

Pupils frequently demonstrate their level of understanding through peer-assessment

ASSESSMENT

ASSESSMENT FOR LEARNING IN SCIENCE

What works well?

Claire Hodgson summarises which Assessment for Learning strategies are particularly relevant to primary science teaching and learning and describes how they can be implemented in the classroom

Assessment for Learning (AfL) – assessment that focuses on the gap between present performance and the desired goal – is integral to teaching and learning, and its importance has been recognised over a number of years. With the new status of science assessment in England, following the changes to key stage testing, a research team at the National Foundation for Educational Research investigated, by carrying out a literature review, how AfL can best support primary science. The review looked systematically at many research studies and identified a number of

overarching themes that showed the relevance of AfL in the primary science classroom. These included:

- misconceptions and classroom climate;
- talk and discussion;
- questioning;
- feedback;
- self-assessment and peer-assessment.

The following is a summary of the key messages from the review.

Misconceptions and classroom climate

Eliciting pupils' ideas about science through questioning and

discussion is considered a very valuable AfL strategy and can be useful for revealing pupils' misconceptions. It has been known for many years that children have a range of ideas about a wide variety of science topics and some of these ideas are incorrect. It is important to find out a pupil's understanding at the start of a topic and establish whether they hold any misconceptions (for example, believing that seed will only grow in soil). This allows subsequent teaching to be planned to challenge the misconception and help shape future learning and understanding.

How to elicit scientific misconceptions

Some of the ways in which teachers can elicit or explore misconceptions with their pupils include:

- **concept cartoons** (Keogh and Naylor, 2000), which can prompt questions that motivate investigative work in science – this can lead to a shift in thinking as pupils demonstrate for themselves that their original thinking was either right or wrong;

- **puppets**, which are another way for ideas to be talked through because the puppets can 'own' the ideas rather than the pupils (Keogh and Naylor, 2007); using the puppets, pupils tend to justify their explanation in a more evidence-based way, which is an essential quality of science learning;

- **learning journals**, which allow pupils to record their misconceptions and chart progress through an investigation, evidencing shifts in understanding and showing the resolution of the misconception.

Willingness to discuss ideas in a non-threatening environment is crucial to finding out and addressing pupil misconceptions. Establishing an appropriate classroom climate is, therefore, fundamental to successful implementation of AfL.

How to make pupils feel confident and safe

Scientific learning occurs best when pupils feel comfortable about sharing their ideas and misconceptions without fear of ridicule or embarrassment. Some ways in which this can be achieved include:

- pupils working in groups and offering group responses; it seems less threatening if an answer turns out to be wrong if it is offered as the result of group discussion and agreement;

- the teacher suspending judgement when pupils are explaining their thinking;

- pupils receiving an open and warm reception from the more knowledgeable adult; pupils' ideas are shown to be valued if the teacher repeats them and writes them down rather than dismissing them straight away;

- pupils shutting their eyes when they have been asked a question and then putting up

their hands when they have an answer; this encourages pupils to think for themselves without being intimidated by other pupils instantly raising their hands.

Talk and discussion

Talk in science classrooms is very important because 'Language provides the fundamental means for communicating ideas, but it is also through talk, either with others or "in our heads", that we can develop personal understanding ... Science lessons provide plenty of opportunities for talk' (Asoko and Scott, 2006: 158–159).

How to support children in developing scientific language

Scientific language can be developed through talk and discussion in the science classroom. You might want to try:

- allowing pupils to develop and present their understanding of scientific ideas and concepts in a variety of ways beyond writing, e.g. extensive talk with teachers emphasising the use of simple and visual stimuli;

- highlighting language in science learning by explicitly teaching pupils how to talk about natural phenomena in a scientific way;

- not constraining pupils' interactive talk – explore pupils' views and take account of them, even if they are different from accepted ones.

Questioning

Questioning is a 'key feature of scientific activity and of teaching science' (Harlen, 2006a: 167) and is essential to the success of both AfL and science learning. The review highlighted a variety of question strategies for use during science teaching:

- begin with a 'big' or 'rich' question to set the scene (*Why are different flowers different colours?*); these are open questions posed at the start of a lesson or topic and investigated through the development of further questions;

- use clear, focused questions, modelling the formation of a good question;

- keep returning to the question posed at the start of a lesson so that you and the pupils can monitor their developing understanding;

- use pupils' questions to identify the 'cutting edge' of their understanding;

- use stimulus materials to provoke pupils' questions (for example, providing an object or substance that behaves in an unexpected way or giving an eye-catching demonstration);

- use structures such as 'KWL charts', where pupils identify what they 'know' and 'wonder' about a topic, and 'how' they can find out and decide what they have 'learned';

- provide 'wait time' to allow pupils to consider their answers before responding; eight to nine seconds or more can encourage longer and more thoughtful responses that go beyond factual recall;

- while providing pupils with time to think, discuss and give a considered response, avoid rephrasing a question as this means you may not find out how the pupils would have responded to the initial question;

- adjust questioning to accommodate a range of answers, respond to pupils' thinking, and guide them through enquiry-based discussions;

- use a 'no hands up' strategy in which pupils are selected by the teacher rather than self-selecting by putting a hand up to show they 'know the answer'.

Question types

Diagnostic questions can reveal clear and precise information about what a pupil understands (e.g. *In which of these circuits would the bulb light? Explain why*). They can be used to prompt investigative science work because pupils are inclined to want to find out the answers for themselves.

Productive questions, which stimulate physical or mental activity and reasoning, are particularly useful in science because they help to advance pupils' thinking. Productive questions include measuring, comparison, action and reasoning questions, and can be raised by the teacher or pupils (e.g. a measuring question might be: *How can I measure the distance the car travelled from the ramp?*).

Feedback

Two types of feedback are 'essential to formative assessment: the first is from pupil to teacher, the second from teacher to student. Learning is effected by alternation between these, in which each contribution responds to the other' with effective feedback arising from 'learning experiences

that provide rich evidence so that judgements about the next step in learning can be made' (Black and Harrison, 2004: 3-5).

Non-judgemental comments and the identification of where improvements can be made are key features of useful feedback. It is also important that pupils should be given sufficient time to react to, and act upon, the feedback they have been given in order to 'convey the message that responding to the comments is part of their learning' (Harlen, 2006b: 178). Feedback 'dramatically affected the way students became involved in their own learning [and] improved students' enjoyment of learning science' (Markwick, Jackson and Hull, 2003: 54).

Feedback relating to science work can be given orally or in written form. Suggestions for how to incorporate feedback into the classroom routine, together with the identification of associated benefits, include:

- constructive feedback given during discussions and practical tasks;
- marking against defined learning objectives;
- use of comment-only marking, with no grades;
- marking with constructive feedback to inform future planning;
- the use of comment sheets for pupils to respond to the teacher's feedback with their own thoughts and evidence of changes they have made.

Self-assessment and peer-assessment

Self- and peer-assessment are key to making pupils more autonomous,

able to identify their own learning needs, check progress and develop their own next steps. The review found a number of strategies to help pupils assess their own learning:

- carefully planned use of the plenary for self-evaluation, for example by concluding a science lesson with some questions to prompt self-evaluation;
- using a self-assessment 'journal' where pupils could reflect on their learning and make suggestions for their way forward, noting what to do next time taking into account what has already been learnt;
- pupils colouring in squares of goal statements to indicate their confidence in achieving that goal – pupils tend to be honest as this is a private activity, with the results shared only between the pupil and the teacher;
- self-marking of work against specific criteria;
- using 'concept maps' to show understanding of a particular topic or idea by illustrating links between different concepts;
- pupils rating their understanding of a learning objective on a scale of one to three. This visual response, with fingers held up to indicate where they feel they are on the scale, allows the teacher to see who needs help with particular concepts, thus providing immediate feedback on what further teaching is required;
- rating of understanding using 'traffic light' colours to show good (green), partial (amber) or little (red) understanding.

During peer-assessment, pupils engage in paired-assessment and assess against specific criteria, ideally agreed between themselves. It is through peer-assessment that 'children ... frequently demonstrate their level of understanding through their assessment comments' (Lindsay and Clarke, 2001: 17) and this can assist teachers in making their own judgements.

Conclusions

In order to maximise AfL's benefits in the science classroom:

- assessment coordinators, science coordinators and head teachers must be familiar with the many opportunities for using AfL in science teaching and utilise these to the full;
- teachers must be given support to embed AfL in the science classroom and use a range of strategies;
- small research communities of teachers who undertake their own AfL action research projects should be established. Teachers select and develop a few aspects of AfL in depth, exploring and investigating these aspects with their children. Results can then be shared with the other teachers.

Further information

The full literature review, together with all references, can be found at: www.nfer.ac.uk/publications/AAS01

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