Unit 3

Mathematics through other subjects

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Objectives

- To discuss situations where the teaching of mathematics can be enhanced by using examples from other subjects
- To explore opportunities for collaborative planning and teaching of mathematical topics

Suggested use and organisation

- All schools except those which have already established policies on numeracy across the curriculum; whole-staff meeting or individual department meetings.
- If you are running a whole-school training day, this follows naturally from units 1 and 2. It could also be used as one of a series of staff meetings or for individual department meetings.
- Staff should sit around tables in departmental groups; where possible there should be a member of the mathematics department with each group.
- The school's special needs department could either form a group of their own (using handout 3.12) or could split to join other departments. In the latter case they may wish to meet to discuss handout 3.12 beforehand.
- The mathematics department should discuss handout 3.7 beforehand.

Resources

- OHT 3.0
- Handouts 3.1–3.12 (sufficient copies of relevant sheets for specific departments); handout 1.4 (teachers should bring their own copies from unit 1)
- Photocopies of 'Mathematics across the curriculum', from section 1, pages 23–24, of the *Framework for teaching mathematics: Years 7, 8 and 9* (optional)
- Video sequence 3(a), (b) or (c), Mathematics in (a) geography, (b) history, (c) ICT (choose which of these to use before running the session)
- Copies of current departmental schemes of work and QCA guidance where appropriate; possibly illustrative examples from teaching materials
- *Framework for teaching mathematics: Years 7, 8 and 9* (one copy per group)
- Appendix 2, *Vocabulary checklist* (one copy per group)
- Appendix 3, *Mathematics glossary for teachers in Key Stages 1 to 4* (one copy per group)

Session outline — 75 minutes

Teaching mathematics in other subjects Considering examples of collaboration in Key Stage 3	Talk, video, discussion	25 minutes
Mathematics through other subjects Reviewing schemes of work to identify areas of common ground with mathematics for future collaboration	Talk, group discussion	35 minutes
Feedback Collating feedback from departmental discussions, identifying suitable action points for inter-departmental collaboration	Plenary	15 minutes

Teaching mathematics in other subjects — 25 minutes

Introduce the session's objectives, using **OHT 3.0**.

OHT 3.0

Objectives

- To discuss situations where the teaching of mathematics can be enhanced by using examples from other subjects
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This session concentrates on the role played by other subjects in supporting mathematics and the development of mathematical ideas. Some subjects provide good opportunities for collaborative working. You could provide participants with photocopies of **pages 23–24** of section 1 of the Framework to illustrate this potential for helping pupils to make connections in their learning.

The session begins with video case studies:

- a geography field trip and follow-up work from Sandbach School in Cheshire;
- two lessons (one history and one ICT) from John Masefield School, Ledbury.

Some mathematics is taught in the course of each of the lessons, after the teachers have consulted the mathematics department to agree methods.

Show **video sequence 3(a), (b) or (c)**, which respectively last 13 minutes, 6 minutes and 5 minutes.

Ask teachers to consider, as they watch the video:

- the extent to which they already use mathematics in their own lessons;
- whether they teach the mathematical skills as they arise or expect the pupils already to have those skills.

Allow at least 10 minutes for discussion, questions and comments.

Mathematics through other subjects 35 minutes

The second part of this session asks teachers to look, within their schemes of work, for areas of overlap with mathematics. **Handouts 3.1–3.12** contain notes to guide the discussions in different subject groups. These relate to the current National Curriculum orders for each subject, the QCA schemes of work and other documents such as the Literacy Framework. Mention the *Vocabulary checklist* and *Mathematics glossary for teachers in Key Stages 1 to 4* (**appendices 1 and 2**) which are referred to on some of the handouts.

As the aim is to prepare the ground for the kind of collaborative working that teachers have observed in the video sequences, the handouts act as prompt sheets for discussion on links between subjects and differences that might need to be overcome.

Note that handout 3.7 refers to mathematics; the mathematics department may wish to use this in a separate departmental discussion, before the whole-school training, to create their own department's priority list to refer to in the plenary. Members of the mathematics department can then be allocated to other subject groups for the discussion.

Ask each group to review their Key Stage 3 scheme for areas of overlap with mathematics. Ask them, by the end of the session, to suggest two objectives for whole-school collaborative work and to note on **handout 1.4** up to three points for further departmental action.

Feedback 15 minutes

The aim in this section is to gather the three action points and two objectives from each group and to identify possible links that can be made in the short term, along with others that might take more time to establish.

It may be possible, at a later stage, to include these links in the departments' development plans and the school development plan. Units 8 and 9 follow up this work. In the meantime, the school will have a clear idea of where links with other subjects can be most beneficial.

Identify at least one suggestion for immediate action and agree possible timescales for two more.

Conclude by asking departments how they might use **appendices 2 and 3**, the vocabulary checklist and glossary for mathematics. Share suggestions.

OHT 3.0

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Key Stage 3 *National Strategy*

Handout 3.1

Art and design and mathematics

- How does art and design use the mathematical ideas of ratio and proportion, including similarity and scale?
- How does the work on perspective link to the development of enlargement and scale factor in mathematics?
- How are mathematical ideas of pattern, shape and its transformation taught in art and design, for example through cubism or the tessellations of Escher?
- How can our work in art and design support the *construction* strand of shape, space and measures?
- Are expectations in the yearly teaching programmes for mathematics compatible with the art and design schemes of work? Are there similar expectations regarding the development and use of pupils' vocabulary, exemplified in the *Vocabulary checklist*?
- How can art and design contribute to the development of pupils' problem solving, communication and reasoning?

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for art and design.

Examples from the QCA schemes of work for art and design include unit 8A, 'Objects and viewpoints', which makes specific reference to perspective and to mathematical shapes.

Handout 3.2

Design and technology and mathematics

- How (and when) do the technology subjects reinforce pupils' knowledge, understanding and skills in all aspects of measurement, including estimation of measures?
- In *knowledge and understanding of structures*, do the methods used by pupils in calculating loads reinforce the approach to calculation in the Framework for teaching mathematics?
- Is the approach to ratio, proportion and percentages compatible with work in mathematics? What methods of calculation do we encourage?
- How can our work support the *construction* and *transformations* strands of shape, space and measures when pupils are *developing, planning and communicating* their ideas?
- How are scales and scale factors used in the different strands of technology when pupils are *developing, planning and communicating ideas*?
- Are the different strands of handling data applicable to technology teaching, in particular when pupils are *evaluating processes and products*? If so, is there any ICT in use in this work?
- Do mathematics and technology use a common vocabulary when teaching all these elements?
- What are the links between using and applying mathematics and the problem-solving elements of technology?
- What are our expectations for accuracy of measurements, use of decimal places and significant figures, and use of units and their abbreviations?

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for design and technology.

Handout 3.3

Geography and mathematics

- Which elements of the number and calculation strands of mathematics feature in teaching geography? Are we familiar with the approach to calculation in the Framework for teaching mathematics? Does our teaching support this approach?
- How does teaching within geography support work on coordinates and measures?
- Which parts of the handling data cycle – state problem, identify and collect data, analyse and represent data, interpret results – relate directly to work in geography? Are there opportunities for joint work with the mathematics department? Which units offer greatest potential for joint working? Would there be any ICT use in this work?
- How are graphs and charts used in geography? Does their development support the progression outlined in the yearly teaching programmes for mathematics? Do our labelling conventions for graphs match those of the mathematics department?
- In what ways could our work on thinking skills in geography contribute to the development of using and applying mathematics?

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for geography.

You may find it useful to refer to the teacher's guide for the QCA schemes of work for geography:

pages 12–13	Links with mathematics
pages 14–15	Key skills and thinking skills
pages 29–30	Appendix 6 Possible links between geography and mathematics
pages 33–34	Appendix 8 Possible links between geography and key skills: application of number

Handout 3.4

History and mathematics

- Which elements of the number and calculation strands of mathematics feature in teaching history? Are we familiar with the approach to calculation in the Framework for teaching mathematics? Does our teaching support this approach?
- Which parts of the handling data cycle – state problem, identify and collect data, analyse and represent data, interpret results – relate directly to work in history? Are there opportunities for joint work with the mathematics department? Which units offer greatest potential for joint working? Would there be any ICT use in this work?
- How are graphs and charts used in history? Does their development support the progression outlined in the yearly teaching programmes for mathematics? Do our labelling conventions for graphs match those of the mathematics department?
- In what ways could our work on thinking skills in history contribute to the development of using and applying mathematics?

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for history.

You may find it useful to refer to the teacher's guide for the QCA schemes of work for history:

pages 13–14	Links with mathematics
page 16	Contribution to thinking skills
pages 29–30	Appendix 6 Links between history and mathematics

Handout 3.5

ICT and mathematics

- Do the references to ICT in the Framework for teaching mathematics represent appropriate application of ICT in supporting pupils' learning? Are there other references you would wish to see included?
- Which general-purpose ICT packages are in use to support pupils' mathematical development? Which strands of the yearly teaching programmes do they help to address?
- Are there any mathematics packages used in ICT? If so, how well-matched is the work to the objectives and progressions set out in the yearly teaching programmes for mathematics? Do they include Logo, graph plotting and dynamic geometry software, as indicated in the yearly teaching programmes?
- Does the school use any integrated learning systems (ILS) for pupils learning mathematics? If so, is the structure compatible with the Framework's approach to calculation (particularly the development of mental calculation strategies and the progression to written calculation strategies)?
- Do other subjects have access to appropriate ICT systems for supporting pupils' mathematical development?

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for ICT.

Handout 3.6

Languages and mathematics

- What knowledge, skills and techniques
  - at word level
  - at sentence level
  - at text level

  can be developed in English / language lessons that will help pupils to:
  - use mathematical vocabulary correctly?
  - explain and justify their methods and conclusions?
  - interpret and discuss results?
  - solve word problems?
  - communicate orally and on paper the results of a statistical enquiry or other in-depth piece of mathematics?
- To what extent do we support the development of words involved in reasoning and proof (for example, 'if … then', 'therefore', 'it follows that …', etc.)?
- How can we support the teaching of pupils, including EAL pupils, to understand and use, read, write and spell correctly the mathematics vocabulary in the Framework? Are there particular words in the *Vocabulary checklist* that we could stress?
- Could we support the teaching of place value by exploring the language patterns in counting numbers?
- To what extent does our work on interpreting information/being a critical reader contribute to the development of mathematics (for example, handling data presented in charts, graphs and diagrams)?
- How might the skills developed in language lessons enhance pupils' capacities to solve problems, to reason and justify, and to evaluate their work in mathematics?

There are references to mathematics in the National Curriculum Key Stage 3 programmes of study for English and for modern foreign languages.

You may find it useful to refer to the classroom examples section (pages 14–31) of the QCA publication *Language for learning in Key Stage 3*.

Handout 3.7

Mathematics

Note: This is intended to be used within a department meeting before the whole-school day on numeracy across the curriculum.

- Are there opportunities to work with other departments?
- Which parts of mathematics will have the most applications in other subjects? In which years? For all pupils in the year?
- How can we encourage other departments to be aware of common approaches to calculation, such as ‘grid multiplication’?
- Where would working with another department (or other departments) on a topic be a realistic possibility for us?
- What needs to be done to prepare the ground before such work can take place?
- What would be the anticipated benefits for pupils? All pupils?
- Where should we give priority?

Handout 3.8

Music and mathematics

- Music makes significant use of symbolic representation, as does mathematics. Do we use the similarities in the ways symbols are interpreted in both subjects?
- How can work on equivalent fractions enhance pupils' understanding of the relative values of notes?
- What links are there between mathematical sequences and those found in music, such as rhythm patterns? Counting to a regular rhythm often forms part of a pupil's earlier mathematical education; can we use this to enhance pupils' understanding of rhythm?
- Can rhythm patterns, represented either symbolically or numerically, be seen to have parallels in mathematical sequences?
- Can pupils' knowledge of time and speed enhance their understanding of musical time, when considering technical issues such as beats per second and the differences between certain types of music, for example music from around the world, pop, techno, and so on?
- Is the study of pattern in musical forms such as ABA, AABA, ABAB (leading to fugue, sonata and symphonic form) enhanced by pupils' understanding of repeating patterns in mathematics?
- When looking at shapes in written music (such as high/low, rising/falling, ascending/descending), can comparisons be made with pupils' work on graphs?
- How can music contribute to the development of pupils' skills in organisation, logical thought, problem solving, collaborative working, listening to and sharing opinions?

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for music.

Handout 3.9

Physical education and mathematics

- Are there any links (for example, in gymnastics or dance) building upon ideas of pattern, movement and symmetry developed in mathematics?
- How does the teaching of physical activities develop pupils' awareness of time, distance and speed? At what stage are rates such as km per hour discussed? Is this compatible with the expectations in mathematics?
- How are map references, compass bearings and estimates of distances travelled developed in planning and carrying out outdoor activities? Are these in line with the mathematics yearly teaching programmes?
- In what ways do pupils gather and use performance data:
  - in general fitness work?
  - in specialised work such as athletic activities?

  How does this work support the handling data strand of mathematics? How can mathematics be used to support pupils' interpretations of performance data?
- How are differences in readings from manual and electronic data-logging equipment discussed? Is reference made to statistical terms such as the mean, mode and median that might be appropriate for measuring performance in a range of physical activities?
- How do pupils use problem solving, communication and reasoning in physical activities?

There are references to the key skill of application of number on page 17 of the teacher's guide to the QCA schemes of work for physical education.

There are references to mathematics in the National Curriculum Key Stage 3 programme of study for physical education.

Handout 3.10

PSHE, religious education, citizenship and mathematics

- When discussing numbers (for example, in populations), time differences, fractions, percentages and proportions, does teaching build upon the expectations set out in the number strand of the yearly teaching programmes for mathematics?
- Are methods used in calculations compatible with those advocated in the Framework for teaching mathematics?
- How much work involves handling and interpreting data as a means of enabling pupils to become better informed citizens? Which elements of the handling data cycle – state problem, identify and collect data, analyse and represent data, interpret results – are used most? Do you use ICT in this work?
- Does teaching employ a range of graphs and charts in line with expectations in the mathematics yearly teaching programmes? (It is worth looking at the examples of statistics from these subjects included in the Framework.)
- Are there opportunities to make links with mathematical work on maps, scales and distances? Compare the timing of such work with the objectives in the yearly teaching programmes for mathematics.
- Are pupils introduced to mathematics from other cultures?
- Do we use pupils' mathematical knowledge and skills when we explore the ideas of probability, risk and chance?
- Is correct mathematical vocabulary used where appropriate?
- When exploring evidence, are pupils given opportunities to develop their competence in problem solving, communicating and reasoning?

There is reference to numeracy on page 12 of the teacher's guide to the QCA schemes of work for RE, and references to surveys in some of the modules.

Handout 3.11

Science and mathematics

- What aspects of handling data are developed during science lessons? How are ICT devices used in this work (for example, sensors, spreadsheets, computer graph packages, calculators, graphical calculators)? How does this work enhance pupils' mathematical development?
- Have we agreed with the mathematics department when and how to introduce pupils to continuous data, as distinct from discrete data?
- How does science help develop pupils' understanding of numbers in context, particularly large numbers, fractions and decimals, indices, ratios and proportions, and the relationships between different metric units?
- To what extent does science teaching support the methods and approaches relating to aspects of calculation that are developed through the mathematics yearly teaching programmes?
- Does the teaching and interpretation of formulae and graphs support the expectations in mathematics? What use is made of different forms of graphs in science? Have we agreed with mathematics how graphs should be labelled and presented? Does the progression in graphical work in science support its development in mathematics? How is ICT used (graph plotters, graphical calculators) to support this work?
- To what extent is the approach to the manipulation of algebraic expressions and solution of equations in the Framework for teaching mathematics compatible with the needs of science?
- How does work in science link with using and applying mathematics in our school?

You may find it useful to refer to page 12 of the teacher's guide for the QCA schemes of work for science and to the paragraph on page 13 on application of number. Several of the units make specific use of mathematical skills and understanding.

Handout 3.12

Special educational needs and mathematics

- How do you ensure that pupils have access to their full entitlement to the programmes of study for mathematics?
- Are all members of the SEN department familiar with teaching approaches advocated in the Framework for teaching mathematics, for example the approach to calculation?
- What simplifications/modifications are made for pupils with specific difficulties?
- How does the department use visual and other resources to give pupils access to mathematical thinking?
- How does the department employ real life contexts and problem solving to enable pupils described as having special educational needs to make sense of mathematics?
- How many pupils have been assessed as having difficulties in mathematics? How many have statements relating to mathematics? How does that compare to English?
- Is there sufficient expertise within the department to meet these mathematical needs? If not, where are the gaps in teachers' knowledge of how to address these difficulties? For example, are teachers aware of the progression from mental to written calculations?
- Are teaching assistants aware of supporting resources, such as number lines, hundred squares, place-value charts, vocabulary checklists?
- Have you considered pre-tutoring pupils who are experiencing difficulties so that they can participate in the lesson with their peers and with a little more confidence?
- What are the timetabling implications of providing extra help in mathematics?