

# CHAPTER 12

## Measures of Central Tendencies

### WHAT WILL YOU LEARN?



#### 12.1 Measures of Central Tendencies



### WORD LINK

- Measure of central tendency
- Mode
- Median
- Mean
- Extreme value
- Data
- Table
- Data representation
- Pie chart
- Bar chart
- Dot plot
- Stem and leaf plot
- Frequency table
- *Sukatan kecenderungan memusat*
- *Mod*
- *Median*
- *Min*
- *Nilai ekstrem*
- *Data*
- *Jadual*
- *Perwakilan data*
- *Carta pai*
- *Carta palang*
- *Plot titik*
- *Plot batang dan daun*
- *Jadual kekerapan*

**S**tatistics is a branch of mathematics that uses data.

This is because statistics involves the collection, compilation, description and analysis of data and conclusions from the results of data analysis.

One example of application of statistical knowledge is the stock market. In the stock market, statistics are applied in various ways by using data representations. In this way they are able to study various information and make various inferences from profit data sets, economic development, business, inflation and national finances.



### WALKING THROUGH TIME

John Graunt was a well-known statistician. He used statistical knowledge to make some conclusions and predictions about population and mortality rates in his initial study.

For more information:



[http://rimbunanilmu.my/mat\\_t2e/ms245](http://rimbunanilmu.my/mat_t2e/ms245)

### WHY STUDY THIS CHAPTER?

- Measures of central tendencies is often used in areas related to data.
- Career fields that use this knowledge are economics, statistics, business, entrepreneur and education.



▶ Median

COGNITIVE STIMULATION



**Aim:** Exploring the median for a set of data

**Material:** Worksheets

**Steps:**

1. Open the file MS348 and print the worksheet.
2. Cut out all the cards one by one.
3. Arrange the number cards in ascending order.
4. Identify the card in the middle. Record the number in the provided worksheet.
5. Now, remove any 3 cards at random.
6. Rearrange the cards in ascending order.
7. Identify the two numbers in the middle. Calculate the average of the two numbers. Record on the worksheet.

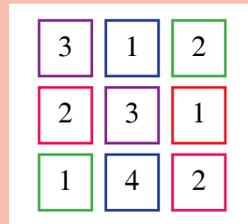
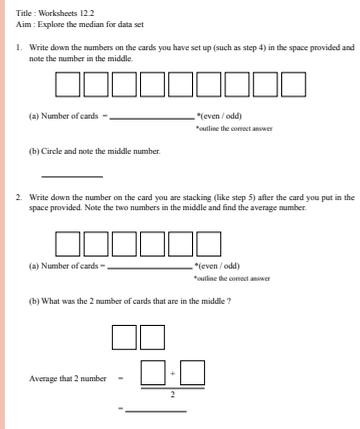
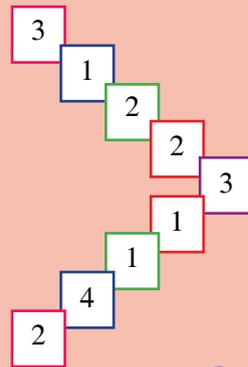


Figure A



Scan the QR Code or browse [http://rimbunanilmu.my/mat\\_t2e/ms248](http://rimbunanilmu.my/mat_t2e/ms248) to retrieve the worksheet.



THINK SMART

Try to repeat this activity by organising the card in descending order. Did you get the same results?

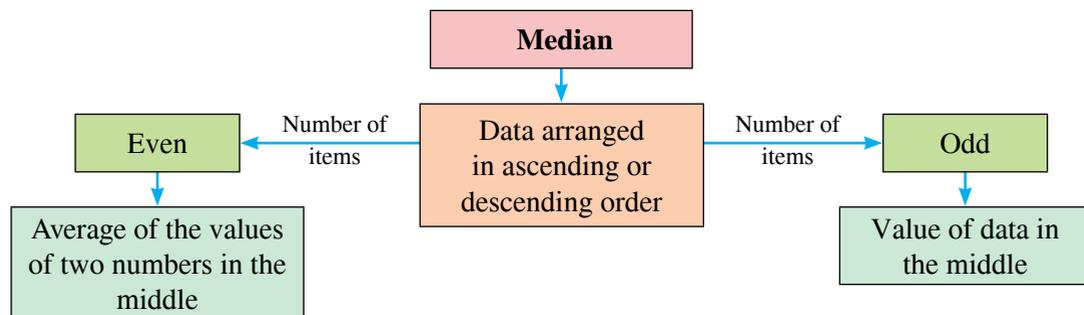
**Discussion:**

How can you locate the middle value for a set of data if the number of items are

- (i) odd
- (ii) even

In the activity above, you have defined the **median** for odd and even data. Note in Step 3, the number of all the cards you have arranged is 9 pieces (odd) and in Step 6 the number of cards arranged is 6 pieces (even). Therefore,

The **median** for a set of data with an odd number of items is the value in the **middle**, while the median for a set of data with an even number of items is the average value of two numbers in the middle arranged in ascending or descending order.



EXAMPLE 2

The data below is the pocket money to for five students each day. Determine the median.

RM5 RM8 RM3 RM7 RM5

**Solution:**

3 5 5 7 8 ← Arrange data in ascending order  
 3 5 5 7 8 ← Mark the data in the middle  
 Median = 5

EXAMPLE 3

The data below shows the total number of goals scored by the Seladang team in 10 games. Determine the median.

1 5 1 1 4 2 5 1 4 4

**Solution:**

1 1 1 1 2 4 4 4 5 5 ← Arrange data in ascending order  
 1 1 1 1 2 4 4 5 5 ← Circle the data in the middle

$\frac{2 + 4}{2} = \frac{6}{2} = 3$  ← Calculate the average of the two numbers  
 Median = 3

Another way to find a median is by deleting left and right data in pairs (ascending or descending).

EXAMPLE 4

Determine median for each set of the following data.

(a) 4, 7, 2, 3, 4, 9, 6, 2, 1

(b) 28, 27, 21, 23, 24, 21, 25, 24

**Solution:**

(a) (a) Arrange data in ascending order.

~~1~~, ~~2~~, ~~2~~, ~~3~~, ~~4~~, ~~4~~, ~~6~~, ~~7~~, ~~9~~  
 Value in the middle

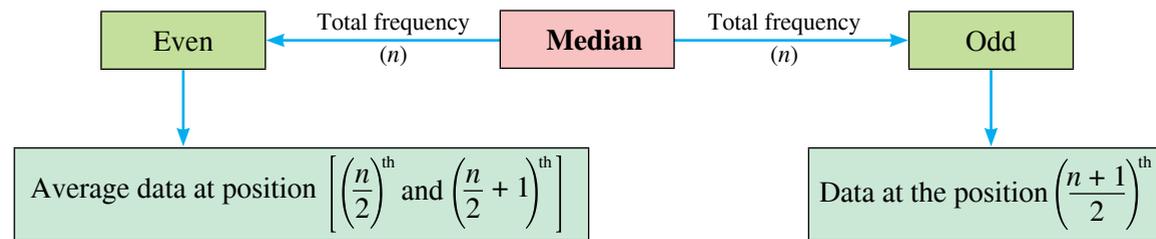
Median = 4

(b) Arrange data in ascending order.

~~21~~, ~~21~~, ~~23~~, ~~24~~, ~~24~~, ~~25~~, ~~27~~, ~~28~~  
 Two values in the middle

Median =  $\frac{24 + 24}{2} = 24$

► Determine the median for even or odd numbers of data in frequency table and data representation



with  $n$  as the total frequency.

**EXAMPLE 5**

- The table shows time taken to build a model of a rocket in a science activity for 11 groups of students.

<b>Time (minutes)</b>	10	20	30	40
<b>Frequency</b>	1	6	3	1

Determine the median using the frequency table

**Solution:**

Total Frequency = 11

$$\begin{aligned} \text{Median} &= \text{data at } \left(\frac{n+1}{2}\right)^{\text{th}} \\ &= \text{data at } \left(\frac{11+1}{2}\right)^{\text{th}} \\ &= \text{data at } \frac{12}{2} \\ &= \text{data at } 6^{\text{th}} \end{aligned}$$

<b>Time (minutes)</b>	10	20	30	40
<b>Frequency</b>	1	6	3	1
<b>Position of data</b>	1	2 - 7	8 - 10	11

1<sup>st</sup> data is 10

2<sup>nd</sup> data till the 7<sup>th</sup> data is 20

The 6<sup>th</sup> data is 20, therefore the median is 20.

- The table shows time taken to solve the number of crossword puzzles in the Malay Language Society activity for 12 groups of students.

<b>Time (minutes)</b>	10	20	30	40
<b>Frequency</b>	2	4	5	1

Determine the median for the frequency table.

**Solution:**

Number of frequencies = 12

$$\begin{aligned} \text{Median} &= \text{Average data at } \left[\left(\frac{n}{2}\right)^{\text{th}} \text{ and } \left(\frac{n}{2} + 1\right)^{\text{th}}\right] \\ &= \text{Average data at } \left[\left(\frac{12}{2}\right)^{\text{th}} \text{ and } \left(\frac{12}{2} + 1\right)^{\text{th}}\right] \\ &= \text{Average data at } (6^{\text{th}} \text{ and } 7^{\text{th}}) \\ &= \frac{\text{Data at } 6^{\text{th}} + \text{Data at } 7^{\text{th}}}{2} \end{aligned}$$

<b>Time (minutes)</b>	10	20	30	40
<b>Frequency</b>	2	4	5	1
<b>Position of data</b>	1 - 2	3 - 6	7 - 11	12

The 3<sup>rd</sup> till the 6<sup>th</sup> data is 20

The 7<sup>th</sup> till the 11<sup>th</sup> data is 30

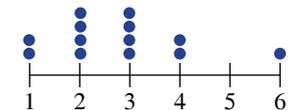
$$\begin{aligned} \text{Median} &= \frac{6^{\text{th}} \text{ data} + 7^{\text{th}} \text{ data}}{2} \\ &= \frac{20 + 30}{2} \\ &= 25 \end{aligned}$$

Therefore, median is 25.

**EXAMPLE 6**

Calculate the median for the situation on the right.

- The dot plot shows the total students at the library in a six days.



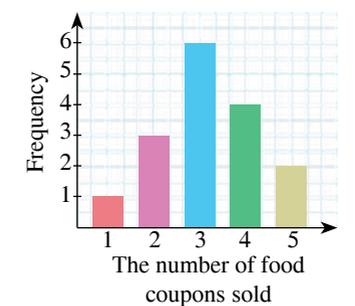
**Solution:**

Number of frequency = 13

Total frequency,  $n$  is odd

$$\begin{aligned} \text{Median} &= \text{data at } \left(\frac{13+1}{2}\right)^{\text{th}} \\ &= \text{data at } 7^{\text{th}} \\ &= 3 \end{aligned}$$

- The bar chart shows the number of food coupons sold by Form 2S teachers during Co-curricular Day.



**Solution:**

Number of frequency = 16

Total frequency,  $n$  is even

$$\begin{aligned} \text{Median} &= \text{Average data at } \left[\left(\frac{16}{2}\right)^{\text{th}} \text{ and } \left(\frac{16}{2} + 1\right)^{\text{th}}\right] \\ &= \text{Average data at } (8^{\text{th}} \text{ and } 9^{\text{th}}) \\ &= \frac{\text{Data at } 8^{\text{th}} + \text{data at } 9^{\text{th}}}{2} \\ &= \frac{3 + 3}{2} \\ &= 3 \end{aligned}$$

► Mean



Today we have managed to collect the jogathon money from each class.

Haikal



I need to find the average of the collection to write reports to Cikgu Amri. How can I set this average value?

Christina



In the situation above, we can find an average value of the collection of the jogathon money. The average value is also called **mean**.

**Mean** for a set of data is the value obtained when **the sum of the data values is divided by the number of data**.

$$\text{Mean} = \frac{\text{Total value of data}}{\text{Number of data}}$$

EXAMPLE 7

Calculate the average jogathon money that Haikal collected from each class.

*Solution:*

$$\begin{aligned} \text{Mean} &= \frac{\text{RM}373.50 + \text{RM}424.00 + \text{RM}363.00 + \text{RM}485.15 + \text{RM}355.10}{5} \\ &= \frac{\text{RM}2\,000.75}{5} \\ &= \text{RM}400.15 \end{aligned}$$

**FLASHBACK**

The data below is called ungrouped data: 2,3,1,1,2, 2,4,4

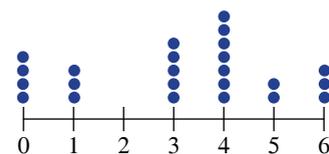
This data can also be compiled in the frequency table as follows.

Number	1	2	3	4
Frequency	2	3	1	2

EXAMPLE 8

This dot plot shows the results of a survey on the consumption of canned carbonated drinks of 26 students per day.

Calculate the mean of the number of cans of carbonated drinks consumed by them in a day.



*Solution:*

$$\begin{aligned} \text{Mean of number of cans of carbonated drinks} &= \frac{(4 \times 0) + (3 \times 1) + (0 \times 2) + (5 \times 3) + (7 \times 4) + (2 \times 5) + (3 \times 6)}{4 + 3 + 2 + 5 + 7 + 2 + 3} \\ &= \frac{78}{26} \\ &= 3 \end{aligned}$$

Therefore, the number of cans of carbonated drinks consumed by them in a day is 3 cans.

EXAMPLE 9

The table shows the hours of Internet usage of Form 2 students in a day.

Internet usage (hours)	1	2	3	4	5
Number of students	2	6	11	7	9

Calculate the mean for the frequency table above.

*Solution:*

Internet usage (hours)	Number of students	Internet usage × Number of students
1	2	1 × 2 = 2
2	6	2 × 6 = 12
3	11	3 × 11 = 33
4	7	4 × 7 = 28
5	9	5 × 9 = 45
<b>Total</b>	<b>35</b>	<b>120</b>

Number of frequency      Sum of data (frequency x data)

$$\begin{aligned} \text{Mean} &= \frac{\text{Sum of data (frequency} \times \text{data)}}{\text{Number of frequency}} \\ &= \frac{120 \text{ hours}}{35} \\ &= 3.43 \text{ hours} \end{aligned}$$

Therefore, mean is 3.43 hours.

Mean for the data in the frequency table can be calculated by finding the sum of the data from the corresponding frequency divided by the number of frequencies.

$$\text{Mean} = \frac{\text{Sum (data} \times \text{frequency)}}{\text{Number of frequencies}}$$

► Existence of extreme value

**Extreme value** is a value that is **too small** or **too large** in a set of data. It means the value is too far from the value of the other data in the set.

EXAMPLE 10

The time in minutes taken by 7 students to complete a three-dimensional polygon model using the toy blocks is

5, 6, 7, 7, 8, 9, 20

Which of these data is one of the extreme value? Explain.

*Solution:*

20 is extreme value because its value is much larger than the other data.

**EXAMPLE 11**

Determine the extreme data in the data below. Explain your answer.  
 -5, 0, 1, 3, 3, 5, 6

**Solution:**

-5 is extreme value because its value is much smaller than other data.

**Impact of extreme value**

**EXAMPLE 12**

1. A set of data of pocket money of 5 students to the school.  
 RM3, RM4, RM4, RM6, RM8

Calculate the mode, median and mean of the data above.

2. You are required to replace RM8 to RM32, then calculate new mode, median and mean .

**Solution:**

RM3, RM4, RM4, RM6, RM8

RM3, RM4, RM4, RM6, **RM32** ← Extreme value

1. Mode = RM4

median = RM4

$$\begin{aligned} \text{mean} &= \frac{\text{RM3} + \text{RM4} + \text{RM4} + \text{RM6} + \text{RM8}}{5} \\ &= \frac{\text{RM25}}{5} \\ &= \text{RM5} \end{aligned}$$

2. Mode = RM4

median = RM4

$$\begin{aligned} \text{mean} &= \frac{\text{RM3} + \text{RM4} + \text{RM4} + \text{RM6} + \text{RM32}}{5} \\ &= \frac{\text{RM49}}{5} \\ &= \text{RM9.80} \end{aligned}$$

When an extreme value exists in a set of data, it will affect the value of mean. As in the example, the value of mean shows an increase of RM4.80, while the value of median and mode do not change with extreme values.

**12.1.2 The effect of changing a set of data to the mode, mean and median**

**Data is changed uniformly**

Carry out the given activity to identify the effect on mode, median, and mean when each data is changed uniformly or non-uniformly.



Make conclusion about the effect of changes in a set of data to value of mode, mean and median.

**COGNITIVE STIMULATION**



**Aim:** Investigating the effects of changes in mean, median and mode if any data is changed in a uniform manner

**Material:** Worksheets

**Steps:** Five students are given Mathematics Quiz questions with a minimum score of 20. The table below shows their results.

Students	Amin	Ben	Chia	Don	Eva
Score	3	4	4	6	8

1. Copy and complete the following table.

Score	Students					Mean	Median	Mode
	Amin	Ben	Chia	Don	Eva			
Row 1 → $n$	3	4	4	6	8			
Row 2 → $n + 1$								
Row 3 → $n \times 2$								

Table 1

2. Copy and complete the following table.

Score	Students					Mean	Median	Mode
	Amin	Ben	Chia	Don	Eva			
Original Score	3	4	4	6	8			
Addition to the Score	+1	+2	+3	+4	+5			
New Score	4							

Table 2

**Discussion:**

- (i) Compare the answers obtained in row 1, row 2, and row 3 in Table 1 when the data is uniformly changed?
- (ii) Compare the mean, median and mode between the original scores and new scores in Table 2 when each data is changed in a non-uniform manner?

From the activity above, when 1 is added to each original data (row 2) or multiplied by 2 (row 3), we find that the values of mean, median and mode will also be added with 1 or multiplied by 2.

This means that a **uniform change in data** will result in a uniform change in **values for mean, median and mode**.

However, if the data is changed in a non-uniform manner, the values of mean, median and mode will also change in a **non-uniform** manner.

**EXAMPLE 13**

Kanang bought 5 types of stationery at the school cooperative which cost RM1, RM2, RM3, RM3 and RM6 respectively.

- (a) Calculate the mean, median and mode for the data.
- (b) Calculate the new mean, median and mode if the price of each stationery
  - (i) is increase by RM 2
  - (ii) is multiplied by 3

**Solution:**

(a) RM1, RM2, RM3, RM3, RM6

$$\text{Mean} = \frac{\text{RM1} + \text{RM2} + \text{RM3} + \text{RM3} + \text{RM6}}{5} \quad \text{median} = \text{RM3} \quad \text{mode} = \text{RM3}$$

$$= \frac{\text{RM15}}{5}$$

$$= \text{RM3}$$

(b) (i) New data (price increased by RM 2) = RM3, RM4, RM5, RM5, RM8

$$\text{Mean} = \frac{\text{RM3} + \text{RM4} + \text{RM5} + \text{RM5} + \text{RM8}}{5} \quad \text{median} = \text{RM5} \quad \text{mode} = \text{RM5}$$

$$= \frac{\text{RM25}}{5}$$

$$= \text{RM5} \leftarrow \text{Value of original mean also increases by 2}$$

Value of original median also added by 2

Value of original mode also added by 2

(ii) New data (price multiplied by 3) = RM3, RM6, RM9, RM9 dan RM18

$$\text{Mean} = \frac{\text{RM3} + \text{RM6} + \text{RM9} + \text{RM9} + \text{RM18}}{5} \quad \text{median} = \text{RM9} \quad \text{mode} = \text{RM9}$$

$$= \frac{\text{RM45}}{5}$$

$$= \text{RM9} \leftarrow \text{Value of original mean also multiplied by 3}$$

Value of original median also multiplied by 3

Value of original mode also multiplied by 3

**EXAMPLE 14**

Raju's scores in a Japanese quiz are 3, 6 and 6.

(a) Calculate the mean, median, and mode for the data.

(b) Add the first data by 1, add the second data by 2 and add the third data by 3. Next, determine the new values of mean, median and mode.

**Solution:**

(a)  $\text{Mean} = \frac{3 + 6 + 6}{3} \quad \text{median} = 6 \quad \text{mode} = 6$

$$= \frac{15}{3}$$

$$= 5$$

(b) New data are (3 + 1), (6 + 2), (6 + 3), hence, they are 4, 8, 9.

$$\text{Min} = \frac{4 + 8 + 9}{3}$$

$$= \frac{21}{3}$$

$$= 7$$

median = 8,      No mode

In the example above, the data is not uniformly changed. Similarly the new values of mean, median and mode **do not change in a uniform manner.**

**12.1.3 Organise data in frequency tables for grouped data**

**► Frequency table for grouped data**



Collect data, construct and interpret the frequency table for grouped data.

**COGNITIVE STIMULATION**



**Aim:** Organising data by group or class

**Materials:** Worksheets and weighing scales

**Steps:**

1. Students in the class are required to weigh themselves and record the weight on the whiteboard.
2. Organise the weight in kg, in the table on the right according to the following classes.  
30 - 39, 40 - 49, 50 - 59, 60 - 69, 70 - 79
3. Tally and complete the frequency table on the right.

Weight (kg)	Tally	Frequency
30 - 39		
40 - 49		
50 - 59		
60 - 69		
70 - 79		

**Discussion:**

What is the difference between the grouped data frequency table and the ungrouped data frequency table that you have learned earlier?

From the activities above, for a table of a grouped data, data is classified with a uniform class interval to prevent the data from overlapping.

This class can be used to categorise those data into appropriate groups such as grades, passes, failures and achievement levels. The information will help us make a conclusion.

This situation is very important if we want to organise a large set of data.

**EXAMPLE 15**

The data on the right shows the mathematics test score for 30 Form Two Saturn students in the mid-year examination. Organise the data in the frequency table according to classes.

Marks	Tally	Frequency
0 - 19		
20 - 39		
40 - 59		
60 - 79		
80 - 99		

Mathematics Marks Form 2 Saturn				
85	58	75	41	53
12	61	63	45	72
37	55	29	42	95
31	22	18	25	19
47	38	50	78	58
90	57	63	49	88

**Solution:**

Marks	Tally	Frequency
0 - 19	///	3
20 - 39	//// /	6
40 - 59	//// // /	11
60 - 79	//// /	6
80 - 99	////	4

Data in class 80 - 99 are 85, 88, 90 and 95

**REMEMBER !**

Tally  
//// = 5

**TIPS**

How to tally the data into classes:

Example: 85 is located between 80-99 class interval then tally it in the 80-99 row.

In the example above, the marks have been classified into five categories according to the same interval.

**EXAMPLE 16**

Silvia interviewed 20 of her friends about the time they wake up in the morning during the school holidays. The findings from the interview are shown on the right.

Organise the data in a frequency table according to the following classes.

Time (a.m.)	Tally	Frequency
5:00 - 5:29		
5:30 - 5:59		
6:00 - 6:29		
6:30 - 6:59		
7:00 - 7:29		

Wake-up time (a.m.)	
6:00	6:35
5:01	6:42
6:22	5:40
5:30	7:23
6:03	6:15
6:40	5:41
5:20	6:45
6:50	5:35
6:40	6:05
6:50	6:35

From the frequency table, answer the following questions.

- How many students wake up between 6:00 a.m. to 6:29 a.m.?
- Describe the highest and lowest frequencies of the time the students wake up.

**Solution:**

- Five students.
- From the frequency table, most of the students wake up between 6:30 a.m. to 6:59 a.m.. There are eight of them. Only one student wakes up between 7:00 a.m. to 7:29 a.m..

Time (a.m.)	Tally	Frequency
5:00 - 5:29	//	2
5:30 - 5:59	////	4
6:00 - 6:29	////	5
6:30 - 6:59	//// //	8
7:00 - 7:29	/	1

**12.1.4 Modal class and mean of a set of grouped data**

**EXAMPLE 17**

Below is a survey finding of the weekly pocket money, in RM brought by 30 students of SMK Tasek Damai.

15	21	18	22	35	40	55	40	45	50
25	32	45	15	10	20	35	45	15	25
25	15	60	30	45	50	30	10	12	30

**LEARNING STANDARD**

Determine the modal class and mean of a set of grouped data.

- Copy and complete the frequency distribution table below.

Pocket money (RM)	Tally	Frequency
1 - 10	//	2
11 - 20		
21 - 30		
31 - 40		
41 - 50		
51 - 60		

- From frequency distribution table, state the class with the highest frequency.

**Solution:**

- | Pocket money (RM) | Tally   | Frequency |
|-------------------|---------|-----------|
| 1 - 10            | //      | 2         |
| 11 - 20           | //// // | 7         |
| 21 - 30           | //// // | 8         |
| 31 - 40           | ////    | 5         |
| 41 - 50           | //// /  | 6         |
| 51 - 60           | //      | 2         |

Modal class

21 - 30

8

Highest frequency

- The class with the highest frequency is 21-30.

When the data is organised, we will know the highest frequency value and its class. In the Example 17, the highest frequency is 8 and the class is 21-30. Thus, class 21-30 are known as **modal class**.

**EXAMPLE 18**

The table of frequency below shows marks for an aptitude test for 30 students. Determine the modal class.

Marks	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	65 - 69
Frequency	7	4	1	4	9	5

**Solution:**

Marks	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	65 - 69
Frequency	7	4	1	4	9	5

Modal class

Highest frequency

Highest frequency = 9

Modal class = 60 - 64

► Mean for grouped data

For grouped data, we have classified the data to a specific group, so before the mean for this data is determined, we must find the midpoint of this class to represent the class.

**EXAMPLE 19**

The table below recorded the number of newspapers sold by different stores in a week. Determine the midpoint for each class.

Number of newspaper	Number of stores (Frequency)
70 - 74	4
75 - 79	10
80 - 84	8
85 - 89	2

**DO YOU KNOW ?**

Number of newspaper	Number of stores (frequency)
70 - 74	4

Lower limit      Upper limit

**Solution:**

Number of newspaper	Midpoint of the class	Number of stores (Frequency)
70 - 74	$\frac{70 + 74}{2} = 72$	4
75 - 79	$\frac{75 + 79}{2} = 77$	10
80 - 84	$\frac{80 + 84}{2} = 82$	8
85 - 89	$\frac{85 + 89}{2} = 87$	2

**TIPS**

Midpoint  

$$= \frac{\text{Lower limit} + \text{upper limit}}{2}$$

After obtaining the midpoint for each class, we calculate the mean with the following formula,

$$\text{Mean} = \frac{\text{The sum (frequency} \times \text{midpoint)}}{\text{Number of frequencies}}$$

**EXAMPLE 20**

The table below records the height of 30 saplings observed by Umeswary in a science experiment. Calculate the mean of the height of the tree.

Height of tree (cm)	Frequency
5 - 9	4
10 - 14	5
15 - 19	4
20 - 24	8
25 - 29	7
30 - 34	2

**Solution:**

1. Calculate the midpoint of each class. The following steps can be followed.

Height of tree (cm)	Midpoint of the class	Frequency
5 - 9	$\frac{5 + 9}{2} = 7$	4
10 - 14	$\frac{10 + 14}{2} = 12$	5
15 - 19	$\frac{15 + 19}{2} = 17$	4
20 - 24	$\frac{20 + 24}{2} = 22$	8
25 - 29	$\frac{25 + 29}{2} = 27$	7
30 - 34	$\frac{30 + 34}{2} = 32$	2

2. Multiply each midpoint with the frequency.

Height of tree (cm)	Midpoint, $x$	Frequency, $f$	Frequency $\times$ midpoint, $fx$
5 - 9	$\frac{5 + 9}{2} = 7$	4	$4 \times 7 = 28$
10 - 14	$\frac{10 + 14}{2} = 12$	5	$5 \times 12 = 60$
15 - 19	$\frac{15 + 19}{2} = 17$	4	$4 \times 17 = 68$
20 - 24	$\frac{20 + 24}{2} = 22$	8	$8 \times 22 = 176$
25 - 29	$\frac{25 + 29}{2} = 27$	7	$7 \times 27 = 189$
30 - 34	$\frac{30 + 34}{2} = 32$	2	$2 \times 32 = 64$
		$\Sigma f = 30$	$\Sigma fx = 585$

**TIPS**

Mean for grouped data can also be written in the form of a symbol.

$\Sigma$  is read as "sigma".  $\Sigma$  is a notation for sum.  
 $fx$  represents frequency of multiplication of midpoint.

$$\bar{x} = \frac{\Sigma fx}{\Sigma f}$$

Symbol  $\bar{x}$  for mean is read as "x bar".  
 $f$  represents frequency.

3. Calculate the mean of the height of sapling,

$$\begin{aligned} \text{mean} &= \frac{\text{sum (frequency} \times \text{midpoint)}}{\text{Number of frequencies}} \\ &= \frac{\Sigma fx}{\Sigma f} \\ &= \frac{585}{30} \\ &= 19.5 \end{aligned}$$

### 12.1.5 The most appropriate measure for central of tendencies

We can choose and justify any measure of central tendency to describe the distribution of a given set of data as seen appropriate.

The type of data is very important if we want to make the selection of the appropriate measure of central tendency. Justification for the choice should be clear and precise so that it can represent the entire data.

#### LEARNING STANDARD

Choose and justify the appropriate measures of central tendencies to describe the distribution of a set of data, including those with extreme values.

**Mean** is chosen as a measure of central tendency because it involves the entire data. When there is an extreme value, the mean cannot give an accurate interpretation of the data because the extreme value affects the mean.

**The median** is a more appropriate measure of central tendency to use when there is an extreme value because the median is not influenced by extreme values. It is the value at the midpoint of the set of data.

**Mode** is a more appropriate measure of central tendency when the set of data involves non-numerical values like category data. Additionally, mode is also suitable for favourite or popular items.

#### EXAMPLE 21

Determine the type of measure of central tendencies that is suitable for the situations below.

- The stems and leaf plot on the right shows the weight of marbles in 10 plastic jars.

**Solution:**

Mean because there is no extreme value in the set of data

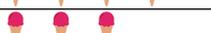
Weight of marbles		
Stem	Leaf	
5	0 6 8	
6	1 1 4	7
7	2 6 9	

Key: 5 | 0 refers to 50 g

- The pictograph on the right shows the flavour of ice cream favoured by kindergarten students.

**Solution:**

Mode because this is a category data and it will determine the favourite item.

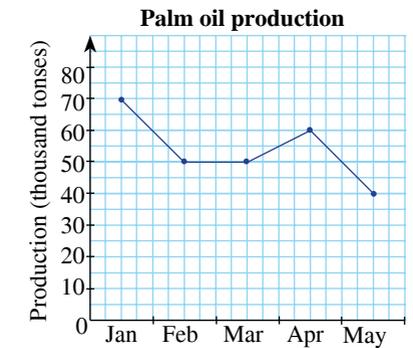
Favourite ice cream flavour	
Flavour	Frequency
Chocolate	
Pandan	
Yam	
Strawberry	

 represents 5 students

- The line graph on the right shows the production of palm oil in a factory for 5 months.

**Solution:**

Mean - because there is no extreme value in the set of data.



- The table below shows the number of hours spent browsing the Internet by Form 2 Melor students.

Hours spent browsing the Internet	1	2	3	4	5	6	7
Number of students	2	5	5	7	6	4	3

Hours spent browsing the Internet by Form 2 Melor students

**Solution:**

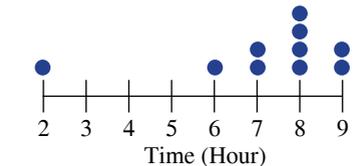
Mean - because there is no extreme value in the set of data.

- The dot plot on the right shows the time taken in hours when 10 drivers made a trip from Ipoh to Melaka by car.

**Solution:**

Median because there is an extreme value in the set of data.

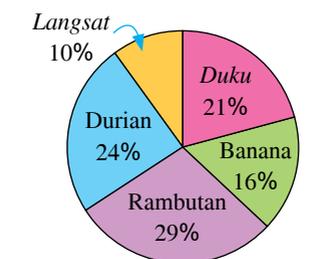
Driving time taken from Ipoh to Melaka



- The pie chart on the right shows the favourite fruits of the students of Form 2 Gemilang.

**Solution:**

Mode because this is a category data and it will determine the favourite item.

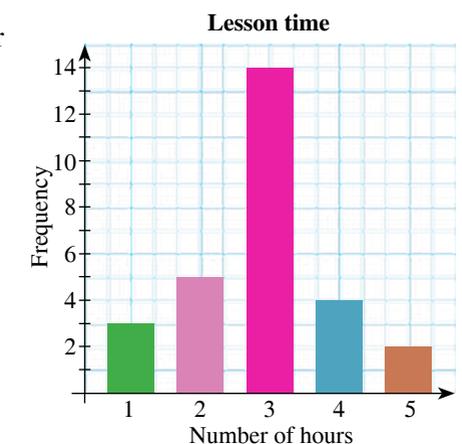


The favourite fruits of the students of Form 2 Gemilang

- The bar chart on the right shows time taken in hours for some students to do revision in a day.

**Solution:**

Median because there is an extreme value in the set of data.



### 12.1.6 Mode, mean and median from data representation

The use of measures of central tendencies in statistics or daily routine.

#### EXAMPLE 22

Determine the mode in the following data representations.

- (a) The bar chart shows the number of tourists to resort islands.

**Solution:**

Modes are Perhentian Island and Langkawi Island.

- (b) The pictograph shows the kind of fruits that are favoured by Form 2 Bestari students.

**Solution:**

No mode.

- (c) The pie chart shows how students go to school.

**Solution:**

Mode is bus.

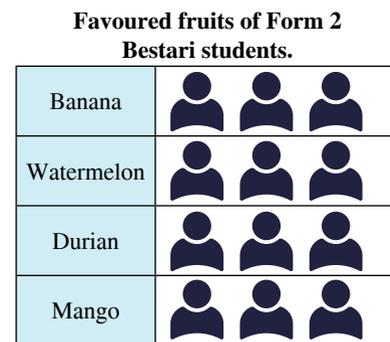
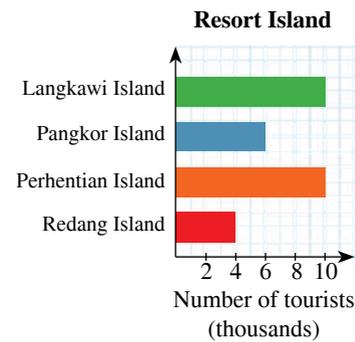
- (d) The table shows the profit of online sales in a year.

**Solution:**

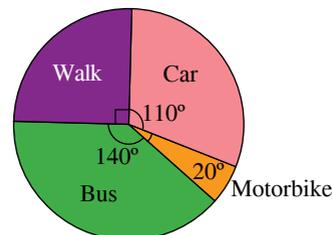
Mode is women accessories.

#### LEARNING STANDARD

Determine mode, mean and median from data representations.



Person icon represents three students



Transportation used by students to school

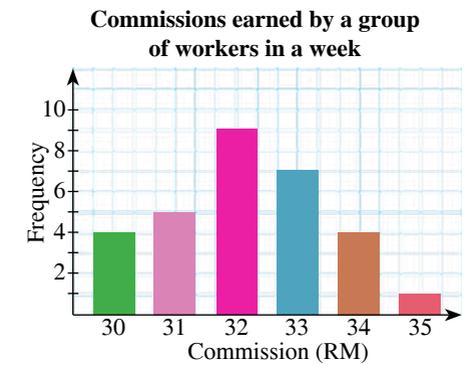
Item	Profit (%)
Books	87
Computer software	54
Cinema tickets	72
Women accessories	130
Travel package	78

Profit of online sales

#### EXAMPLE 23

The bar chart on the right shows commissions earned by a group of workers at a restaurant in a week.

- (a) Determine the mean, median and mode by the employee within a week.  
 (b) Determine the number of workers who receive commissions less or equal to RM32 compared to the total number of workers, in fraction form.



**Solution:**

$$\begin{aligned} \text{(a) Mean} &= \frac{4(30) + 5(31) + 9(32) + 7(33) + 4(34) + 1(35)}{4 + 5 + 9 + 7 + 4 + 1} \\ &= \frac{965}{30} \\ &= \text{RM}32.17 \end{aligned}$$

$$\begin{aligned} \text{Median} &= \text{Average data at } \left[ \left( \frac{30}{2} \right)^{\text{th}} \text{ and } \left( \frac{30}{2} + 1 \right)^{\text{th}} \right] \\ &= \text{Average data at } (15^{\text{th}} \text{ and } 16^{\text{th}}) \\ &= \frac{\text{Data at } 15^{\text{th}} + \text{data at } 16^{\text{th}}}{2} \\ &= \frac{32 + 32}{2} \\ &= \text{RM}32 \end{aligned}$$

Mode = RM32

- (b) The number of workers receiving commissions less or equal to RM32
- $$\begin{aligned} &= \frac{4 + 5 + 9}{30} \\ &= \frac{3}{5} \end{aligned}$$

#### EXAMPLE 24

The table shows the number of spelling errors made by Form 2 Amanah students when writing essay in Malay.

Number of spelling errors	0	1	2	3	4	5
Number of students	4	8	$x$	6	5	4

- (a) If the mean of the students' spelling errors is 2.4, calculate the value of  $x$ .  
 (b) If the median for the frequency distribution is 3, calculate the maximum value of  $x$ .  
 (c) If the mode of students' spelling errors is 2, determine the minimum possible value of  $x$ .

**Solution:**

$$\text{(a) Mean} = \frac{4(0) + 8(1) + x(2) + 6(3) + 5(4) + 4(5)}{4 + 8 + x + 6 + 5 + 4} = 2.4$$

$$\begin{aligned} \frac{2x + 66}{x + 27} &= 2.4 \\ 2x + 66 &= 2.4(x + 27) \\ 2x + 66 &= 2.4x + 64.8 \\ 2.4x - 2x &= 66 - 64.8 \\ 0.4x &= 1.2 \\ x &= 3 \end{aligned}$$

(b)  $\underbrace{0, 0, 0, 0}_4$   $\underbrace{1, 1, 1, 1, 1, 1, 1, 1}_8$   $\underbrace{2, \dots, 2}_x$   $\underbrace{3}_3$   $\underbrace{3, 3, 3, 3, 3}_5$   $\underbrace{4, 4, 4, 4, 4}_5$   $\underbrace{5, 5, 5, 5}_4$

The maximum value for  $x$  if the median is located here  
 $4 + 8 + x = 5 + 5 + 4$   
 $12 + x = 14$   
 $x = 2$   
 Thus, the greatest value for  $x$  is 2

Therefore, the maximum value of  $x$  is 2.

(c) The minimum possible value of  $x$  is 9.

### 12.1.7 Measures of central tendencies in making predictions, forming an argument and conclusion

In making comparisons or selecting the most appropriate measure of central tendency, the importance of the range should be taken into consideration.

#### LEARNING STANDARD

Apply the understanding of measures of central tendencies to make predictions, form convincing arguments and conclusions.

#### EXAMPLE 25

Encik Rahman would like to choose a school representative for the game of bowling at the zone level. Ramesh and Khairil are among those who have been shortlisted in this selection. In the last five exercises prior to the selection, Ramesh's score was 116, 118, 200, 207 and 209. Khairil's score was 240, 240, 75, 220 and 75. Which player will be selected as the school representative?

**Solution:**

$$\begin{aligned} \text{Mean score for Ramesh} &= \frac{116 + 118 + 200 + 207 + 209}{5} \\ &= \frac{850}{5} \\ &= 170 \end{aligned}$$

$$\begin{aligned} \text{Mean score for Khairil} &= \frac{240 + 240 + 75 + 220 + 75}{5} \\ &= \frac{850}{5} \\ &= 170 \end{aligned}$$

Both players have the same mean. Therefore, the mean cannot be used in the decision for the selection of the school representative.

$$\begin{aligned} \text{Score range of Ramesh} &= 209 - 116 \\ &= 93 \end{aligned}$$

$$\begin{aligned} \text{Score range of Khairil} &= 240 - 75 \\ &= 165 \end{aligned}$$

Ramesh's range of scores is lower than that of Khairil's because there is a very low score (extreme value) that caused the range to be large. Therefore, selecting Ramesh as a school representative is more suitable.

#### FLASHBACK

Range is the difference between the smallest value and the largest value.

#### EXAMPLE 26

Encik Johan who is a teacher formed three basketball teams. The table below shows the total number of goals scored by the teams in five competitions.

Team	Competition				
	1	2	3	4	5
Kijang	65	95	32	96	88
Harimau	50	90	65	87	87
Seladang	90	85	46	44	80

(a) You want to join one of these teams.

- Given the mean, which team will you join? Justify your answer by showing the workings.
- If you consider the median in making a decision, which group would you choose? Explain by showing your workings.

(b) If Encik Johan was asked to submit a report of the achievements by team Harimau to the school principal, which measures of central tendencies should by Encik Johan choose? Explain.

**Solution:**

$$\begin{aligned} \text{(a) (i) Mean for team Kijang} &= \frac{65 + 95 + 32 + 96 + 88}{5} \\ &= 75.2 \end{aligned}$$

$$\begin{aligned} \text{Mean for team Harimau} &= \frac{50 + 90 + 65 + 87 + 87}{5} \\ &= 75.8 \end{aligned}$$

$$\begin{aligned} \text{Mean for team Seladang} &= \frac{90 + 85 + 46 + 44 + 80}{5} \\ &= 69 \end{aligned}$$

The Harimau team is selected because the mean is the highest; that is 75.8.

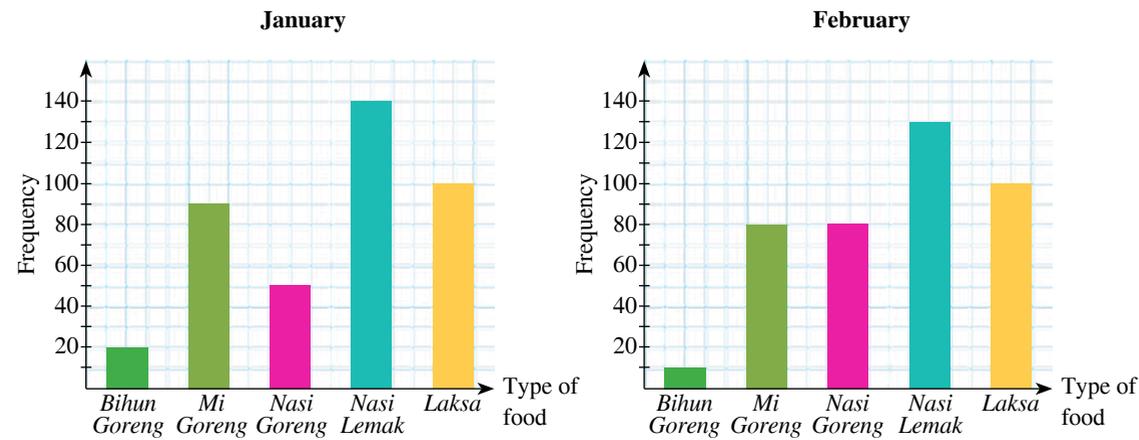
Data set for Kijang is 32, 65, 88, 95, 96. Thus, median is 88.

- Team Kijang = 32, 65, **88**, 95, 96. Median = 88  
 Team Harimau = 50, 65, **87**, 87, 90. Median = 87  
 Team Seladang = 44, 46, **80**, 85, 90. Median = 80

The Kijang team is selected because the value of the median is the highest; that is 88.

(b) Mean. This is because mean uses the entire set of data in the table. Therefore, mean is most appropriate because there is no extreme value in this set.

**EXAMPLE 27**



The bar chart above shows food selection at school canteens in January and February from a study conducted on 400 students.

- (a) Which measures of central tendencies is appropriate for the above situation? Explain.

Nasi lemak is the most favoured dish of the students.

- (b) Do you agree with the above statement? Explain your reasons.  
 (c) You are a canteen committee member of the Consumer Association. You are asked to suggest a type of food that needs to be reduced. Give your reasons.

**Solution:**

- (a) From the graphs above, mean and median are not suitable because the data provided are category data. So, mode is more appropriate.  
 (b) Yes because Nasi lemak is the mode for January and February.  
 (c) Bihun Goreng should be reduced due to its lowest frequency in January and February.

**SELF PRACTICE 12.1**

1. Specify the mode for each of the following sets of data.  
 (a) 3, 0, 1, 1, 4, 3, 2, 2, 1                      (b) RM10, RM8, RM7, RM7, RM8, RM9  
 (c) 64, 60, 63, 60, 60, 67

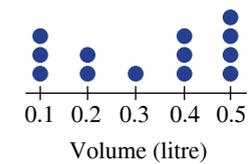
2. The table below shows shirt size of 145 participants of the "Jom Sihat" run.

Size	SS	S	M	L	XL	XXL
Frequency	20	17	15	37	31	25

State the mode for the size of shirts.

3. State the mode for the data representation below.

(a) Volume of oil in the bottle

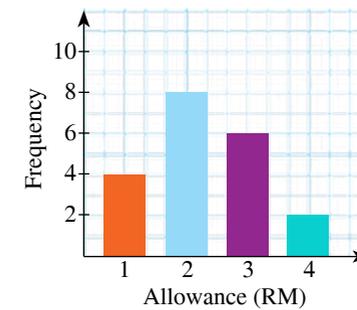


(b) Marks for fitness test

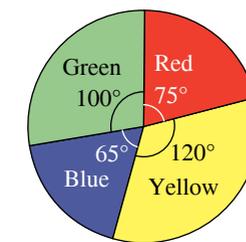
Stem	Leaf
2	6 6 7 8
3	1 1 2 2 2 3 6 7 7 7
4	0 2 5

Key: 2 | 6 refers to 26 km

(c) The allowance paid to students to sell bookmarks



(d) Team Helang's favourite colour



4. Determine the median for the following sets of data.

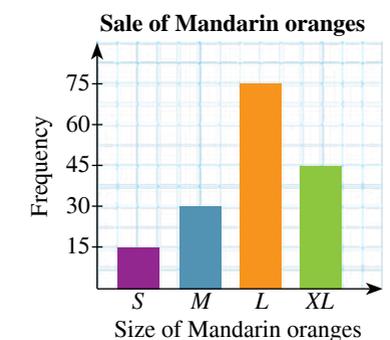
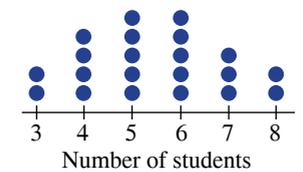
- (a) 7, 5, 7, 8, 3, 12.                                      (b) 37, 38, 27, 28, 48, 47, 58, 68.  
 (c) 3, 200, 4, 10, 50, 7, 90, 3, 50, 11, 3.

5. The table shows the number of ferry passengers at Pulau Pangkor jetty in January. Calculate the median.

Number of passengers	10	20	30	40
Frequency	5	8	7	10

6. Calculate the median for the following representation of data.

- (a) Dot plot indicates the number of students visiting the access centre in a week.  
 (b) Bar chart shows the size of mandarin oranges sold at a store during Chinese New Year.



7. Calculate the mean for the following set of data.  
 (a) 9, 5, 2, 3, 11, 12 (b) 3.5, 2.4, 1.7, 3.2, 4.5
8. (a) Given the value of mean of 4, 7,  $x$ , 9, 8 is 6, calculate  $x$ .  
 (b) Given the value of mean of 7 cm, 15 cm, 12 cm, 5 cm,  $h$  cm and 13 cm is 10 cm. calculate the value  $h$ .
9. The table below shows the trend of absenteeism among 40 students in January.

Number of days absent	0	1	2	3	4	5	8
Frequency	24	3	4	5	2	1	1

Calculate the mean. Round off your answer to the nearest whole number.

10. Complete the of frequency table below.

(a)

18	28	18	24
18	23	30	24
26	35	22	13
16	33	19	32
6	16	34	27

(b)

47	34	23	23
47	48	54	42
42	65	43	15
31	32	48	58
35	39	42	31

The data above shows the age for 20 visitors at the National Museum.

Age (year)	Tally	Frequency
6 - 10	/	1
11 - 15		
16 - 20		
21 - 25		
26 - 30		
31 - 35		

The data above shows the number of table tennis balls contained inside 20 baskets.

Number of table tennis balls	Tally	Frequency
10 - 19	/	1

11. 2, 2, 3, 5, 7, 10, 11, 16, 17, 40
- (a) Calculate the value of mean, median and mode.  
 (b) Which measure of central tendencies is suitable? Explain.

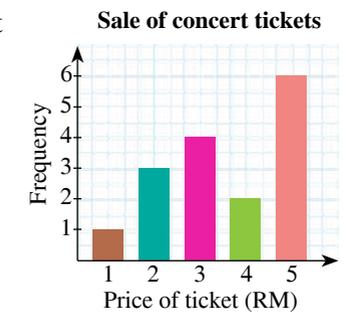
12. The table below shows the scores of an English spelling test for a group of Form 1 students.

Score	5	6	7	8	9	10
Number of students	4	16	12	7	6	5

- (a) Calculate the mean, median and mode.  
 (b) Which measure of central tendencies is suitable? Explain.

13. Determine the measures of central tendencies suitable in the situation below. Justify your answer.

- (a) The bar chart shows the number and the price of concert tickets sold by the school Theatre Club.



- (b) The stem-and-leaf plot shows the volume of chemical solution, in ml, for 19 different bottles.

Stem	Volume of chemical solution									
	Leaf									
2	0	1	3	5	6					
3	6	7	1	1	0	1	1	2	3	5
4	1	1	1							
13	7									

Key: 2 | 0 refers to 20 ml

14. Which measures of central tendency is suitable to describe situation below?

- (a) The number of students for school societies and uniformed bodies.  
 (b) Students' favourite television programmes in your class.  
 (c) Number of pets owned by Form 2 Amanah students.

### GENERATING EXCELLENCE

1. The table below shows the number of children from 40 families in a motivational programme.

Number of children	0	1	2	3	4	5
Frequency	3	2	8	5	17	5

Determine the mode.

2. The mean for seven numbers is 10. Five of the numbers are 6, 5, 14, 10 and 11. Two other numbers are represented by  $k$ . Calculate
- (a) the sum of the seven numbers. (b) the value of  $k$ .

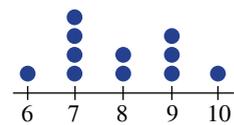
3. In each of the data representation below, calculate the mean.

(a) **Marks for Mathematics test**

Stem	Leaf
7	2 3
8	1 1 4 5
9	2 6

Key: 7 | 2 refers to 72 marks

(b) **Packets of noodles sold**



Number of packets

4. The table shows the qualifying marks for a History quiz obtained by a group of students. Calculate the median.

Marks	5	10	15	20	25	30
Frequency	2	7	5	11	9	7

5. Given the following numbers: 2, 4, 6, 6, 8 and 12,

(a) determine the mean, median and mode of the set of data above.

(b) calculate the new mean, median and mode if

- (i) 2 is added to each number.
- (ii) each number is multiplied by 2.
- (iii) 2 is subtracted from each number.
- (iv) each number is divided by 2.

6. The mean of four numbers is 14. If two numbers,  $x$  and  $x + 2$  are added to the set of data, the new mean is 15. Calculate the value of  $x$ .

7. The mean of four numbers is 71. Two of the numbers are 56 and 48. The value of the other two numbers is  $x$  respectively.

(a) Calculate,

- (i) the sum of the four numbers.
- (ii) the value of  $x$ .

(b) Subtract 5 from each of the four numbers. Calculate the new value of mean.

8. The stem-and-leaf table below represent the distance, in km, by a group of runners during a cross-country event.

Distance	
Stem	Leaf
2	3 4 6 9
3	0 1 2 2 2 4 4 5 8
4	2 2

Key: 2 | 3 refers to 23 km

(a) Determine

- (i) mean
- (ii) mode
- (iii) median

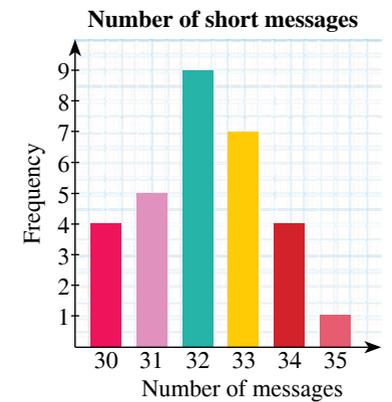
(b) What is the percentage of participants who ran a distance of 32 km or more?

9. The bar chart shows the number of short messages sent by 30 students a week.

(a) Calculate

- (i) mean
- (ii) mode
- (iii) median

(b) Calculate the number of students who sent less than 33 messages in a week compared to the total number of students, in fraction form.



10. Time taken for 40 students to finish crossword puzzles is recorded in the table below.

Time (minutes)	2	4	6	8	10
Number of students	$x$	2	$y$	6	14

(a) Show that  $x + y = 18$ .

(b) If  $y = 6$ , calculate the mean.

(c) Determine: (i) median (ii) mode

11. Malek, Rani and Yip have been selected to the final round in the long jump competition. They have made their respective jumps and their distance is recorded in metre.

Participants	Jump		
	1	2	3
Malek	3.2	4.5	6.1
Ravi	6.3	3.4	5.2
Yip	4.5	6.7	4.9

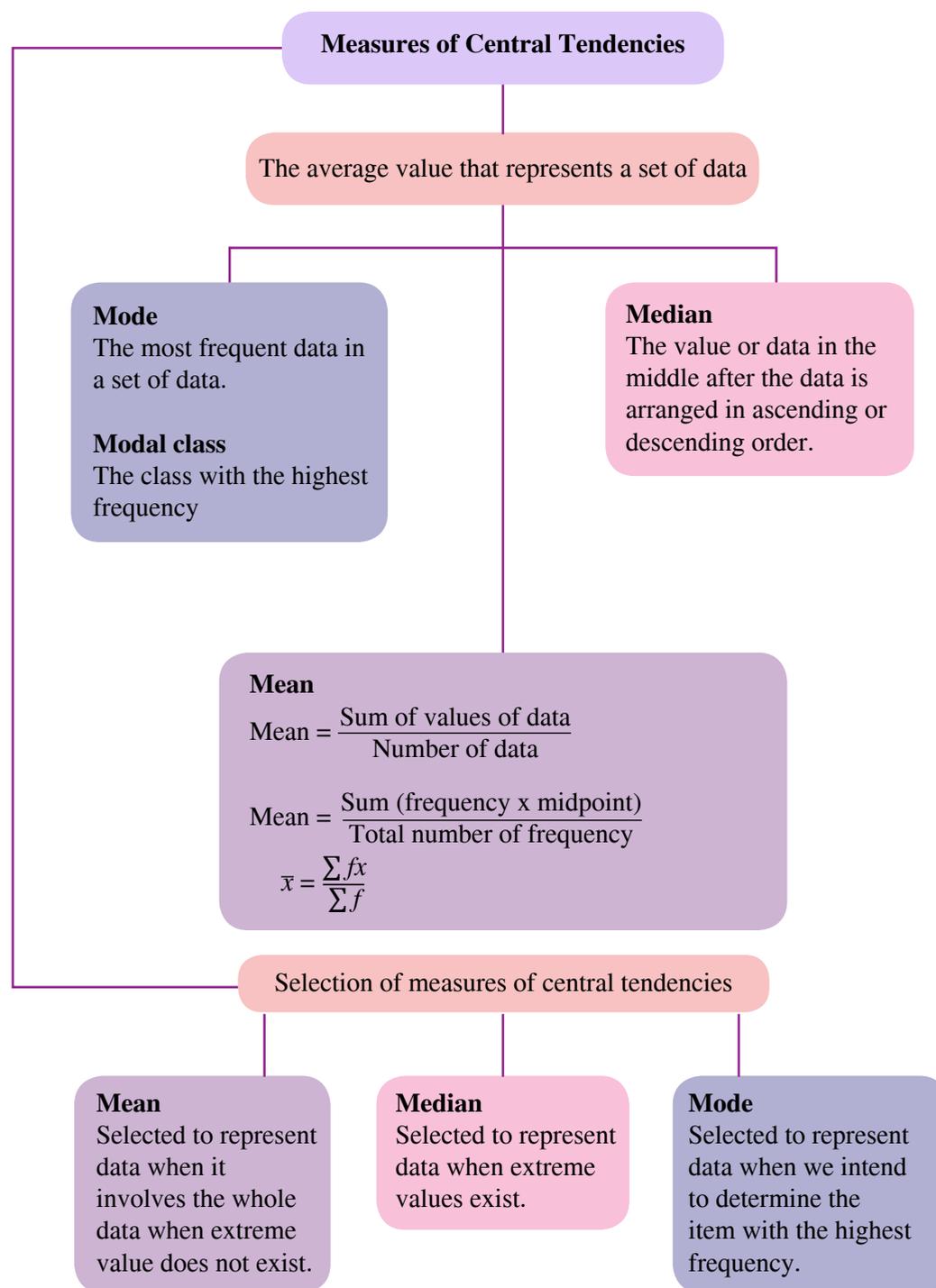
From the table above, which measures of central tendencies would you choose to determine the winners of the gold, silver and bronze medals? Explain your answers.

12. Joshua has scored 74, 95, 98, 84 and 74 in his History tests.

(a) How could Joshua convince his parents that he had worked hard to achieve the best results in History? Which measures of central tendencies should Joshua use for this purpose? Justify your answer.

(b) Encik Shamsudin is Joshua's History teacher. He encouraged Joshua to work harder because his marks for History were still inconsistent. Which of the marks did Encik Shamsudin refer to when he expressed his concern for Joshua's achievement?

**CHAPTER SUMMARY**



**SELF REFLECTION**

At the end of the chapter, I will be able to:



1. Determine the mode, mean and median values of set of a non-grouped data.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Makes conclusion about the effect of changes in a set of data to the value of mode, median and mean.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Collect data, construct and interpret the frequency table for grouped data.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Determine the modal class and mean of a set of a grouped data.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Select and justify the appropriate measures of central tendencies to describe the distribution of a set of data, including those with extreme values.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Determine mode, mean and median from data representations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Apply the understanding of the measures of central tendencies to make predictions, forming convincing arguments and make conclusions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



**MINI PROJECT**

You are required to find information and write reports on students' height and weight from three different form 2 classes. Obtain the data through questionnaires containing gender, height and weight.

Then, organise your data using a suitable frequency table. You can use a computer software or do it manually in writing this report.

For the data from each class, analyse the data by using measures of central tendencies that is mode, mean, and median. State the measures of central tendencies you would choose to represent the data. Next, calculate BMI for each student and provide suggestions to stay healthy.

