WHOLE SCHOOL NUMERACY POLICY

Aim

To become fluent in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.

Purpose of the Whole School Numeracy Policy:

- To secure high standards in numeracy across the school
- To raise awareness of current numeracy skills and vocabulary used across the curriculum.
- To record agreed methods, vocabulary and notation.
- To assist in the transfer of pupils' knowledge skills and understanding between subjects and to ensure students are able and confident to use their mathematical knowledge and skills in other related areas.
- To provide and facilitate areas for collaboration between departments in numeracy related projects.

It is the responsibility of the Head of Mathematics to lead the whole school development in numeracy. The current priorities for cross -curricular numeracy are the following:

- To raise awareness of the use and application of mathematics in the wider curriculum and the world around them;
- Enable students to make links between work they do in other subjects and the mathematical skills learnt in mathematical classes.

General Procedures

A common approach to numeracy is to be undertaken across all departments. A "common approach" is taken to refer to common acceptance and knowledge of a variety of methods being acceptable. However, staff are expected to show awareness that students may be exposed to a variety of teaching methods and to actively encourage the students to use the "most successful" means of solving a problem.

Where a mathematical concept is embedded in another subject lesson, it will be the responsibility of that subject teacher to (a) be aware, via the KS3 numeracy objectives, of whether the students have previously met the concept in Mathematics and (b) teach that concept to the best of their ability if it has not been taught before.

Clear links can be made between many subjects' areas and mathematical topics. It is this school's policy to make these links explicit wherever possible. This may be done through use of known examples from other subject areas or designing specific cross-curricular projects to promote the natural links. It is not expected that departments contrive to design a lesson or project to derive numeracy content that would not otherwise be evident. Cross curricular teaching resources are disseminated to relevant departments periodically. Where administration tasks require numerical calculations then it is encouraged that pupils engage with this process as frequently as possible (e.g. changing test scores to percentages, reading and interpreting graphs, etc.)

Agreed Approaches to Calculation

- Students should always be encouraged to calculate first mentally, followed by a written method and only use a calculator if the two former methods are inappropriate. The appropriate use of these methods will vary between students.
- Students should be encouraged to use mental estimates in all calculations as a rough check on the suitability of the answer.
- Some standard calculations appear in the numeracy section of the journal and students' attention should be drawn to these as and when necessary.
- Students should be encouraged to explain whatever written or mental methods they have used. Showing working and the relevant formula is imperative.
- Students should be encouraged to recall their times tables 1 to 12 from memory whenever required. These are reproduced in the journal to aid learning.
- A variety of methods for multiplication division, mental addition and subtraction are to be expected and accepted.

Methods from Year 6

As well as traditional written methods:

Mental addition may be done as tens first then units e.g. 52+13, add 10 and add 3 or make up to10
e.g. 18 + 17, add 2 and add 15

Similarly, subtraction
e.g. 46-17, take off 10, then 7 or take off 6, then 11, or take off 6, then 10, then 1.

Standard written algorithms

The following algorithms are taken directly from the new KS2 mathematics programmes of study and are expected to be promoted throughout KS3/4.

Addition and subtraction

789 + 642 becomes

$$\begin{array}{r} {\scriptstyle 1\ 1} \\ 7\ 8\ 9 \\ +\ 6\ 4\ 2 \\ \hline 1\ 4\ 3\ 1 \end{array}$$

Answer: 1431

874 – 523 becomes

$$\begin{array}{r} 8\ 7\ 4 \\ -\ 5\ 2\ 3 \\ \hline 3\ 5\ 1 \end{array}$$

Answer: 351

932 – 457 becomes

$$\begin{array}{r} {\scriptstyle 8\ \ 12\ 1} \\ 9\ \not{3}\ \not{2} \\ -\ 4\ 5\ 7 \\ \hline 4\ 7\ 5 \end{array}$$

Answer: 475

932 – 457 becomes

$$\begin{array}{r} {\scriptstyle 1\ \ 1} \\ 9\ 3\ 2 \\ -\ \not{4}\ \not{5}\ 7 \\ {\scriptstyle 5\ \ 6} \\ \hline 4\ 7\ 5 \end{array}$$

Answer: 475

Short multiplication

24 × 6 becomes

$$\begin{array}{r} 2\ 4 \\ \times\ \ 6 \\ \hline 1\ 4\ 4 \\ {\scriptstyle 2} \end{array}$$

Answer: 144

342 × 7 becomes

$$\begin{array}{r} 3\ 4\ 2 \\ \times\ \ 7 \\ \hline 2\ 3\ 9\ 4 \\ {\scriptstyle 2\ 1} \end{array}$$

Answer: 2394

2741 × 6 becomes

$$\begin{array}{r} 2\ 7\ 4\ 1 \\ \times\ \ 6 \\ \hline 1\ 6\ 4\ 4\ 6 \\ {\scriptstyle 4\ 2} \end{array}$$

Answer: 16 446

Long multiplication

24 × 16 becomes

$$\begin{array}{r} {\scriptstyle 2} \\ 2\ 4 \\ \times\ 1\ 6 \\ \hline 2\ 4\ 0 \\ 1\ 4\ 4 \\ \hline 3\ 8\ 4 \end{array}$$

Answer: 384

124 × 26 becomes

$$\begin{array}{r} {\scriptstyle 1\ 2} \\ 1\ 2\ 4 \\ \times\ \ 2\ 6 \\ \hline 2\ 4\ 8\ 0 \\ 7\ 4\ 4 \\ \hline 3\ 2\ 2\ 4 \\ {\scriptstyle 1\ 1} \end{array}$$

Answer: 3224

124 × 26 becomes

$$\begin{array}{r} {\scriptstyle 1\ 2} \\ 1\ 2\ 4 \\ \times\ \ 2\ 6 \\ \hline 7\ 4\ 4 \\ 2\ 4\ 8\ 0 \\ \hline 3\ 2\ 2\ 4 \\ {\scriptstyle 1\ 1} \end{array}$$

Answer: 3224

Short division

98 ÷ 7 becomes

$$\begin{array}{r} 1\ 4 \\ 7\overline{)\ 9\ \overset{2}{8}} \end{array}$$

Answer: 14

432 ÷ 5 becomes

$$\begin{array}{r} 8\ 6\ \text{r}\,2 \\ 5\overline{)\ 4\ 3\ \overset{3}{2}} \end{array}$$

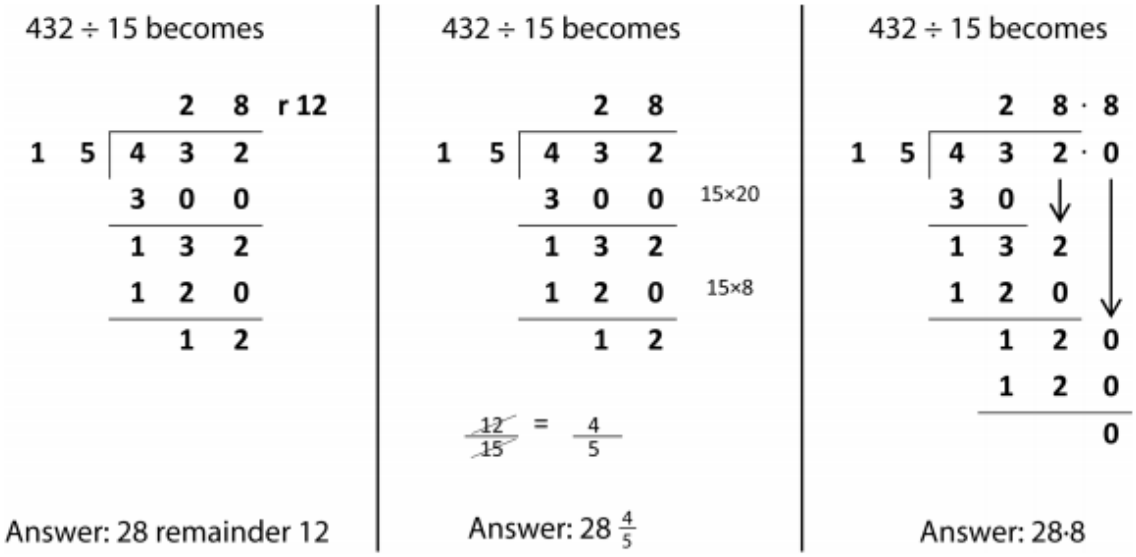
Answer: 86 remainder 2

496 ÷ 11 becomes

$$\begin{array}{r} 4\ 5\ \text{r}\,1 \\ 1\ 1\overline{)\ 4\ 9\ \overset{5}{6}} \end{array}$$

Answer: $45\frac{1}{11}$

Long division



Percentages

Percentages are widely used in mathematics, other subjects and in real life. It is important that students are introduced to mental and calculator methods of working with percentages. It is advised that the methods taught in Mathematics are replicated and consolidated in other subjects across the curriculum.

Mental methods

Students should be encouraged to calculate percentages of amounts by using breaking down and chunking methods. The following guidelines will be helpful when mentally calculating percentages:

1. Finding a percentage of an amount

   To find 1% of a number: Divide by 100
   e.g. 1% of 250m = 250 ÷ 100
   = 25m

   To find 10% of a number: Divide by 10
   e.g. 10% of £3000m = 3000 ÷ 10
   = £300

   To find 20% of a number: First find 10% then double it
   e.g. 20% of 80kg
   10%: 80 ÷ 10 = 8kg
   Therefore: 20% of 80kg = 2 × 8
   = 16kg

Similarly to find 5% of a number: First find 10% then half it
e.g. 5% of 50cm
10%: 50 ÷ 10 = 5cm
Therefore: 5% of 5cm = 5 ÷ 2
= 2.5cm

Other combinations of percentages can be found using this method.
e.g. to find 17.5% of £600
Find 10%: 600 ÷ 10 = £60
Then 5%: 60 ÷ 2 = £30
Then 2.5%: 30 ÷ 2 = £15
And finally add the 3 answers: £60 + £30 + £15 = £105

2. Percentage Increase and decrease

Percentage increase methods can be used to calculate, for example, employees' new wages after salary increases, product prices after adding VAT.

The methods discussed above can be used to find the percentage of an amount and then added to the old amount to find the new total.

To find new salary after and old salary of £8000 is increased by 10%.
Find 10% of a number: 8000 ÷ 10 = £800
New salary: 8000 + 800 = £8800

VAT questions can be calculated using the same approach.

Percentage decrease methods are useful especially in calculating sale prices.

The methods discussed above are used to find the percentage of an amount and then subtracted from the original price to find the sale price.

To find the sale price of an item costing £200 after a sale offer of 20% off the price.
Find 20% of a number: (200 ÷ 10) × 2 = £40
Sale price: 200 - 40 = £160

Calculator methods

Students should be encouraged to use scientific calculators (Casio FX83, Casio FX85) when calculating percentages. The calculators have a % key which helps students find answers when dealing with percentages.

1. Finding percentage profit

   Scientific Calculator:

   $$\frac{Profit}{Original\ amount} then\ press\ Shift\ (or\ Inv) = \%$$

   This calculation gives the profit margin as a percentage in one calculation. Business Studies students at KS4 will find this calculation useful.

   If students don't have a scientific calculator they can carry out the same operation as follows:

   $$\frac{Profit}{Original\ amount} \times 100 =$$

2. Calculating percentage score in a test

   If a test total is 100 marks it is easy because the student's mark is also the percentage score. However most exams and test totals are not 100 and a conversion has to be carried out to turn the actual mark on the paper in an exam into a percentage score. The method for profit percentage discussed above can be modified to find percentage scores.

   Scientific Calculator:

   $$Percentage\ Score = \frac{Test\ Mark}{Paper\ Total} then\ press\ Shift\ (or\ Inv) = \%$$

   If students don't have a scientific calculator they can carry out the same operation as follows:

   $$\frac{Test\ Mark}{Paper\ Total} \times 100 =$$

3. Using multipliers

   The multiplier method is recommended for higher ability students when solving percentage increase/decrease problems and when calculating compound interest and depreciation problems.

   The problems discussed above can be calculated using the multiplier method approach.

To find new salary after an old salary of £8000 is increased by 10%.
100+10=110%
Multiplier = 110÷100
= 1.1
New salary: 8000 × 1.1 = £8800

Compound interest questions can be calculated using the multiplier method.
e.g. Investment of £10,000 at 5% compound interest for 3 years.
Total amount after 3 years:
Total Investment = £10,000 x 1.05^2
= £11,576.25

Depreciation problems can also be calculated using the multiplier method. This time the depreciation percentage is deducted from 100% to determine the multiplier,
eg. To find the value of a car whose brand new value was £15,000 after a depreciation rate of 12% p.a. for 5 years.
100-12 =88%
Multiplier = 88÷100
= 0.88
Value after 5 years: 15,000 × 0.88^5= £7,915.98 (Remember rules of rounding numbers and how to express currency amounts)

Problem Solving and Mathematical Reasoning

Students should be encouraged to:-

- read the question carefully and draw a diagram if possible,
- write down all the known information (on the diagram if applicable),
- establish what is being asked for,
- try as many different approaches as necessary,
- show and explain their working at each stage,
- work individually, in pairs or in groups,
- present their answer with units, if applicable.

Units of Measurement

1. Metric measures are used as follows: nm (nanometre = 10^{-9}m) ; mm; cm; m; km; mg (microgram =10^{-6} grams), g; kg; tonnes; ml; cl; litres; cm^2; cm^3; m^3; hectares; g/cm^3
   Temperature: Celsius (˚C), Fahrenheit (˚F) and Kelvin (K) in science.
   Units of energy: Joules, Kilocalorie and Kilowatt hour (KWh). In design and technology, mm and m are used only and cmactively discouraged.
2. Approximate conversions between metric and imperial measures are taught. Imperial measures are not used by students but referred to across subjects. In science - use SI units only.
3. Measures of rate commonly used are: km/hr; m/s; m/s^2 and J/s. Students should be made aware that the units ms^{-1} and $ms^{-2}$are the same as m/s and m/s^2 etc. mph for miles per hour is referred to but the use of p is not commonly accepted to express compound measures.
4. The triangle method is used to help students remember the formulae for speed.

Distance = Speed x Time

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

or any rearrangements of suitable formulae e.g.: measures of rate, density, fuel consumption, and in electronics and mechanics finding resistance.

5. Measures of scale are given as a scale factor (e.g.: 2 or ½), as a ratio: 1: 25000 and as specific units e.g. 1cm: 1km.
6. Students are expected to present answers with the correct unit of measurement for precision, this should be reflected in marking.
7. Amounts of money are given as £ or p, but both signs are <u>not</u> used in one amount, e.g. 50p or £0.50 but not £0.50p
8. There should be attention to precision in use of upper & lower case in writing units.

Use of a Calculator

1. All students are expected to have their own calculator for all Mathematics lessons and bring it to other classes as required. The Casio fx 83 ES and fx 85Es Scientific calculators are recommended for students to purchase.
2. Students are expected to calculate mentally according to their level of attainment, use written calculations and finally use a calculator when necessary.
3. Students are encouraged to approximate calculations to check sensible answers and to be aware of a suitable degree of accuracy depending on the answer. Approximations of money (sterling) answers are rounded appropriately to 2 decimal places.
4. Specific calculator skills are taught wherever they are used in the curriculum e.g.: percentage questions (including the % key); order of operations using either the bracket keys or memory key or both; standard form calculations using the EXP key; trigonometry; operations with the fraction key.
5. In multiple calculations students are encouraged to avoid approximating solutions before the end of the whole problem, leaving interim answers in the calculator whenever possible and using the memory key.
6. Graphical calculators are available on loan from the Mathematics department to enhance learning and investigative skills.
7. Even when using a calculator, students are expected to show all workings.

Vocabulary and Notation

1. Key formulae and key words are listed in the pupils' journals and are referred to across subjects where appropriate.
2. Students are expected to use the correct vocabulary when talking or writing about mathematical /numerical work.
3. Students are expected to spell key words correctly and marking of work should reflect this.
4. Where possible key numerical words for the lesson should be displayed.
5. Mathematical symbols such as: $= < > \geq \leq$ and are expected to be precise in their meaning (e.g. when approximating $63 \neq 60$ $63 \approx 60$)
6. Students are taught to be consistent in their use of letters and to define each one when writing algebraic statements. Letters in algebra are not used to stand for objects but for a number.
7. Derivation of a prefix is highlighted to clarify values e.g. kilo, milli, centi, micro.
8. Roman Numerals are referred to across subjects.

Drawing and Reading Graphs

1. The following forms of graphs are frequently taught/ used across subjects: bar charts, pictographs, line graphs, histograms, cumulative frequency graphs, scatter graphs, frequency polygons, conversion graphs, pie charts.
2. Graphs should always have a title and axes labelled. Units of measurements should also be included.
3. Cumulative frequency and curved graphs are expected to be drawn free-hand (not using a ruler).
4. Pie charts may be expressed in angles or percentages.

5. For scatter graphs, the consistent drawing of a line of best fit should be taught by either
   (1) using a piece of tracing paper
   or (2) using a transparent ruler
   and (3) establishing equal points are on both sides, with an awareness of
   gradient.

   In Higher Tier GCSE and "A" level maths, the mean averages are used.
6. A distinction should be made between plotting (drawing) and sketching graphs. The latter should have only significant points marked on the axes and / or graphs, plotting or drawing a graph must have the axes fully labelled and drawn on graph or squared paper.
7. Graphs are also used as an analytical tool to describe relationships.
8. Students should be encouraged to check the scale of the axes when reading graphs. Particular care is needed when units of time are used.
9. Students should always draw / sketch graphs in pencil and label in pen. The preferred pencil is a sharpened HB. Use of ruler, protractor and rubber is essential.
10. In technology students are encouraged to use ICT for drawing graphs. In other subjects e.g. science and maths, the ability to draw a graph is important, although ICT is also used extensively.
11. Students are taught awareness of anomalous points in line graphs, scatter graphs etc - and the reason for them.
12. Graphs should be scaled sensibly for the size of paper being used.
13. The independent variable should be on the horizontal axis.
14. Students need to be made aware that axes are scaled uniformly before plotting.
15. "G - wizz" graphs - pupils should be made aware of misleading scales! this is specifically taught in technology and GCSE statistics courses.

Surveys and questionnaires

Survey is used as a broad term to refer to the collection of information, either qualitative, quantitative, secondary or primary.

Questionnaire refers to the specific form of collecting information by asking a set of questions.

The following departments include some form of Survey and / or questionnaire as part or whole of their GCSE or A level coursework: Psychology, Food and technology; Textiles; Business Studies; Modern Foreign languages; Graphics, Geography, Media Studies and Mathematics. Subject specific exam criteria should be adhered to. The following points are a general guideline:

- A survey should be considered in three parts:
  A plan;
  The survey itself;
  The analysis of results

- At KS3 & 4 students might consider the following in their plan:
    1. Stating the Hypotheses if a more advanced survey of GCSE standard or above is being conducted (Maths, Psychology)
    2. Sample size is important for accurate representation of the population being surveyed – the greater the sample size the better the results.
    3. The sample should be representative of the different groups within the population i.e. age ranges, gender etc.
    4. How their sample is to be chosen to avoid bias (i.e. random, stratified etc in more advanced surveys).
    5. Planning the "type" of analysis is important – numerical answers to questions will give rise to more interesting possible statistical analysis i.e. how much… how many… how long… etc.
    6. A pilot survey could be carried out to test out a set of questions and find initial problems.
    7. Students should show an awareness of whether their data is primary (collected themselves) or secondary (obtained from another source).
    8. A suitable data collection sheet which will give access to as much information as required or a table of results as in Science e.g.

sample	Q1	Q2	Q3	Q4

    9. Consideration to possible constraints of the survey.

The survey itself:

- Questionnaires should avoid bias by considering:
    Who is asking the questions (neutral to the answers?)
    Who is targeted to be asked the questions (fair sample?)
    The way the question is posed i.e. does it "expect" agreement?
- Questions should give a range of selections to cover the whole spectrum of a set of answers and avoid overlap
    e.g.: 1-2 3-4 5-6 7-8 9+
- Questions could use an opinion scale as an alternative to discrete answers e.g. on a scale of 1 to 10 where 1 is "strongly agree" and 10 is "strongly disagree" …
- Categories should be clearly defined e.g. "summer" refers to which months?
- Appropriate graphs and charts should be used and not the whole range of possible charts! ICT can be used for obtaining these but again thought should be given to the appropriate nature of the chart chosen.
- Averages and range can be considered for some data. Students should be aware of the most appropriate average to use i.e. mean, mode or median.

Analysis should include:

- Comments on all graphs and statistical calculations done.
- Results linked back to the aim of the survey (or original hypotheses) with due care to consider whether the results can be considered representative of the whole population or only a part.
- Comparisons should be made across the data where and when possible.

Conclusions should:

- Draw together the main findings of the survey
- Give consideration to the limitations of the survey (sample size?) and problems overcome.
- Suggest possible improvements / extensions that could be made.

Roles and Responsibilities:

Classroom Teachers

- To follow the Numeracy Policy.
- To be familiar with any cross curricular numeracy tasks.
- To assess students work in accordance with the school's ARR Policy.
- To implement the school Numeracy Policy and common marking symbols at all times.
- All staff to be fully committed to raising numeracy skills ***at all levels*** of student attainment.

Numeracy Co-ordinator

- Encourage activities that integrate different aspects of mathematics
- Promote specific cross-curricular projects with individual departments

Responsibilities

- To establish and successfully manage numeracy across the curriculum as a whole school priority.
- To ensure continuity of numeracy standards across the School Curriculum.
- To raise the profile of numeracy across the whole curriculum.
- To ensure numeracy is used as a tool in raising standards across the curriculum.
- To liaise with the Head of Mathematics, the SENCO and other members of staff with relevant roles and responsibilities, to ensure that a collaborative approach to numeracy is established and maintained.

Duties

- To monitor and support departments in the implementation of the Numeracy Policy.
- To coordinate an annual improvement plan for raising standards of numeracy across the school, monitoring the implementation of the plan.
- To contribute to the monitoring and evaluation of the Numeracy Policy.
- Plan and develop numeracy progression across KS3, 4 and 5.
- To support departments in developing strategies to enhance numeracy skills in their subject.
- To analyse numeracy attainment on entry in Year 7 advising Heads of Department and year 7 teachers on specific numeracy issues and how they can be addressed.
- Have an up-to-date working knowledge of national strategies pertaining to numeracy.
- To keep abreast of successful and innovative current practice to improve the numeracy skills of students at every attainment level.

- Provide at school and departmental level, clear guidance on important aspects and developments in the delivery of numeracy.
- Co-ordinate and audit numeracy across departments.
- Co-ordinate numeracy initiatives across the school.
- Monitor the impact on standards of numeracy by sampling student work.
- To observe staff with a numeracy focus.
- To identify where staff support and development is required and assist in providing appropriate training.
- To work with the SENCO and Head of Maths in identifying students who require numeracy intervention, planning appropriate intervention and ensuring the effectiveness of provision.
- To monitor and manage numeracy based intervention classes, including the year 8 and 9 booster and intervention classes.
- Liaise with the SENCO to ascertain how students with special needs are supported in numeracy.
- In consultation with the SENCO and Head of Maths to liaise with parents and encourage parents to support the development of their child's numeracy skills.
- To produce an annual report for Governors evaluating achievement and standards and quality of numeracy provision.

Head of Maths Department

- To ensure the effective implementation of the Numeracy Policy/common marking symbols by all departmental members.
- To ensure and sustain numeracy as a priority in departmental policy, improvement planning and delivery.
- To ensure a broad range of numeracy objectives/skills are embedded in schemes of work, monitoring and evaluating the effectiveness of the department's contribution to numeracy development.
- To identify and share good numeracy practice across the department.
- Implement regular audits of students' books to ensure that the common marking symbols are being used properly.
- Ensure that all staff follow the green pen practise where applicable.
- To ensure that staff training with a numeracy focus is attended by at least one department member and that information from these sessions is fed back to all other members.

Heads of Other Departments

- Ensure that departmental staff follow the Numeracy Policy.
- Keep fully up to date with the numeracy tasks being implemented in their department.
- Implement monitoring and evaluation systems to ensure numeracy task is correctly carried out.
- Promote further numeracy activities in line with the school numeracy objectives.

SENCO

- To ensure that students with special educational needs and numeracy difficulties get the help that they need in order to make progress with their numeracy skills.
- To liaise with the numeracy coordinator, the Head of Maths and all HODs for the purpose of assessing identifying and monitoring the needs of students with numeracy difficulties.
- To plan intervention programmes for SEN students with identified numeracy difficulties. As part of this, to offer advice and support to departments about differentiating materials and implementing support strategies that will match the teaching of numeracy with learning.
- To coordinate a range of ***Numeracy Support Programmes*** in each year group that will target to provide additional numeracy support that is tailored to the needs of students that have SEN.
- The SENCO will deploy SEN teaching staff, teaching assistants, parent helpers and Guardian Angels to support the teaching of numeracy throughout school. Where appropriate the SENCO will involve the support of outside agencies.
- To maintain an up-to-date register of SEN students that have numeracy problems that are affected by their learning difficulties. These students have an IEP that will inform staff of each child's unique learning profile and advises them of strategies for enhancing attainment in numeracy. SEN students with numeracy difficulties will have targets tailored for their needs and the IEP will articulate how support is set and met.
- To scrutinise mid-year and end-of-year performance data across all curriculum areas for the purpose of monitoring student progress and to help identify underachievement and emerging needs relating to numeracy.
- To ensure that there are clear systems implemented for reviewing and monitoring the progress of all SEN students and also the effectiveness of numeracy support programmes.
- To undertake a programme of mid-year and end-of year reviews with the parents of SEN students to help gather family/student views in relation to numeracy support and to agree/plan new support.
- Training on numeracy support is an ongoing element of the SEN Teaching Assistant's continuing professional development. The SENCO will target to identify training needs and ensure that the SEN learning support team will undertake to keep abreast of the latest developments in the area of numeracy support.

SMT/Leadership of teaching and learning responsibilities

- To raise standards of numeracy and mathematics for all students across the school.
- To support and drive the Numeracy Policy across all relevant subject areas.
- To review the overall effectiveness of the Numeracy Policy across the school.
- To ensure that where relevant a broad range of numeracy and mathematical skills are embedded within schemes of work so that students are provided with a range of opportunities to develop, apply and advance their mathematical skills.
- To ensure that staff training needs, in connection with this policy, are met.

The Numeracy Policy is considered a working document and is subject to additions and changes over time.