



Assessing pupils' progress in mathematics at Key Stage 3: Standards File

Pupil J



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Pupil J – Year 8 – Low level 6

Assessing pupils' progress in mathematics at Key Stage 3

Assessment summary

Although his attainment in using and applying mathematics and handling data is within level 5, his performance in significant aspects of number and algebra is within level 6. Since number and algebra carries the greatest weighting and Pupil J also demonstrates level 6 performance in shape, space and measures, his subject level is calculated at level 6. Pupil J is best described as low level 6.

Using the Standards Files

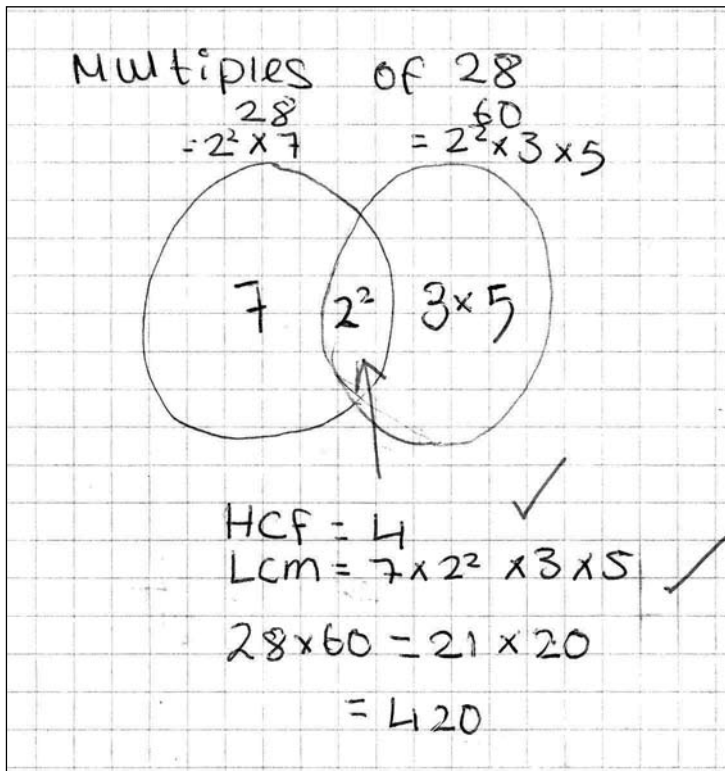
- The current Standards Files are based on work planned and assessed in relation to the 1999 National Curriculum programme of study. A new set of Standards Files based on the 2008 National Curriculum are currently in production, but the current set will provide useful guidance on making APP assessments against national standards in the transition period as the new programmes of study are introduced.
- The commentaries in the Standards Files are provided for guidance and reference, and are much more extensive than any teacher would be expected to make when carrying out APP assessments. It is also important to remember that APP encourages and enables a broader overview of current learning, and that there is no need to collect special portfolios of pupils' work. Evidence from pupils' written and oral work, backed up by brief teacher's notes where necessary, is all that is required.
- The evidence base presented in each Standards File is necessarily partial, as it would of course be impractical to reproduce all of each pupil's work. Examples of each pupil's work have been selected to provide evidence to support judgements against APP criteria. This evidence should be considered in conjunction with the teacher's notes, which will provide a broader context and further justification for the assessments that are made.

Assessment focus

Numbers and the number system; Using and applying mathematics

Context

Homework: Pupils were set the task of finding the highest common factor and lowest common multiple of 5 pairs of numbers.



Teacher's notes

- uses prime factor decomposition
- decides independently to record factors in a Venn diagram
- represents two intersecting sets: factors of 28, factors of 60
- identifies the highest common factor, using the intersection of the sets
- multiplies all factors in the union of the sets to achieve the lowest common multiple

Next steps

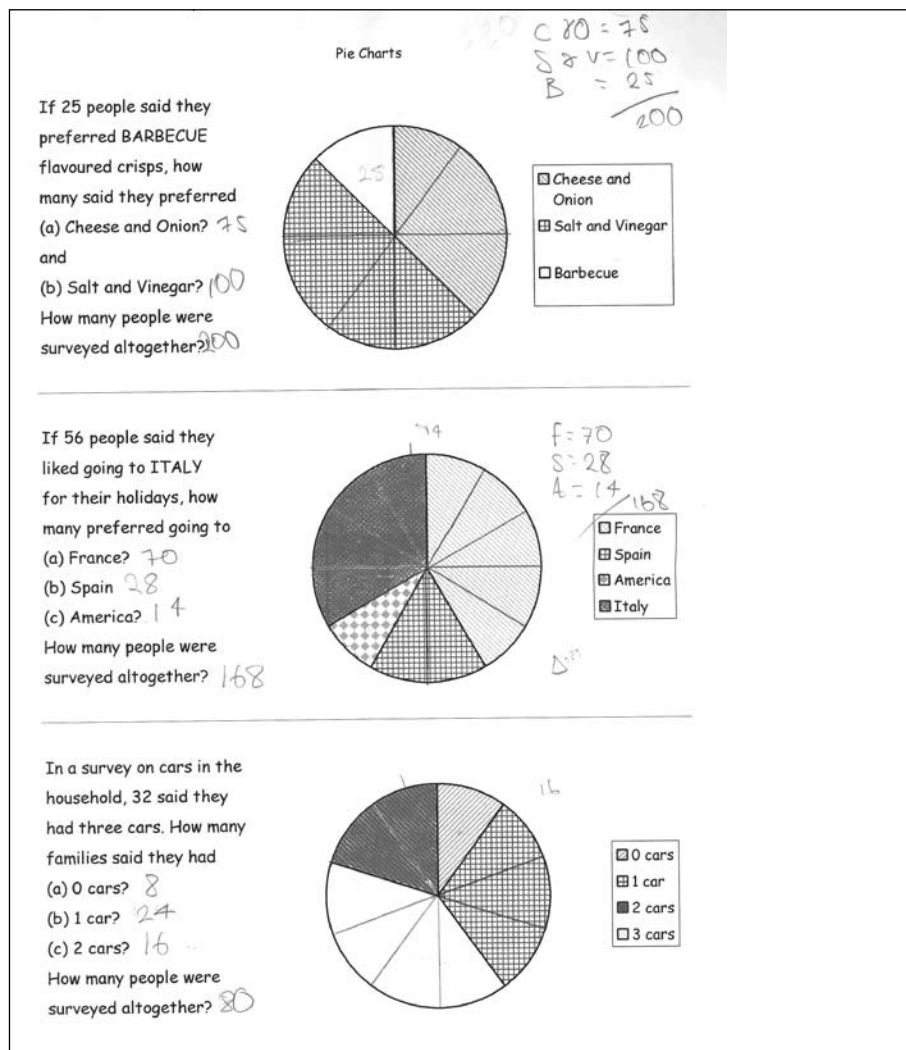
- review how he has recorded his working:
the line $28 \times 60 = 21 \times 20$ should be LCM of 28 and 60 is $21 \times 20 = 420$
- find the HCF and LCM of three numbers

Assessment focus

Calculating

Context

Classwork: In a unit on solving numerical problems, pupils interpreted pie charts. Following a class discussion, they used their understanding of fractions and approximate proportions of the circles to calculate the numbers represented in different categories.



Teacher's notes

divides pie charts into roughly equal sectors to help interpret the data

- uses information about the number of people in one category to calculate the number represented by one of his sectors
- calculates the number of people in other categories and the whole data set
- uses mental methods to calculate

Next steps

- make links between ratio and proportion
- records the method used to calculate proportions

Assessment focus

Algebra; Using and applying mathematics

Context

Classwork: In a unit of work on properties of functions, pupils were asked to investigate linear graphs with the aid of a graphing calculator.

Investigating Linear Graphs


These are all linear equations

$$y = 3x$$

$$y = 5x + 3$$

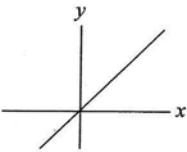
$$y = x - 7$$

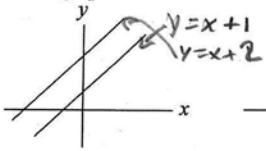
$$y + 3 = 2x$$



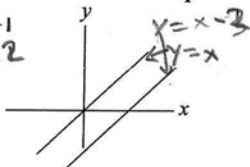
Use Y= X/T/θ GRAPH ZOOM

- Graph $y = x$

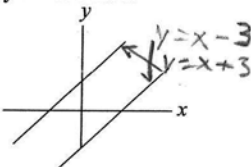

- Make graphs similar to these. Write down the equations you have used.



$y = x + 1$
 $y = x + 2$

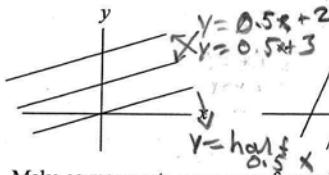


$y = x - 3$
 $y = x$

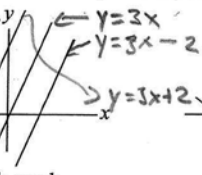


$y = x - 3$
 $y = x + 3$

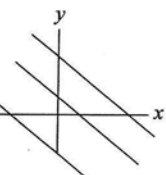
Make as many pairs as you can for each graph.
- Make graphs similar to these. Write down the equations you have used.



$y = 0.5x + 2$
 $y = 0.5x + 3$



$y = 3x$
 $y = 3x - 2$



$y = 3x + 2$

Make as many sets as you can for each graph.

Teacher's notes

- uses a graphing calculator to investigate linear functions and their graphs
- works systematically: varies the constant but keeps the coefficient of x unchanged and vice versa
- comments on the coefficient of x , 'The number multiplying x tells you how steep the line is'
- comments on the constant, 'The other number is where it crosses the y -axis'

Next steps

- begin to refer to features such as the coefficient of x and constant using precise terminology
- explore negative gradient
- start to use the language of transformations

Assessment focus

Algebra

Context

Homework: This exercise was given to pupils following a lesson on solving equations.

The image shows a student's handwritten work on solving three linear equations, labeled f, g, and h. The work is written on a grid background.

f $7p = 3p + 8$ $\xrightarrow{-3p}$
 $\frac{4p}{4} = \frac{8}{4}$ $p = 2$ ✓

g $4m = +2m - 12$ $\xrightarrow{-2m}$
 $\frac{2m}{2} = \frac{-12}{2}$ $m = -6$ ✓

h $6y = 5y - 2$
 $\frac{1y}{1} = \frac{-2}{1}$ $y = -2$ ✓

i $9q = 4q - 20$
 $\frac{5q}{5} = \frac{-20}{5}$ $q = -4$ ✓

Teacher's notes

- in the context of solving linear equations, consistently transforms both sides in the same way
- in discussion explains the difference between constant and variable terms

Next steps

- solve linear equations requiring more steps, for example, with negative coefficients of the variable or where it is necessary to manipulate algebraic expressions
- begin to solve quadratic equations using a trial and improvement method
- make links between solving equations and graphs
- recognise the need to check by substitution

What the teacher knows about Pupil J's attainment in number and algebra

Pupil J constructs and uses simple formulae. For example, when he investigated the area of a parallelogram by cutting and rearranging paper shapes, Pupil J derived the formula. He used the formula to calculate areas of given parallelograms and, for example, to calculate the vertical height given the area and length of the base.

Pupil J plots the graphs of linear equations. Investigating the graphs of equations of the form $y = mx + c$ using a graphing calculator, he explained the effect of changing the coefficient of x and of changing the constant. He commented that 'the number multiplying x tells you how steep the line is, and the other number is where it crosses the y -axis.' He plots graphs of linear equations, without a calculator, and matches straight-line graphs to their equations correctly. When plotting graphs and transforming plane shapes on a grid, Pupil J understands and uses coordinates in all four quadrants.

He solves linear equations by consistently transforming both sides in the same way. He is beginning to manipulate algebraic expressions when solving equations. He is also beginning to use trial and improvement to solve equations involving x^2 or x^3 .

Pupil J recognises and uses relationships between numbers. For example, he understands and uses factors. He identifies the highest common factor of two numbers and their lowest common multiple. He uses his knowledge of common factors to simplify fractions and to identify equivalent fractions and ratios. He uses common multiples to add, subtract and order fractions by expressing them with a common denominator. He expresses a fraction as a decimal or percentage and knows the decimal and percentage equivalents of the fractions he uses most often. He expresses one number as a fraction, percentage or decimal of another. He understands the effect of multiplying by a fraction. For example, he knows that multiplying by $\frac{1}{4}$ is equivalent to dividing by 4 and that multiplying by $\frac{3}{4}$ is equivalent to multiplying by 3 and dividing by 4. He uses a calculator to calculate percentage increases or decreases. He solves problems such as finding the percentage of people completing a survey whose preferred drink was coffee, knowing that he must find the total number of people taking part to take as 100%.

Pupil J understands the effect of multiplying and dividing whole numbers by 10, 100 and 1000. Further experience of measuring using rulers, weighing scales and electronic instruments calibrated in different ways is helping him to consolidate his understanding of place value in decimals as well as to understand reasonable degrees of accuracy in measuring.

Pupil J orders negative numbers in contexts such as counting back past zero and temperatures above and below freezing. He is beginning to operate with negative numbers, for example, when solving problems involving temperature changes and when solving linear equations.

He uses known facts and place value to multiply and divide with larger numbers. He uses a written method to multiply or divide a three-digit by a two-digit number, for example. Pupil J knows how to estimate answers using approximations and how to check calculations using inverse operations but doesn't always check his work.

Summarising Pupil J's attainment in number and algebra

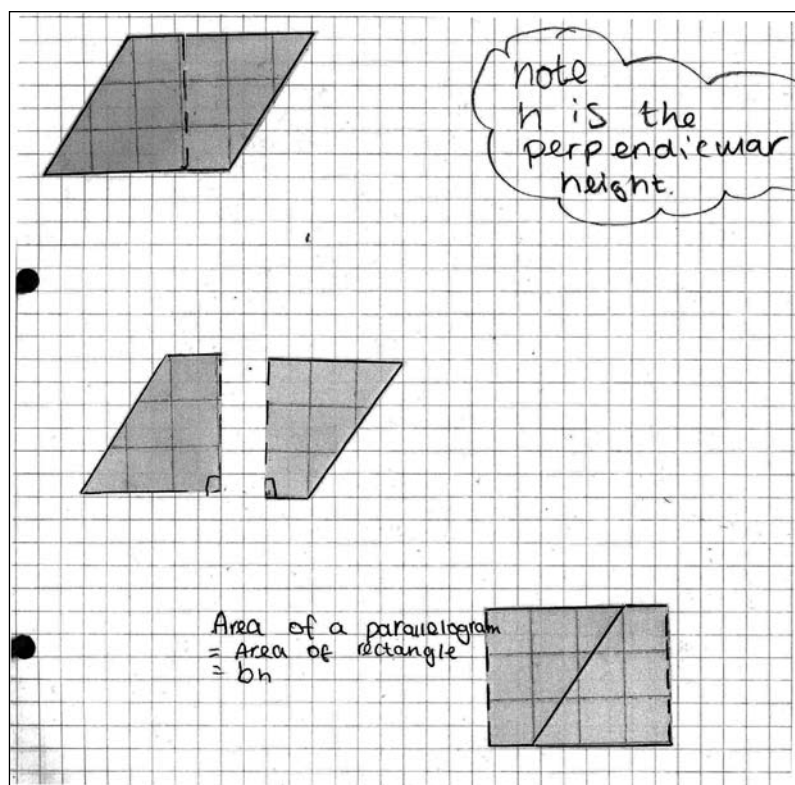
His teacher judges that Pupil J's attainment in number and algebra is best described as just into level 6. To make further progress within level 6, Pupil J needs to construct his own formulae and equations in a wider range of contexts and plot their graphs. He needs to consolidate his understanding of the order of operations in arithmetic to help him to solve equations where it is necessary to manipulate algebraic expressions.

Assessment focus

Shape, space and measures; Using and applying mathematics

Context

Classwork: During a unit on calculating areas of shapes, the lesson began with pupils recalling what they knew about finding the area of a triangle. The teacher demonstrated how different types of triangle could be shown to have half the area of the smallest enclosing rectangle. They established the formula for the area of a triangle as 'half the base multiplied by the perpendicular height'. Pupils were asked to deduce the formula for the area of a parallelogram. In a later lesson they used diagrams to investigate the area of a trapezium.



Teacher's notes

- uses a practical approach of drawing a parallelogram, cutting and rearranging the parts to form a rectangle
- uses b to represent the length of the base and h for the perpendicular height
- derives the formula for the area of the parallelogram

Next steps

- draw a parallelogram whose sides are not horizontal or vertical on the square grid, and identify a 'perpendicular height' along which to cut so that the pieces can be rearranged to form a rectangle
- find the area of a trapezium

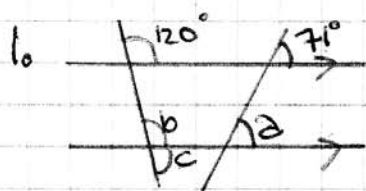
Assessment focus

Shape, space and measures

Context

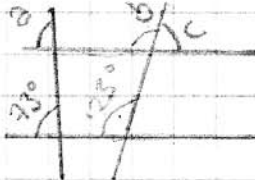
Classwork: Pupils were set this exercise following a class discussion.

1.



$a = 71^\circ$ corresponding angles are equal
 $b = 120^\circ$
 $c =$ Angles on a straight line add up to 180°

2.



$a = 73^\circ$ corresponding angles are equal
 $b = 123^\circ$
 $c = 180 - 123 = 57^\circ$ Angles on a straight line will equal to 180°

Teacher's notes

- knows and uses the sum of angles at a point and uses the sum of angles at a point on a straight line
- understands and uses the properties of corresponding angles when a line intersects parallel lines

Next steps

- calculate all other angles in the diagrams and identify alternate angles
- investigate angles in a trapezium and a parallelogram
- recognise, mark and use corresponding and alternate angles when pairs of parallel lines are not horizontal, or are 'hidden', for example, in polygons

What the teacher knows about Pupil J's attainment in shape, space and measures

Pupil J classifies quadrilaterals using a range of geometric properties. For example, he designed tree diagrams with decisions about equal sides, equal diagonals and equal angles to sort squares, rectangles, rhombuses, parallelograms and kites so that someone who did not know the names of the shapes could identify them.

Pupil J knows the sum of angles at a point and at a point on a straight line. He also knows the relationships between corresponding and alternate angles when a line intersects parallel lines. He knows the sum of interior angles in a triangle and understands a proof. He uses the sum of angles in a triangle to calculate the sum of interior angles in other polygons by joining each vertex to a point inside the shape and creating a number of triangles around that point. He uses precise mathematical language to describe angles.

Pupil J identifies reflective symmetry in 2-D shapes and their order of rotational symmetry. He uses angles, parallel lines and symmetry properties to describe different types of triangle and quadrilateral.

Pupil J writes simple Logo procedures to draw regular polygons. He reasons about the sum of exterior angles with reference to the angles through which the Logo turtle turns as it completes the whole shape. He explains that 'altogether the turtle does one complete turn when it travels all the way round the shape and gets back to its starting position, so you divide 360° by the number of sides to get the angle for each turn'. He recognises that each turtle turn is an exterior angle of the polygon and is beginning to think about how to use the sum of exterior angles to calculate the sum of interior angles. Pupil J transforms shapes on a grid using coordinates. He translates and reflects shapes, identifying the effect on the coordinates of each vertex. He enlarges shapes by multiplying all coordinates of vertices by a positive, whole number and recognises the origin as the centre of the enlargement.

Pupil J knows and uses the formulae for the area of a triangle, a rectangle and a parallelogram. With the assistance of probing questions, he explains why the area of a parallelogram is equal to the area of a rectangle with the same base and vertical height. In the unit on the mensuration of shapes, Pupil J explored the relationship between the area and circumference of a circle by dissecting into sectors and making successive approximations to the area of a parallelogram. He uses formulae to find the circumference and area of a circle.

Summarising Pupil J's attainment in shape, space and measures

Pupil J's attainment in shape, space and measures is best described as secure in level 6. To make further progress within the level, he needs to develop his use of 2-D representations of 3-D shapes and his understanding of the properties of transformations. He needs to broaden his use of ICT to generate and transform shapes.

Assessment focus

Handling data

Context

Homework: During a unit on statistics and probability, pupils experimented with discs of different colours and dice that had different numbers of faces. They learned the term 'sample space' for the set of all possible outcomes. In this exercise, pupils listed all the possible outcomes in similar experiments.

The image shows handwritten student work on a grid background. At the top, there is a two-way table for spinning two discs. The columns are labeled 'Disc 1' with 'green' and 'blue' as headers. The rows are labeled 'Disc 2' with 'Green' and 'Blue' as headers. The cells contain the following pairs: (Green, Green) is 'GG', (Green, Blue) is 'BG', (Blue, Green) is 'GB', and (Blue, Blue) is 'BB'. To the right of the table, it says 'G = green' and 'b = blue'. Further right, it says 'Two-way Table sample space'.

Below the table, there is a list of outcomes for throwing two dice simultaneously. The outcomes are listed in pairs: (1,1), (1,2), (1,3), (1,4), (2,1), (2,2), (2,3), (2,4), (3,1), (3,2), (3,3), (3,4), (4,1), (4,2), (4,3), (4,4), (5,1), (5,2), (5,3), (5,4), (6,1), (6,2), (6,3), (6,4). A large curly bracket on the left groups all these outcomes, and a large curly bracket on the right groups them, with the number '8' written next to each bracket, indicating there are 8 outcomes in total.

Teacher's notes

- completes a two-way table to identify all possible outcomes from spinning two discs
- uses the same systematic approach to list the sample space for throwing two dice simultaneously, that is, a 1–4 and a 1–6 dice
- in discussion, explains how he knows he has all possibilities
- uses his work to demonstrate why some outcomes are more likely than others: blue with green is more likely than both blue; a total of 7 is more likely than a total of 8

Next steps

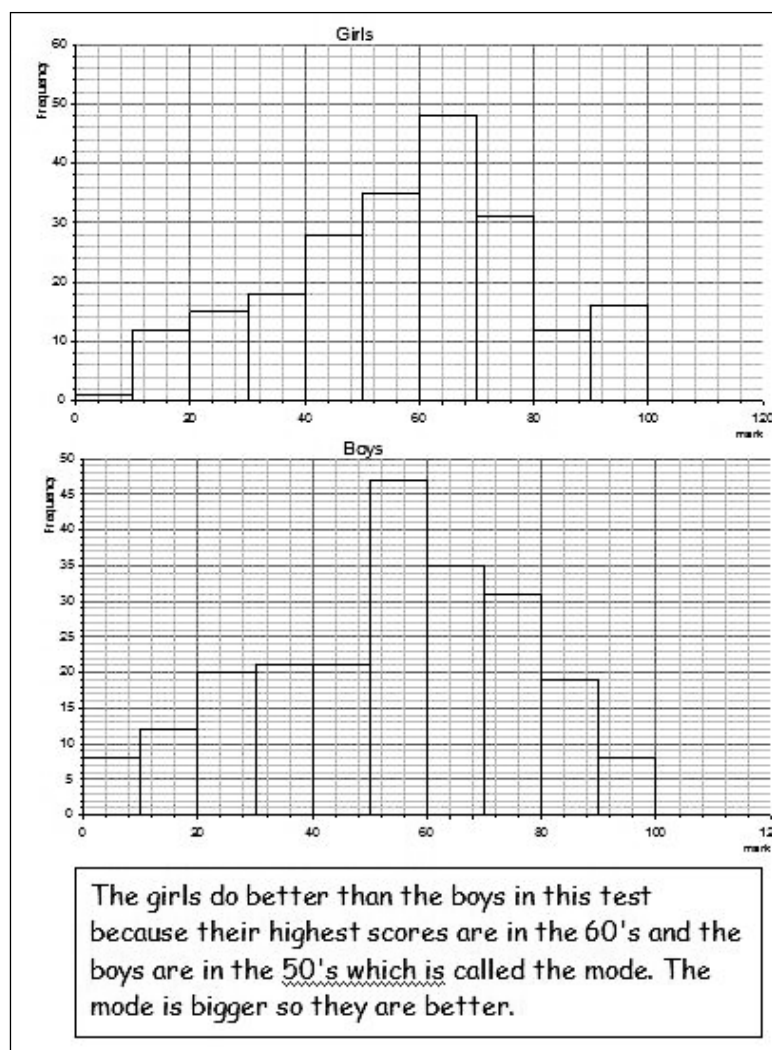
- calculate the theoretical probabilities of each possible total dice score
- experiment with two similar dice and record the frequency of different total scores
- compare the theoretical probabilities with the outcomes of the experiment

Assessment focus

Handling data

Context

Homework: During a statistics unit, pupils used a spreadsheet to compare sets of English test results.



Teacher's notes

- uses a spreadsheet to create frequency diagrams for grouped data
- chooses suitable class intervals for test scores
- compares the modal classes of the two distributions

Next steps

- describe the modal classes more accurately to avoid confusion between highest test scores and most common or frequent scores
- discuss why the range is the same for boys and girls

What the teacher knows about Pupil J's attainment in handling data

When setting up a survey, Pupil J designs suitable questions to capture the data he needs. He is beginning to consider the type of people to ask and how many people to ask so that his results are fair and representative. As well as collecting primary data, Pupil J uses the school's intranet and reference materials as a source of secondary data. For example, he has used statistics relating to the attendance at school of pupils in different year groups over a period of one month.

Pupil J creates graphs of grouped discrete data on paper and using ICT. He chooses appropriate equal class intervals that have no overlap. He interprets line graphs and pie charts from a variety of sources such as newspapers, travel brochures and materials from history and geography lessons. He tends to use the mode and range to compare sets of data although he knows how to find the median and calculate the mean of discrete data.

In probability, Pupil J completes two-way tables to show all possible outcomes. He uses the results to determine the theoretical probability of each outcome. He expresses probabilities using words, fractions or decimals. He places probabilities in order on a 0 to 1 scale. Pupil J understands that different outcomes may result from repeating an experiment. For example, having worked out the theoretical probabilities from throwing two dice and adding their scores, he experimented by throwing the two dice 50 times. He compared his results with others' results and found that they varied. With the support of group discussion he explained that the more they all experimented, the closer their combined results might be to the theoretical probabilities.

Summarising Pupil J's attainment in handling data

Although Pupil J is beginning to demonstrate some aspects of attainment at level 6, his teacher feels that high in level 5 is the 'best fit' judgement. To consolidate level 5 and progress into level 6, Pupil J needs to use the range with the median or mean as well as the mode to compare sets of discrete data. He needs to begin to group continuous data. He needs to use ICT to construct pie charts and frequency diagrams for continuous data. He needs to communicate his conclusions, supported by appropriate graphs and diagrams, more effectively.

What the teacher knows about Pupil J's attainment in using and applying mathematics

Pupil J solves problems and investigates in a range of mathematical contexts. He makes decisions about the approach to adopt and gathers the information he needs. For example, he decided on the approach to use to find the formula for the area of a parallelogram, drawing on his experience of finding the formula for the area of a triangle. He represents problems using diagrams, such as the Venn diagram he used when finding the highest common factor and lowest common multiple of two numbers. He recognised that the product of numbers in the intersection of the two sets gave the highest common factor. He reasoned about the union of the two sets and concluded that the lowest common multiple was the product of all the factors recorded.

Pupil J represents and interprets information in a variety of forms, for example, Venn diagrams, pie charts, tables and line graphs. When using a graphing calculator to investigate linear equations he worked systematically, keeping the coefficient of x the same while varying the constant to see the effect on the graph and then varying the coefficient of x but leaving the constant the same. He recorded the graphs he created, labelling them clearly, so that he was able to draw conclusions and justify them with reference to his results.

Pupil J expresses his conclusions in words and more generally using algebraic notation. From his investigation of linear graphs he concluded that 'the number multiplying x tells you how steep the line is and the other number is where it crosses the y -axis'. He expressed the formula for the area of a parallelogram alongside his diagrams as 'Area of parallelogram = Area of rectangle = bh '. Pupil J recognised that in his procedure for a Logo turtle to draw a regular polygon he could repeat a forward movement followed by a turn. He reasoned that the turn needed to be $360^\circ \div n$, where n represents the number of sides. He also concluded that varying the number of units of the forward movement would change the size of the polygon. He is beginning to use logical argument in recording his solutions, for example, when he finds angles in diagrams.

Summarising Pupil J's attainment in using and applying mathematics

Pupil J is beginning to meet some assessment criteria for level 6, for example, as he is starting to engage with more substantial tasks and use logical argument in his solutions. However, the description for level 5 is still the 'best fit' description of Pupil J's attainment in mathematics and his teacher judges Pupil J's attainment as high in level 5. To make progress into level 6 he needs to begin to communicate his findings for an audience or for himself at another time using a combination of symbols, diagrams or graphs and explanatory text.

	Using and applying mathematics	Numbers and the number system	Calculating	Algebra	Shape, space and measure	Handling data
Level 6	<ul style="list-style-type: none"> solve problems and carry through substantial tasks by breaking them into smaller, more manageable tasks, using a range of efficient techniques, methods and resources, including ICT; give solutions to an appropriate degree of accuracy interpret, discuss and synthesise information presented in a variety of mathematical forms present a concise, reasoned argument, using symbols, diagrams, graphs and related explanatory texts use logical argument to establish the truth of a statement 	<ul style="list-style-type: none"> use the equivalence of fractions, decimals and percentages to compare proportions 	<ul style="list-style-type: none"> calculate percentages and find the outcome of a given percentage increase or decrease divide a quantity into two or more parts in a given ratio and solve problems involving ratio and direct proportion use proportional reasoning to solve a problem, choosing the correct numbers to take as 100%, or as a whole add and subtract fractions by writing them with a common denominator, calculate fractions of quantities (fraction answers), multiply and divide an integer by a fraction 	<ul style="list-style-type: none"> use systematic trial and improvement methods and ICT tools to find approximate solutions to equations such as $x^3 + x = 20$ construct and solve linear equations with integer coefficients, using an appropriate method generate terms of a sequence using term-to-term and position-to-term definitions of the sequence, on paper and using ICT; write an expression to describe the nth term of an arithmetic sequence. plot the graphs of linear functions, where y is given explicitly in terms of x; recognise that equations of the form $y = mx + c$ correspond to straight-line graphs construct functions arising from real-life problems and plot their corresponding graphs; interpret graphs arising from real situations 	<ul style="list-style-type: none"> classify quadrilaterals by their geometric properties solve geometrical problems using properties of angles, of parallel and intersecting lines, and of triangles and other polygons identify alternate and corresponding angles; understand a proof that the sum of the angles of a triangle is 180° and of a quadrilateral is 360° devise instructions for a computer to generate and transform shapes and paths visualise and use 2-D representations of 3-D objects enlarge 2-D shapes, given a centre of enlargement and a positive whole-number scale factor know that translations, rotations and reflections preserve length and angle and map objects onto congruent images use straight edge and compasses to do standard constructions deduce and use formulae for the area of a triangle and parallelogram, and the volume of a cuboid; calculate volumes and surface areas of cuboids know and use the formulae for the circumference and area of a circle 	<ul style="list-style-type: none"> design a survey or experiment to capture the necessary data from one or more sources design, trial and, if necessary, refine data collection sheets; construct tables for large discrete and continuous sets of raw data, choosing suitable class intervals; design and use two-way tables select, construct and modify, on paper and using ICT: <ul style="list-style-type: none"> pie charts for categorical data bar charts and frequency diagrams for discrete and continuous data simple time graphs for time series scatter graphs and identify which are most useful in the context of the problem find and record all possible mutually exclusive outcomes for single events and two successive events in a systematic way know that the sum of probabilities of all mutually exclusive outcomes is 1 and use this when solving problems communicate interpretations and results of a statistical survey using selected tables, graphs and diagrams in support
Level 5	<ul style="list-style-type: none"> identify and obtain necessary information to carry through a task and solve mathematical problems check results, considering whether these are reasonable solve word problems and investigations from a range of contexts show understanding of situations by describing them mathematically using symbols, words and diagrams draw simple conclusions of their own and give an explanation of their reasoning 	<ul style="list-style-type: none"> use understanding of place value to multiply and divide whole numbers and decimals by 10, 100 and 1000 and explain the effect round decimals to the nearest decimal place and order negative numbers in context recognise and use number patterns and relationships use equivalence between fractions and order fractions and decimals reduce a fraction to its simplest form by cancelling common factors understand simple ratio 	<ul style="list-style-type: none"> use known facts, place value, knowledge of operations and brackets to calculate including using all four operations with decimals to two places use a calculator where appropriate to calculate fractions/percentages of quantities/measurements understand and use an appropriate non-calculator method for solving problems that involve multiplying and dividing any three-digit number by any two-digit number solve simple problems involving ordering, adding, subtracting negative numbers in context ratio and direct proportion apply inverse operations and approximate to check answers to problems are of the correct magnitude 	<ul style="list-style-type: none"> construct, express in symbolic form, and use simple formulae involving one or two operations use and interpret coordinates in all four quadrants 	<ul style="list-style-type: none"> use a wider range of properties of 2-D and 3-D shapes and identify all the symmetries of 2-D shapes use language associated with angle and know and use the angle sum of a triangle and that of angles at a point reason about position and movement and transform shapes measure and draw angles to the nearest degree, when constructing models and drawing or using shapes read and interpret scales on a range of measuring instruments, explaining what each labelled division represents solve problems involving the conversion of units and make sensible estimates of a range of measures in relation to everyday situations understand and use the formula for the area of a rectangle and distinguish area from perimeter 	<ul style="list-style-type: none"> ask questions, plan how to answer them and collect the data required in probability, select methods based on equally likely outcomes and experimental evidence, as appropriate understand and use the probability scale from 0 to 1 understand and use the mean of discrete data and compare two simple distributions, using the range and one of mode, median or mean understand that different outcomes may result from repeating an experiment interpret graphs and diagrams, including pie charts, and draw conclusions create and interpret line graphs where the intermediate values have meaning
BL						
IE						

Key: BL-Below Level IE-Insufficient Evidence

Overall assessment (tick one box only)

Low 5

Secure 5

High 5

Low 6

Secure 6

High 6

Audience: Secondary mathematics subject leaders

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