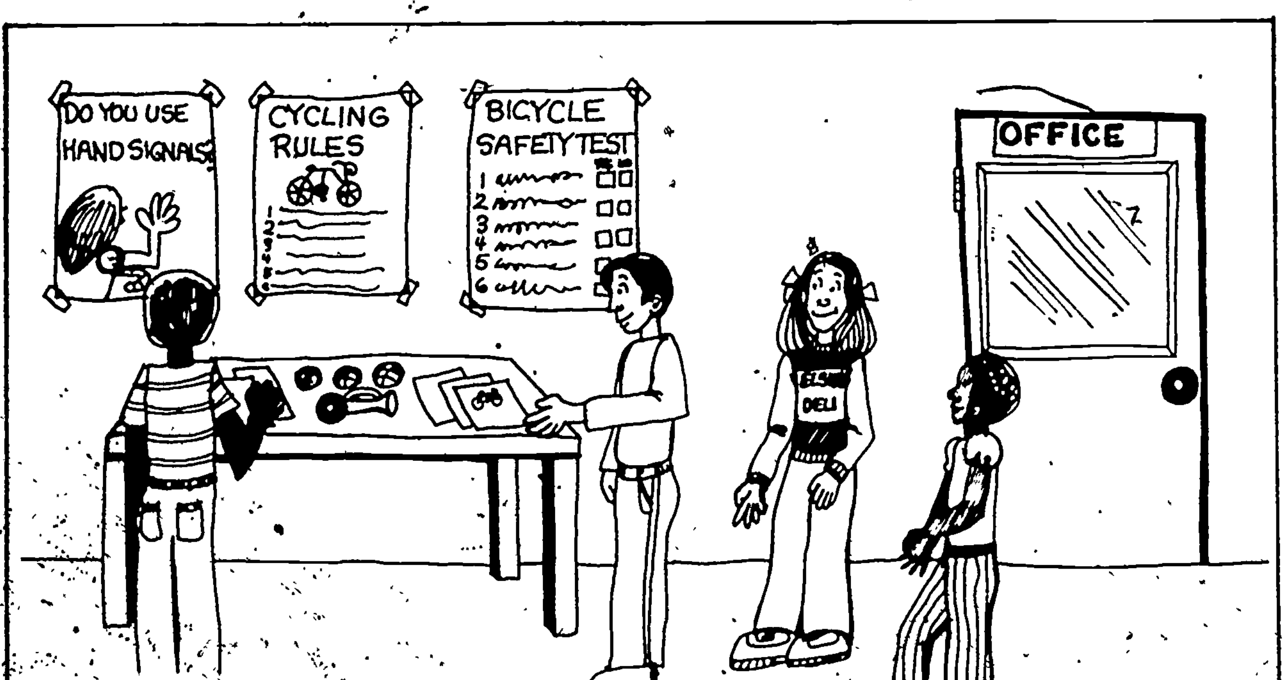
Teresa is looking at the BEFORE SCHOOL graph. She says, "The main lobby is the mode for the number of children passing by before school. The most children passed by there before school and they will pass by there on their way home, too. Maybe it would be better to put the display in the main lobby."

Willy disagrees. "When I am on my way home," he explains, "I am in a big rush. I'm not going to stop in the lobby and look at the display."

Katrin is looking at the LUNCH TIME graph. "The cafeteria is the mode for the number of children passing by at lunch time. Kids will have a chance to stand around and look at the display after they finish lunch."

Willy likes the location by the office. He says, "Kids can stand around and look at the display if it's next to the office. More kids go by the office than other places we checked. We can tell that by looking at the graph showing the TOTAL NUMBER OF CHILDREN FOR BOTH TIMES. Lots of kids go by the office both before school and at lunch time. NO ONE goes by the cafeteria before school."

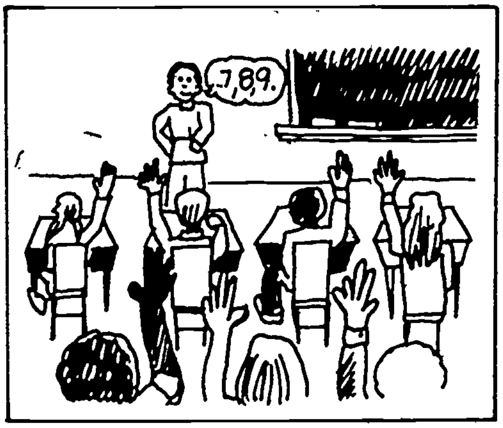
The class agrees. Next to the office is where the most children pass by. They will put the display next to the office.



DECIDING WHAT TO MAKE FOR THE CRAFTS SALE

Belmont School is having their annual crafts sale. Rachel's class wants to decide on one thing to make in quantity for the sale. Many suggestions have been made. Now the class needs to pick one thing.

Rachel lists the suggestions on the board and everyone in the class votes for their favorite two items. The results of the vote look like this:



ITEMS FOR CRAFTS SALE

ITEM	NUMBER OF VOTES
Candles	9
Bead Jewelry	10
Wristbands	5
Checkerboards	6
Key Chains	15
Autograph Books	15

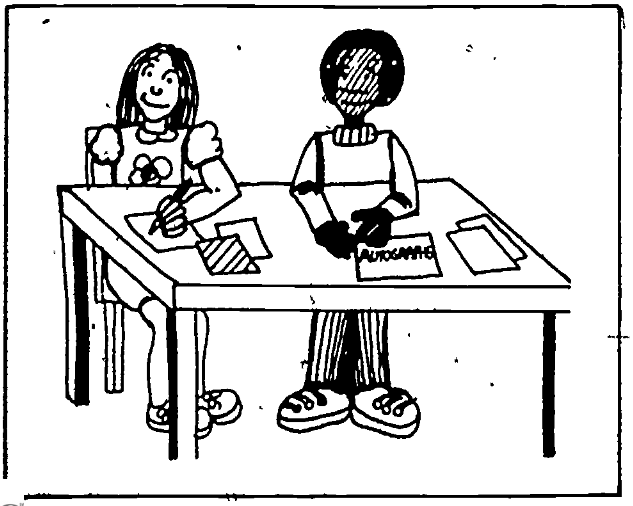
Rachel looks for the MODE. She wants to pick the item with the highest number of votes. But there's no one item with the highest number of votes. There are two items that are tied for the highest number of votes. THERE ARE TWO MODES. Autograph books and key chains both got 15 votes.

Rachel wonders how the class can decide between the two modes. She tells the class, "I think we should vote on just these two things. Maybe then we will get a winner. And if the votes are tied again we can make both things.

The children decide to vote again. Everyone has one vote. They can vote only for key chains or autograph books. When the votes are counted, key chains and autograph books are still tied.

Rachel says, "We have a tie because we have two groups of children who want to make different things. So we should make two things. One group can make key chains, and the other group can make autograph books."

Everyone in the class agrees. So Rachel's class makes two things for the crafts sale.



TWO OR MORE MODES

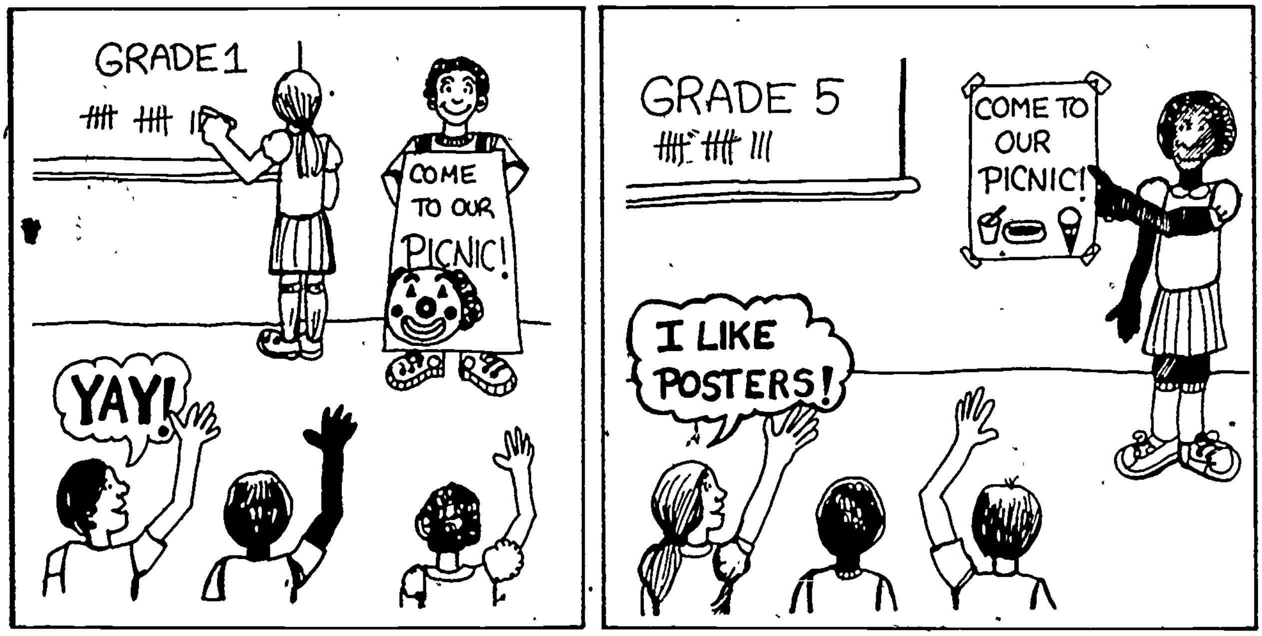
In this story, the children had two modes in their data. You may have data that has two or even more than two modes. What should you do when your data are like that?

If you have two modes or two numbers that almost tie, you should first see if the modes are telling you something about your set of data. Two modes in your data may mean that your data are the results from two separate groups of people who want or like different things. Then it may be a good idea to pick both things.

Sometimes you may not want to pick both things. You may want to pick just one thing. If so, you may have to collect new data by voting or counting again.

WHICH METHOD OF ADVERTISING DID YOU LIKE BEST?

You can use the MODE to compare the data from two different groups. Looking at the MODES for both groups will help you decide if two groups of people like the same thing best or like different things best. That is what the boys in the next story find out.



Carlo, Jamie, and Brian have conducted an opinion survey to find out which method of advertising for the school store was the most popular with their student customers. After dividing the completed surveys into primary (grades 1-3) and intermediate (grades 4-6) piles, the boys tally the responses.

Their data look like this:

WHAT METHOD OF ADVERTISING DID YOU LIKE BEST?			
PRIMARY		INTERMEDIATE	
METHOD	NUMBER OF STUDENTS	METHOD	NUMBER OF STUDENTS
Posters	27	Posters	36
Intercom	11	Intercom	5
Sandwich Boards	32	Sandwich Boards	12
Gimmick	16	Gimmick	29

The boys want to use their data to decide whether to use one method of advertising or two methods of advertising next year. They think that just one method would be better because that would take less time and they have many other things to do for the store besides advertising.

The three boys look at the data. It's easy to see that the primary students liked the sandwich boards best and the older students liked the posters best.

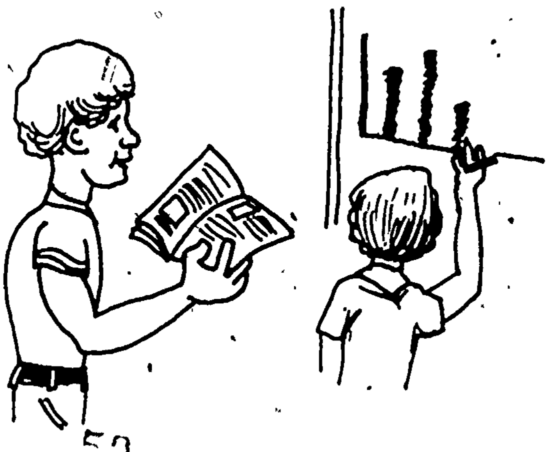
Jamie says, "We know what the mode for each group is. The mode for the primary grades is sandwich boards and the mode for the intermediate grades is the posters. But I wonder how we could pick one method that would be liked by most of the kids."

I know what we could do," says Carlo. "We can make posters to advertise the school store. We can use them on the sandwich boards we have already made. We can glue the new posters on the old sandwich boards. Then we won't be spending a lot of time on the advertising and everyone will be happy."

"Yes," says Brian, "the little kids will have what they like best and the big kids will have what they like best. But what would we have done if it didn't work out that way? What if the primary kids liked the intercom best instead of the sandwich boards? Would we have to use two methods?"

"Maybe not," says Jamie. "If the modes don't help us to decide, then we can make a graph to help us decide. I found that out when I read "How To" Use Graphs to Compare Two Sets of Data."

"I suppose I should read that booklet to see if it answers my questions," says Brian.



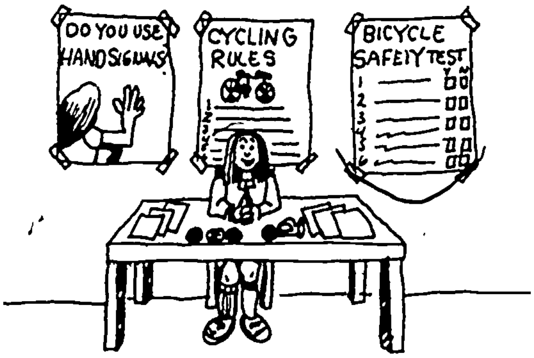
WHEN CAN YOU USE THE MODE?

USE THE MODE

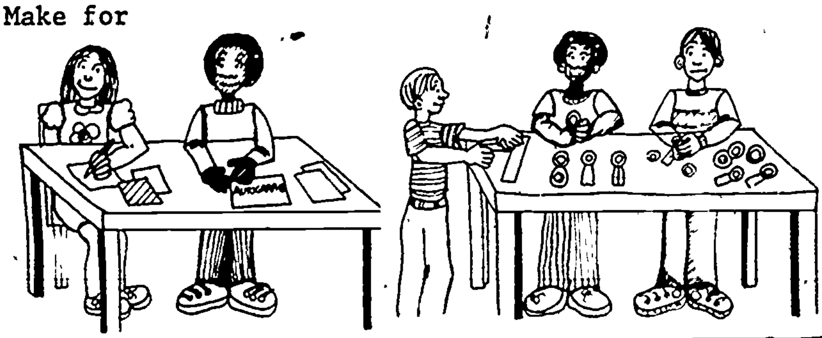
- when your data are CATEGORIES and NUMBER COUNTS.

FOR ONE SET OF DATA, USE THE MODE

- to find the most frequent count or measurement of something. The story called "Putting a Display in the Best Location" tells about this.

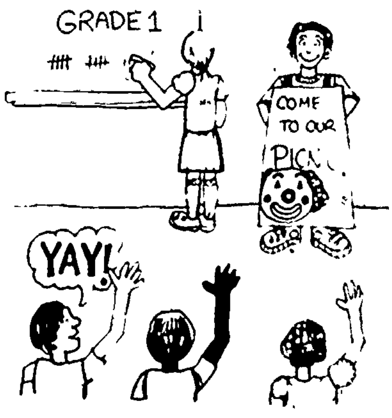


- to find the thing that most people want to do or like. See the story called "Deciding What to Make for the Crafts Sale."



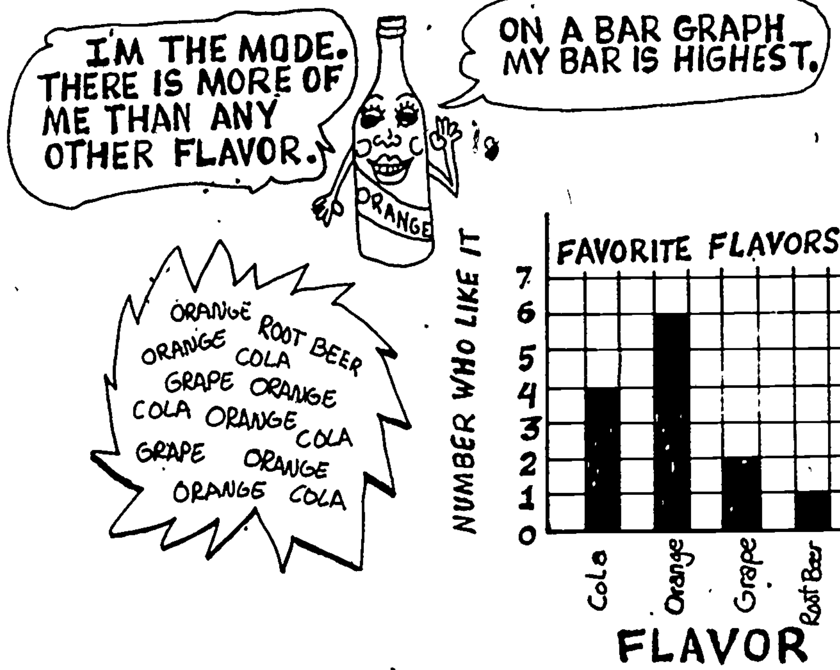
FOR TWO OR MORE SETS OF DATA, USE THE MODE

- to find if two groups or people want the same thing or different things. See the story called "Which Method of Advertising Did You Like Best?"



THINGS TO KEEP IN MIND

1. The MODE IS THE NUMBER OR THING THAT IS LISTED THE MOST TIMES IN A SET OF DATA. It is the value that occurs the most often. On a BAR GRAPH, it is the longest or highest bar.



2. With some kinds of data, such as CATEGORIES and NUMBER COUNTS, you should use the MODE. With other kinds of data, such as MEASUREMENTS and NUMBER COUNTS or two sets of MEASUREMENTS, you should use another KEY NUMBER.

3. The MODE, the MEDIAN, and the MEAN are all KEY NUMBERS. Each of them tells something about a whole set of numbers or measurements. Each of them tells what a typical number or measurement may be for a whole set of data.

Maybe the MEDIAN or the MEAN would be better to use than the MODE for your data. If you are not sure about which KEY NUMBER to use, you can look at "How To" Tell What Your Data Show and "How To" Use Key Numbers to Compare Two Sets of Data.

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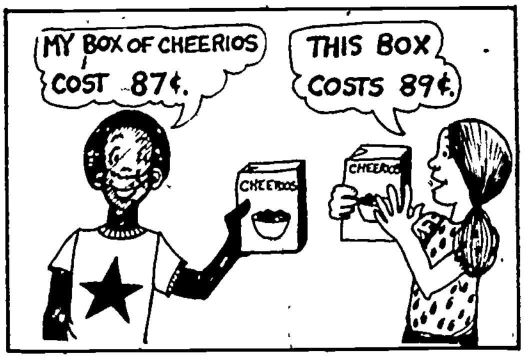
"HOW TO"

FIND DIFFERENT KINDS OF RANGES

DO YOU WANT TO FIND OUT HOW MUCH YOUR DATA VARIES OR CHANGES?

Maybe you want to know how much the price of a certain product changes from store to store.



DO YOU WANT TO COMPARE TWO DIFFERENT THINGS TO SEE WHICH THING CHANGES MORE?

Maybe you want to compare the price ranges of two different brands of cereal. Perhaps you want to compare the measurements you have made using two different tools to see which tool gives a better measurement.

DO YOU WANT TO MAKE A PREDICTION THAT HAS A 50% CHANCE OF BEING RIGHT?

You may want to predict how many times heads will come up when you toss pennies. You may want to predict the most likely temperature range for a picnic or outing.

You can use RANGES for all of these things.

WHAT IS THE RANGE?

The RANGE is the difference between the largest and smallest numbers in a set of data. The RANGE shows how much the data changes or varies. There are three kinds of RANGES. When you find the range for a whole set of data, you find the FULL RANGE. Sometimes you may want to find the RANGE of only part of the data. You may want to trim some of the largest and smallest numbers from the data. Then you find the RANGE of the TRIMMED set of data. That is the TRIMMED RANGE. Sometimes you may want to use only the numbers in the middle half of the data. Then you find the RANGE of the middle half of the data. That is the MIDDLE RANGE.

The RANGE is easy to find. This booklet will show you how to find the range. It will show you some examples of when to use different kinds of ranges. It will help you decide which range is the best to use to tell about your data.

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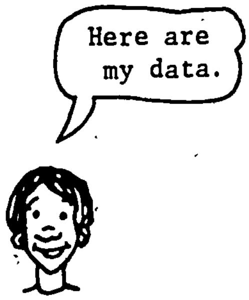
THE FULL RANGE: FINDING A PRICE RANGE 6
THE TRIMMED RANGE: DECIDING WHICH TOOL IS BETTER 7
THE MIDDLE RANGE: PREDICTING HEADS AND TAILS 9
THE MIDDLE RANGE: PREDICTING A TEMPERATURE RANGE 11
WHEN CAN YOU USE DIFFERENT KINDS OF RANGES? ....
THINGS TO KEEP IN MIND 16

FINDING DIFFERENT KINDS OF RANGES

THE FULL RANGE: To find the FULL RANGE of a set of data, subtract the smallest number in the data from the largest number in the data.

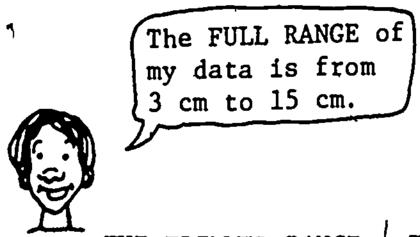


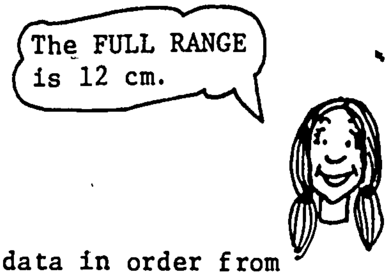
DATA

12 cm, 7 cm, 10 cm, 8 cm, 15 cm, 9 cm, 11 cm, 3 cm

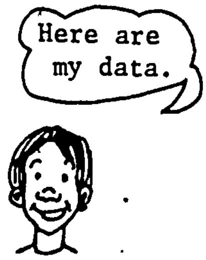
LARGEST NUMBER ↑ (15 cm) SMALLEST NUMBER ↑ (3 cm)

15 cm - 3 cm = 12 cm ⟵ THE FULL RANGE





THE TRIMMED RANGE: To find the TRIMMED RANGE, first put the data in order from smallest to largest. Then trim some of the largest and smallest numbers from your data. You can trim as many as you need to, but you should trim the SAME NUMBER of pieces of data from each end. Trim your data when the largest or smallest numbers (or both) may be MISTAKES or MEASUREMENTS THAT ARE UNLIKELY TO HAPPEN AGAIN.

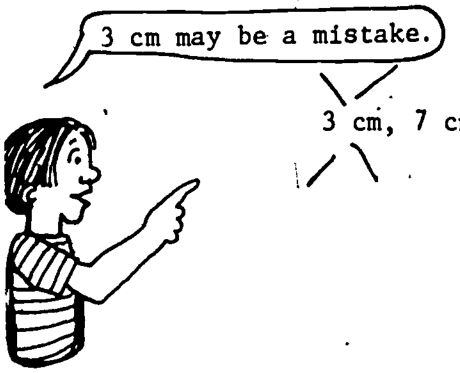


DATA

12 cm, 7 cm, 10 cm, 8 cm, 15 cm, 9 cm, 11 cm, 3 cm

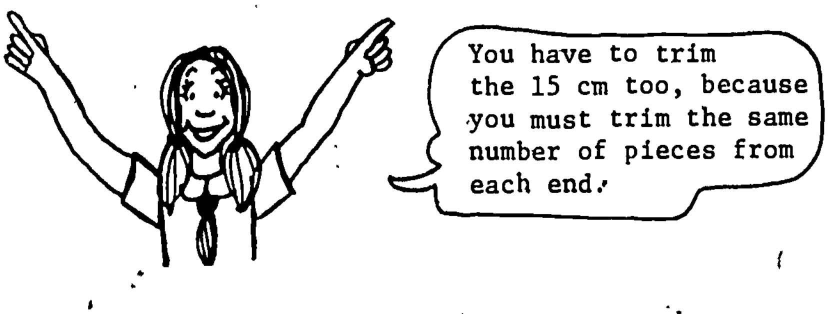
DATA PUT IN ORDER FROM SMALLEST TO LARGEST

3 cm, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm, 15 cm

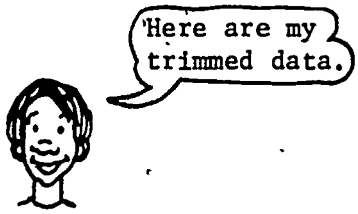


TRIMMED DATA

~~3 cm~~, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm, ~~15 cm~~



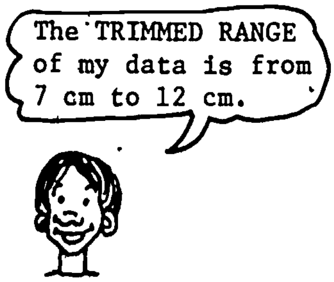
After the data are trimmed, find the range of the data that are left.



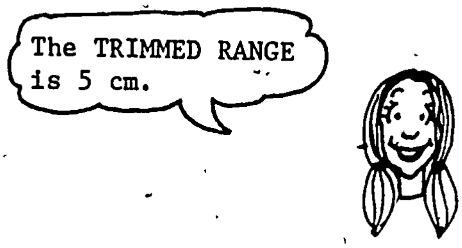
TRIMMED DATA

7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm

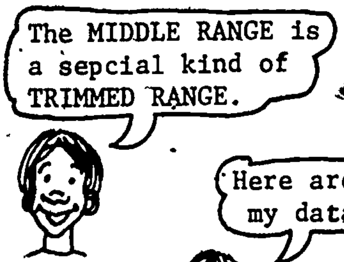
↑ SMALLEST NUMBER ↑ LARGEST NUMBER



12 cm - 2 cm = 5 cm ⟵ THE TRIMMED RANGE



THE MIDDLE RANGE: To find the MIDDLE RANGE, first put the data in order from smallest to largest. Then count how many pieces of data you have. Divide that number by 4. Cross off that many pieces of data from each end of the data. Now you have the middle half of the data.

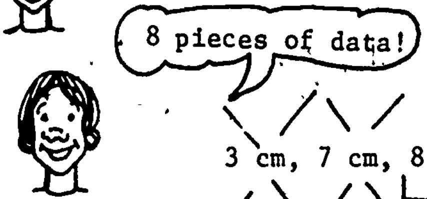


DATA

12 cm, 7 cm, 10 cm, 8 cm, 15 cm, 9 cm, 11 cm, 3 cm

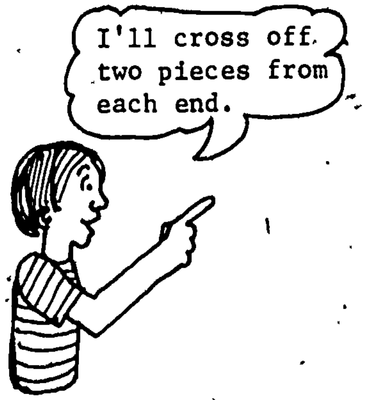
DATA PUT IN ORDER FROM SMALLEST TO LARGEST

3 cm, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm, 15 cm



~~3 cm~~, ~~7 cm~~, 8 cm, 9 cm, 10 cm, 11 cm, ~~12 cm~~, ~~15 cm~~

MIDDLE HALF OF DATA

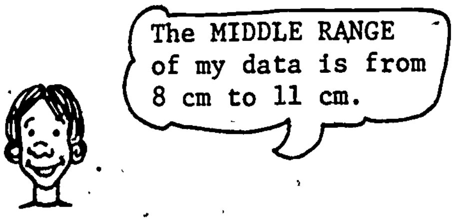


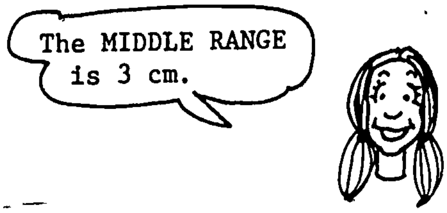
Now find the range of the MIDDLE HALF OF THE DATA.

8 cm, 9 cm, 10 cm, 11 cm

SMALLEST NUMBER (8 cm) — LARGEST NUMBER (11 cm)

11 cm - 8 cm = 3 cm ⟵ MIDDLE RANGE





FINDING THE MIDDLE RANGE WHEN THE NUMBER OF PIECES IN YOUR DATA ARE NOT DIVISIBLE BY FOUR

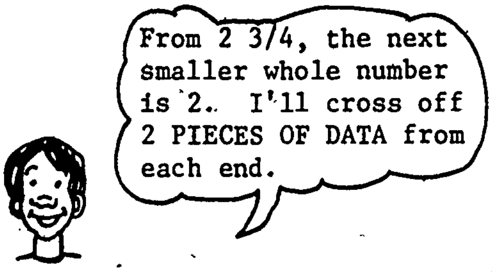
Sometimes you may divide the number of pieces of data by 4 and get a FRACTIONAL ANSWER.

DATA

3 cm, 4 cm, 4 cm, 5 cm, 7 cm, 7 cm, 8 cm, 9 cm, 11 cm, 12 cm, 15 cm

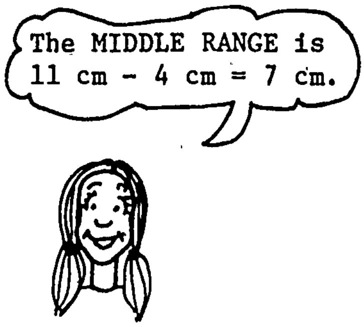
When you have a fractional answer like 2 3/4 or 7 1/2 or 9 1/4, round it off to the next smaller whole number:

$$2\tfrac{3}{4} \longrightarrow 2 \qquad 7\tfrac{1}{2} \longrightarrow 7 \qquad 9\tfrac{1}{4} \longrightarrow 9$$

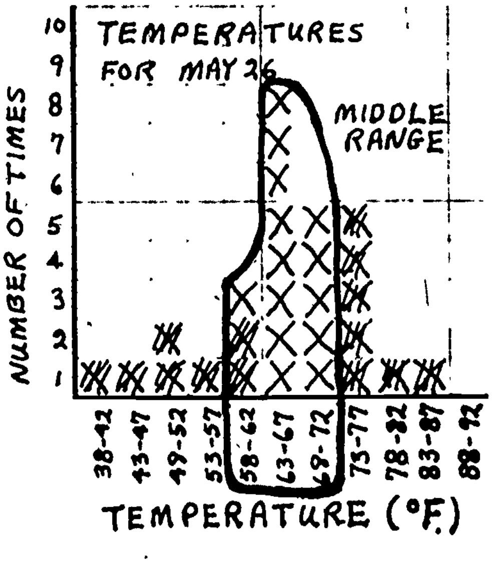


~~3 cm~~, ~~4 cm~~, 4 cm, 5 cm, 7 cm, 7 cm, 8 cm, 9 cm, 11 cm, ~~12 cm~~, ~~15 cm~~

$\underbrace{\text{4 cm, 5 cm, 7 cm, 7 cm, 8 cm, 9 cm, 11 cm}}_{\text{MIDDLE HALF OF DATA}}$

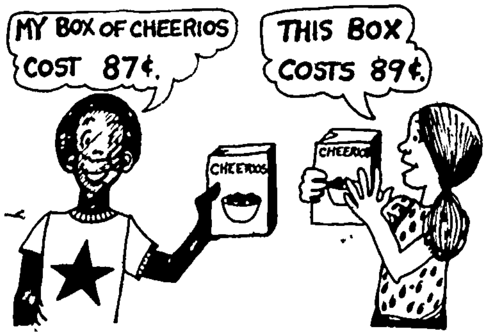


If you have a lot of numbers in your data, it's easier to find the middle half of the data by making a histogram. You can find out how to use a histogram to do this by reading the story called PREDICTING A TEMPERATURE RANGE.



THE FULL RANGE: FINDING A PRICE RANGE

Sometimes when you are collecting data, you may want to know how much the data changes or varies. You may want to see how much the scores on a test vary or how much the price of a product changes in different stores. You can use the RANGE to find out these things. That's what the next story is about.



Clea's class is working on a consumer research project. Donna, Clea, and Peter are the Cheerios group. They are testing Cheerios to see how good a cereal it is. They are interested in the price of Cheerios, too. They have found that an 18 oz. package of Cheerios sells for different prices at different stores. They have made a list of the prices. It looks like this.

CHEERIOS PRICES	
STORE	PRICE
A & P	89¢
Star	87¢
Kenny's	97¢
Purity	85¢

Clea wonders how they can tell anything about the price of Cheerios from the data. "Let's put the prices in order from smallest to largest," says Donna. "Then we can see how much the price changes. We can see what the range of the prices is."

And so they do.

CHEERIOS: 85¢, 87¢, 89¢, 97¢

Cheerios has a price range of 85¢ to 97¢. Donna subtracts 85¢ from 97¢. She finds that the range is 12¢.

"Good," says Clea. "We can tell the class that Cheerios has a price range of 85¢ to 97¢ or a range of 12¢ in price in the stores we visited."

Peter thinks that a range of 12¢ is large. He asks the Corn Flakes group if they have done anything with the prices they got for Corn Flakes. The Corn Flakes group shows Peter their data. It looks like this.

	A & P	Kenny's	Star	Purity
CORN FLAKES	79¢	83¢	81¢	77¢

The Corn Flakes is an 18 oz. package, too. Peter figures out the price range for Corn Flakes. It is from 77¢ to 83¢. The range for Corn Flakes is 83¢ - 77¢ or 6¢. Peter is surprised. "The price of Corn Flakes doesn't change as much at the stores we visited," he says. "The range for Corn Flakes is 6¢ and the range for Cheerios is 12¢.

Peter says, "We should tell the class that the price of Cheerios changes quite a bit from store to store. It's more important to shop carefully for Cheerios than for Corn Flakes because the price varies more."

THE TRIMMED RANGE: DECIDING WHICH TOOL IS BETTER

Maybe you want to find which of two tools is better to use for a measurement. You can take several measurements of the same thing with both tools and then find out how much each set of measurements varies. Finding the TRIMMED RANGE of each set of measurements is a good way to do this. That's what the next story is about.

Darlene, Tania, and Clinton are measuring for a new playground. They have to measure along a wall of the school. Because the ground is rather bumpy where they need to measure for the playground, they decide that they should test their measuring tools to see which tool will give them the best measurement. They measure along the wall ten times with a trundle wheel and ten times with a tape measure. They measure to the nearest meter with both tools. Then they put the two sets of measurements in order from smallest to largest. Now the data look like this.

LENGTH OF WALL USING THE TRUNDLE WHEEL (meters)

149, 150, 154, 157, 157, 159, 159, 160, 161, 168

LENGTH OF WALL USING THE TAPE MEASURE (meters)

144, 145, 152, 152, 153, 154, 154, 155, 156, 160

Clinton looks at the highest and lowest measurements for each set of data. "Look," he says, "these numbers seem quite a bit bigger or smaller than most of our measurements."

Tania is confused. "What numbers are your talking about?" she asks. Clinton puts a check mark over the measurements he means.

TRUNDLE WHEEL: 149, 150, 154, 157, 157, 159, 159, 160, 161, 168
(meters)

TAPE MEASURE: 144, 145, 152, 152, 153, 154, 154, 155, 156, 160
(meters)

Darlene and Tania look at the numbers that Clinton has marked. They agree that they may have made some mistakes when they measured. Darlene is upset. "I wanted to find the ranges. Then we could decide which tool to use by looking at the ranges for each group of measurements. The measurements with the smallest range would show us which tool is better. But, if the biggest and smallest numbers are mistakes, finding the ranges won't help too much."

Clinton has a solution. "Why don't we throw out the numbers that I marked? We can trim them off the data. Then we can find the ranges for the measurements we have left. We can find the trimmed-ranges."

Tania and Darlene think Clinton has a good idea. But they remind him that the same number of measurements must be trimmed from each end of the data. So they trim 2 measurements from each end of each set of data. Altogether, they trim four measurements from each set of data. Now the trimmed data look like this.

TRIMMED DATA FOR TRUNDLE WHEEL (meters)

~~149~~, ~~150~~, 154, 157, 157, 159, 159, 160, ~~161~~, ~~168~~

TRIMMED DATA FOR TAPE MEASURE (meters)

~~144~~, ~~145~~, 152, 152, 153, 154, 154, 155, ~~156~~, ~~160~~

Darlene finds the range for each set of trimmed data by subtracting the smallest number from the largest number:

TRUNDLE WHEEL: 160 m - 154 m = 6 m

TAPE MEASURE: 155 m - 152 m = 3 m

All of the measurements for the trundle wheel are within 6 meters of each other and all of the measurements for the tape measure are within 3 meters of each other.

"We should use the tape measure," says Darlene. "It's a better tool to use than the trundle wheel because the measurements are closer together."

"Yes," says Clinton, "the numbers for the trundle wheel are larger too. We probably measured dips and bumps in the ground with the trundle wheel. The tape measure gives a better measurement of the length."

THE MIDDLE RANGE: PREDICTING HEADS AND TAILS

You may want to predict which numbers are most likely to come up when you toss dice or how many heads are likely to come up when you toss a coin many times. One way to make a prediction that has a 50% chance of being right is to find the MIDDLE RANGE of the data. That is what the next story is about.

Amy, Rico, and Gus want to find out if there is a pattern to the number of heads that come up when a set of ten pennies is tossed many times. Rico thinks that five heads will come up the most often but Gus thinks that three heads or four heads are just as likely to come up as five heads. So Amy, Rico, and Gus decide to toss pennies to see what kind of pattern they get.

They decide that each of them will toss ten pennies ten times and record their results. When they finish tossing, the data look like this.

NUMBER OF HEADS IN A TOSS OF TEN PENNIES

Amy's Tosses	4, 7, 6, 5, 6, 8, 5, 6, 2, 5
Rico's Tosses	9, 5, 5, 3, 2, 6, 5, 5, 7, 10
Gus' Tosses	1, 6, 5, 4, 5, 6, 4, 8, 5, 6

Amy, Gus, and Rico look at their results. They don't see any pattern to the tosses. Then Amy says, "Let's put all our numbers in order from smallest to largest. Maybe we will see a pattern then." She lists the numbers in order on the board:

1,2,2,3,4,4,4,5,5,5,5,5,5,5,5,5,5,6,6,6,6,6,6,6,7,7,8,8,9,10

"Hey!" says Gus. "Now I see a pattern. The numbers in the middle are repeated a lot. The numbers on the ends come up only once or twice. It looks like 5 heads and 6 heads are the most likely to come up."

Rico shows the teacher what they have done. "You have done a good job so far," she says. "Now you can use the middle range to predict the number of heads that will come up 50% of the time."

Rico tells Amy and Gus what the teacher said. "We can find the middle range. The numbers that are in the middle range will have a 50% chance of coming up."

Amy wants to see. "What is the middle range? How do you find it?" she asks Rico.

Rico explains some more. "It's easy," he says. "The middle range is the range of the middle half of the data. All we have to do is find the middle half of our data. Then we look at the largest and smallest numbers in the middle half. They tell what the range of the middle half of the data is."

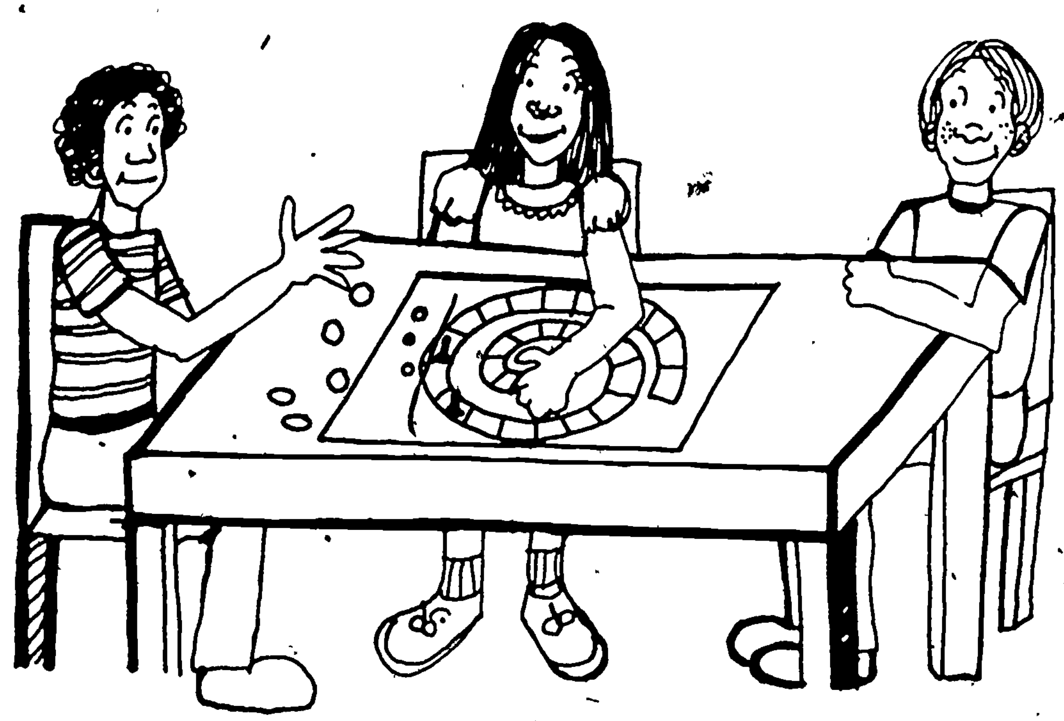
Then Rico finds the middle half of the data. First he counts the pieces of data. There are 30 pieces of data. He divides the number of pieces by four, and gets $7\frac{1}{2}$. Then he changes the $7\frac{1}{2}$ to 7 because 7 is the next smaller whole number. "I am dividing the data into 4 parts," he tells Amy. "But the parts won't be exactly equal because 4 doesn't divide into 30 evenly. Since I can't cross off $7\frac{1}{2}$ pieces of data from each end, I make the $7\frac{1}{2}$ be the next smaller whole number and cross off 7 pieces of data from each end. The middle half of the data will be what is left."

Rico crosses off 7 pieces of data from each end. Now the data look like this.

X,X,X,X,X,X,X,5,5,5,5,5,5,5,5,5,5,6,6,6,6,6,6,X,X,X,X,X,X,1X

Amy and Gus look at what Rico has done. The smallest number in the middle range is 5. The largest number is 6. Five and six are the most likely number of heads to come up when 10 pennies are tossed many times. And 5 heads is more likely than 6 heads because there are 10 fives and only 6 sixes in the middle range.

Amy, Gus, and Rico are happy that they have found a way to predict how many heads will come up when pennies are tossed. They decide that they will make up a game that uses penny tossing to tell the number of spaces to jump. They know that they will jump 5 or 6 spaces more than any other number of spaces if they use ten pennies.



THE MIDDLE RANGE: PREDICTING A TEMPERATURE RANGE

Maybe you are planning an outdoor event, such as a picnic, fair, or bicycle trip. Predicting what the temperature range will be can help you plan your activities better. You can use the MIDDLE RANGE to do this. That's what the next story is about.

Denise and Jason are planning activities for their class picnic which will be held on May 26. Denise wonders whether it will be warm enough to go swimming. Jason thinks that they should try to predict what the temperature will be on May 26. Then they can plan activities to fit the temperature.

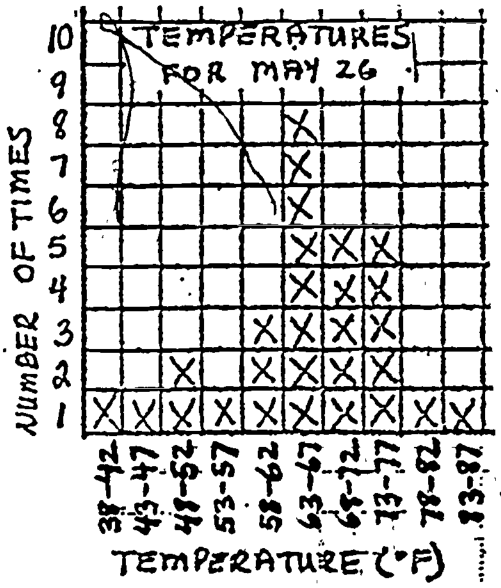
First they go to the library and find a book that lists temperatures. It tells the highest temperature on May 26 for 1976, 1975, and all the way back to 1900. Denise and Jason want to use the highest temperatures because the picnic will be held during the hottest part of the day.

Denise and Jason decide that they will list the highest temperatures on May 26 from 1949 to 1976. They will have 28 numbers. They think that is enough numbers to make a prediction. Their list looks like this.

TEMPERATURES FOR MAY 26 (^{o}F)			
YEAR	HIGHEST TEMPERATURE	YEAR	HIGHEST TEMPERATURE
1949	60	1963	67
1950	45	1964	77
1951	76	1965	87
1952	65	1966	74
1953	67	1967	40
1954	70	1968	70
1955	74	1969	65
1956	66	1970	62
1957	70	1971	72
1958	67	1972	62
1959	78	1973	49
1960	67	1974	51
1961	64	1975	72
1962	76	1976	53

There are a lot of numbers on the list. Jason, who has read "How To" Make A Histogram, knows what to do when there are a lot of numbers. "We can group these temperatures by fives and make a histogram. We will be able to tell which temperatures occur most often by looking at the columns of the histogram."

"Yes," says Denise, "a histogram will help us to see the data better." So Jason and Denise make a histogram. It looks like this.



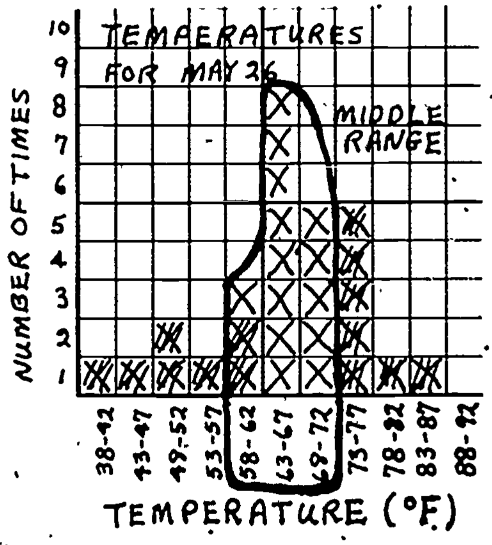
Denise knows how to find the range. She tells Jason, "The lowest temperature is in the 38°-42° column. The highest temperature is in the 83°-87° column. So the temperature range for our picnic will be between 38° and 87°F."

"Yes," says Jason, "but that's a difference of almost 50°. We might as well not bother to predict at all if we have to use those temperatures. If it's 38°, I want to wear my winter coat, and if it's 87°, I want to go swimming. We can't plan anything with a temperature range like that.

Denise wonders who they can predict. Then she has an idea. "Why don't we get rid of some of the temperatures that don't happen so often and find the range of what's left?" she asks Jason.

Jason listens to Denise. "O.K.," he says, "there are more Xs in the middle of the graph than on the sides. Let's just use the middle half of the data. Here's how we can find the middle half: there are 28 Xs all together and half of that is 14. There should be 14 Xs in the middle half of the data and 14 Xs outside. And 14 Xs outside means 7 Xs on each end. We can just cross off 7 Xs from each end and look at what's left on the graph. And if we use just the middle half of the data, we will have 14 chances of being right and 14 chances of being wrong. That's a 50% chance of being right."

So Jason crosses off 7 Xs from each end of the graph. There are 14 Xs left in the middle. Now the graph looks like this.



Denise looks at the graph. "Now we can find the range of these temperatures. The range will go from 58°-72°."

"Yes," says Jason, "and if we predict the temperature will be 58°-72°F., we'll have a 50% chance of being right."

Denise looks at the graph again. She asks Jason about the other Xs between 58° and 72° that are inside the loop but are crossed off.

Jason is happy. "These Xs are in the 58° to 62° column. That means that if we predict a temperature of between 58° and 72°F., we really have 16 chances out of 28 of being right instead of 14 chances. We have more than a 50% chance of being right."

"That's a good prediction," says Denise. "We can tell the rest of the class that the temperature will probably be between 58° and 72°F. for the picnic. That's a range of 14°. We can tell from these temperatures that games like baseball, or volleyball, or badminton would be good activities but that it will be too cold to go swimming."

The next day Denise looks at the graph again. She wonders what the temperature range would be for exactly the middle half of the data.

Jason asks her, "You mean what the temperatures are on our first list for the middle 14 Xs?"

"Yes," says Denise. "I can see from the picture that 2 out of the 3 Xs in the 58°-62° column are crossed off. Only the X for the highest temperature in that column is left."

"Let's find out what that temperature is by looking at our first list," says Jason. "But what about the other end? All of the Xs in the 68°-72° column are included in the middle half of the data."

"We can look for the highest temperature on the list that fits in that column, too. It's probably 72°," Denise replies.

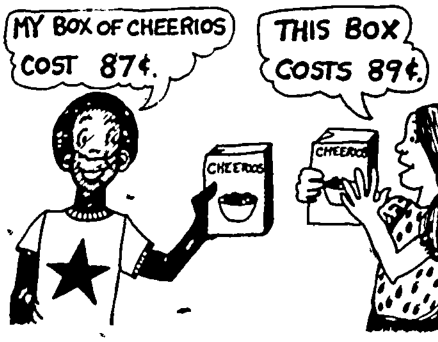
And so they do. They look at the list for the highest temperature that could be in the 58°-62° column. First they circle all the temperatures on the list that are in that column. Then they pick out the highest one. It is 62°F. Next they put checks next to all the temperatures that fit in the 68°-72° column. They pick the highest temperature. It is 72°F. The list looks like this.

TEMPERATURES FOR MAY 26 (°F)			
YEAR	HIGHEST TEMPERATURE	YEAR	HIGHEST TEMPERATURE
1949	60	1963	67
1950	45	1964	77
1951	76	1965	87
1952	65	1966	74
1953	67	1967	40
1954	70 ✓	1968	70 ✓
1955	74	1969	65
1956	66	1970	62
1957	70 ✓	1971	72 ✓
1958	67	1972	62 HIGHEST
1959	78	1973	49
1960	67	1974	51
1961	64	1975	72 ✓ HIGHEST
1962	76	1976	53

"Isn't this interesting?" says Denise. "The temperature range for the exact middle half of the data is from 62° to 72°. That's a range of only 10°. That's an even better prediction than we got yesterday. But it doesn't change our plans for the picnic. We can still play volleyball, or baseball, or badminton."

WHEN CAN YOU USE DIFFERENT KINDS OF RANGES?

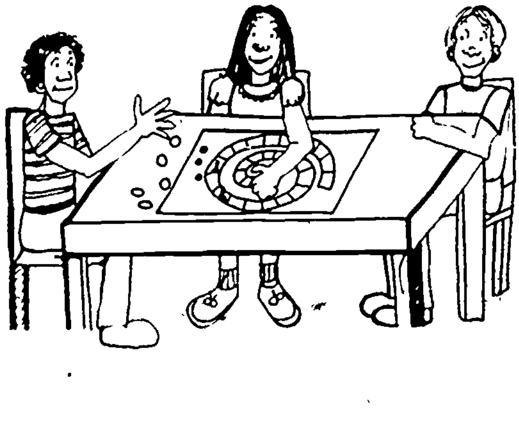
FOR ONE SET OF DATA,



- use the FULL RANGE to find out how much your data varies or changes. You may want to find the range of a set of test scores or the price range of a product. The story called "The Full Range: Finding A Price Range" tells about this.

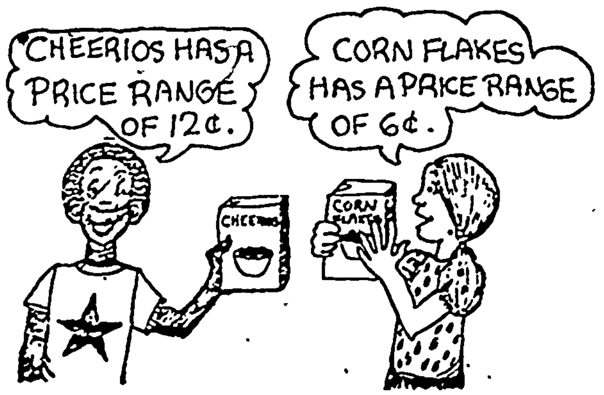
- use the TRIMMED RANGE when you need to trim your data because of possible errors or because of measurements that won't happen again.

- use the MIDDLE RANGE to predict the number of heads that will come up 50% of the time when you toss coins or to predict a temperature range that will have a 50% chance of being right. See the stories called "The Middle Range: Predicting Heads and Tails," and "The Middle Range: Predicting a Temperature Range."



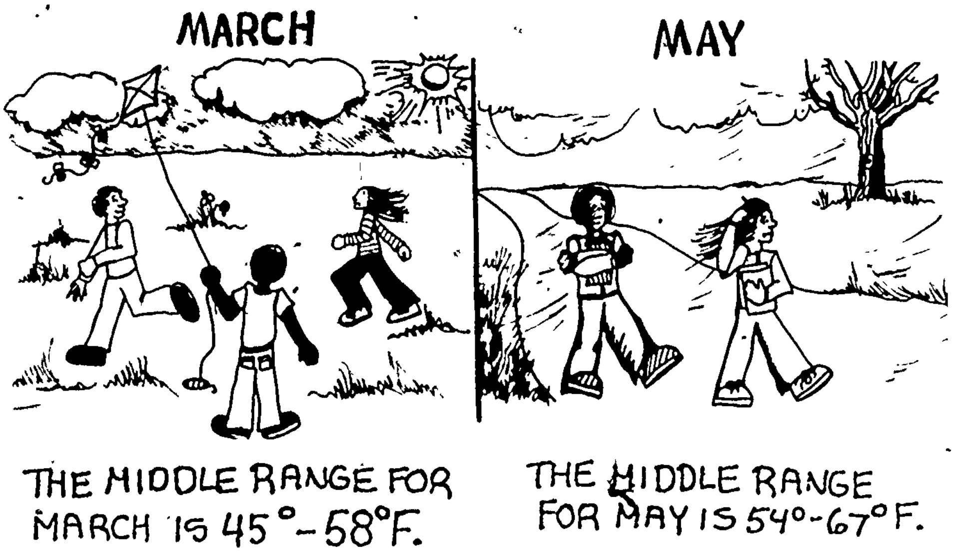
FOR TWO SETS OF DATA,

- use the FULL RANGE when you want to compare two different things to see which thing changes more or less. You can compare the price ranges of two different products or the test scores for two groups of children.

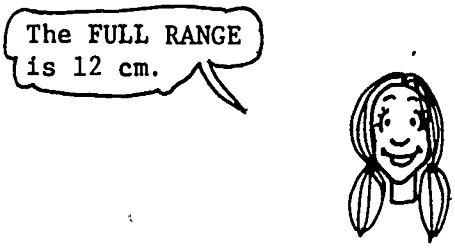


- use the TRIMMED RANGE when you want to compare two different things but you need to trim the data because of possible errors or because of measurements that won't happen again. "The Trimmed Range: Deciding Which Tool is Better" tells about this.

- use the MIDDLE RANGE when you want to compare the middle 50% of two sets of data. You can compare the temperature ranges for two different months or the middle range of coin tosses for two sets of data.



THINGS TO KEEP IN MIND

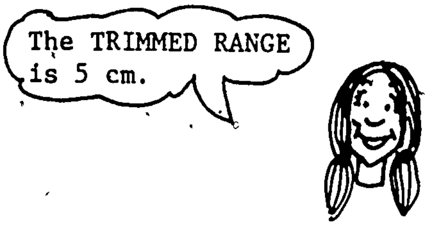


1. The FULL RANGE is the difference between the largest and smallest numbers in a set of data. It shows how much the data changes or <u>varies</u>.

DATA

3 cm, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm, 15 cm

15 cm - 3 cm = 12 cm ⟵ THE FULL RANGE



2. The TRIMMED RANGE is the difference between the largest and smallest numbers in a trimmed set of data.

TRIMMED DATA

~~3 cm~~, 7 cm, 8 cm, 9 cm, 10 cm, 11 cm, 12 cm, ~~15 cm~~

12 cm - 7 cm = 5 cm ⟵ THE TRIMMED RANGE

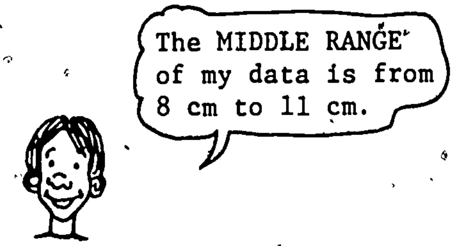
3. The MIDDLE RANGE goes from the smallest to the largest number in the middle half of the data.

~~3 cm~~, ~~7 cm~~, $\underbrace{\text{8 cm, 9 cm, 10 cm, 11 cm}}$, ~~12 cm~~, ~~15 cm~~

↑

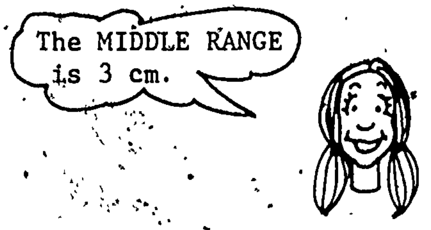
MIDDLE HALF OF DATA

11 cm - 8 cm = 3 cm ⟵ MIDDLE RANGE

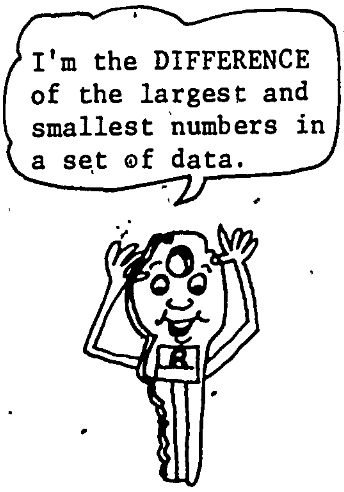


Sometimes you may want to use the smallest and largest numbers in the middle range.

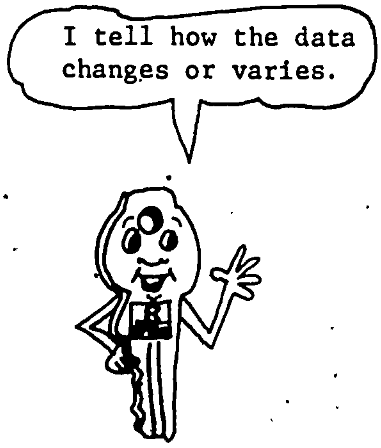
Sometimes you may want to find the <u>difference</u> between the largest and smallest numbers in the middle range.

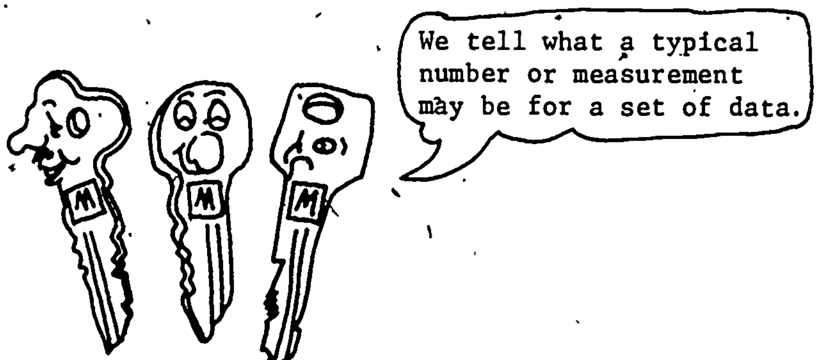


4. You always find the RANGE the same way, even if it's a TRIMMED RANGE or a MIDDLE RANGE. You subtract the smallest number from the largest number in the data you are using. But sometimes you use only a part of the data (when you are finding a trimmed range or a middle range). Then you have to do something to the data before finding the range.

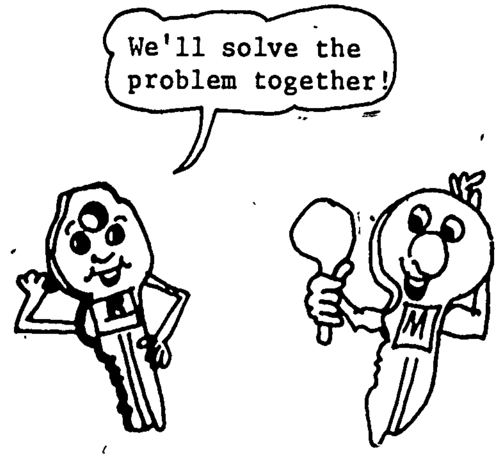


5. The RANGE is a KEY NUMBER. But it is different from the other key numbers. The RANGE tells how much a set of data changes or varies. The other KEY NUMBERS are the MEDIAN, the MODE, and the MEAN. They all tell what a typical number or measurement may be for a set of data.





Maybe the MODE or the MEDIAN or the MEAN would be better to use than the RANGE for your data. Or maybe you can solve your problem by using a RANGE and another KEY NUMBER. If you are not sure about which KEY NUMBER to use, you can look at "How To" Tell What Your Data Show and "How To" Use Key Numbers to Compare Two Sets of Data.



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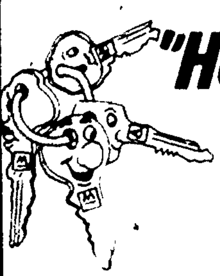
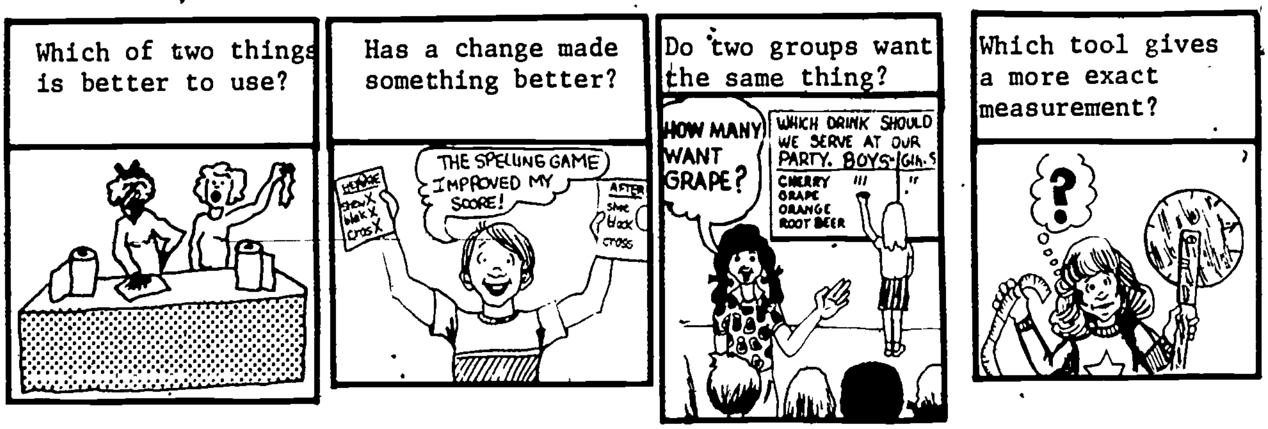


"HOW TO"

Do you have only one set of data? Do you want to find out more about KEY NUMBERS? Then read "How To" Tell What Your Data Show.

USE KEY NUMBERS TO COMPARE TWO SETS OF DATA

Maybe you have collected two sets of data, but you don't know what to do with your data. You may want to find out one of these things:



It is better to compare your data than to guess. You will be more confident of your results. And so will others.

KEY NUMBERS will make the data easy to compare. You can find a KEY NUMBER for each set of data. You may want to find the MEDIAN, or the MEAN, or the MODE, or the RANGE for each set of data. They are all KEY NUMBERS. Then you can compare the two KEY NUMBERS. It is easier to compare two numbers than to compare two big bunches of numbers.

But how will you know which KEY NUMBERS to compare for YOUR data?

THAT DEPENDS. It depends on what your data are like.
It depends on what you want to find out from your data.

The stories inside use KEY NUMBERS to compare two sets of data. They will help you decide the best way to compare your sets of data using KEY NUMBERS.

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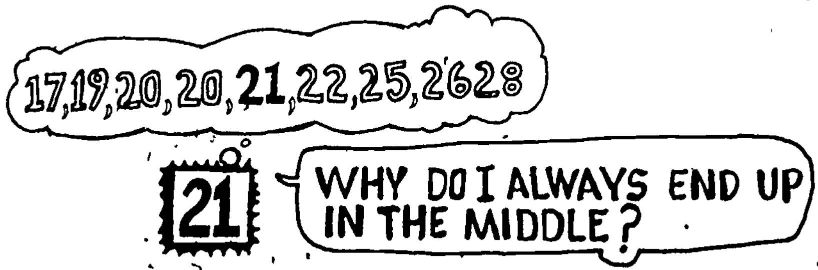
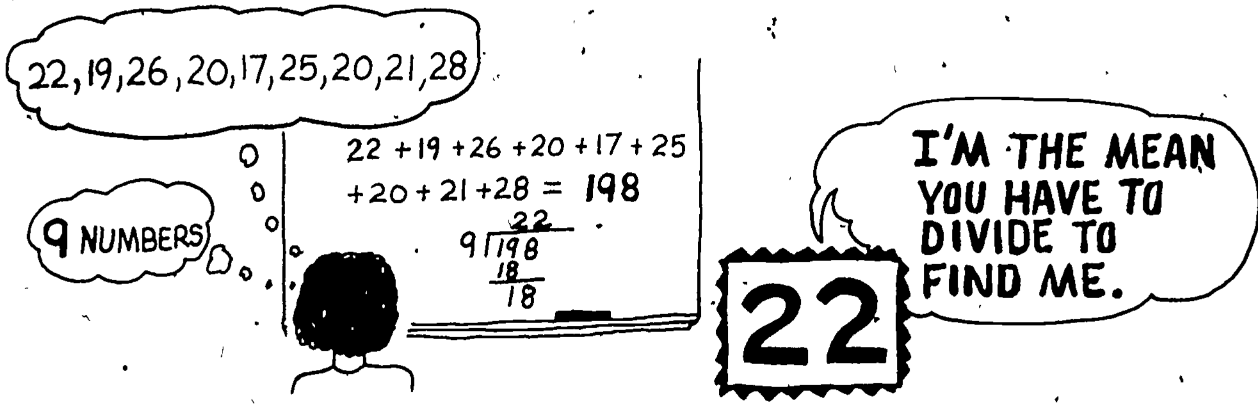
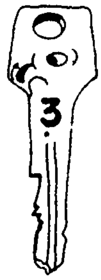
DEFINITIONS OF KEY NUMBERS

MEDIAN: The middle number in a set of data that has been put in order from smallest to largest. There are just as many numbers smaller than the median as there are numbers larger than the median.

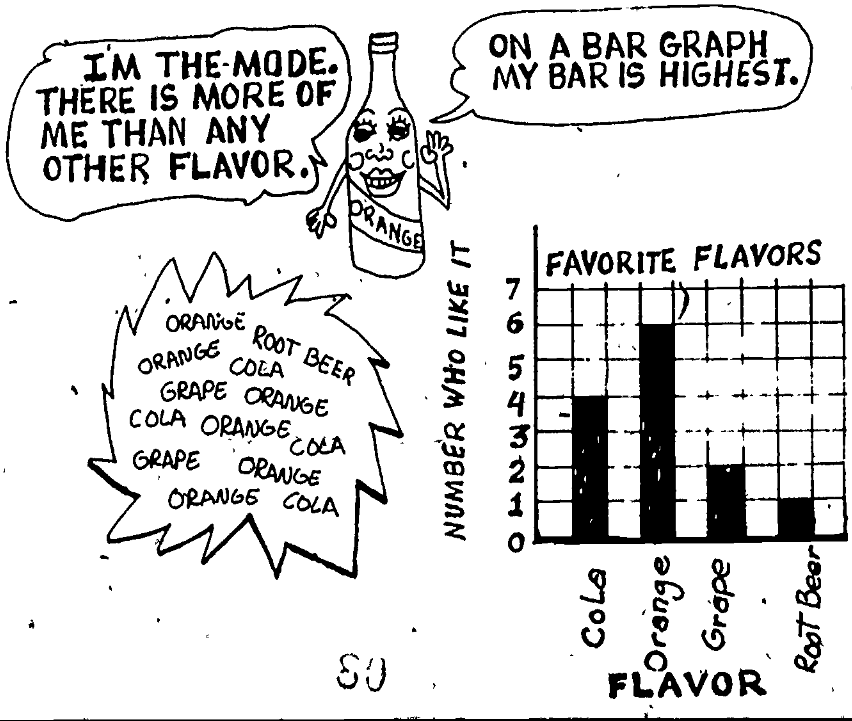


MEAN: The number that shows the amount per week, per person, per meter. You can find the mean by dividing the sum of the numbers in your set of data by the number of numbers in your set of data. The mean is often called the average.

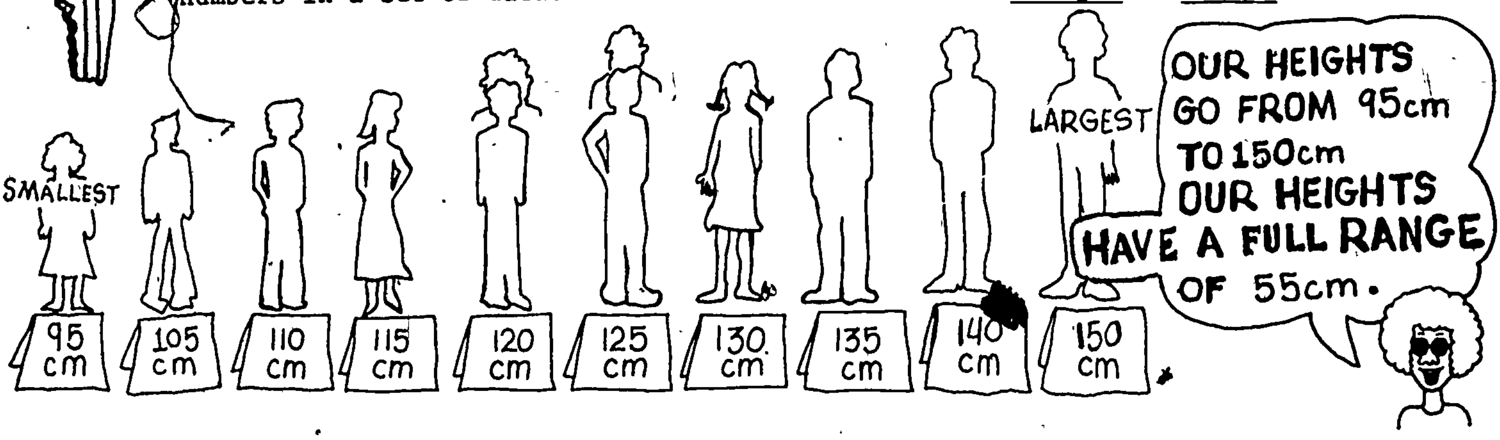


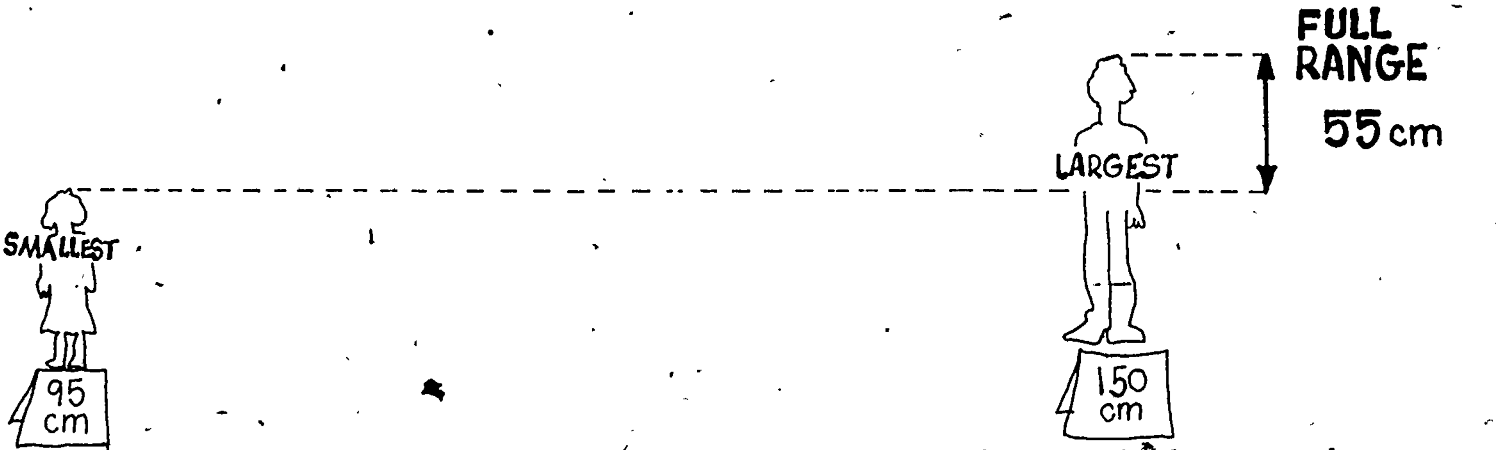


MODE: The number or thing that is listed the most times in a set of data. If you make a bar graph, the mode is shown by the highest bar.

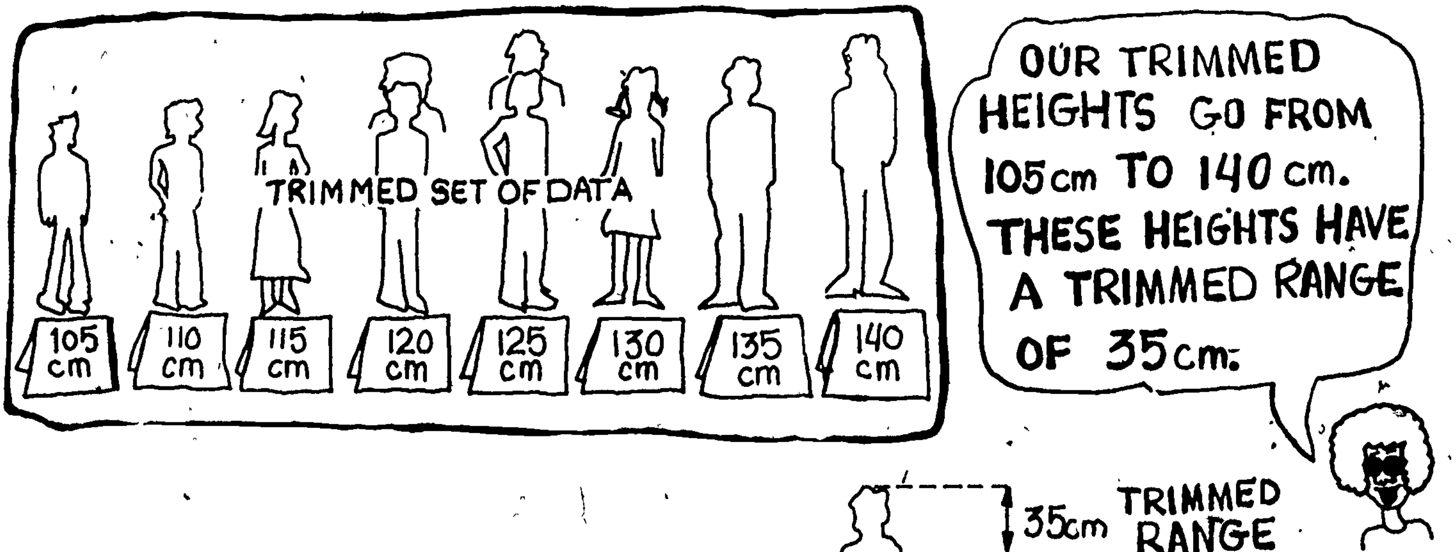


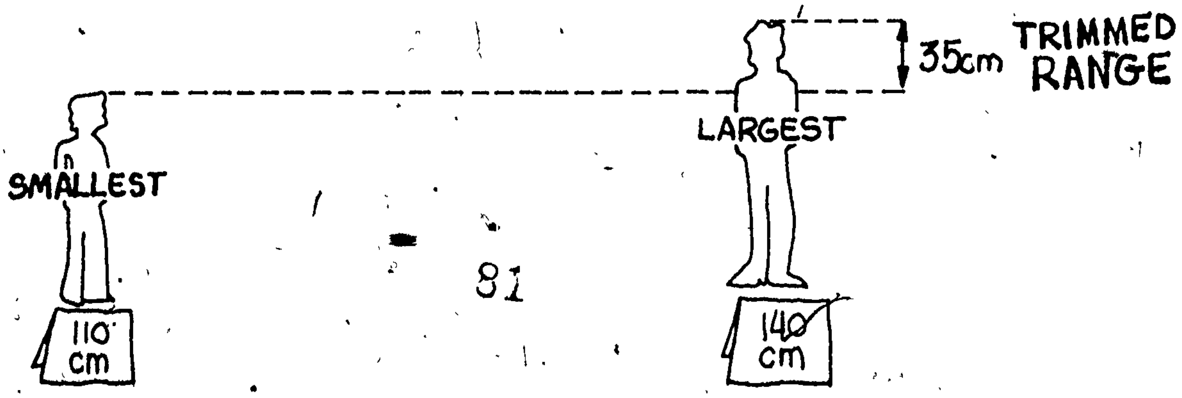
FULL RANGE: The full range is the difference between the largest and smallest numbers in a set of data. It shows how much the data changes or varies.



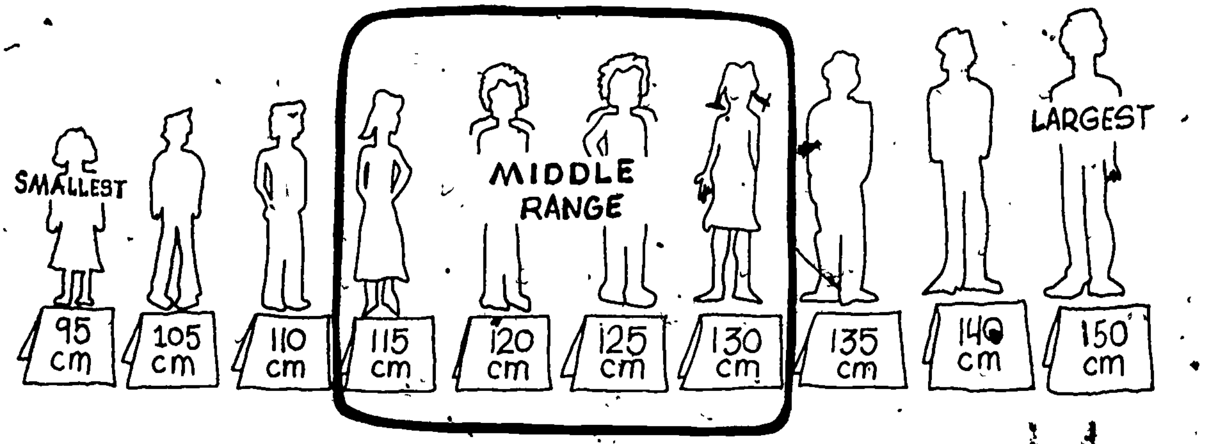


TRIMMED RANGE: The trimmed range is the difference between the largest and smallest numbers in a trimmed set of data.

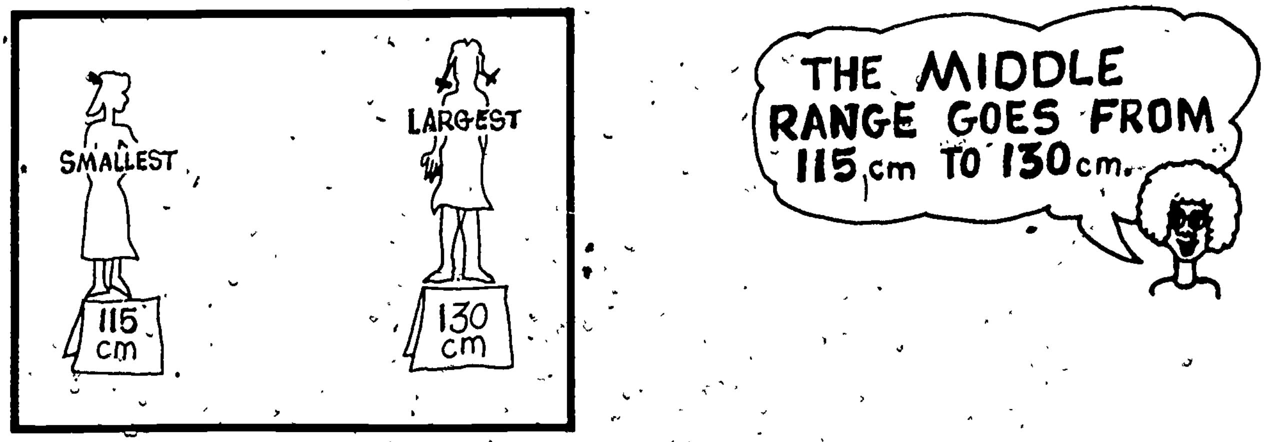




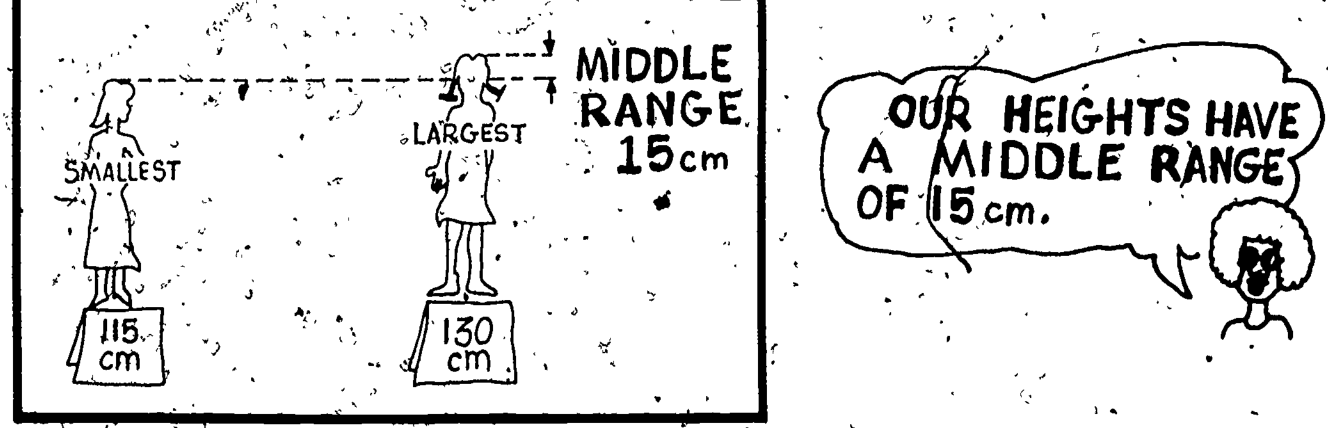
MIDDLE RANGE: This range goes from the smallest to the largest number in the middle half of the data.



Sometimes you may want to use the smallest and largest numbers in the middle range.



Sometimes you may want to find the difference between the largest and smallest numbers in the middle range.

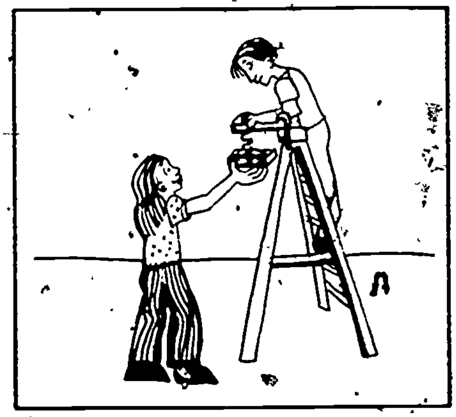


COMPARING MEDIANS TO FIND OUT WHICH THING IS BETTER

You may have collected data about two different groups or things. Maybe you want to find out which group or thing is bigger, or stronger, or takes longer. You may want to compare:

- *the heights of two groups of plants*
- *the strength of two brands of string*
- *the time it takes two different groups of children to cross the street*

You may have measured or tested each group or thing many times. Now you have two big bunches of numbers. What can you do?



You can find the MEDIAN of each set of data. Then you will only have TWO numbers to look at. It will be easy to decide which group or thing is better. That's what the children in this story do.

Juan, Helena, and Cary want to find out which brand of kite string is the strongest. They have made up a test to find out. First they tie a book to one end of a piece of string. Then, Juan ties the other end of the string to a piece of wood clamped to the top of a ladder. Helena drops the book from different heights until the string breaks. While Helena and Juan test each brand of string ten times, Cary records the results. When the testing is finished, the data look like this.

TESTING STRING MARCH 3	
BRAND	HEIGHTS AT WHICH STRING BROKE (cm)
Brand A	36, 45, 32, 42, 38, 41, 43, 35, 40, 42
Brand B	32, 30, 31, 40, 33, 32, 37, 34, 33, 27

"What do we do with all these numbers?" ask Cary and Juan. Helena, who has read <u>"How To" Find The Median</u>, says, "It's easy. We just have to find the median for each list." She writes the numbers for each kind of string in order from smallest to largest. The numbers look like this.

Brand A	32, 35, 36, 38, 40, 41, 42, 42, 43, 45
Brand B	27, 30, 31, 32, 32, 33, 33, 34, 37, 40

Helena crosses off numbers from the ends of each list until there are only two numbers left in each list. Now the lists look like this.

Brand A	~~32~~, ~~35~~, ~~36~~, ~~38~~, 40, 41, ~~42~~, ~~42~~, ~~43~~, ~~45~~
Brand B	~~27~~, ~~30~~, ~~31~~, ~~32~~, 32, 33, ~~33~~, ~~34~~, ~~37~~, ~~40~~

She says, "If there were only one number left in each list, that would be the median. But there are two numbers left. The median is the number halfway between the two numbers."

She finds the number halfway between 40 and 41 in the first set of data. It is 40.5. Then she finds the number halfway between 32 and 33 in the second list of data. It is 32.5. 40.5 centimeters and 32.5 centimeters are the medians of the two sets of data.

The median height for Brand A (40.5 cm) is 8 centimeters greater than the median height for Brand B (32.5 cm). Cary wonders whether the 8 centimeter difference really proves that Brand A is stronger.

The group asks the teacher. He says, "You have to compare the 8 centimeter difference between the medians with the middle range of each set of your data. If the difference between the medians is about as large or larger than both the middle ranges, you can say that Brand A is stronger than Brand B."

Juan, Helena, and Cary read "How To" Find Different Kinds of Ranges. Helena finds the middle range for the Brand A data. First, she puts the data in order from smallest to largest. Then she counts the pieces of data. There are 10 pieces of data. Next, she divides 10 by 4. Her answer is 2½. That is a fractional number so she rounds it down to the next lower whole number. She changes 2½ to 2. Then she crosses off 2 numbers from each end of the Brand A data. The data look like this.

BRAND A HEIGHTS (cm) ~~32~~, ~~35~~, 36, 38, 40, 41, 42, 42, ~~43~~, ~~45~~

The middle range for Brand A is from 36 centimeters to 42 centimeters. It is 6 centimeters.

Juan finds the middle range for Brand B. It is from 31 centimeters to 34 centimeters. It is only 3 centimeters. The Brand B data look like this.

BRAND B HEIGHTS (cm) 27, 30, 31, 32, 32, 33, 33, 34, 37, 40

"The middle ranges are 6 centimeters for Brand A and 3 centimeters for Brand B," says Cary. "They are both smaller than the 8 centimeter difference between the medians. Now we know for sure that Brand A is stronger."

* * * * *

In this story the group found the MEDIANS for several sets of data. In order to decide whether the sets were really different they compared the difference between the MEDIANS and the largest MIDDLE RANGE of the sets.

> *The MIDDLE RANGE is the difference between the largest and smallest numbers in the middle half of the data. The MIDDLE RANGE tells how much the numbers in the middle half of the data VARY or CHANGE.*

The group found that the difference between the MEDIANS was <u>larger</u> than the larger MIDDLE RANGE. They were then sure that the difference between the MEDIANS was not just the result of variations in the data. There was a real difference between the sets of data.

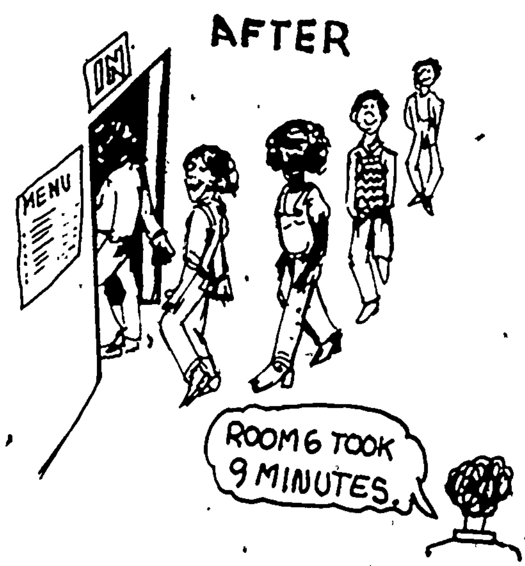
COMPARING MEANS WHEN THE NUMBERS ARE UNUSUAL

Maybe you have collected two sets of data about the same thing. You may have collected data about something BEFORE CHANGES WERE MADE and AFTER CHANGES WERE MADE.

- *Your data might be two sets of test scores about something you were learning.*
- *Your data might be how long students spend waiting in the lunch line before and after changes have been made in the lunchroom.*

When you have data like these, you can find the MEDIAN for each set of data and then compare them. Or you can find the MEANS and compare them. The MEDIANS or the MEANS will usually tell you whether there has been a change or not.

In the next story, the children find the MEAN for each set of data. Then they compare MEANS. Why do they use the MEAN? Read the story and find out.



Bella, Peter, and Bernie are working on improving the lunchroom. Most children think the lunch line is too slow, and they want to see if making changes in the lunchroom schedule will make it go faster. They have already timed how long it takes one class from each grade to go through the lunch line on different days.

They have been careful about the way they time. They have timed each class from when the first person in the class gets in line to when the last person sits down to eat. Their list of classes and times looks like this.

TIME IN LUNCH LINE OCTOBER 10-12			
ROOM	NUMBER OF MINUTES IN LUNCH LINE		
	Day 1	Day 2	Day 3
Room 10	11	14	16
Room 18	9	12	15
Room 6	10	12	14
Room 22	8	11	12
Room 4	11	12	13
Room 15	11	11	14

Bella and her group set up a new schedule of lunch times. The children use the new schedule for two weeks. Then Bernie, Peter, and Bella time the same classes using the new schedule. Their second set of data looks like this.

TIME IN LUNCH LINE (NEW SCHEDULE) NOVEMBER 11-13			
ROOM	NUMBER OF MINUTES IN LUNCH LINE		
	Day 1	Day 2	Day 3
Room 10	9	7	10
Room 18	7	8	11
Room 6	8	9	9
Room 22	8	7	9
Room 4	7	10	10
Room 15	10	12	11

The group looks at all the times from the first data chart and all the times from the second data chart. There are a lot of numbers. They want to use the numbers to find out if the students are going through the line faster with the new schedule. But they don't know exactly what to do.

Bella wants to find the median for each set of times. But Peter wants to find the mean. (He has read "How To" Find the Mean.)

Bella says, "I think the median is easier to find."

But Peter thinks that the mean is better. He says, "It's just as much trouble to put the numbers in order from smallest to largest as it is to add them all up and divide. But I have another reason for wanting to use the mean. We have been careful with our data. We threw out all the data that we thought might be mistakes. If we take the mean, we will be using all of the data, even the days when the times were quite long or short. If we use the median, we will lose those times."

Bernie thinks about what Peter has said. He says, "Times are long when everyone wants to buy the hot lunch. Times are short when a lot of children are absent. But these times should be included in our figuring."

So the group decides to find the mean of each set of times. They think the mean is better to use for these data than the median.

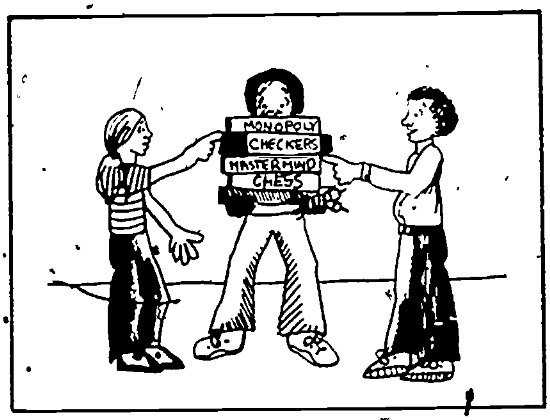
They compute the mean for the first set of times. They add all the times for Day 1, Day 2, and Day 3 together and then divide by 18. The mean for the first set of times is 12 minutes.

Then they compute the mean for the second set of times in the same way. It is 9 minutes. The difference between the two means is 3 minutes. Everyone is pleased that the new schedule has made the mean time spent waiting in line shorter by 3 minutes.

COMPARING MODES TO PICK ONE THING

Sometimes when you collect data, all you want to know is what got the most votes or what the most people like. You may want to compare data from two groups of people to find out whether the two groups like the same thing best or like different things best.

- *You may want to find out whether you can buy one game for your classroom that both boys and girls like best or whether you need to buy two games.*
- *You may want to find out whether you can pick one flavor of soft drink for two different grades or whether you need two flavors.*



If you are trying to decide something like this, you can find the MODE for each set of data. Looking at the MODES may help you solve your problem. That's how the students in the next story solved theirs.

Julia, Keith, and Rene are in charge of picking a game to buy for the class that everyone will like. First, they survey the class to find out what the favorite game is. They ask the students to vote for all the games they like. Their data look like this.

FAVORITE GAMES	
GAME	NUMBER WHO LIKE IT
Checkers	10
Bowling	11
Indoor Basketball	18
Mastermind	7
Chess	9
Twister	12
Parcheesie	4
Horseshoes	11
Monopoly	11
Darts	6

Julia has read "How To" Find the Mode. She sighs. "It looks like the indoor basketball wins. It's the MODE. It got the most votes. I don't really like indoor basketball, though. I wish we could get something else."

"The other girls in the class don't really like indoor basketball that much either," says Rene. "But there are more boys in the class than girls. Maybe we can vote on the games again."

Keith wants to be fair. He doesn't want to get a game that many students in the class won't use. "I have an idea," he says. "Let's do another survey but this time we can count up the boys' votes and the girls' votes separately. Then we can see which game the girls like best and which game the boys like best."

Julia and Rene agree. The group surveys the class again. They count the girls' votes and the boys' votes separately. The data look like this:

FAVORITE GAMES		
GAME	NUMBER OF BOYS WHO LIKE IT	NUMBER OF GIRLS WHO LIKE IT
Checkers	3	7
Bowling	8	3
Indoor Basketball	15	3
Mastermind	2	5
Chess	5	4
Twister	0	12
Parcheesie	2	2
Horseshoes	9	2
Monopoly	2	9
Darts	5	1

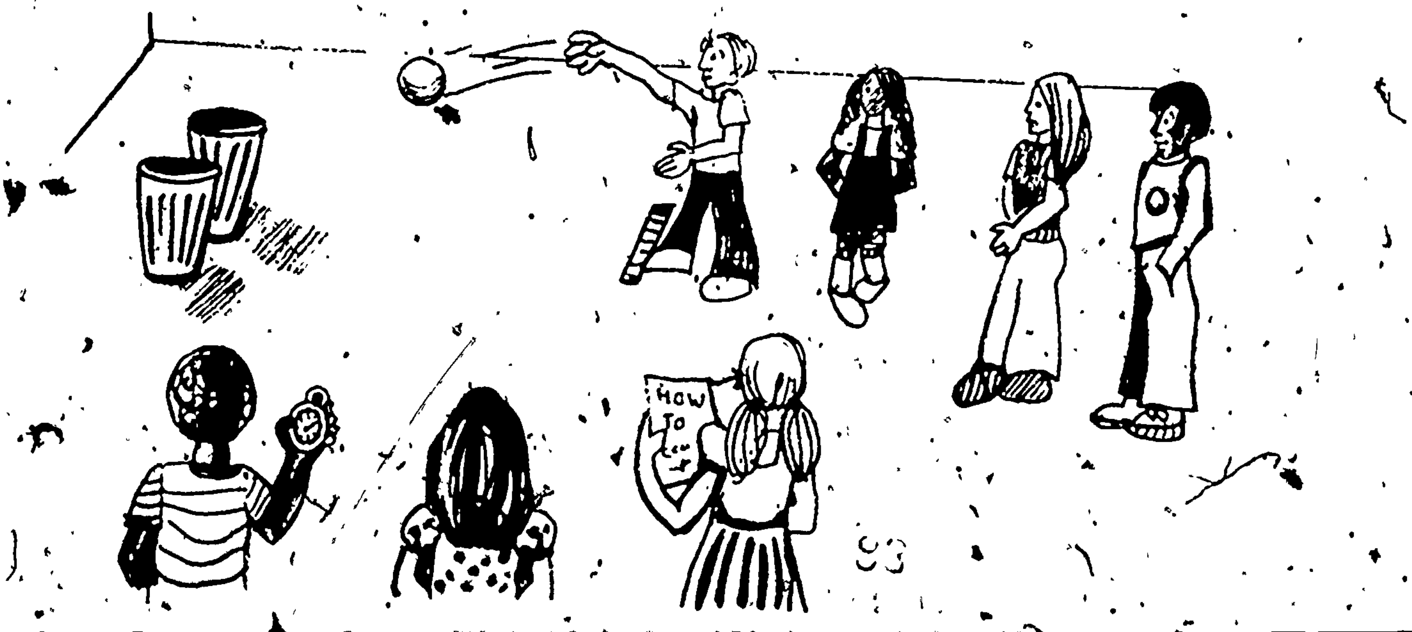
"Look," says Rene, "The boys do like indoor basketball best and the girls like Twister best. Indoor basketball is the mode for the boys and Twister is the mode for the girls. What do we do now?"

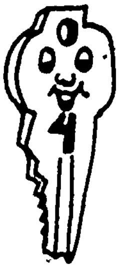
"We should buy two games," says Keith. "More of the boys voted for indoor basketball than any other game. None of the other games got that many votes. And Twister got the most votes for the girls. Monopoly was second and got only 9 votes."

So Keith, Julia, and Rene decide that they should get two games for the class.

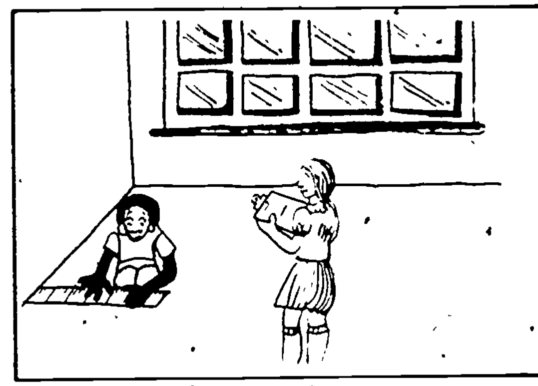
"But what if we only could buy one game?" asks Julia. "What would we do?"

Keith is happy to help Julia. He tells her that there is a way to use the data to pick just one game and that making a graph would help them decide which game to buy. He adds that there is a booklet that tells more about this: "How To" Use Graphs to Compare Two Sets of Data. Julia decides that she will look at the booklet to find the answers to her questions.





COMPARING RANGES TO SEE CHANGES IN THE DATA



Sometimes when you need to compare two different things, you may not want to know which thing is bigger, or stronger, or takes longer. Instead, you may want to know which thing changes more.

- *Maybe you want to compare how much the temperature usually changes during two different months of the year.*
- *Maybe you want to find out which method of learning spelling words shows greater differences between pretest and posttest scores.*
- *Maybe you want to compare the changes in measurements for two different tools to find out which one is better to use.*

Then it is better to compare RANGES for each set of data than to compare medians. (The RANGE tells you how much the numbers in each set of data change or vary.)

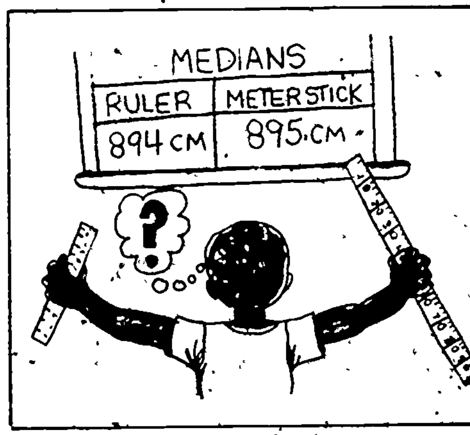
In the next story, three students find out that they need to compare RANGES to solve their problem.

Caroline, Justine, and Troy are trying to decide which is the best tool to use to measure their classroom. They have measured the width of their classroom a dozen times with a ruler. They have also measured it a dozen times with a meter stick. After they put each set of data in order from smallest to largest, their results look like this.

ROOM WIDTHS USING A RULER (cm)
884, 888, 891, 893, 894, 894, 894, 895, 896, 896, 899, 902

ROOM WIDTHS USING A METER STICK (cm)
889, 890, 893, 894, 894, 895, 895, 896, 896, 896, 898, 901

The children first decide to find the median of each set of data. The medians are easy to find. They are 894 centimeters using a ruler and 895 centimeters using a meter stick.

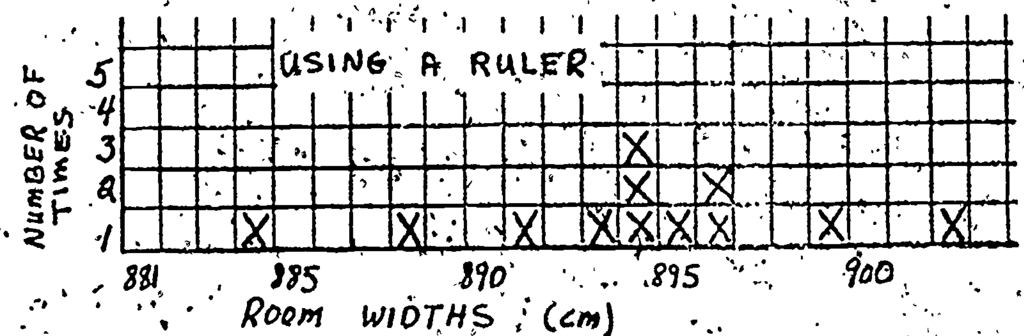


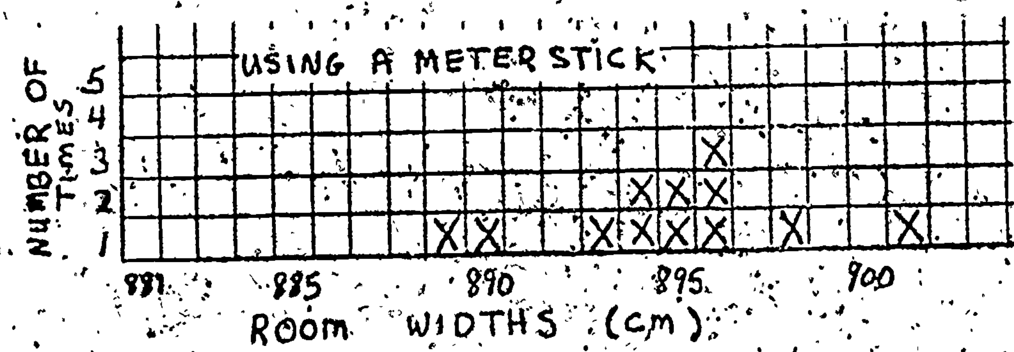
Troy looks at the medians. "The median using a meter stick is bigger. But how does that help us to decide which tool to use?"

No one answers. No one in the group can tell. The medians do not help them to decide which tool to use.

After a short discussion, the group decides to make graphs of their data. They think that by looking at the graphs they may see something that will help them to decide.

Their graphs look like this.





Caroline looks at the graphs. She looks at the biggest number and smallest number on each graph. She writes these numbers down on her paper. She thinks that these numbers might help the group decide because she has noticed that the graph for the ruler is wider than the graph for the meter stick. She shows the paper to the rest of the group. It looks like this.

TOOL	BIGGEST	SMALLEST
Ruler	902 cm	884 cm
Meter Stick	901 cm	889 cm

"How far apart are those numbers?" asks Troy. Caroline figures out how far apart the numbers are by subtracting:

Ruler: 902 cm - 884 cm = 18 cm

Meter Stick: 901 cm - 889 cm = 12 cm

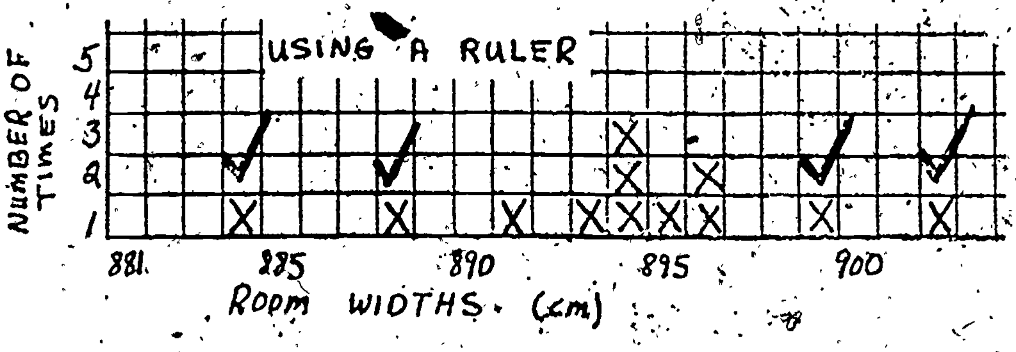
Troy says, "I think the meter stick is better to use because the answers weren't so different when we measured with it."

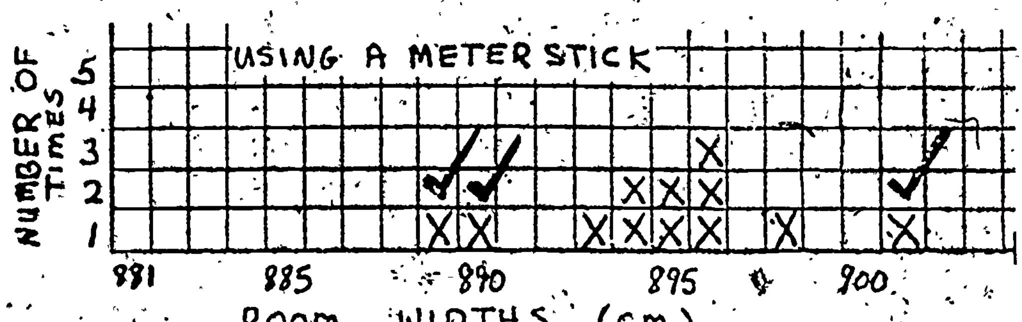
Caroline is not so sure that either the ruler or the meter stick is good enough. Even the 12 centimeter difference for the meter stick seems like a lot. Caroline says that she doesn't want her measurements to be off by that much.

Justine looks at the graphs again. "I just noticed something," she says. "The measurements that are high and low in each set of data are quite far away from the other numbers."

"What do you mean?" asks Troy.

Justine puts a check mark over the Xs that she means.

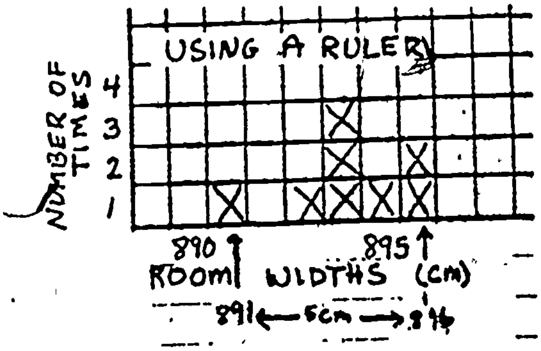




Troy says, "We probably made some mistakes when we measured. Why can't we throw out those numbers?"

"Yes," says Caroline. "They probably are mistakes. They are 3 centimeters or more from most of the measurements. They can be trimmed off. Then the biggest and smallest numbers will be closer together. But we should trim off the same amounts from each end. Let's trim off two numbers from each end on both of the graphs."

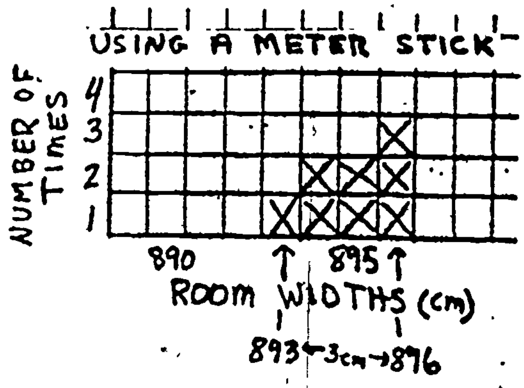
Justine trims the four Xs from each graph. She trims two Xs from each end. The trimmed graphs look like this.



Justine looks at the highest and lowest numbers on the trimmed graphs. She figures out how far apart these numbers are by subtracting:

Ruler: 896 cm - 891 cm = 5 cm

Meter Stick: 896 cm - 893 cm = 3 cm



All of the measurements for the ruler are within 5 centimeters of each other and all of the measurements for the meter stick are within 3 centimeters of each other.

Caroline thinks that 3 centimeters is not too great a difference to allow for. The group decides that the meter stick is a better tool to use to measure the room. It is better than the ruler because the measurements are closer together.

* * * *

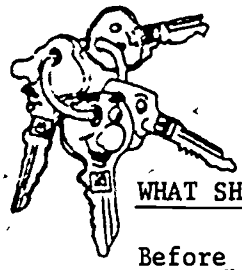
In this story, the group looked at the difference between the largest and smallest numbers on each graph. They subtracted the smallest number from the largest number for each graph. This gave them the FULL RANGE for each set of data.

> *The FULL RANGE is the difference between the largest and smallest numbers in a set of data. The FULL RANGE tells how much numbers in a set of data VARY or CHANGE.*

Then the group noticed that some of the numbers in the set of data were quite large or small compared to the other numbers. So they threw out the two biggest and smallest numbers in each set of data. They trimmed some data from each graph. Then they found the range again for each set of trimmed data. They found the TRIMMED RANGE. They compared the TRIMMED RANGES to decide which tool to use.

> *The TRIMMED RANGE is the difference between the largest and smallest numbers in a trimmed set of data. The TRIMMED RANGE tells how much numbers in a trimmed set of data VARY or CHANGE.*

IF YOU WANT TO FIND OUT MORE ABOUT RANGES, YOU CAN READ "HOW TO" FIND DIFFERENT KINDS OF RANGES.



WHAT SHOULD YOU DO WITH YOUR DATA?

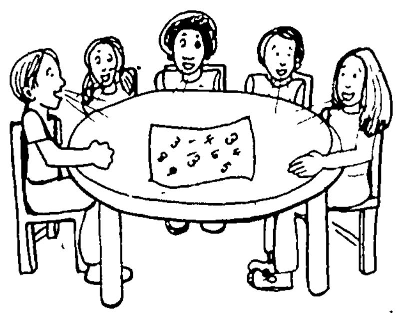
Before you do anything with your data, look at your numbers.

- Do you have TWO sets of data? If you have ONLY ONE set of data, read "How To" Tell What Your Data Show. If you have MORE THAN TWO sets of data, compare them the same way as you would two sets of data.

- Do your numbers make sense? Did you measure what you wanted to measure? If your data look wrong, you may have to collect new data. If you have SURVEY DATA, read "How To" Make An Opinion Survey. If your data are MEASUREMENTS, read "How To" Collect Good Data.

Suppose you have checked your numbers. They look O.K. What should you do with your data? Which KEY NUMBERS should you compare? You can follow this checklist. It will help you decide.

1. Know why you collected your data. Talk with your group about what you want to find out.



2. Do you want to find out which of two different things is bigger, is stronger, or takes longer?

Sometimes you can compare medians.

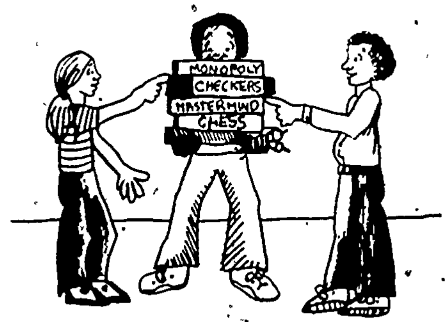
- You should compare medians if some of the data are likely to be mistakes or are due to something that won't happen again.
- You can compare medians when none of the numbers are unusually large or small.

Sometimes you can compare means.

- You can compare means when none of the numbers are unusually large or small.
- You should compare means if some of the numbers are unusually large or small but are due to something that may happen again.

Most of the time it doesn't matter. You can use MEDIANS to compare your data, or you can use MEANS to compare your data. If you have trouble deciding whether to compare the medians or the means, read "How To" Tell What Your Data Show.

3. Do you want to find out if two groups of people like the same thing best or like different things best? Then find the MODE for each set of data.



4. Do you want to find out which of two things changes more or less? Then you can find the RANGE (or the TRIMMED RANGE) for each set of data and compare them.

5. Are you still confused about what to do with your data? Maybe doing one of these things will help.

   A. Look at the examples in this booklet again.

   B. Try making a graph of your data.

   C. Look at your data again to decide what you want to find out.

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