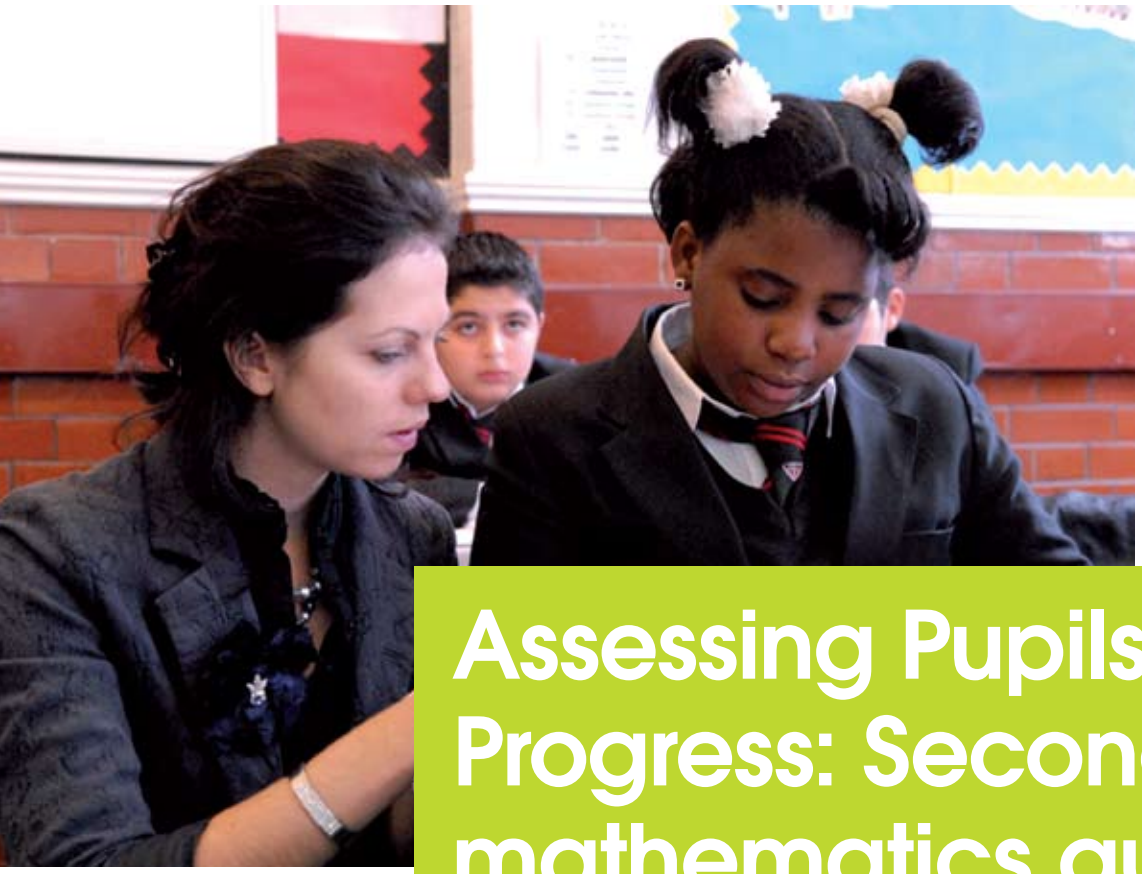
The National Strategies
Secondary



Assessing Pupils' Progress: Secondary mathematics guidance

Day-to-day assessment in mathematics

department for
children, schools and families

Assessing Pupils' Progress: Secondary mathematics guidance

Day-to-day assessment in mathematics

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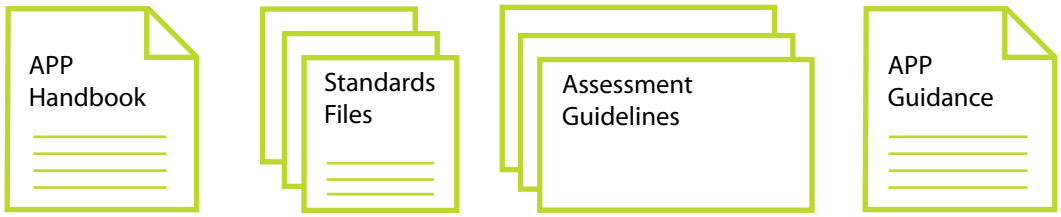
Background

The Assessing Pupils' Progress (APP) resources



There is a range of Assessing Pupils' Progress (APP) resources available to teachers.

- The **APP Handbook** explains the whole-school context for assessment and introduces APP as a tool for periodic assessment. It provides all the practical guidance that departments will need to develop and embed APP in mathematics.
- The **Standards Files** are exemplifications of national standards. These will help departments to reach consistent and reliable judgements about National Curriculum levels for different areas of mathematics. The Standards Files are described more fully in the Appendix to the APP Handbook.
- The **Assessment Guidelines** set out level-related APP assessment criteria for mathematics. These are available in two formats. An A3 version covering levels 2 to 8 is available to download from the Framework website. Alternatively, a set of A4 versions, covering two National Curriculum levels on each sheet, is provided with the APP materials. Either version will provide a simple recording sheet for an individual pupil, containing the assessment criteria for each element of mathematics.
- This document, the **APP Guidance** booklet, along with the **focused assessment materials** and the **assessment packages**, provide additional support for departments in implementing the APP approach through Assessment for Learning (AfL) in mathematics lessons.

This APP guidance should be used in conjunction with the other APP resources listed above. All these resources can be found at: www.standards.dcsf.gov.uk/nationalstrategies – click on Secondary mathematics and select Assessment.

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Embedding APP into teaching and learning

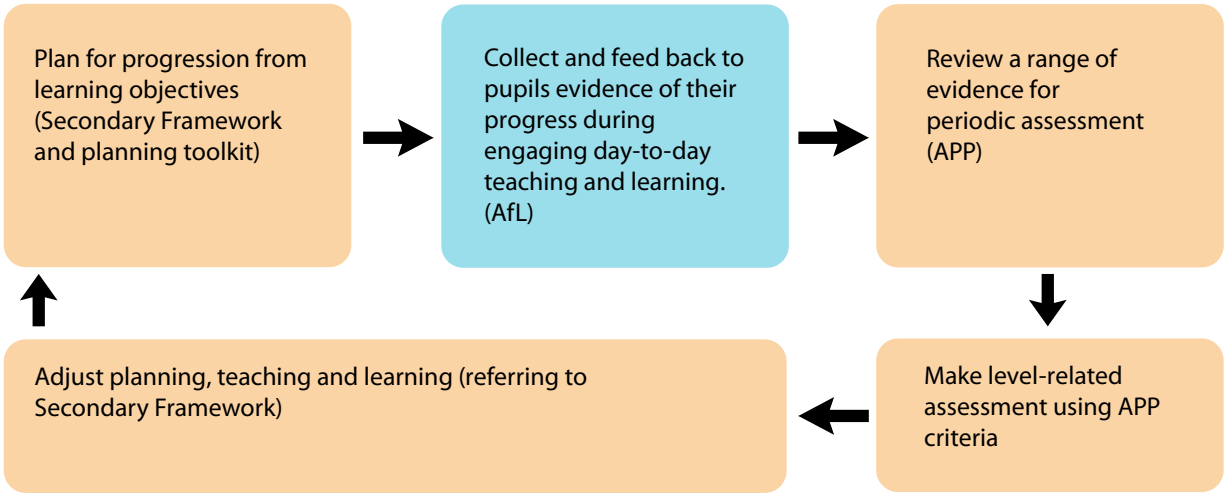
The approach and materials in this guidance have been trialled by teachers during a two-year project between September 2004 and August 2006 involving 40 schools in eight local authorities. Since the project, the materials have been extended and developed further. Quotes in this booklet are from teachers who have worked extensively with the materials.

The DCSF Assessment for Learning Strategy describes three viewpoints for assessment:

Day-to-day	Learning objectives made explicit and shared with pupils Peer- and self-assessment in use Pupils engaged in their learning and given immediate feedback
Periodic	Broader view of progress across the subject for teacher and learner Use of national standards in the classroom Improvements to medium-term curriculum planning
Transitional	Formal recognition of pupils' achievement Reported to parents/carers and next teacher(s) May use external tests or tasks

The APP Handbook focuses on the process of periodic assessment, which involves stepping back from the daily and weekly process of teaching, and assessing progress made across the subject over a longer period – perhaps a whole term.

These mathematics guidance materials focus on how you as a mathematics teacher can use AfL **in lessons** in order to generate the widest range of evidence of your pupils' learning. This stage is shown in the blue box in the APP cycle below. This evidence then informs the next stage of the cycle when you review it to make your periodic judgements in relation to the APP criteria set out in assessment guidelines.



Using the assessment guidelines for mathematics

The assessment guidelines sheets have been produced to support you in tracking and securing every pupil's progress in the key areas of mathematics. This mathematics guidance has been produced to support you as a mathematics teacher in expanding the range of evidence you have about pupils' learning, not in additional time, but in normal mathematics lessons.

In your lessons, you will be gathering a range of evidence to guide your teaching and to help you assess how well pupils are progressing in mathematics. Your evidence is likely to include:

- the work in pupils' exercise books
- information from observing and listening to pupils when they are working
- information from dialogue with pupils, initiated by careful questioning to explore and probe their understanding
- evidence from the occasional test.

All these sources of evidence have value, although mathematics teachers have sometimes relied rather too heavily on testing at the expense of the other approaches. This guidance specifically supports the use of questioning and dialogue to help secure evidence which can inform your periodic judgements in relation to the APP assessment criteria. The **focused assessment materials**, described below, have been designed for this purpose.

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Exploring the focused assessment materials

These materials are based on the APP assessment criteria and organised in National Curriculum levels. There is a set for each of levels 4 to 8.

The focused assessment materials include for each assessment criterion:

- **examples of what pupils should know and be able to do** so teachers have a feel for how difficult the mathematics is intended to be. These are not activities or examples that will enable an accurate assessment of work at this level. To do this, you need a broad range of evidence drawn from day-to-day teaching over a period of time; this is exemplified in the Standards Files, which are provided as part of the overall APP resources.
- some **probing questions** for teachers to use with pupils in lessons to initiate dialogue to help secure their assessment judgement.

The following is an example from the level 6 focused assessment materials.

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	
Examples of what pupils should know and be able to do	Probing questions
Add and subtract more complex fractions such as $11/18 + 7/24$, including mixed fractions. Solve problems involving fractions, e.g.: *In a survey of 24 pupils, ⅓ liked football best, ¼ liked basketball, ⅜ liked athletics and the rest liked swimming. How many liked swimming?*	Why are equivalent fractions important when adding or subtracting fractions? What strategies do you use to find a common denominator when adding or subtracting fractions? Is there only one possible common denominator? What happens if you use a different common denominator? Give pupils some examples of adding and subtracting of fractions with common mistakes in them. Ask them to talk you through the mistakes and how they would correct them. How would you justify that $4 \div \frac{1}{5} = 20$? How would you use this to work out $4 \div \frac{2}{5}$? Do you expect the answer to be greater or less than 20? Why?

A level 6 assessment criterion for the assessment focus 'Calculating'.

Examples to give an idea of the intended difficulty of the mathematics.

Probing questions for teachers to use to start a dialogue about the mathematics in order to explore pupils' mathematical thinking. The evidence from pupils' responses helps to secure assessments in relation to the criterion, particularly for those pupils about whose performance teachers are not sure.

Using probing questions

Some of the most valuable AfL information comes from dialogue and observation during mathematics lessons. Increasing the amount of talk about mathematics helps you and your pupils explore their understanding and learning of mathematics. For this reason, each set of focused assessment materials includes probing questions to help you extend the range of evidence available to support your assessment of the APP criteria. The probing questions are an assessment tool designed to initiate a dialogue between you and your pupils and between pupils, about the targeted mathematics. They are 'probing' because they are intended to explore mathematical thinking. They are an important assessment tool because they can help confirm pupils' understanding or identify their misconceptions.

> *'Most of us use questioning in the classroom anyway, but this was using questioning for a different purpose. We would use questioning as a teaching aid, to draw things out of the pupils, whereas now we also use questioning to check pupils' understanding and explore misconceptions.'*

The probing questions are best used when pupils are engaged in activities closely related to the assessment criteria being assessed. They work more effectively with open or problem-solving activities.

The intention is that teachers target pupils whose performance they are not sure about during the main activity part of the lesson and use the probing questions to start a dialogue about the mathematics involved. The dialogue is important. It has the potential to help pupils and teachers explore the depth of the pupils' understanding and, as with all dialogue, can also contribute to strengthening learning.

> *'The pupils say some great things in response to the probing questions. It gives me a good opportunity to praise them about the mathematics. They leave the lessons buzzing, and that enthusiasm and feeling good about themselves transfers to the next lesson. It makes them actually want to engage with the activities.'*

When exploring pupils' understanding, you will need to select and modify the probing questions to suit the context of the activity and the needs of the pupils . Pupils may find it difficult to respond to probing questions at first, so you may need to increase opportunities for pupils to use mathematical talk during lessons.

> *'Pupils are a lot more on task during discussions, and their confidence in answering questions has grown. I feel the approach promotes the penetration of learning and understanding for pupils.'*

The use of probing questions is not the only way for dialogue to inform assessment. Pupils may show insight, understanding, or misunderstanding not just by the way they answer questions, but also by the questions they themselves ask. Sometimes these questions can indicate a deeper grasp of a concept.

> *'Before we talked about it, I always thought if the shape had three numbers you just times them. But now I know that you split the shape into rectangles and I can find the area of a rectangle. It's so easy. I understand it fully now.'*

(Comment from a pupil after dialogue about understanding and using the formula for the area of a rectangle using the probing questions.)

Collaborative activity

You may find it useful to work together on:

- strengthening the use of open and problem-solving activities in your schemes of work
- experimenting with the probing questions in lessons and then discussing outcomes and next steps.

Devising probing questions

It is a useful professional development activity for teachers to devise probing questions. The process focuses the mind on the underlying mathematical thinking that pupils need to develop to have a deep understanding of an area of mathematics. Mathematics consultants and teachers were involved in devising and trialling the probing questions included in the focused assessment materials. The following stems were found to be particularly powerful in generating probing questions:

Stem	Example to illustrate
How do you know…	when a fraction is in its simplest form?
How do you go about…	finding the set of coordinates for a straight line graph?
Give me some… that are equivalent to…	expressions $n + 3$.
What clues do you look for…	to decide if a sequence is linear or quadratic?
What important tips would you give someone…	about using a protractor?
Which of these … are easy to… Which are difficult? What makes them difficult?	equations solve?
When is this statement true? When is it false?	Multiplication makes numbers bigger.
Talk me through the steps you would take to…	find an estimate for the answer to this calculation.

Collaborative activity

You may find it useful to work together on:

- reflecting on the probing questions for specific assessment criteria
- devising your own probing questions using the stems.

Using the examples of what pupils should know and be able to do

The assessment criteria for mathematics indicate the progression from one level to the next for each of the assessment focuses. To illustrate, here is a set of related assessment criteria for the strand 'Calculating':

level 7:	Calculate the result of any proportional change using multiplicative methods
level 6:	Use proportional reasoning to solve a problem, choosing the correct numbers to take as 100%, or as a whole
level 5:	Solve simple problems involving ratio and direct proportion

The examples of what pupils should know and be able to do (referred to as 'examples') will support you in identifying the range of mathematics implicit in the criteria as well as indicating the expected level of difficulty. Often the examples are expressed as mathematical questions. You do not need to use these questions with your pupils. This is just to illustrate the sorts of mathematics that pupils can do with understanding. Sometimes the examples describe the methods and thinking pupils should be using, for example 'Use unitary and multiplicative methods…'.

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Solve simple 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	Calculate the result of any proportional change using multiplicative methods
The ratio of yogurt to fruit purée used in a recipe is 5:2. If you have 200g of fruit purée, how much yogurt do you need? If you have 250g of yogurt, how much fruit purée do you need? A number of cubes are arranged and the ratio of red cubes to green cubes is 2:7. If the pattern is continued until there are 28 cubes of one colour, how many cubes of the other colour will there be? Three bars of chocolate cost 90p. How much would six bars cost? And 12 bars?	Use unitary methods and multiplicative methods, e.g.: • There was a 25% discount in a sale. A boy paid £30 for a pair of jeans in the sale. What was the original price of the jeans? • When heated, a metal bar increases in length from 1.25m to 1.262m. Calculate the percentage increase correct to one decimal place. • A recipe for fruit squash for six people is: 300g chopped oranges 1500ml lemonade 750ml orange juice Trina made fruit squash for ten people. How many millilitres of lemonade did she use? Jim used two litres of orange juice for the same recipe. How many people was this enough for?	The new model of an MP3 player holds ⅛ more music than the previous model. The previous model holds 5000 tracks. How many tracks does the new model hold? The previous model cost £119.99 and the new model costs £144.99. Is this less than or greater than the proportional change to the number of tracks? Justify your answer. After one year a scooter has depreciated by ⅐ and is valued at £996. What was its value at the beginning of the year? Weekend restaurant waiting staff get a 4% increase. The new hourly rate is £6.50. What was it before the increase? My friend's savings amount to £957.65 after 7% interest has been added. What was the original amount of her savings before interest was added? Use a multiplicative method such as: **Original ← Result — Multiplier** **100% ← 107% — x 100/107** **? ← £957.65 — x 100/107**
From the level 5 focused assessment materials	From the level 6 focused assessment materials	From the level 7 focused assessment materials

Collaborative activity

You may find it useful to work together on:

- analysing the differences in the examples from one level to the next for sets of related assessment criteria.

Integrating the assessment criteria into mathematics planning and teaching

The APP Handbook emphasises the need for teachers to identify relevant assessment criteria as part of their planning for mathematics so they can see, in advance, the areas of focus for assessment.

To illustrate, this is what it might look like when teaching a unit on solving linear equations to a Year 9 class. Your planned teaching and learning will be based on a range of related learning objectives, but you might focus on just one assessment criterion as illustrated below:

Learning objectives	Assessment criteria
Manipulate algebraic expressions and equations; use accurate notation and record methods and solutions Distinguish between the different roles played by letter symbols in equations, identities, formulae and functions Simplify or transform algebraic expressions by taking out single-term common factors; add simple algebraic fractions Construct and solve linear equations with integer coefficients (with and without brackets, negative signs anywhere in the equation, positive and negative solution)	Construct and solve linear equations with integer coefficients, using an appropriate method

Teachers who piloted the use of the focused assessment materials found it useful to integrate the probing questions into their planning. This made it easier to use the questions in lessons, particularly in plenaries (to deepen mathematical thinking) and to probe and assess pupils' understanding.

Collaborative activity

You may find it useful to work together on:

- deciding on the outcomes to be assessed in each unit of work, then selecting the relevant assessment criteria to include in your unit plans
- incorporating the probing questions into your unit plans, modifying and adding other questions as appropriate.

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How will your teaching be different?

Almost all the information needed for making periodic assessment judgements comes from AfL practice in everyday mathematics lessons. So, what are the small changes that you may need to make to units of work in order to generate the widest range of evidence to support periodic assessment?

In the first half of the teaching of a unit of work, your practice is likely to be unchanged, unless you know you need to increase pupils' opportunities to talk about their mathematics as they work on activities and problems.

As you get further into the teaching of the unit, perhaps about half way in, pupils will be beginning to develop understanding of the key areas of new learning, so it is from this time that you will begin to focus more on the APP assessment criteria. For example:

- When pupils are working on problems and activities you will find it useful to focus your observation and interaction on the targeted assessment criteria, perhaps using some of the probing questions.
- As you reach the last two or three lessons you will find it helpful to jot down the names of pupils who are having difficulty and those you are not sure about and then group these pupils together for one or two lessons so you can:
  - provide focused support (perhaps as a guided learning group[1]) for those who are having difficulty
  - explore the depth of understanding, using the probing questions, of those pupils whose performance you are not sure about.
- For those pupils who remain insecure in relation to the assessment criteria, the interaction based on the probing questions will help you to pinpoint their difficulties. You will need to note each weakness, probably as a curricular target, with the names of pupils who will need support in the future. (See the next section 'Using information from assessments to improve teaching and learning' for guidance on identifying and achieving curricular targets for pupils having difficulty.)
- Throughout the second half of the unit, as you secure your evidence of learning, you may be annotating pupils' work or recording significant evidence based on dialogue and observation.

1. See *Pedagogy and practice: Teaching and learning in secondary schools Unit 9*: *Guided learning* (DfES 0432-2004G) for more information on using guided learning in lessons.

Using information from assessment to improve teaching and learning

One of the strengths of using the probing questions is that the dialogue will reveal the pupil's misconceptions and misunderstandings. In some cases, the dialogue between you and the pupil will address the problem, but sometimes you will need to express the weakness as a curricular target for yourself and the pupil. A curricular target clarifies the specific area of mathematics that the pupil needs to work on in order to have a secure understanding of the assessment criterion. So, for example, returning to the unit of work on solving linear equations:

Construct and solve linear equations with integer coefficients, using an appropriate method	
Examples of what pupils should know and be able to do	Probing questions
Solve, e.g.: • $3c - 7 = -13$ • $4(z + 5) = 84$ • $4(b - 1) - 5(b + 1) = 0$ • $12 / (x + 1) = 21 / (x + 4)$ Construct linear equations, e.g.: • The length of a rectangle is three times its width. Its perimeter is 24cm. Find its area.	How do you decide where to start when solving a linear equation? Given a list of linear equations ask: Which of these are easy to solve? Which are difficult and why? What strategies are important with the difficult ones? $6 = 2p - 8$. How many solutions does this equation have? Give me other equations with the same solution. Why do they have the same solution? How do you know? How do you go about constructing equations from information given in a problem? How do you check whether the equation works?

For pupils whom you judge to have limited or no understanding of this area of mathematics, discussion with the pupil using the probing questions might reveal weaknesses with understanding the process of solving an equation by finding equivalent and easier equations to solve. The curricular target then might be:

- I am able to find equivalent equations and know why they are important when solving equations.

Alternatively, the problem may lie with manipulating positive and negative numbers, suggesting this curricular target:

- I am able to work with positive and negative numbers when solving equations.

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Another possibility is that the pupil does not understand the conventions of the use of brackets, leading to this curricular target:

- I can solve linear equations that have brackets.

You will probably communicate these targets to the pupils in their exercise book, but you will also need to keep a note of the curricular targets with the pupils' names. In most situations you will be identifying one or two curricular targets for about five or six pupils. If the problems are greater than this, you will probably decide to teach the topic again to the whole class in a different way.

Having identified the curricular targets and shared them with the pupils you then need to decide on your strategy for the pupils to achieve the target. This is unlikely to involve any major re-drafting of the schemes of work, but may require one or more of the following:

- one or two additional lessons – particularly if most pupils have the same or similar curricular targets
- a few focused oral and mental starters
- changes to planned teaching in a subsequent, related unit
- focused teaching of targeted pupils when the topic is next taught – perhaps using guided learning approaches
- putting the class into groups for part of a lesson so pupils can support each other in overcoming the difficulties
- individual tuition or focused support from a teaching assistant.

Tracking pupils' progress using the assessment guidelines

Over time, by generating evidence in relation to assessment criteria you will build up a profile of each pupil's achievements. You may decide to annotate the criteria or flag up those where you need to act to address identified weaknesses. Alternatively you may prefer to 'traffic light' the criteria using green highlighting for secure understanding, yellow highlighting for limited understanding and red highlighting for little or no understanding.

These records will then form an important source of evidence for APP periodic review which is explained through seven steps in the APP teachers' handbook[2], pages 9–11. The main outcomes of the periodic review are a level judgement for each pupil for each of the assessment focuses and an overall sub-level judgement for mathematics.

2. *Assessing pupils' progress in mathematics at Key Stage 3: Teachers' handbook* (00651-2008BKT-EN).

Exploring the benefits of developing APP practice

There are benefits for pupils, mathematics teachers and mathematics subject leaders in developing and using APP practice. Fundamentally, the dialogue and mathematical thinking generated through probing questioning will lead to better learning and deeper understanding. In addition, the significant benefits are as follows:

For pupils

APP can add direction and motivation for pupils that result from a clear understanding of:

- what they have achieved
- where they need to improve in order to make progress on to the next level of attainment
- the progress they are making towards their end-of-year and end-of-key-stage targets.

For mathematics teachers

APP has huge potential for teachers in tracking pupils' progress and raising standards in mathematics by:

- identifying strengths and weaknesses of individual pupils, which lead to action including the setting of curricular targets and tailored teaching in future lessons
- securing evidence on which to base clear, constructive feedback to pupils in class and to their parents through the school's system for reporting
- seeing and understanding the progression in the assessment criteria from one level to the next
- providing rigorous evidence for making level and sub-level judgements.

For mathematics subject leaders

Use of APP across the department can help subject leaders by:

- making it straightforward to identify pupils whose progress towards their targets is stalling
- providing information, based on nationally agreed assessment criteria about the common weaknesses of underperforming groups of pupils, which can then be addressed through strengthening planning for teaching and learning
- identifying patterns in performance of pupils in different teaching groups or different ability groups
- analysing pupils' performance in the different assessment focuses and identifying areas of relative low performance.

Furthermore, as APP becomes embedded in primary and secondary practice the assessment guidelines sheets for individual pupils will greatly support progression in learning as they move from one teacher to the next and from one school to the next.

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Using the assessment packages

The assessment packages have been produced to provide additional evidence to help inform your picture of pupils' performance in the different attainment targets. A summary of the packages and the levels they are designed to assess is given below.

The use of the assessment packages is optional and you should decide whether and when to use them.

The intention is that they can be used to:

- provide further evidence which will contribute to periodic judgements in relation to the assessment criteria
- support you in providing formative feedback to pupils
- strengthen your understanding of levels in specific attainment focuses
- support professional development activities to discuss and agree standards.

Each of the assessment packages requires two consecutive mathematics lessons. The two lessons are interactive and engaging for pupils and provide rich opportunities to assess pupils' learning in mathematics. Pilot schools reported that pupils enjoyed the lessons and often developed or strengthened their learning through the group work and the activities.

> *'The lessons from the assessment packages were good fun. I enjoyed teaching them and had fun doing the activities with the pupils.'*

The materials are designed to be used with the whole class, but you may not need to consider every pupil's response in the same detail. Focusing on a targeted group can save time, while also giving better-quality information on the pupils you need to know more about. The actions that follow the use of the assessment packages to help pupils address misconceptions and misunderstandings are vital in further raising standards.

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Steps to integrate the use of assessment packages

Select an assessment package that fits into the programme of work that pupils are following and covers an appropriate range of levels

⇩

Dedicate two consecutive lessons to the material

⇩

Prepare carefully: you will need to study each lesson plan in detail and check and prepare the resources that are required for each lesson

⇩

If helpful, decide on the pupils that you want to focus on when your class is working on the activities

⇩

Focus your marking on the assessment activities, using the solutions in the assessment package to check method and accuracy

⇩

Use the notes on 'good' and 'better' responses to get a feel for the quality of the work and to focus your feedback to pupils

⇩

Use the performance indicators and examples of pupils' work to consider how they relate to national curriculum levels

⇩

At **periodic review**, add this to your other evidence to inform your level judgement for the pupil in the relevant attainment focus

It is important to note that each assessment package addresses only part of each attainment target. The package cannot provide all the evidence you will want to draw on to make a periodic, level-related judgement where you will take into account the full range of available evidence. There may be good reasons why your overall periodic judgement should differ from the level suggested by evidence arising from one of the assessment packages. However, each assessment package does provide useful, focused information for teachers on what pupils should know and be able to do for each of the targeted levels in the context of the assessment activities. For example, some pilot schools were surprised by the level of difficulty expected for pupils performing at level 6 in Shape, space and measures in the assessment package targeted at Year 8. They found this useful in reviewing their planning.

> *'Finding the area of a triangle at level 6 is not just about using the formula. The Year 8 assessment package really helped me to understand this in a way I never had before. It changed the way I teach area.'*

The assessment packages

The 12 assessment packages are designed to assess and exemplify performance at the following levels:

Attainment targets	Assessed levels and suggested year group		
	Year 7	Year 8	Year 9
Number	3/4/5	3/4/5/6	4/5/6
Number/algebra	3/4/5		
Algebra		(3)/4/5/6	4/5/6
Shape, space and measures	3/4/5	3/4/5/6	(3)/4/5/6
Handling data	3/4/5		4/5/6
Number/handling data		(3)/4/5/6	

Where the 3 is given in brackets, this indicates that the assessment activities may provide some evidence of level 3 for pupils who do not achieve level 4.

Collaborative activity

You may find it useful to work together on:

- looking in detail at a chosen assessment package, exploring the lesson plans, trying the activities and discussing how the evidence might support judgements of pupils' performance
- after the two lessons, discussing and comparing assessments to ensure they are consistent
- deciding what you need to do to address any misconceptions and misunderstandings.

A final point

This mathematics guidance is focused mostly on what you as a teacher do in your mathematics lessons; the ways in which you observe, question, listen and respond. The practice that is being outlined here covers all these activities, in a coordinated way that will help you to build up evidence of pupils' understanding in relation to the APP assessment criteria. It is true to say that many teachers find the development of this use of questioning and dialogue difficult and, at times, professionally challenging – particularly when pupils' responses do not confirm expected understanding. But the overwhelming message as teachers get to grips with the approach is that it is worth it.

> *'I know I'm a better mathematics teacher. I assumed pupils understood because they got answers right in their books or in tests, but this kind of conversation has opened my eyes to misconceptions and misunderstandings that might otherwise have remained hidden.'*

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