Burscough Priory Science College

NUMERACY

POLICY

Our Mission Statement:

Burscough Priory Science College is committed to raising the standards of numeracy of all of its pupils, so that they develop the ability to use numeracy skills effectively in all areas of the curriculum and the skills necessary to cope confidently with the demands of further education, employment and adult life.

Introduction:

The purposes of our whole-school numeracy policy:

I. to develop, maintain and improve standards in numeracy across the school;
II. to ensure consistency of practice including methods, vocabulary, notation, etc.;
III. to indicate areas for collaboration between subjects;
IV. to assist the transfer of pupils' knowledge, skills and understanding between subjects.

A current definition of numeracy:

Numeracy is a proficiency which is developed mainly in mathematics but also in other subjects. It is more than an ability to do basic arithmetic. It involves developing confidence and competence with numbers and measures. It requires understanding of the number system, a repertoire of mathematical techniques, and an inclination and ability to solve quantitative or spatial problems in a range of contexts. Numeracy also demands understanding of the ways in which data are gathered by counting and measuring, and presented in graphs, diagrams, charts and tables.

(Framework for Teaching Mathematics – yrs 7 to 9 – DfES)

Practice at Burscough Priory Science College

Raising Standards

Raising Standards in Numeracy across our school cannot be solely judged in increased test percentages. There is a need to evaluate the pupils' ability to transfer mathematical skills into other subject areas, applying techniques to problem solving. Their confidence in attempting this is initially as important as achieving the correct solution. Pupil interviews and work sampling will be the main processes for evaluating the success of our practice.

Consistency of Practice

Teachers of mathematics should:

1. be aware of the mathematical techniques used in other subjects and provide assistance and advice to other departments, so that a correct and consistent approach is used in all subjects.

2. provide information to other subject teachers on appropriate expectations of students and difficulties likely to be experienced in various age and ability groups.

3. through liaison with other teachers, attempt to ensure that students have appropriate numeracy skills by the time they are needed for work in other subject areas.

4. seek opportunities to use topics and examination questions from other subjects in mathematics lessons.

Teachers of subjects other than mathematics should:

1. ensure that they are familiar with correct mathematical language, notation, conventions and techniques, relating to their own subject, and encourage students to use these correctly.

2. be aware of appropriate expectations of students and difficulties that might be experienced with numeracy skills.

3. provide information for mathematics teachers on the stage at which specific numeracy skills will be required for particular groups.

4. provide resources for mathematics teachers to enable them to use examples of applications of numeracy relating to other subjects in mathematics lessons.

Possible Areas of Collaboration:

Mental Arithmetic Technique

All departments should give every encouragement to pupils using mental techniques but must also ensure that they are guided towards efficient methods.

Use of calculators

The school expects all pupils to bring their own scientific calculator to lessons when required.

In deciding when pupils use a calculator in lessons we should ensure that:

- pupils' first resort should be mental methods;
- pupils have sufficient understanding of the calculation to decide the most appropriate method: mental, pencil and paper or calculator;
- pupils have the technical skills required to use the basic facilities of a calculator constructively and efficiently, the order in which to use keys, how to enter numbers as money, measures, fractions, etc.;
- pupils understand the four arithmetical operations and recognise which to use to solve a particular problem;
- when using a calculator, pupils are aware of the processes required and are able to say whether their answer is reasonable;
- pupils can interpret the calculator display in context (e.g. 5.3 is £5.30 in money calculations);
- we help pupils, where necessary, to use the correct order of operations – especially in multi-step calculations, such as (3.2 - 1.65) x (15.6 - 5.77).

Vocabulary

The following are all important aspects of helping pupils with the technical vocabulary of Mathematics:

- Use of Word walls
- Using a variety of words that have the same meaning e.g. add, plus, sum
- Encouraging pupils to be less dependent on simple words e.g. exposing them to the word multiply as a replacement for times
- Discussion about words that have different meanings in Mathematics from everyday life e.g. take away, volume, product etc

- Highlighting word sources e.g. quad means 4, lateral means side so that pupils can use them to help remember meanings. This applies to both prefixes and suffixes to words.

Pupils should become confident that they know what a word means so that they can follow the instructions in a given question or interpret a mathematical problem.

Transfer of Skills:

Some examples of where links could be made:

ART – Symmetry; use of paint mixing as a ratio context.

ENGLISH – comparison of 2 data sets on word and sentence length.

FOOD TECHNOLOGY – recipes as a ratio context, reading scales,

GEOGRAPHY – representing data, use of Spreadsheets

HISTORY – timelines, sequencing events

ICT – representing data

MFL – Dates, sequences and counting in other languages; use of basic graphs and surveys to practise foreign language vocabulary and reinforce interpretation of data.

PHYSICAL EDUCATION – collection of real data for processing in Maths

RELIGIOUS EDUCATION – interpretation and comparison of data gathered from secondary sources (internet) on e.g. developing and developed world

RESISTANT MATERIALS – measuring skills, units of area and volume

SCIENCE – calculating with formulae, 3 way relationships,

Appendix

Section 1 – Number

Reading and writing numbers

Pupils must be encouraged to write numbers simply and clearly. It is now common practice to use spaces rather than commas between each group of three figures. eg. 34 000 not 34,000 though the latter will still be found in many text books and cannot be considered incorrect.

In reading large figures pupils should know that the final three figures are read as they are written as ***hundreds, tens*** and ***units.***

Reading from the left, the next three figures are ***thousands*** and the next group of three are ***millions.***

eg. 3 027 251 is three million, twenty seven thousand and fifty one.

Order of Operations

It is important that pupils follow the correct order of operations for arithmetic calculations. Most will be familiar with the mnemonic: **BODMAS.**

Brackets, power **O**f, **D**ivision, **M**ultiplication, **A**ddition, **S**ubtraction

This shows the order in which calculations should be completed. eg

5 + 3 x 4	**NOT**	5 + 3 x 4
means		
5 + 12		
= 17 ✓		= 32 **x**

The important facts to remember are that the **B**rackets are done first, then the **P**owers, **M**ultiplication and **D**ivision and finally, **A**ddition and **S**ubtraction.

eg(i) (5 + 3) x 4
= 8 x 4
= 32

eg (ii) $5 + 6^2 \div 3 - 4$
$= 5 + 36 \div 3 - 4$
$= 5 + 12 - 4$
$= 17 - 4$
$= 13$

Care must be taken with **S**ubtraction.

eg $5 - 12 + 4$
$= -7 + 4$
$= \underline{-3}$ ✓

but $5 - 12 + 4$ [1]
$= 5 - 16$
= $\underline{-11}$ **x**

1 For this to be correct it would have to be written**:** 5 – **(**12 + 4**)** so that the bracket is worked out first.

Mental Calculations

Most pupils should be able to carry out the following processes mentally though the speed with which they do it will vary considerably.

- recall addition and subtraction facts up to 20
- recall multiplication and division facts for tables up to 12 x 12.

Written Calculations

Pupils often use the ' **=** ' sign incorrectly. When doing a series of operations they sometimes write mathematical sentences which are untrue.

eg 5 x 4 = 20 + 3 = 23 – 8 = 15 **x** since 5 x 4 is not equal 15

It is important that all teachers encourage pupils to write such calculations correctly.

eg
$5 \times 4 = 20$
$20 + 3 = 23$
$23 - 8 = \underline{\underline{15}}$ ✓

Pencil & Paper Calculations

All pupils should be able to use some pencil and paper methods involving simple addition, subtraction, multiplication and division. Some less able pupils will find difficulty in recalling multiplication facts to complete successfully such calculations. In these circumstances it may be more useful to use a calculator in your subject to complete the task.

Before completing any calculation, pupils should be encouraged to estimate a rough value for what they expect the answer to be. This should be done by rounding the numbers and mentally calculating the approximate answer.

After completing the calculation they should be asked to consider whether or not their answer is reasonable in the context of the question.

Addition & Subtraction

Estimate

Addition 3 456 + 975 3 500 + 1 000 = 4 500

$$\begin{array}{rr} & 3\,456 \\ + & 975 \\ \hline & 4\,431 \\ \hline & {\scriptstyle 1\ \ 1\ 1} \end{array}$$

Subtraction

Estimate
8 000 – 3 000 = 5000

$$\begin{array}{lr} & {\scriptstyle 7\ \ 9\ \ 9\ \ 1} \\ \text{eg} & \cancel{8}\,\cancel{0}\,\cancel{0}\,3 \\ & -2\,5\,6\,9 \\ \hline & 5\,4\,3\,4 \end{array}$$

Addition and subtraction of decimals is completed in the same way but reminders may be needed to maintain place value by keeping decimal points in line underneath each other.

Multiplication and Division by 10,100,1000…

When a number is multiplied by 10 its value has increased tenfold and each digit will move one place to the left so multiplying its value by 10. When multiplying by 100 each digit moves two places to the left, and so on… Any empty columns will be filled with zeros so that place value is maintained when the numbers are written without column headings.

eg. 46 x 100 = 4 600

Th	**H**	**T**	**U**
		4	6
4	6	0	0

The same method is used for decimals.

eg. 5.34 x 10 = 53.4

H	T	U	.	t	h
		5	.	3	4
	5	3	.	4	

Empty spaces after the decimal point are not filled with zeros. The place value of the numbers is unaffected by these spaces.

When dividing by 10 each digit is moved one place to the right so making it smaller.

eg. 350 ÷ 10 = 35

H	T	U	.	t	h
3	5	0	.		
	3	5	.		

eg. 53 ÷ 100 = 0.534

H	T	U	.	t	h
	5	3	.		
		0	.	5	3

When the calculation results in a decimal the units column must be filled with a zero to maintain the place value of the numbers.

Multiplication

eg 327 x 53 Estimate: 300 x 50 = 15 000

X	300	20	7	**Total**
50	15 000	1000	350	16 350
3	900	60	21	981
Total	15900	1060	371	**17331**

Division

eg 351÷13

$$\begin{array}{rl} & 2\ 7 \\ 13 & \overline{\big)\ 3\ \ 5\ {}^{9}1} \end{array}$$

Multiplying Decimals

- As always, estimate the answer.
- Complete the calculation as if there were no decimal points.
- In the answer insert a decimal point so that there is the same number of decimal places in the answer as there were in the original question.
- Check to see if the answer is reasonable

eg (i) $1.2 \times 0.3 \approx 1 \times 0.3 = 0.3$

Ignoring the decimal points, this will be calculated as 12 x 3 = 36 and will now need two decimal places in the answer.

$\therefore 1.2 \times 0.3 = 0.36$

Percentages

Whilst pupils should be familiar with many operations involving percentages in mathematics lessons it is not proposed to elaborate on all of them in this booklet. The following is a sample of operations which pupils will be expected to use in other areas.

Calculating percentages of a quantity

Methods for calculating percentages of a quantity vary depending upon the percentage required. Pupils should be aware that fractions, decimals and percentages are different ways of representing part of a whole and know the simple equivalents eg 10% = $^1/_{10}$ 12% = 0.12

Where percentages have simple fraction equivalents, fractions of the amount can be calculated.

eg. i) To find 50% of an amount, halve the amount.
ii)To find 75% of an amount, find a quarter by dividing

by four and then multiply it by three.

Most other percentages can be found by finding 10%, by dividing by 10, and then finding multiples or fractions of that amount

eg. To find 30% of an amount first find 10% by dividing the

amount by 10 and then multiply this by three.

30% = 3x10%

Similarly: 5% = half of 10% and 15% = 10% + 5%

Most other percentages can be calculated in this way.

When using the calculator it is usual to think of the percentage as a decimal. Pupils should be encouraged to convert the question to a sentence containing mathematical symbols. ('of' means X)

eg. Find 27% of £350 becomes

0.27 X £350 =

and this is how it should be entered into the calculator.

Calculating the amount as a percentage

In every case the amount should be expressed as a fraction of the original amount and then converted to a percentage in one of the following ways:

i) What is 15 as a percentage of 60?
(using simple fractions)

$$\frac{15}{60} = \frac{1}{4} = 25\%$$

ii) What is 27 out of 50 as a percentage?
(using equivalent fractions)

$$\frac{27 \times 2}{50 \times 2} = \frac{54}{100} = 54\%$$

iii) What is 39 as a percentage of 57?
(Using a calculator)

$$\frac{39}{57} = 39 \div 57 = 0.684 \text{ (to 3 d.p.)} = 68.4\%$$

Section 2 – Algebra

The most common use of algebra across the curriculum will be in the use of formulae.

When transforming formulae pupils will be taught to use the ‘balancing’ method where they do the same to both sides of an equation.

eg $A = Lb$ Make b the subject of the formula

Step 1: Divide both sides by L

$$\frac{A}{L} = \frac{Lb}{L}$$

Step 2: Cancel the L’s on the right hand side

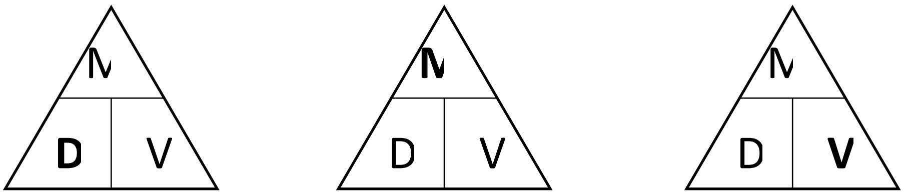
$$\frac{A}{L} = b$$

Step 3: Start with the subject of the formula

$$b = \frac{A}{L}$$

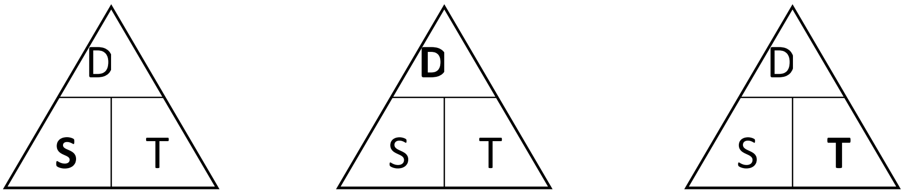
However , in some cases triangles can be useful for specific cases.

eg Density = $\frac{\text{Mass}}{\text{Volume}}$



$$D = \frac{M}{V} \qquad M = D \times V \qquad V = \frac{M}{D}$$

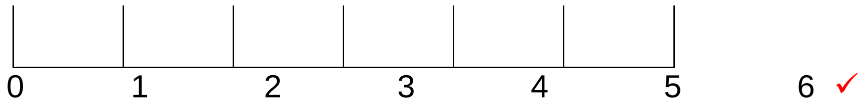
Similarly with **Distance, Speed and Time**



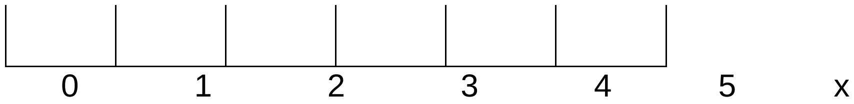
$$S = \frac{D}{T} \qquad D = S \times T \qquad T = \frac{D}{S}$$

Plotting Points
When drawing a diagram on which points have to be plotted some pupils will need to be reminded that the numbers written on the axes must be on the lines not in the spaces.

eg



NOT

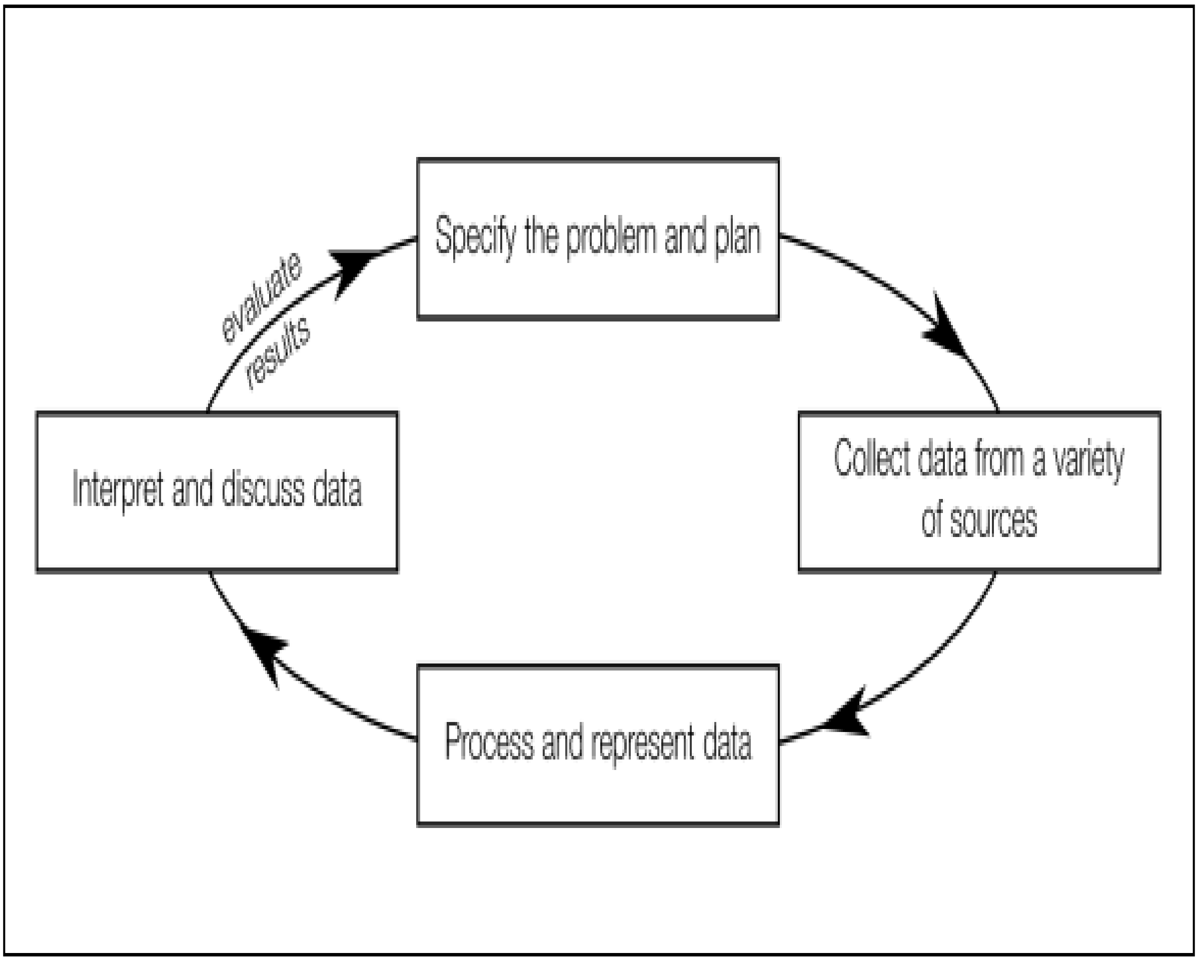


Axes
When drawing graphs to represent experimental data it is usual to use the horizontal axis for the variable which has a regular class interval.

eg In an experiment in which temperature is taken every 5 minutes the horizontal axis would be used for time and the vertical axis for temperature.

Having plotted points pupils can sometimes be confused as to whether or not they should join the points. If the results are from an experiment then a ‘line of best fit’ will usually be needed. Further details appear in the following section on Data Handling.

Section 3 – Data Handling



Pupils use this four stage cycle from Key Stage 1 through to Key Stage 4 in many subject areas.

Bar Charts

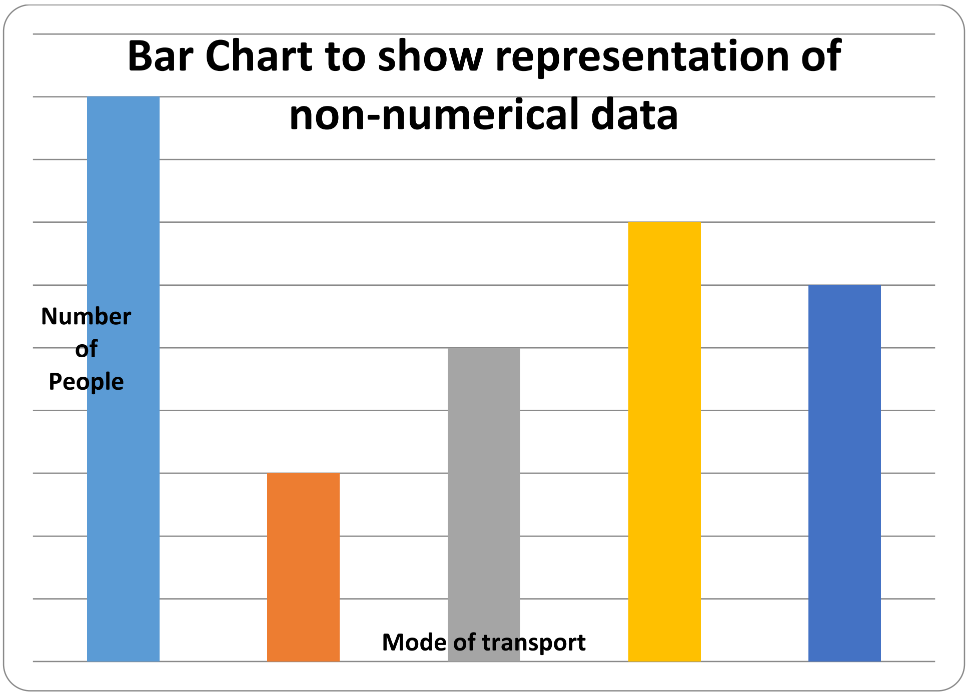
It is important that graphs and diagrams are drawn on the appropriate paper:

- bar charts and line graphs on squared or graph paper.
- pie charts on plain paper.

These are the diagrams most frequently used in areas of the curriculum other than mathematics. The way in which the graph is drawn depends on the type of data to be processed.

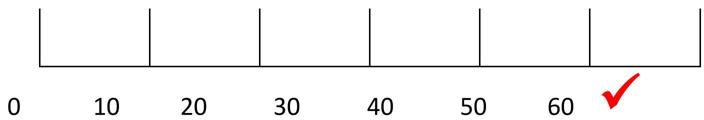
Graphs should be drawn with **gaps between the bars** if the data categories are not numerical (colours, makes of car, names of pop star, etc). There should also be gaps if the data is numeric but can only take a particular value (shoe size, KS3 level, etc). In cases where there are gaps in the graph the horizontal axis will be labelled beneath the columns.

The labels on the vertical axis should be on the lines.



Where the data are continuous, eg. lengths, the horizontal scale should be like the scale used for a graph on which points are plotted.

eg



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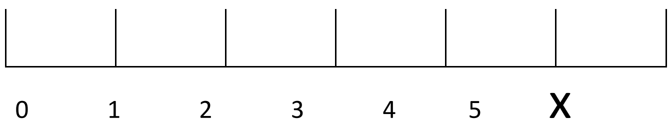
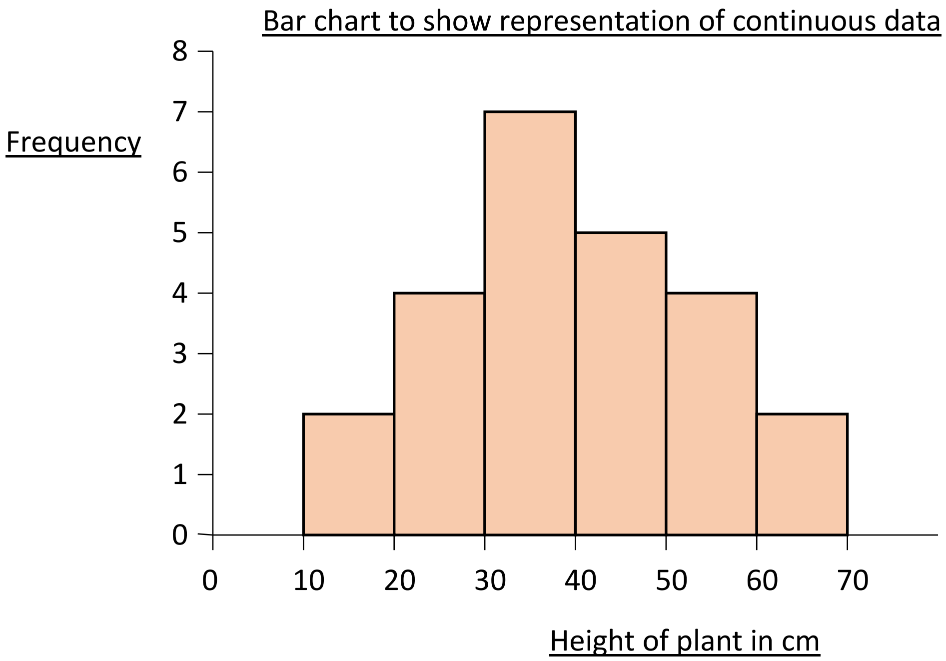
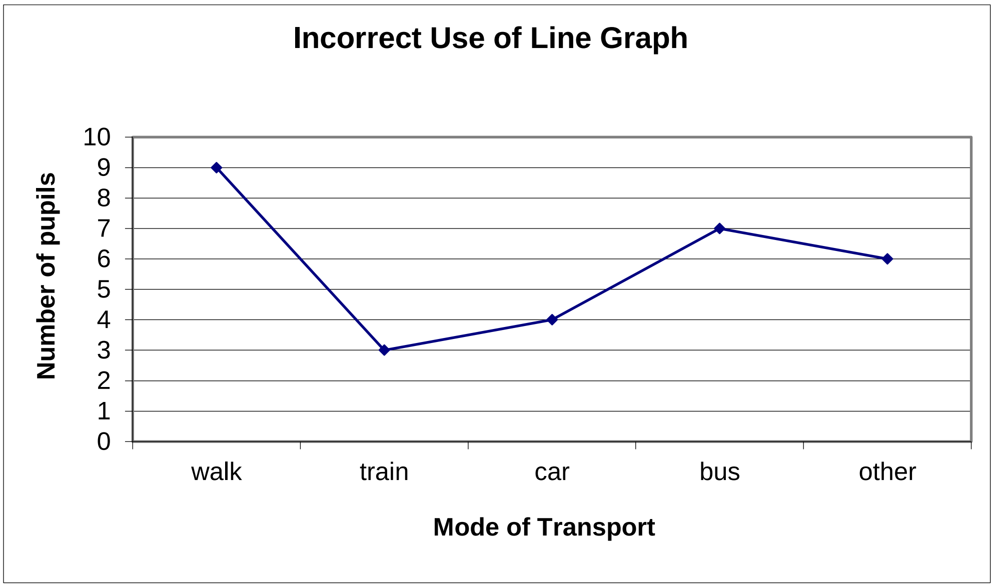




Line Graphs

Line graphs should only be used with data in which the order in which the categories are written is significant.

Points are joined if the graph shows a trend or when the data values between the plotted points make sense to be included. For example the measure of a patient's temperature at regular intervals shows a pattern but not a definitive value.



Computer Drawn Graphs & Diagrams

Pupils throughout the school should be able to use **Excel** or other spreadsheets to draw graphs to represent data. Because it is easy to produce a wide variety of graphs there is a tendency to produce diagrams that have little relevance. Pupils should always be encouraged to write a comment explaining their observations from the graph.

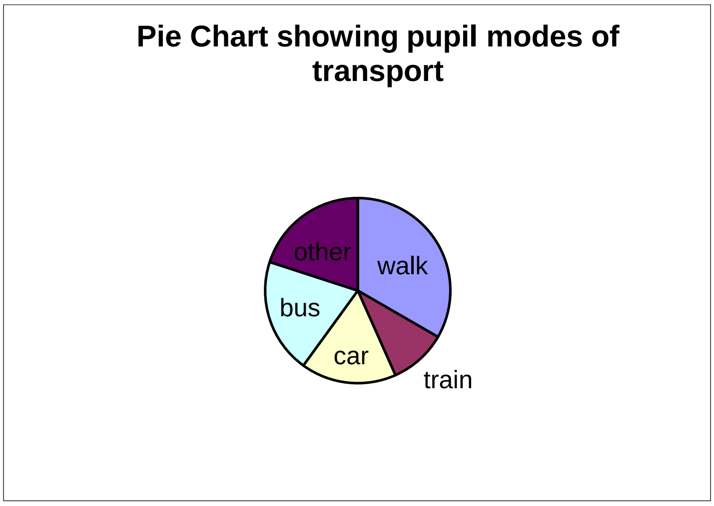
Pie Charts

The way in which pupils should be expected to work out angles for a pie chart will depend on the complexity of the question. If the numbers involved are simple it will be possible to calculate simple fractions of 360°.

eg. The following table shows the results of a survey of 30 pupils travelling to school. Show this information on a pie chart.

Mode of Transport	Frequency	Fraction	Angle
Walk	10	$\frac{1}{3}$	120º
Train	3	$\frac{1}{10}$	36º

Car	5	$\frac{1}{6}$	60º
Bus	6	$\frac{1}{5}$	72º
Other	6	$\frac{1}{5}$	72º
Total	**30**	**1**	**360º**



However, with more difficult numbers which do not readily convert to a simple fraction pupils should first work out the share of 360° to be allocated to **one** item and then multiply this by its frequency.

eg. 180 pupils were asked their favourite core subject.

Each pupils has 360 ÷ 180 = 2° of the pie chart.

Subject	Number of pupils	Pie Chart Angle
English	63	63 x 2 = 126º
Mathematics	75	75 x 2 = 150º
Science	42	42 x 2 = 84º
Total	180	360º

If the data is in percentage form each item will be represented by 3.6° on the pie. To calculate the angle pupils will need to multiply the frequency by 3.6.

eg. 43% will be represented by 43 X 3.6 = 154.8°
$\approx \underline{155°}$

Any calculations of angles should be rounded to the nearest degree only at the **final stage of the calculation.** If the number of items to be shown is 47 each item will need:

$360 \div 47 = 7.659574468°$

This complete number should be used when multiplying by the frequency and then rounded to the nearest degree.

Using Data

Range

The range of a set of data is the difference between the highest and the lowest data values.

eg. If in an examination the highest mark is 80% and the lowest mark is 45%, the range is 35% because 80% - 45% = 35%

The range is always a **positive number**, so it is **NOT** 45% - 80%

Averages

Three different averages are commonly used:

Mean – is calculated by adding up all the values and dividing by the number of values**.**

Median – is the middle value when a set of values has been arranged in order.

Mode – is the most common value. It is sometimes called the **modal group.**

eg. for the following values: **3, 2, 5, 8, 4, 3, 6, 3, 2,**

Mean = $\frac{3+2+5+8+4+3+6+3+2}{9} = \frac{36}{9} = 4$

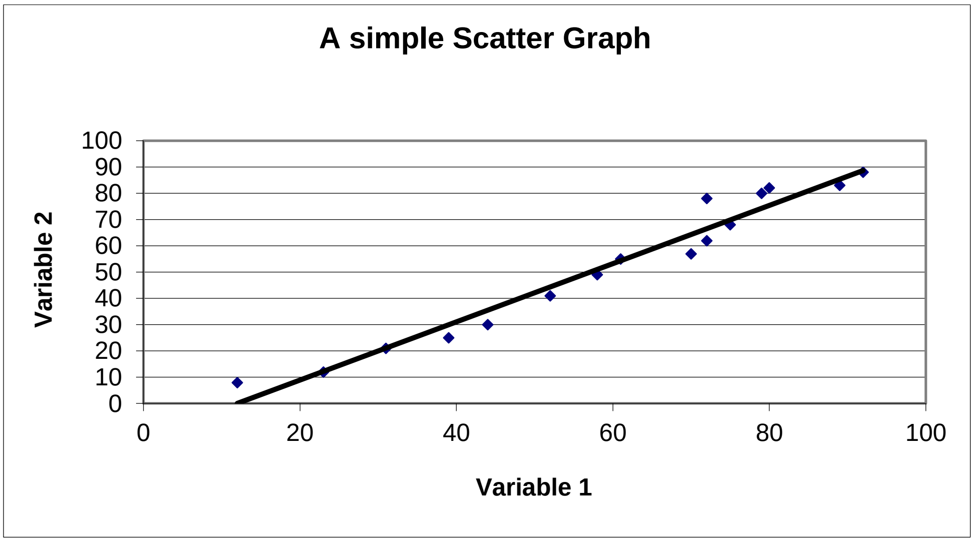
Median – is 3 because 3 is in the middle when the values are put in order.

2, 2, 3, 3, 3, 4, 5, 6, 8

Mode - is 3 because 3 is the value which occurs most often.

Scatter graphs

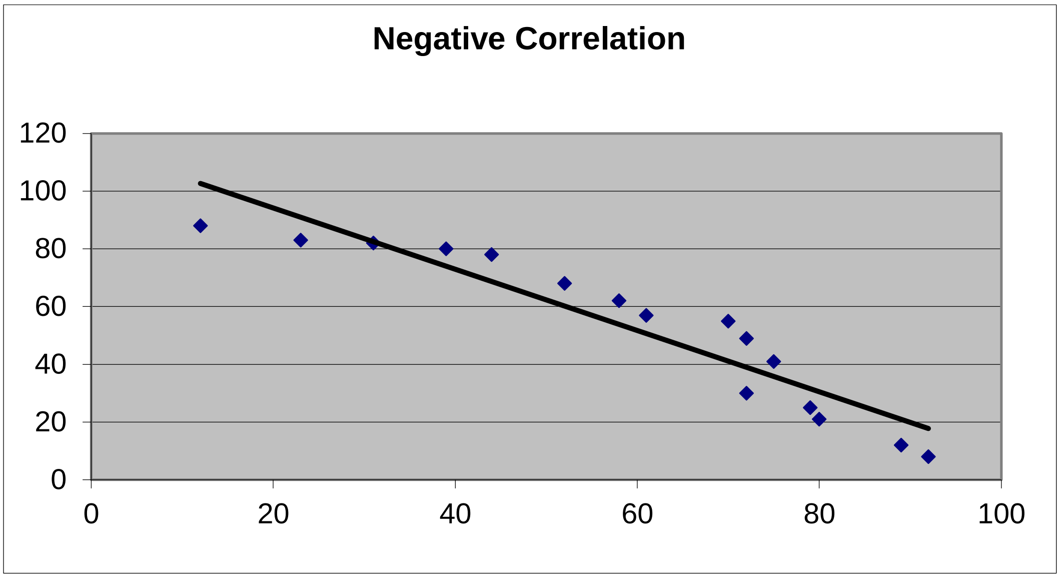
These are used to compare two sets of numerical data. The two values are plotted on two axes labelled as for continuous data. If possible a 'line of best fit ' should be drawn.

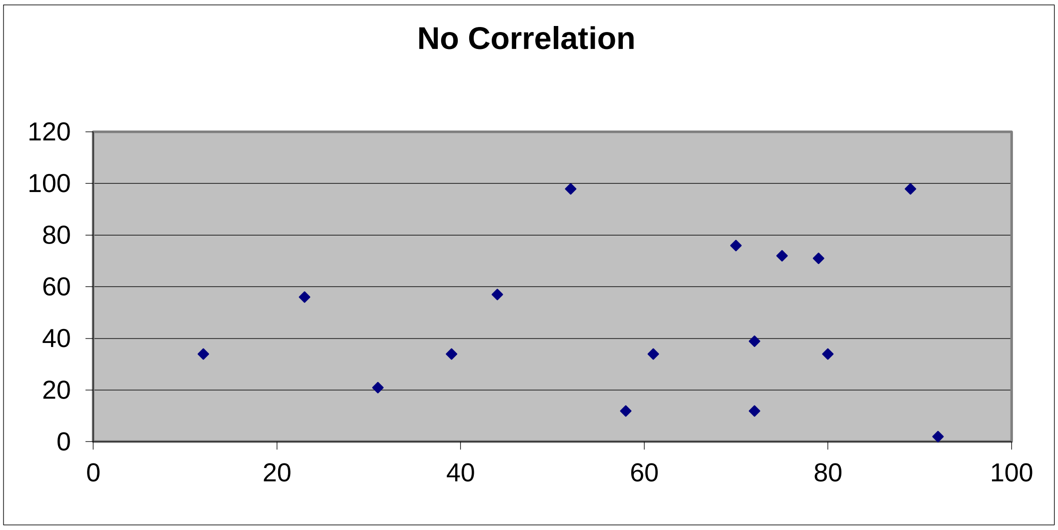


The degree of correlation between the two sets of data is determined by the proximity of the points to the 'line of best fit'

The above graph shows a positive correlation between the two variables. However you need to ensure that there is a reasonable connection between the two, e.g. ice cream sales and temperature. Plotting use of mobile phones against cost of houses will give two increasing sets of data but are they connected?

Negative correlation depicts one variable increasing as the other decreases; no correlation comes from a random distribution of points. See diagrams below.





Mathswatch

If departments want to see different mathematical techniques being taught it is recommended that they visit Mathswatch on the school system