Guidance

Curriculum, Examination and Assessment

Key Stage 3

National Strategy

Access and engagement in science

Teaching pupils for whom English is an additional language

Heads of science and EMA teachers

Status: Recommended

Date of issue: 11/02

Ref: DfES 0610/2002

department for
education and skills
creating opportunity, releasing potential, achieving excellence

Introduction

The Key Stage 3 National Strategy is based on four important principles:

- **Expectations**: establishing high expectations for all pupils and setting challenging targets for them to achieve;
- **Progression**: strengthening the transition from Key Stage 2 to Key Stage 3 and ensuring progression in teaching and learning across Key Stage 3;
- **Engagement**: promoting approaches to teaching and learning that engage and motivate pupils and demand their active participation;
- **Transformation**: strengthening teaching and learning through a programme of professional development and practical support.

This guidance focuses on how these principles apply to the teaching and learning of science for pupils for whom English is an additional language (known as 'pupils learning EAL'). It suggests some strategies to help teach pupils at different points of learning English. The guidance shows the importance of supporting pupils in their development of the academic language alongside their learning in science.

The Strategy has high expectations for **all** pupils, and the inclusion of pupils learning EAL is a fundamental principle. This is highlighted in the *Framework for teaching science: Years 7, 8 and 9* (page 55).

> *It is all too easy to underestimate what pupils learning EAL can achieve in science, simply because they are new learners of the English language. The expectations should be that they progress in their scientific learning at the same rate as other pupils of their age.*

The Ofsted report *Managing support for the attainment of pupils from minority ethnic groups* (October 2001) identifies factors that enable bilingual learners to develop their English successfully:

- joint planning between mainstream and specialist ethnic minority achievement (EMA) staff;
- a focus on the content of the lesson, ensuring appropriate cognitive challenge;
- a parallel focus on the language necessary to complete the task;
- activities that enable pupils to rehearse and explore the language they need;
- opportunities to use and build on their first-language skills, where appropriate;
- continuing support with writing through, for example, the use of matrices for organising information and writing frames for more extended contributions.

The report draws attention to the 'considerable evidence that once proficiency in English was achieved, the progress for pupils with EAL across the curriculum was rapid and their attainment on a par with or higher than that of their monolingual peers'.

The report also recognises that the acquisition of academic language can take considerably longer to develop than social language. It is important for science teachers to recognise that the academic language used in science lessons is more advanced than the social language and seek to address these differences in their teaching. Teachers of science often use the term 'scientific literacy' in a variety of ways. In this guidance it refers to the academic language used in science lessons.

Securing progress for pupils learning English as an additional language: the role of the subject leader

Success for pupils learning EAL depends on close monitoring of their academic and personal targets. Meeting their needs should be an integral part of a department development plan. The Key Stage 3 Strategy booklet *Securing improvement: the role of subject leaders* identifies three core roles for subject leaders in securing the progress of pupils. These are:

- judging standards;
- evaluating teaching and learning; and
- leading sustainable improvement.

Part of the role of a head of science is to ensure that there is an effective learning environment across the department – one which promotes an ethos where pupils learning EAL feel secure in their learning and know that their contributions are respected.

These roles are further exemplified in the management training materials related to pupils learning EAL entitled *Unlocking potential: raising ethnic minority attainment at Key Stage 3* (ref: DfES 0579/2002).

About this guidance

This guidance is for teachers of science, heads of science and EMA teachers in secondary schools. It is intended to help teachers support pupils learning EAL in the classroom in order to raise their attainment in science. It provides examples of engaging teaching methods to support pupils learning EAL who already have a good working knowledge of English but do not make the progress expected in science at Key Stage 3.

The guidance has four sections:

Acknowledgements

In this booklet EMA advisers, EMA teachers and science teachers describe how they have supported pupils learning EAL in science.

We would particularly like to thank:

Manny Vazquesz	Hounslow Language Service
Matthew Newbury	Camms Hill School, Hampshire
Jenny Lane	Challney Community College, Luton
Jane Smith	Oaklands Community School, Southampton

References

Framework for teaching science: Years 7, 8 and 9 (ref: DfES 0136/2002) www.standards.dfes.gov.uk/keystage3

Managing support for the attainment of pupils from minority ethnic groups (Ofsted 2001; ref: HMI 326) www.ofsted.gov.uk

Misconceptions in Key Stage 3 science (ref: DfES 0287/2002)

Progress in Key Stage 3 science (Ofsted, March 2000; ref: HMI 221) www.ofsted.gov.uk

Secondary subject report 2000/01 (Ofsted ref: HMI 371) www.ofsted.gov.uk

Securing improvement: the role of subject leaders (ref: DfES 0102/2002) www.standards.dfes.gov.uk/keystage3

Unlocking potential: raising ethnic minority attainment at Key Stage 3 (ref: DfES 0579/2002) www.standards.dfes.gov.uk/keystage 3

1 Pupils learning English: some considerations

Pupils for whom English is an additional language are not a homogenous group. Extra planning and support may be required to take their specific learning needs into account. Pupils in science classes will vary in the length of time and their experience in learning English.

In your school, pupils learning EAL may be in science classes where:

- the majority of pupils share a common home language and cultural identity other than English – this is common in many inner-city schools;
- there are just one or two other pupils with a shared home language in common in the class;
- they are the only pupil learning EAL in the class or a speaker of a language not represented elsewhere in the school – an 'isolated learner'.

The rate at which individual pupils learning EAL make progress in science lessons is likely to be determined by their literacy and schooling in their first language and their prior experiences of learning.

Science teachers may be allocated some additional support for pupils learning EAL in their classes. The provision and frequency of staffing support will vary from school to school. Some possible ways of using the support effectively are listed below.

- **Joint planning**: where two teachers work together to prepare the lesson and support materials. In some instances this would lead to shared teaching between the EMA staff and the science teacher.
- **Joint teaching**: where the science teacher and the EMA staff can alternate in the roles of leading whole-class sessions or supporting group activities, pairs or individual pupils within lessons.
- **Mediation**: EMA and other support staff acting as mediators between teacher and pupils to ensure that pupils learning EAL access the learning. They can do this by:
  - offering alternative explanations;
  - assigning appropriate work to pupils;
  - intervening where necessary.
- **Managing other adult support**: other support staff and additional adults may also support planning, prepare resources or use appropriate intervention strategies jointly with the science teacher.
- **Contribution to the collection of assessment evidence**: EMA and support staff can give feedback on the progress of pupils learning EAL and may provide valuable evidence in assessing the pupils' future learning needs.

***discussion** points*

Pupils learning English: some considerations

- *A school's population can change over time. Which of the descriptions above most closely fits the situation in your school? How close a description is it? Is it the same in all classes across Years 7, 8 and 9?*
- *What additional support is available to your department in Key Stage 3? How is this allocated?*
- *Is the departmental grouping policy flexible to meet the changing needs of pupils?*

2 Developing pupils' visualisation skills in science

One of the most important aspects of learning science in Key Stage 3 is for pupils to be able to use and apply the key scientific ideas using precise language and conventions to explain a range of phenomena and events. These key scientific ideas are abstract in nature and scientists often use models and analogies to help in their understanding. Pupils learning EAL need proficiency in using the complex conventions and language of science in order to progress in their:

- visualisation of the key scientific ideas by using models and analogies;
- use of the key scientific ideas when making predictions, interpreting evidence, drawing conclusions;
- application of the key scientific ideas, within a range of scientific enquiries.

The Framework for teaching science identifies the importance of models and analogies in developing pupils' understanding of the key scientific ideas. The Ofsted report *Progress in Key Stage 3 science* (March 2000) states that where pupils make good progress:

- models are used as an effective teaching tool;
- a strength of the teaching is the way in which models and analogies are used to represent and illustrate abstract ideas;
- the most effective teachers are aware of the limitations and strengths in common models and analogies and pupils are encouraged to analyse them critically;
- effective teachers encourage pupils to make up their own models.

For pupils learning EAL the use of models is a powerful tool in learning science. Models can provide concrete representation of abstract ideas and complex relationships. These concrete representations are vital in helping pupils learning EAL to unlock their potential in science alongside their development of scientific literacy.

In science the term ‘model’ is used in a variety of different ways. Clarity about what is meant by a model in the teaching of science will help to identify the support required for pupils learning EAL.

- **Scientific models** are generally accepted views of a scientific idea such as rays of light, the notion of energy and the cell as a basic building block of life.
- **Teaching models** are generally:
  - **physical models**, which represent objects and processes that are either too small or too large, or abstract ideas – examples include the solar system, digestion process and particle arrangement;
  - **analogies**, such as the use of traffic-flow systems to represent an electric circuit;
  - **visual diagrams**, which represent objects, processes and abstract ideas such as cells, food webs and respiration in two dimensions;
  - **flow charts**, which summarise key points from scientific text;
  - **graphs, tables, charts and mathematical formulae**, which show how variables such as speed, distance and time are related.

Page 15 of the *Framework for teaching science: Years 7, 8 and 9* focuses on scientific models and the way they are illustrated to pupils through physical models and analogies. The use of models and analogies to teach the key scientific ideas is further exemplified in the training unit *Misconceptions in Key Stage 3 science*.

When teachers use models and analogies to help explain abstract ideas in science to pupils learning EAL, some basic principles are important to follow:

- **The purpose of the models and analogies must be made clear to pupils**. For example, pupils learning EAL need to be taught why scientists construct scientific models before they start to develop their understanding of the key scientific ideas.
- **The model or analogy must be relevant to individual pupils learning EAL**. For example, the use of the traffic-flow system might be appropriate when teaching about electricity for pupils who live in cities and towns, but pupils who come from very rural areas may require a more relevant model, such as the transportation of water.
- **The model or analogy should be matched to pupils’ ability and maturity**. For example, the model of particles being all the same is good enough to explain changes in state, but needs modifying to explain density and dissolving.
- **Pupils learning EAL should be taught the scope and limitations of models and analogies**. Pupils need to be aware that models and analogies provide pictures that are ‘good enough’ to help them understand many complex ideas. For example, the idea that light travels in straight lines is ‘good enough’ to explain reflection and refraction but not other phenomena they may observe in everyday life, such as diffraction.

When pupils learning EAL become actively engaged in using models and analogies in science and are communicating their ideas confidently using scientific terminology, they can be encouraged to discuss and debate the strengths and weaknesses of models and analogies. Their ideas can be extended further to develop their own models and analogies. This is an important stage in developing their understanding in science.

Case study

Teaching pupils to construct their own models

Teachers at Camms Hill School, Hampshire, devised this sequence of lessons explaining absorption in cell membranes for classes in Year 9, which included an isolated pupil learning EAL from Europe.

Reason for developing this approach

The main purpose for developing this approach was to extend all pupils' visualisation of challenging concepts by considering the strengths and limitations of different models. In debating and challenging each other's models, pupils were encouraged to use scientific terminology to explain their ideas. By evaluating their own models to explain absorption all pupils – including an isolated pupil learning EAL – were able to gain a better understanding of the complexities of cell membranes.

Methodology

Lesson 1

After covering the basic structure of the digestive system, pupils were introduced to the concept of digestion and the role of enzymes in breaking down large insoluble substrate molecules into smaller soluble ones.

The teacher demonstrated the tests for starch and reducing sugars. They used a slice of bread mashed up in a beaker of water and then added amylase. It is important not to start with the starch solution as pupils learning EAL may find it difficult to relate this to the digestion of a meal – in this case the bread.

Lesson 2

Pupils were introduced to Visking tubing to represent a semipermeable cell membrane, which has many microscopic holes in it. This enables it to work similarly to a sieve, which was demonstrated by the teacher. The isolated pupil learning EAL worked on an enquiry with other pupils (who can provide good role-models of science and spoken English) to explain how the intestine works (model gut) using the Visking tubing. Physical models of particles were used to help pupils visualise how smaller particles diffuse through the 'gaps' in the membranes of the small intestines, whereas larger ones cannot.

Lesson 3

Pupils were encouraged to consider the physical models of particles again to explain the model gut. They were asked to consider: 'Why can't our intestines really have tiny little holes in the cell membranes? … What is wrong with our particle model?'

From discussions in groups, the pupils came up with the following problems:

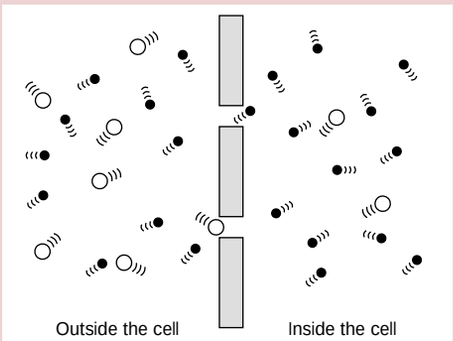
- Small holes would let any small molecule in.
- What would stop small molecules leaking out of the intestine cells?
- If amino acids are bigger than sugar, wouldn't they need bigger holes? If so, could some of the shorter chain insoluble starch get through?
- Wouldn't you just bleed to death if you had holes in your intestine?

Pupils were then encouraged to think of better models to explain how particles of sugar are able to be absorbed through cell membranes and to present these to the class and discuss their relative strengths and limitations. The models the pupils devised are illustrated overleaf.

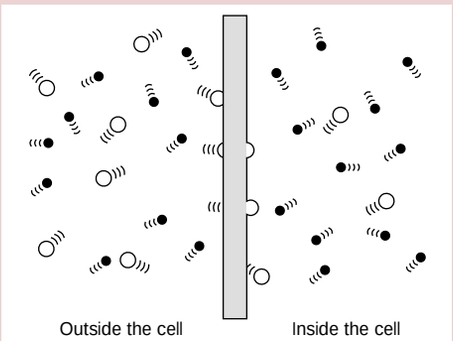
classroom *examples*

Examples of pupils' models

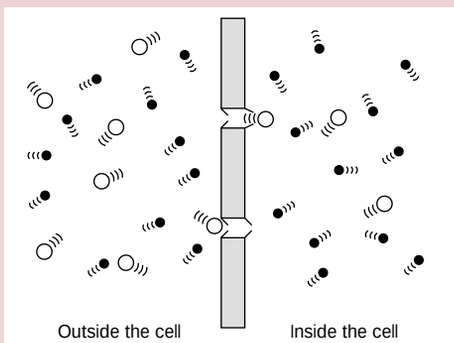
How do dissolved substances get through a selectively permeable cell membrane?



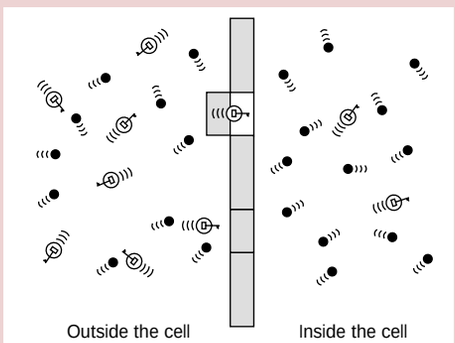
The Sieve model



The Terminator (T2) model
dissolving through the membrane



The One Way Valve model



The Door model

By the end of the series of lessons the pupils (including the isolated pupil learning EAL):

- started to appreciate that models are scientists' way of trying to explain difficult phenomena;
- were challenged to think and use the correct scientific vocabulary to explain their own models and evaluate each other's;
- gained a deeper understanding about the complexities of cell membranes and absorption.

discussion *points*

Constructing models and analogies

- *When and how do you explain to pupils learning EAL the reason why scientists construct models?*
- *Are pupils learning EAL encouraged to develop their scientific language through the construction and use of physical models?*
- *Are pupils learning EAL encouraged to use flow diagrams to model scientific processes, such as photosynthesis, respiration and changes to rocks?*
- *Are analogies which are planned into the teaching programme appropriate to pupils learning EAL, for example energy transfer and electricity?*
- *Are pupils learning EAL encouraged to construct their own models and analogies?*
- *Which strategies have you identified as in need of development, bearing in mind the particular needs of your pupils?*

3 Improving scientific literacy

Although science is often regarded as a practical subject, the progress of pupils learning EAL depends on their ability to explain their observations and findings. They should be encouraged to make reference to the models of the key scientific ideas using precise scientific language.

The Ofsted secondary subject report 2000/01 identified that science departments are giving language increased attention. The report includes some useful pointers to support teaching and learning in science departments. These are:

- reinforcement of meaning and the use of terminology by pupils in context;
- a reduction in routine written descriptions of practical activity and more writing about pupils' own understanding and interpretation of information;
- extending writing for other purposes such as 'ideas and evidence';
- reading about science issues as well as reading for information.

Scientific terminology

In science in Key Stage 3, pupils learning EAL will be expected to use scientific terms precisely when they speak and in their writing. To support pupils learning EAL it should be recognised that:

- Many words used in science have 'everyday' meanings, such as *tissue*, *cell* and *force.*
- Some words are easy to read but difficult to understand, such as *particles*, *energy* and *atom.*
- Misspellings cause problems as scientific terminology is often based on patterns or word roots. For example, '*photosinthesus*' misses an understanding of the word root *'syn'* so pupils are unable to connect the word with the notion of building or putting together, as in *synthesis*. '*Hydraulic acid'* is a common mistake because pupils have not been taught that the *chlorine atom* is present.
- Any time a model is used to enhance pupils' visualisation of key scientific ideas, there is opportunity to exemplify, generate and make explicit new scientific language.

Many departments provide word lists when tackling a new topic in Key Stage 3. Sometimes there are too many words and on their own these words are not enough to underpin pupils' understanding. Scientific words have to be introduced carefully and used regularly. One way to reduce the list is to use a taxonomy of words in three categories:

1. Naming words: *cell*, *cytoplasm*, *hydrogen*
2. Process words: *diffusion*, *digestion*, *reflection*
3. Concept words: *electromagnetism*, *energy*, *particles*

To make category word lists easier to use for pupils learning EAL:

- ☐ list the words in alphabetical order;
- ☐ identify the words that may be difficult;
- ☐ employ strategies during lessons to develop understanding of the words.

Case study

Dealing with new scientific words and their meanings

When studying the unit 'environment and feeding relationships', pupils learning EAL from Challney Community College, Luton, are provided with word lists, which indicate pronunciation and meaning associated with each aspect of the topic in alphabetical order. The pupils are encouraged to add to these. An example is provided below on 'food chains and webs'.

Words	Pronunciation	Meaning
carnivore	carn-ni-vor	An animal that only eats animals
consumer	con-su-mer	An animal that eats animals and plants to stay alive
energy	en-er-gee	Something that is transferred so that animals and plants can stay alive
food chain		A way of showing what eats what in a habitat
food web		Many food chains linked together
herbivore	herb-bee-vor	An animal that only eats plants
omnivore	om-nee-vor	An animal that eats both plants and animals
prey	pray	An animal that is caught and eaten by other animals
predator	pred-a-tor	An animal that catches and eats other animals
primary consumer	pry-mar-ee …	The first animal in the food chain
producer	prod-you-ser	Plants that make their own food
pyramid of numbers	pir-a-mid …	Ways of showing the number of plants and animals in a food chain
secondary consumer	seck-on-dree …	The second animal in the food chain
tertiary consumer	tersh-a-ry …	The third animal in the food chain
top predator		The last animal in the food chain

At the end of the unit 'environment and feeding relationships' including the aspect 'food chains and webs' the topic's words, together with their pronunciation, form part of a loop card game. This helps pupils learning EAL to reinforce scientific words and meanings for the unit.

Case study

Breaking words down, spelling rules and word roots

Manny Vasquez, of the Hounslow language service, describes how pupils learning EAL were helped to improve their spelling of scientific terminology.

Science teachers and EMA staff planned for pupils to use personalised dictionaries in their science lessons. These personalised dictionaries were in three sections:

1. Words and definitions
2. Word roots
3. Grouping words

As part of their introduction to science in Year 7, all pupils are provided with some examples in each section and taught how to use the personalised dictionaries. The personalised dictionaries are collected monthly and reviewed by teachers.

Section 1 *Words and definitions*
Pupils are encouraged to record scientific words and their definitions in alphabetical order. On occasions EMA staff provide support.

Section 2 *Word roots*
This is a brief feature of most lessons. Words are listed as roots and meanings, recorded by the pupils but exemplified by the teacher. Teachers explain the Greek and Latin roots of both prefix and suffix. For example:

Root	Meaning
chlor-	green
poly-	many
therm-	heat
hydro-	water
photo-	light
electro-	electricity
-lys	breakdown
-ose	carbohydrate

Section 3 *Grouping words*
Pupils are encouraged to look for patterns from roots and record them; for example, *electro-* (from the Greek *elektron* taken to mean electricity) as in *electric*, *electron*, *electrolysis*, *electrode*, *electrotherapy* etc. Meanings of words can then be discussed:

electro - lys - is meaning: electricity breakdown.

Periodically pupils are asked to share their examples with the rest of the class.

A spelling game focusing on scientific terminology increased the pupils' confidence and contributed to their progress.

The EMA teacher recognised that pupils learning EAL benefited most from section 2, 'Word roots'. This is because:

- it gave pupils an insight into word-building in English;
- the roots occur in other subject areas;
- it explicitly focuses on and reinforces some parts of words which will be more familiar to first-language speakers of English.

Strategies to support pupils learning EAL to develop their scientific terminology based on the teaching of word roots and patterns will secure foundations for these pupils to express their scientific explanations with increased clarity. Examples of these can also be found in the spelling module of *Literacy across the curriculum*.

classroom *example*

Exemplifying patterns in elements and compounds

Through the teaching of ideas and evidence in science pupils use historical examples to provide scientific explanations. To make explanations related to Sc3, 'Materials and their properties', pupils learning EAL are introduced to the work of Antoine Lavoisier who provided the basis for the patterns for naming elements and compounds.

- Metals identified after the work of Lavoisier end in **-ium** (e.g. alumin**ium**, calc**ium**, magnes**ium**).
- When an acid whose name ends in **-ic** (e.g. sulphur**ic** acid) reacts with a metal, this leads to the formation of salts with an ending of **-ate** (e.g. magnesium sulph**ate**, aluminium sulph**ate**).
- Other acids ending in **-ic** (e.g. hydrochlor**ic** acid) also react with metals and lead to the formation of salts ending in **-ide** (e.g. magnesium chlor**ide**, calcium chlor**ide**).

discussion *points*

Scientific terminology

Consider the case studies on pages 10 and 11 and the strategies outlined on page 13.

- *What strategies do you currently use to develop the use of scientific terminology by pupils learning EAL?*
- *Which strategies do you need to develop further?*
- *What strategies do you use to share with science staff the words and expressions that pupils learning EAL are likely to find more challenging?*

An outline of strategies to support pupils learning EAL

Type of difficulty	Examples	Teaching strategy
The word has a different meaning in everyday English	Tissue, cell, consumer, producer, energy, power, moment, trial	Ask the pupil learning EAL to make up two different sentences, each representing the word with different meaning. *The cell is connected in the circuit.* *The prisoner is locked in his cell.* For homework pupils can be set a challenge*:* *In this text there are several science words that have different meanings in everyday English.* *How many can you find?*
Similar word related to the same area of science	In topic 7H, Solutions, the words and phrases related to dissolving are solution, solute, solvent, soluble insoluble, saturated solution, solubility	Ask the pupils to devise a learning map as part of a plenary to link all the words connected with dissolving.
More formal but common vocabulary particularly related to scientific enquiry that may not be part of their everyday English	Reliable, validity, sufficient, insufficient, accuracy, variable, anomalous results, sampling, proportional	Provide the pupil learning EAL with the meaning of the words and some examples of sentences with the words or phrases underlined: *There are two anomalous/different results that do not fit the same pattern as the other measurements.* (Year 9) Highlight the use of these words during scientific enquiries.
Using connectives or link words to express explanations (this should be rehearsed orally first to help fluency)	So that, although, if, since, because, however	At the end of a practical session pupils learning EAL are asked to discuss and note their conclusions using selected link words. When the metal bar was heated it expanded **because** … **Since** there are fewer robins in the food pyramid the number of sparrow hawks will decrease **because** there is less to eat. **However**, the number of caterpillars will increase **because** there are not enough robins to eat them.
Back-referencing pronouns and determiners	It … they … these …	During science reading sessions the teacher should pause at the end of a paragraph and ask pupils to trace back what 'it' is referring to. Mark and link pronouns with their nouns and invite pupils to try other examples for themselves. ***Metals** are good conductors. **They** let …* ***Hydrogen** is produced when a metal reacts with an acid. **It** can be tested by …*

Writing

On average pupils spend about a third of their time writing in science. It is therefore important to make sure that what pupils are asked to write helps them progress in science.

Types of writing in science	Possible purposes
Answers to questions	To check understanding
Plan for an enquiry	To learn how to make decisions about how to collect evidence that is valid and reliable To learn how to set out a procedure To assess planning skills
Record of observations or measurements	To learn how to assemble evidence in such a way that it can be interpreted easily To assess recording skills
Conclusion to an experiment	To learn how to analyse evidence, construct arguments and develop reasoning skills To assess understanding
Evaluation of an enquiry	To learn how to evaluate procedures To check procedural understanding, e.g. the need for the reliability and precision of measurements
Note taking	As an aid for revision and to help synthesise ideas To organise thinking To clarify ideas in order to write more precisely sometime later
Explanation	To help pupils make links between ideas and apply their understanding To probe understanding and reveal misconceptions To help pupils explain their thinking, ensuring they can distinguish between the **how** explanations (describing how something works or how something happens) and the **why** explanations (giving scientific reasons why something happens)
Argument	To analyse and present conflicting views To develop the skills of considering evidence To engage pupils To allow pupils to demonstrate achievement To capture creative thought
Writing up enquiries	To show how scientists report findings To assess pupils' application of the key scientific ideas
Recording information	To assess understanding To summarise the key points

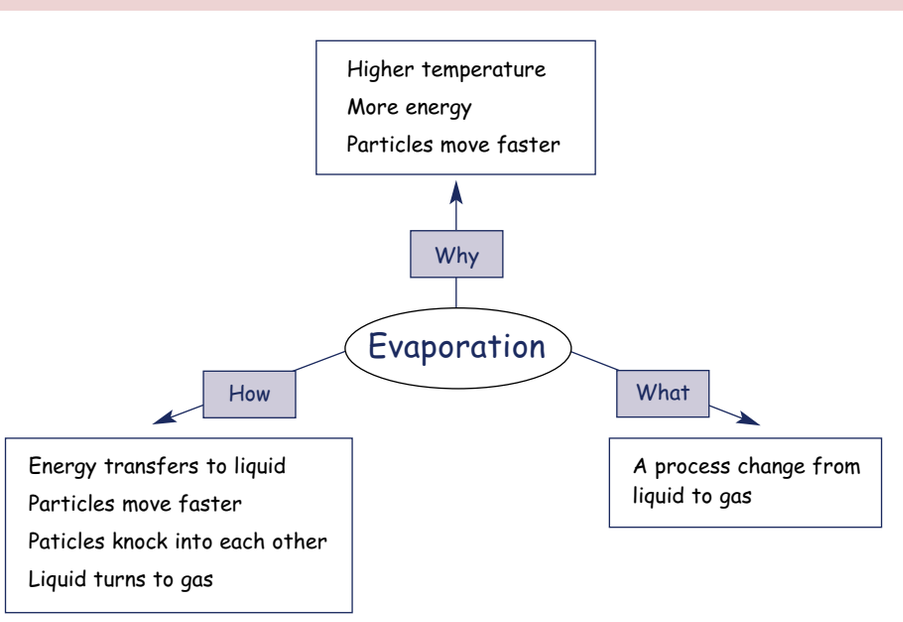
For writing to support the learning of pupils learning EAL it is important that:

- The writing supports the objective of the lesson.
- The purpose of the writing is clear. Pupils learning EAL need to know why writing is important in helping them learn science.
- Pupils are clear about the characteristics of the writing expected. Pupils need to be taught how to structure a conclusion and how to frame an argument when considering ideas and evidence. Sharing good examples of these with the class or group clarifies what is expected of pupils.
- Pupils are provided with opportunities to write for different audiences and purposes; writing up experiments and answering questions can often be demotivating for pupils.
- Writing in different forms helps pupils organise their thinking. For example:
  - In Year 7, pupils learning EAL should be taught how to structure simple sentences when explaining evaporation. First they have to structure their thinking, perhaps by using a mind map (see the example below).
  - In Year 9, pupils learning EAL should be taught to structure text to clarify pros and cons. For example: they might consider Pasteur injecting a live rabies vaccine into a young boy.

classroom *example*

Using mind maps

Pupils learning EAL could use a mind map to organise the thinking of before writing. The three important words are *what*, *how* and *why*.



discussion *points*

Writing

What methods do you use to help pupils structure:

- *simple explanatory sentences;*
- *complex text when presenting conflicting views?*

Consider how you might disseminate the different methods teachers use to support pupils learning EAL to structure sentences across the department.

Reading

Although pupils are expected to obtain information from science textbooks and the Internet, less than 10% of Key Stage 3 science lessons are spent on active reading tasks. In addition, science textbooks are known to be some of the most difficult for pupils to read and understand. Often reading tasks are left for homework with some of the most difficult techniques for pupils learning EAL to master without teacher support. Although many pupils learning EAL are fluent in reading texts, they still require support in extracting meaning and obtaining information from science texts.

Reading about science therefore has an important part to play in pupils' progress and engagement in lessons.

Using DARTs

'Directed activities related to text types' (DARTs) are useful tools for science teachers to help pupils learning EAL engage with a variety of texts. DARTs must always be interactive and oral: they should **not** be designed as worksheet tasks. There are two main types:

- **Reconstruction activities**. These use text modified by the teacher which pupils learning EAL complete in some way and transfer to another form.
- **Analysis activities**. These involve pupils categorising information in the text by marking and labelling. They are more challenging for pupils learning EAL but once mastered can underpin pupils' independent study and revision techniques.

When using these extended active reading tasks pupils learning EAL must be offered the opportunity to rework their ideas in their own words and sentences. This provides an opportunity for them to think about their ideas and express them using scientific language.

The table opposite summarises some of the activities possible.

A summary of the range of reconstruction and analysis activities

Reconstruction activities	Analysis activities
These use modified text. Pupil tasks: completion activities with deleted or segmented text. **1 Text completion** Pupils predict deleted words (cloze), sentences or phrases. **2 Diagram completion** Pupils predict deleted labels on diagrams using text and other diagrams as sources. **3 Table completion** Pupils complete deleted parts using table categories and text as sources of reference. **4 Completion activities with disordered text** **a** Pupils predict logical order for sequence. **b** Pupils classify segments according to categories given by the teacher. **5 Prediction** Pupils predict next part(s) of text with segments presented in sequence.	These use straight text. Pupil tasks: text marking and labelling or recording. **1 Underlining** Pupils search for specific target words or phrases that relate to *one* aspect of content and write a brief summary. **2 Labelling** Pupils label segments of text, which deal with different aspects, e.g. labelling a scientific account with labels provided by the teacher such as *prediction, evidence, conclusion.* **3 Segmenting** Segmenting of paragraphs or text into information such as *identifying steps in a chemical process.* **4 Diagrammatic representation** Pupils construct diagrams from models and text using flow diagrams, labelled models, concept maps and other learning maps. **5 Tabular representation** Pupils construct and represent information in tabular form, extracting it from a written text.

This summary is adapted from *Reading for learning in the sciences* by Davies and Greene. (Although first published in 1984, by Oliver and Boyd, this book remains a good reference.)

Active reading tasks as summarised above are more effective than attempting to simplify the reading. Pupils learning EAL need to develop strategies to read challenging science texts, including journals and articles. For success, a great deal of practice is required rather than reducing the difficulty of the reading.

***discussion** points*

Reading

- *How much time do you allow pupils learning EAL to read in science?*
- *Do you provide opportunities for analysis of text to promote more independent study for pupils learning EAL?*
- *Identify which suggestions listed above could be developed further in your teaching.*

Talk in science

The use of talk in science is a very important aspect of teaching and learning. It provides opportunities for pupils to describe, explain and justify their understanding of the key scientific ideas, and to use precise scientific vocabulary. However, talk in science does not occur spontaneously but requires careful planning and appropriate interactive skills on the part of the teacher. The following are examples where talk can be promoted with pupils learning EAL.

Listening to the teacher

In science lessons a significant amount of time is spent listening to the teacher. This assumes incorrectly that pupils learning EAL can follow lengthy instructions, explanations and summaries from the teacher, which often use scientific vocabulary and conventions. For pupils learning EAL, active listening techniques have been shown to improve understanding when teachers introduce and summarise the lesson. For example, during a plenary pupils learning EAL can be asked to use a different connective following on from a teacher's statement:

> *'The bulb lights up **because** energy is transferred from the cells'.*

A pupil might say:

> *'**If** energy is provided from the cells the bulbs will light up'*

Class discussions

Most class discussions occur at the beginning and end of lessons and tend to be managed by the teacher. To increase the active engagement of pupils learning EAL during starter and plenary sessions, the following points should be considered:

- Make whole-class discussions purposeful, brisk and no longer than 5–10 minutes.
- Provide pupils learning EAL with scientific vocabulary before the discussion and support them in using it.
- Ensure there is a good balance of speaking and listening from individual pupils learning EAL or groups.
- Encourage pupils learning EAL to talk about the key scientific ideas with reference to a model or an analogy.
- Provide opportunities for pupils learning EAL to report back their ideas to the rest of the class.

Group discussions

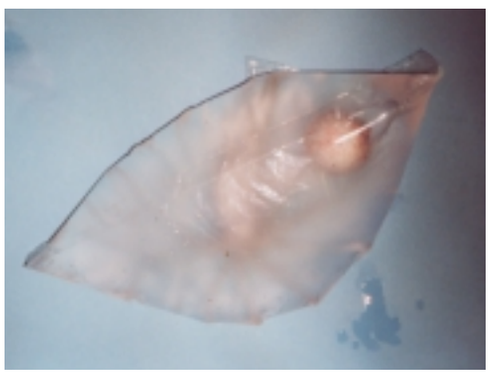
Many science lessons provide opportunities for pupils to talk during the main part of the lesson. Often these discussions take place between pupils during practical sessions. These are to help confirm the instructions and exemplify what they are doing. Many pupils learning EAL spend less of their time using and applying the scientific ideas to explain their observations and findings. Additional prompts or scaffolding during lessons can help pupils learning EAL to structure their thinking and make their discussion purposeful. Care however needs to be taken to gradually remove prompts or scaffolding as pupils learning EAL gain confidence in discussing and debating their own ideas.

Case study

Supporting pupils learning EAL in contributing to group discussions and debates

Jane Smith, Oaklands School, Southampton, devised the following for a class in Year 7 with a relatively low number of pupils learning EAL in the class.

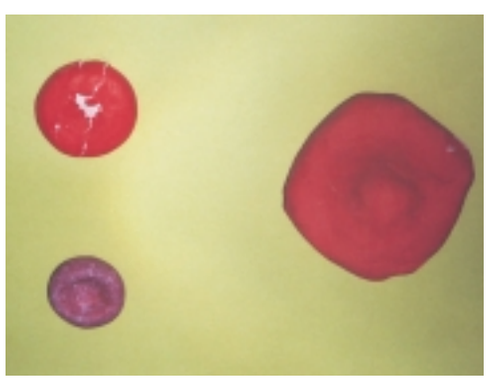
Pupils were asked to build models of animal and plant cells.



Model of an animal cell

Model of a plant cell

Following discussions pupils were asked to research (using information provided by the teacher) and build for homework a specialist cell of their choice.



Model of blood

Model of sperm

Model of xylem

During the following lesson pupils were asked to work in groups of six to discuss, debate and evaluate each other's specialist cell. Pupils learning EAL were placed in groups where they were provided with good role models in English and science. All pupils were expected to make a contribution to the discussions. To promote the discussions pupils were provided with a scientific description of specialised cells and additional adults intervened appropriately. At the end of the lesson all pupils were asked to join with another group and make mini-presentations of their findings. All pupils, including those learning EAL, were expected to be part of the team presentations. These types of activity help increase pupils' confidence in thinking about and using the language associated with cells and scientific enquiry (evaluation) techniques.

discussion *points*

Talk in science

- *How long do your pupils spend listening to teachers in science lessons?*
- *What strategies have you tried to promote active listening skills?*
- *Which of the group discussion techniques promoted by* Literacy across the curriculum *have you tried with pupils learning EAL? These could include paired talk, pairs to fours, snowballs, envoys, listening triads, rainbow groups, jigsaw and spokesperson.*

4 Supporting teaching and learning in science

This section summarises suggestions for making sure that teaching supports pupils learning EAL.

Before the lesson

- Whenever possible, plan jointly with EMA staff.
- Plan for opportunities for pupils learning EAL to talk with and listen to their peers or the teacher to help develop their understanding of the key scientific ideas in science.
- Plan the use of adult and pupil models of spoken English.
- Prepare questions so that there is a balance of open and closed questions.
- Plan which pupils will be targeted with particular questions.
- Provide physical models and other learning aids to support pupils' visualisation of the key scientific ideas.
- Identify the science vocabulary related to the unit of work that is being planned.
- Display the scientific vocabulary, appropriately categorised to match the topic and lesson objectives.
- Review previously used vocabulary and new vocabulary in relevant contexts.
- Provide clear explanations of the meaning of scientific vocabulary but do not simplify the science. For example, provide a glossary to paste into books at the start of a unit of work.

During starter activities

- Sit pupils learning EAL with a ‘buddy’ so that they can receive support from a partner if required.
- Ask pupils to discuss something with a partner; encourage them to practise responses in pairs, using home or first languages where appropriate. Allow pupils time to rehearse any feedback to another pupil or an adult assistant.

- Encourage pupils learning EAL to join in the range of starters provided, either by responding to questions or providing feedback from their group.
- Build in time for pupils learning EAL to think before responding.
- Be explicit about using scientific vocabulary and ensure that pupils also use the scientific language exemplified by the teacher.
- Explain the meanings of new words carefully and rehearse them several times; encourage their use in context during discussion sessions.
- Use quick word games to reinforce key vocabulary.

During main teaching activities

- Organise the class to provide time with pupils learning EAL to probe their understanding and monitor their progress.
- Check that pupils learning EAL understand safety procedures before starting any practical activity.
- When assigned to the lesson, ensure the EMA teacher or teaching assistant effectively supports pupils learning EAL.
- Ensure pupils learning EAL have the opportunity to work collaboratively in a range of groups and paired contexts:
  - with a pupil who shares the same first language when that is possible;
  - with pupils who are good role models for science as well as with pupils who provide good language models.

- Encourage discussion and cooperation between pupils.
- Build in time for pupils learning EAL to consolidate their use of scientific vocabulary.
- Set explicit listening tasks.
- Provide matching, grid or DARTs activities with some completed parts as a model. Ensure these are used for reading and thinking activities, not written tasks.
- Encourage pupils to use dual-language dictionaries and to list their *own* definitions.
- Provide instructions and information in ways that combine visual presentation and short text.
- Support pupils learning EAL in recording a summary of what they have learned using scaffolds or writing frames, talk frames, word lists etc. appropriate to the nature of the task; *avoid* independent worksheet tasks that limit talk or enquiry work.

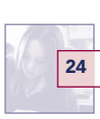
During plenaries

- Summarise key facts and ideas.
- Highlight scientific vocabulary.
- Differentiate questioning.
- Encourage pupils learning EAL to present their work to the class and to talk about their conclusions and the learning strategies they have used.
- Encourage other pupils to ask pupils learning EAL questions and provide time for them to respond.
- Ensure pupils learning EAL are provided with the necessary information and resources to complete their homework.
- Use opportunities to revise and consolidate new or key vocabulary.
- Use 'sentence starters' to encourage pupils to summarise what they have learned and record it.
- Provide scaffolds to help pupils learning EAL express what they have learned during the lesson and how they learned it.

***discussion** points*

Supporting teaching and learning in science

- *Identify which of the suggestions for starter activities, for main teaching activities and for plenaries are already strong features of teaching science to pupils learning EAL in your school.*
- *Identify which suggestions you would like to develop further in your teaching.*
- *Prioritise these suggestions and agree how you will put them into action.*
- *Where can you get the support you need to develop these strategies?*



Key Stage 3
National Strategy

Access and engagement in science

Teaching pupils for whom English is an additional language

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