Assessment aims in science lessons

Discuss, evaluate and reflect upon the aims of assessment for learning in primary science, and consider strategies that may be employed to identify children's strengths and weaknesses. Show how assessment information can be used to monitor children's progress in science, and inform and develop quality teaching and learning.

Introduction:

Science became a core subject for primary schools in 1989 with the introduction of the National Curriculum. Primary Science has a broad agenda, an important element of which is the development of ' scientific literacy' in the population (Howe *et al.,* 2005, p. 5), the scientific understanding that should be part of everyone's education. Teachers have a responsibility to ensure that children's experiences in primary science are positive ones so that more children will undertake post primary science subjects. Assessment for learning, an important element of primary science, has come to prominence in educational policy because of its perceived potential to underpin lifelong learning (Black et al., 2006, p. 120). Described as a teaching strategy of very high leverage (Howe, 2004, cited in Marshall & Drummond, 2006, p. 133), assessment for learning allows teachers to track pupil learning and progress and plan quality teaching using appropriate strategies.

Aims of Primary Science Teaching:

Children have many ideas about the world and how it works before they come to school and experience science in the context of their everyday lives, for example most children will have some knowledge about plants and animals, or will understand that a lolly melts. The most important aim of

primary science is to foster children's appreciation of the world around us, to encourage a close observation of our physical environment, and to develop an understanding of how different aspects of it are related (Howe *et al.,* 2005, p. 6).

Views about science have changed in recent decades with a recognition that transmission modes for teaching in science are not appropriate (Gray & Bryce, 2006, p. 171). A constructivist view of teaching science has been adopted which recognises that children learn best when they are able to construct new ideas and concepts from existing ones. In order to teach primary science effectively, teachers must have a sound subject knowledge and an appropriate understanding of these constructivist theories (Traianou, 2996, p. 828). Key Stage one children, for example, learn a lot about science through play and ideas must be rooted in experiences that are meaningful to them. Effective learning in science cannot be facilitated by providing children with facts and information because:

- Facts unrelated to concepts that children already have are meaningless and therefore of no use to them.
- Children use their own ideas to construct understanding. While they may be able to recall answers, understanding only evolves out of their own experience.

(Harlen & Jelly, 1998, p. 26).

Science is very much a process based subject in which learners develop their understanding of things around them by using and developing process skills

(Harlen & Qualter, 2004, p. 133). Effective assessment in science should be reflective of this by being an ongoing process in the classroom.

The Primary Science Curriculum:

One of the main ideas in the National Curriculum is that of scientific enquiry which is seen as learning about ‘ ideas and evidence’ and three stands of ‘ investigative skills’: ‘ planning’, ‘ obtaining and presenting evidence’ and ‘ evaluating’ (Howe *et al* ., 2005, p. 8). Each strand consists of a number of processes which are to be taught through the subject areas of ‘ life processes and living things’, ‘ materials and their properties’ and ‘ physical processes’. A practical approach to learning in science is vital for primary school children. The teacher’s role as learning facilitator centres on creating a rich and stimulating learning environment, allowing children to explore and test their ideas. At every stage in the science process, language skills can be developed to assist the learning of science and vice versa (Sherrington, 1993, p. 206). Assessment begins from the beginning and it is useful to start science teaching with an activity to find out what children know about a topic before beginning teaching, paying particular attention to the language children use..

Assessment in Science:

Assessment is a process of deciding, collecting and making inferences or judgements about evidence of children’s learning and skills (Harlen & Qualter, 2004, p. 121). One of the main conclusions arrived at by the Children Learning in Science Project (CLISP) is the importance of establishing whether children have any misconceptions about scientific concepts and addressing these before moving on. Effective assessment is therefore crucial

for primary science as pre-conceived ideas can have an adverse effect on learning.

There are two main areas in assessment, formative and summative. Formative assessment, an ongoing process for the teacher, provides immediate evidence of learning and should be used to inform planning for teaching. Gathering information about learning and giving feedback while it is in progress has been seen as a crucial aspect of teaching since the Task Group on Assessment and Testing (TGAT) report was published in 1988 (MacGilchrist *et al.,* 2006, p. 84). It has a number of strengths because of its focus on learners and how they learn.

Summative assessment is generally administered to gather evidence of learning at the end of the teaching period. It has often been criticised as failing to take a holistic view of the learner. A comprehensive science programme will incorporate both elements but the formative assessment will be of most use to the teacher on a day-to-day basis.

The Purposes of Assessment:

Assessment is a statutory requirement for teachers. Section 3. 2 of the Requirements for Qualifying to Teach has a range of requirements in respect of monitoring and assessment, among them that teachers ‘ monitor and assess as they teach, giving immediate and constructive feedback to support pupils as they learn. They involve pupils in reflecting on, evaluating and improving their own performance (TTA, 2002, p. 11).

Assessment enables teachers to ascertain how effectively children have been learning in science. It has a number of aims including:

- To help children's learning by identifying what they are making good progress with and areas in which they need further support.
- To summarise achievements at certain times.

(Harlen & Qualter, 2004, p. 124).

This has important implications for primary science teaching in light research suggesting that children have many misconceptions in respect of scientific concepts. Harlen and Jelly have reported that misconceptions in science arise from:

- Attributing an effect to a particular feature and not having an understanding that a number of factors may be operating.
- A lack of awareness that there may be more than one explanation.
- Not understanding science vocabulary.
- Insufficient opportunity to test ideas and discuss findings.
- A lack of access to alternative ideas that might provide a better explanation.

(Harlen & Jelly, 1998, p. 24).

Effective assessment can address this by being an integral part of activities, with teachers constantly seeking information that enables them to support learning and give appropriate feedback. The teacher can then diagnose learning responses and needs, and note the progress that is being made (MacGilchrist *et al.,* 2006, p. 85). Formative assessment methods have received attention in recent years, being more suited to achieving the goals of:

- Learning with understanding

- Understanding learning

highlighted by the Assessment Reform Group as being crucial in the aim to equip learners for a place in a rapidly shrinking world and changing society (Assessment Reform Group, 2006, p. 8).

Methods of Assessing Children's Progress in Science:

A substantial amount of learning in science occurs outside school, being accessed through field trips, zoos, science museums etc. (Braund & Reiss, 2006, p. 214). Because of this teachers must have a range of ways of gathering evidence to assess pupil learning and understanding and be able to use this as the basis for subsequent teaching.

Methods that the teacher can use include:

- Observing children as they work- the teacher can gauge learning by listening to the ways in which children work their way through an activity, with particular attention to their use of scientific vocabulary. The language used by the children is a very good indicator of their understanding. Open-ended teacher questioning gives children opportunities to express their ideas and develop them. Research shows that where correct scientific language is taught, children develop more accurate scientific concepts (Sparks-Linfield & Warwick, 1998, p. 128).
- Studying children's work in relation to a task – drawings, reports and written work. For this to be most effective, it is important that the task requirements are clear. For example, if the aim is to assess children's understanding of the structure of a flowering plant, it is important that

the children are not simply asked to draw a flower, but that the task requires the parts to be labelled or indicated in some way.

- Administering tests related to the learning activity.
- Having a plenary session where the children can talk about what they think they have learned from a task or activity.

Involving Children in the Assessment Process:

Central to formative assessment is the idea of involving children in their learning. Black and William found that self and peer assessment in children as young as five was successful in raising achievement (Black & William, 1998). The effectiveness of involving children in the assessment process stems from an understanding that children learn most effectively when they have opportunities to build new ideas on existing experiences. For this approach to be successful, it has to be carefully planned for by the teacher. The children need a clear understanding of the learning intentions of a lesson to be able to assess if they have achieved them.

The teacher must be very explicit, particularly in relation to processes within science. If it is not clear that the learning intention is process based, children tend to focus on their answers rather that the methods used for obtaining them. Harlen & Qualter point out that when children understand what they should be doing and how well, they are in a position to share in deciding the next steps to be taken (Harlen & Qualter, 2004, p. 179). This approach does not suggest a lack of rigour in terms of assessment, the ultimate decisions in the management of which are teacher directed.

Assessing Children's Process Skills:

Children use the process skills they have developed when they engage with tasks. Teacher observation is very important here but it is important for teachers to be aware that some types of behaviour are more indicative of learning than others and to be able to differentiate between them. The teacher needs to consider what would indicate that a child is employing a particular skill, for example observation. In this case the teacher might look for evidence of the child paying attention to detail, really exploring an object. The degree to which a particular skill is being employed will also be different for older and younger children. With younger children it is most important to develop positive attitudes to science and to give children opportunities to be scientists through access to a range of science equipment and to nurture correct use of scientific vocabulary.

Using assessment to improve learning in science:

Evidence gathered by the teacher must be used to make judgements regarding the effectiveness of the learning. This process can be enhanced by discussion with the children. Harlen and Qualter have identified three reasons for using assessment to help learning in science:

- Knowing what ideas learners bring to new experiences and how these ideas develop during their activities is central to learning through enquiry. Using assessment as part of the teaching means that information can be collected about progress towards goals. If activities provide opportunities for skills, understanding and attitudes to be

developed, then they also provide opportunities for these to be assessed and for the information to be used to help learning.

- Widely accepted theories of learning emphasis the role of learners in constructing their own understanding, the constructivist approach. Formative assessment involves children in recognising where they are in progress towards goals and in the decisions about what their next steps are and how to take them.
- There is firmly established evidence that when the key components of formative assessment are practised, levels of achievement are raised.

(Harlen & Qualter, 2004, p. 132).

Assessing Children's Ideas in Science:

Children have many ideas about science when they start school. It is important to establish what these are and plan teaching accordingly. Discussion is extremely important in primary science and teachers must create a climate in which children can express ideas with confidence. Keogh and Naylor have pointed out the importance of this:

If we want children to ' think out loud', to be creative in their thinking and to argue about alternative possibilities, then we need to provide the kind of learning environment in which they feel comfortable to do that. They need to know they can make mistakes or give wrong answers and still feel good about themselves. (Keogh & Naylor, 2004, p. 18). Scientific language should be introduced when appropriate and in contexts that allow children to develop an awareness of the different meanings that words may have in everyday and scientific contexts.

Using Assessment to Inform Teaching:

Children's ideas, whether in oral or written form, often give an indication of experience or skills that are lacking. This is an important consideration when planning teaching. When children are displaying a lack of experience, it is necessary to provide experiences for them. For example, organising a trip to the local park to investigate living things. Children often have ideas about science which may not reflect reality and can be difficult to change. In this case it is necessary to scaffold and model alternative explanations for children. It is important that teachers use assessment information and evidence to address any misunderstandings or misconceptions that children may have. The strength of formative approaches to assessment is that difficulties can be addressed in the short term before misconceptions are too well cemented.

Conclusion:

The Government believes that primary education is about;

' Children experiencing the joy of discovery, solving problems, being creative in writing, art and music, developing their confidence as learners and maturing socially and emotionally' (DfES, 2003, p. 4). Discovery and problem solving are central to science teaching and an effective programme for assessment can be used to facilitate this by enabling teachers to plan and devise lessons accordingly. Research has shown that implementing the essential features of formative assessment in classrooms leads to gains in achievement that are greater than those of equivalent groups where formative assessment is not practised (Harlen & Qualter, 2004, 137).

Marshall & Drummond have pointed out that assessment for learning demands a high degree of organisation in the classroom if it is going to help pupils become independent learners (Marshall & Drummond, 2006). It is essential that teachers feel sufficiently confident in respect of subject knowledge pertaining to science and plan interactive lessons for children that mirror the interactive nature of assessment for learning.

In science learning children must begin with what they know. The teacher must therefore employ a range of strategies for gathering this information and must apply it to subsequent teaching. This can lead to quality teaching and learning in science and to positive experiences for children and their teachers.

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