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Research in effective assessment
Key Stage Two science

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Abstract

This paper will report on a project which began in 1995. The aim is to a) research current assessment practice in Primary schools, b) explore assessment issues highlighted by science and assessment coordinators and c) develop and trial effective assessment instruments and strategies. The focus is assessment of Attainment Target 1 within the context of the other attainment targets. During the first stage of the project semi-structured interviews were conducted in 12 schools in England and Wales. The second stage involved classroom observations and taped interviews with teachers and pupils about science investigations and activities. In the third stage assessment support materials are being developed and trialled.

Background

In 1995 the Standard Assessment Tasks and Tests at the end of Key Stage 2 tested Attainment Targets 2, 3 and 4, while Attainment Target 1 was assessed through teacher assessment only. The investigative and experimental aspects of science carried 50% of the teacher assessment. In 1996 AT1 was again addressed in teacher assessment with a weighting of 40%. It is still the case that the responsibility for the assessment of most of the AT1 criteria rests with teachers, as part of their teacher assessment procedures. Therefore they need to be able to assess this area of the science curriculum with confidence, especially since they may have to justify differences between test results and teacher assessment levels at the end of the key stage.

As long ago as 1980, in its Report on Science in Schools (Age 11 Report No. 2 1980), the Assessment of Performance Unit concluded that science activities in Primary schools involved the development of general abilities, mainly literacy, rather than specific science skills and processes. The development of a more specifically scientific curriculum in primary schools in recent years has led to difficulties in assessment.

The complexity of scientific development must inevitably be reflected in the assessment of children's performance, or what they can do at a particular time. Looking closely at any classroom activity shows that it involves a combination of many skills In order to be able to say what sorts of things children can do well and what they do less well, the different aspects of performance have to be separately assessed. This means defining separate categories of performance and developing test questions relating as closely as possible to one category only. At the same time the separate categories must still make sense in relation to the whole of which they are parts.
(APU Science in Schools Age 11 Report No. 2)

In 1988 the Task Group on Assessment and Testing identified two extremes for assessment, 'test situations' and 'normal work'. They also recognised that some 'special activities' may be necessary to foster the assessment of science process skills. Such special activities, involving several skills, can cause difficulties in assessment and recording. Teachers need to feel confident when making judgements, that they understand and can identify the criteria against which a child is being assessed.

While it is important that assessment planning and recording should be systematic, it is equally important that strategies should be practicable in the classroom. Interrelated teaching, learning and assessment at the planning stage lead to more effective teacher assessment. However there are difficulties because the criteria for assessing ATs 2, 3 and 4 are easier to identify and to include in schemes of work and lesson plans, whereas the AT1 criteria are not so readily assessable.

* Task Group on Assessment and Testing - A Report - Dept. of Education and Science and the Welsh Office.

* Assessment of Performance Unit - Science in Schools - Age 11: Report No. 2

The Cambridge Primary Assessment Scheme Project began in 1995 and is part of a research programme being undertaken by the Primary Assessment Unit at the University of Cambridge Local Examinations Syndicate. The aim is to carry out research in primary schools, to identify key elements which contribute to effective assessment and to develop assessment support and materials for teachers informed by research findings.

PHASE 1 Semi-structured interviews with science/assessment coordinators

PHASE 2 Classroom observations and verbal protocols

PHASE 3 Development of support activities and materials

Phase 1

In the initial stage of the project interviews were carried out to gather the views of science and assessment co-ordinators in schools. Teachers were interviewed in 12 schools from a wide geographical area of England and Wales. Contacts were made either directly or through county assessment co-ordinators and interviews were carried out by researchers from the Primary Assessment Unit. The teachers who were interviewed had responsibility for assessment and/or science and so were involved in the development of these areas within their schools. The opportunity to access the expertise of practising teachers was invaluable in providing an overview of the situation in primary science assessment. It offered the opportunity to identify current policy and practice and to gather information to inform future stages of the project. It also highlighted the areas where teachers found most difficulty in carrying out assessment of Key Stage 2 science and the kind of support they would like to have. The interviews were an important part of the information gathering process and the aim was to use the information to target issues in assessment and to aid the selection of activities for classroom observations. The following points emerged:-

- The majority of teachers identified the need for support in science assessment generally, and especially in AT1. Half of the teachers were working in schools where there was a co-ordinated approach to the teaching and assessment of science. When comparing the assessment of science with the other core subjects, teachers felt more comfortable in mathematics and English where there has been a tradition of testing. There was evidence of insecurity in the teaching and assessment of science, especially at levels 4 and 5.
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- Problems related to confidence and knowledge of the curriculum were identified by many of the teachers interviewed. They recognised that science and its assessment were areas which needed to be targeted and many schools were in the process of trying to address the problems, or had included them in their development plans for future attention. Teachers felt pressured about end of Key Stage assessment requirements and Ofsted inspections.
- There were wide variations in current practice in science assessment. Half of the schools had no co-ordinated strategy and in such schools teachers highlighted the need for discussion, agreement and an organised approach.

- Where progress had been made in co-ordinating a whole school approach, a variety of strategies were used in an attempt to reach sound judgements about levels of attainment.
- As well as marking work, observation notes were made during or after practical activities and knowledge was assessed through periodic written tests. Work was collected in portfolios for individual children and these were used by teachers to inform judgements. School portfolios were developed containing collections of pieces of work from a variety of age groups and across the attainment targets. The value of the school portfolio was that it promoted consistency among teachers and involved staff in moderation procedures. Almost half the schools were involved in some form of moderation which could involve the whole staff, as well as other primary and high school colleagues.
- There were concerns that assessment should not be seen as the sole responsibility of the end of key stage teachers, but that teachers within the key stages should play a full part in the process. There was evidence to suggest that it was difficult to involve other staff because of the demands on their time.
- 'Time' was seen as an important factor by the majority of teachers, as they felt that by
 - having more time to plan and record they could assess the performance of individual children more effectively. They also felt that if they had fewer children to teach and assess there would be more time to spend with individual children, especially in practical situations.
 - Seven of the twelve teachers identified AT1 as the most difficult area for assessment. Reasons for this included its practical nature, the national curriculum language and problems in making and recording judgements. Teachers found it difficult to identify criteria for assessment and to target the criteria in a realistic way in classroom situations. Despite these problems, investigative, experimental science was seen as an important area of the Primary science curriculum and one where support and clarification were needed in assessment.
- Most schools were devising their own assessment materials as they felt that no one published scheme was ideal. Published materials were used for ideas. There were advantages and disadvantages in developing 'in-house' assessment materials. It was time-consuming and required organisation on a whole school basis, otherwise there was a danger that isolated tasks would be prepared by individual teachers for their own topics. The main advantage was that the material could be adapted to suit the school, the scheme of work and the resources.
- A variety of recording systems were being used and schools were updating their systems to keep pace with curriculum changes. Individual portfolios were recognised as important records, as were observation notes, although note-taking during lessons was seen as desirable but impractical. Published National Curriculum record books were being used in a minority of schools, but these tended to be used for coverage rather than for individual attainment.
- Differentiation was recognised as desirable but unrealistic and as a difficult area in science teaching and assessment. Most teachers felt that differentiation took the

from of special needs support for the least able. It was considered to be too difficult and time-consuming to build into curriculum and assessment planning.

- Assessment was perceived as an important issue and teachers were experiencing many difficulties in trying to assess in an effective and meaningful way. They welcomed the opportunity to discuss science assessment and were glad that they were being asked their views on issues which they felt were relevant to their work in the practical classroom situation.

Phase 2

After the interviews teachers from three schools were selected to participate in the next phase of the project. Selection was based on the fact that the chosen schools had demonstrated substantial progress in the development of assessment procedures. The teacher assessment of AT1 was targeted as the focus, as this had been identified during the interviews as the most problematic area. The aim of the second phase was to explore the extent to which the criteria of the AT1 level descriptions were identifiable in teachers' planning and how they were demonstrated and assessed in practical classroom situations. Researchers liaised closely with teachers in the selection of activities to be observed. Verbal protocols were conducted with children and teachers immediately after the activities to investigate their perceptions. Each activity was considered in the following way:-

- The areas of the curriculum addressed were identified from the Programme of Study.
- Assessment criteria from the level descriptions were targeted. The criteria spanned two levels and were kept to a realistic number. (see Appendix 1)
- Opportunities for written assessments were identified.
- Criteria for assessment during the activity were selected and kept to a minimum.

Year 6 Activity - Separating Substances.

A level 4/5 activity was selected for a Year 6 class of 25 children. It involved separating iron filings, sand and salt. The teacher had planned the activity with two levels in mind and gave a written exercise after the practical session for assessment purposes. This incorporated the planning and predictions that had preceded the practical activity. One group of four children was observed as they carried out their investigation and their comments were noted and later considered in relation to the national curriculum criteria and levels. Immediately after the activity taped verbal protocols were carried out with the observation group and they were prompted to expand on their earlier comments and groupwork. After the session the teacher commented on assessment issues, such as national curriculum levels, criteria, recording and planning. Pre-planning was recognised as important, but differentiating between levels 4 and 5 was still a problem, especially for AT1. The aim was to give a 'best-fit' level for the activity as a whole. Information during the practical session was described as '*incidental*' and the teacher commented that, '*If anything especially sticks*

in my mind I might make a note of it later. Assessment of the individual was a problem as the children tend to work in groups and tracking each child's performance is difficult in the practical situation. When comparing the assessment of the four ATs the teacher commented that, *'For AT1 after an activity like this, I try to look at all the information and make comments on observing, prediction etc. For ATs 2, 3 and 4 it is content-bound and narrow and therefore much easier to do.'*

The teacher had the opportunity to consider the prompts and responses from the children's verbal protocols. The prompts were designed to elicit responses that would demonstrate the targeted criteria at the appropriate level. He felt that the analysis of the activity and the targeted questions provided a valuable framework which he could use. He also commented that, *'The plans, assessment criteria and questions help me to understand how to identify performance at the different levels in practical science, but I would never have time to do this myself.'* He felt that the activity he had planned to do had been analysed in the national curriculum framework and provided more information he could use for assessment purposes.

Key issues arising from Phase 2

- Assessment of the 'content' ATs was considered easier and there is a danger that this will jeopardise the more difficult AT1 assessment. It would be impossible to assess every child against the identified AT1 criteria in any one activity. However, during the course of the classroom observations, it was clear that the teachers did interact with individual children. Since these interactions were taking place they could be used to inform the assessment process. This may be limited to a small number of children and may address only a few criteria but over a series of activities effective assessment strategies could be developed.
- There was evidence from the observations and interviews to suggest that activities being developed and used by teachers were not being fully used for assessment purposes, especially for AT1. The worksheets used could have been more effective for targeting assessment criteria. The 'normal' marking strategies for targeted assessment activities would be more helpful in national curriculum terms if they were related to selected criteria and levels.
- The assessment of some AT1 criteria was identified as particularly difficult e.g. **using selected equipment with care (level 5)** and **making observations with appropriate precision for the task (level 5)**. Realistic strategies need to be developed to enable the teacher to address the assessment of such areas of the curriculum, otherwise they could be in danger of being considered 'less important'.
- It was clear from teachers' feedback that the analysis of activities and the development of targeted assessment questions would provide welcome support, given the demands made on teachers' time. Such activities could be used to support the teacher in building up a picture of attainment of individual children in areas which are proving difficult to assess.

Phase 3

This phase of the project is currently underway. The aim is to work closely with teachers in schools to develop and trial activities which provide support and guidance for teachers. The activities are designed to focus on the assessment of AT1 in the context of the other ATs. They cover levels 2 to 5, with each activity spanning two levels. The activities can be used at any point which the teacher feels is appropriate for an individual child, for a small group, or for a whole class. The aim is to allow flexibility within a framework of effective, manageable assessment which can be incorporated into teaching and learning schemes. The schools which had been involved in the initial interviews were approached and invited to participate in this stage of the project. Most of the schools were willing to take part and we were able to include 11 schools from a wide geographical area in the trial. The table below shows a series of activities which were designed to cover a range of topics across the Key Stage 2 curriculum.

AT1	AT2 Life Processes and Living Things	AT3 Materials and Properties	AT4 Physical Processes
Level 2	Plants (G)	Soil (B)	Magnetism (A)
	Sorting leaves (M)	Properties of everyday materials (N)	Sound (F)
Level 3	Plants (G)	Reversible/ (K) irreversible changes	Sound (F)
	Sorting leaves (M)	Soil (B)	Electrical circuits (O)
	Habitat/climate/ environment (H)	Properties of everyday materials (N)	Magnetism (A)
Level 4	Pulse rates (E)	Separating substances(D)	Pendulum (C)
	Food/Starch (I)	Thermal insulation (J)	Light (L)
	Habitats/climate/ environment (H)	Reversible/irreversible changes (K)	Electrical circuits (O)
Level 5	Pulse rates (E)	Separating substances(D)	Pendulum (C)
	Food/Starch (I)	Thermal insulation (J)	Light (L)

A Magnetism
B Soil
C Pendulum
D Separate substances
E Pulse rates
F Sound
G Plants
H Habitat/climate/environment

I Food/starch
J Thermal insulation
K Reversible /irreversible changes
L Light
M Sorting leaves
N Properties of everyday materials
O Electrical circuits

Trial 1

Teachers from the trial schools provided details of their schemes of work so that a schedule of trials could be arranged which would be appropriately timed. It was stressed that the activities were for assessment purposes and were not teaching materials and it was therefore important that the targeted curriculum had been covered by the children involved in the trials. For each activity the teacher was provided with details of the assessment criteria on an annotated activity sheet (see Appendix 2). A coding system was trialled to attempt to address the criteria such as observation and using equipment in order to provide the opportunity for the teacher to note performance of practical skills on the child's activity sheet. This information could be used later to inform the 'best-fit' judgements about levels of performance. The children involved in the activities were selected by the teacher on the basis that they were working at the target levels.

Researchers were present for the first trial of each activity so that any problems could be identified. After the activity the teacher completed a Teacher Comment Sheet which covered areas such as:- resources, interest levels, accessibility, organisation, timing, and coding. They were also invited to make any other comments about the assessment activity in the light of their experience. Their comments included:-

It was useful to see how the children coped with a concept in a format that was not so familiar to them.

The specific questions relating to concrete activities guided the children and maintained the level of interest.

The coding boxes give a focus on specific skills which can be difficult to identify.

The boxes were useful especially as they were at the pertinent points.

The criteria were useful, clear and concise.

A very useful manageable assessment activity.

The children's scripts were later analysed and then the activities were considered in the light of all of the feedback so that a decision could be made about further development. The following points were considered:-

- Commonalities in responses.
- Common errors which were due to language/reading.
- Difficulties related to page layout.
- Unrealistic demands in the use of equipment and resources.
- Time taken for the activity.
- Use of 'coding boxes' on the activity sheets.

- Teacher comments.

After analysing the information from the observations, teacher feedback and script analysis, amendments are being made to the Trial 1 activities. Some new activities are currently being trialled in schools for the first time, while others which have been amended are being trialled for a second time with a minimum of 25 children.

Researchers are not present for the second trial of each activity but there is close liaison with the teachers involved and they will provide feedback in due course. The trials are carried out according to a rolling programme as it is important that the assessments take place at the appropriate times for the children in relation to their schemes of work.

After completion of the second trials, guidance for marking will be developed based on the feedback from teachers and the analysis of the responses from pupils' trial scripts. A record sheet will be designed for each activity and the recording system and mark schemes will be trialled by teachers from the previous trials.

The overall aim will be to develop a series of assessment activities which will provide the support needed by teachers in areas which they have identified as problematic. By working closely with teachers from the initial stage of the project it will have been possible to focus on the problems highlighted by those who are attempting to assess Key Stage 2 science in the practical classroom environment.

From the researchers' point of view, a key factor which has emerged has been the teachers' keenness to view the activities as teaching materials rather than assessment activities. This may be seen as a reflection of the difficulties teachers have in identifying the process aspects of Primary science. It would appear that there is not only a need for support in assessing these processes, but also in devising teaching situations which are specifically aimed at giving the children experience in **engaging** in them. It is possible that these materials may be used for a variety of purposes, but the important factor is that they should provide sound support for teachers.

Appendix 1 - selected assessment criteria

SOIL

AT3 Curriculum assessed

- **describe similarities and differences between materials L2**
- **solid particles of different sizes can be separated by sieving L3**

AT1 Curriculum assessed

- **use simple equipment provided L2**
- **compare and observe L2**
- **describe and record L2**
- **simple prediction L3**
- **use range of equipment L3**
- **relevant observations L3**
- **explain observations L3**
- **say what has been found out L3**

Appendix 2

Name _____ Year ____ School _____ B G

SOIL

You need:- soil, a magnifier, a sieve and a bowl

1. Look at the soil.

O2

Write some words to describe the soil.

AT1 L2
observe

The soil is _____

AT1 L2
describe
record

2. Look at the soil through the magnifier.

U2

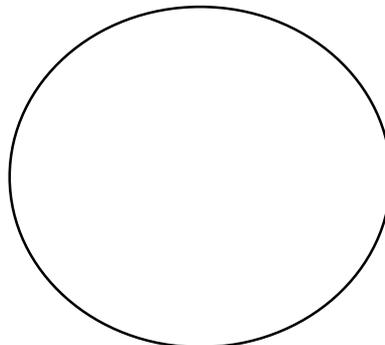
AT1 L2
use simple
equipment
provided

Draw what you see.

O2

AT1 L2
observe

AT1 L2
record



Name _____ Year ____ School _____
_B G

SOIL

3. What do you think will happen if you put some soil in the sieve and shake it gently into a bowl ?

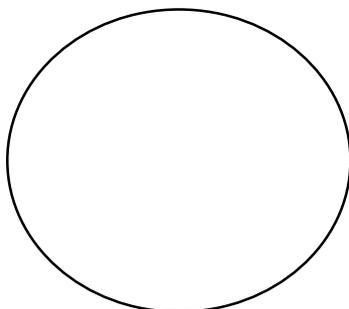
AT1 L3
predict

AT1 L3
use range
of equip.

4. Try it and see if you were right.

U3

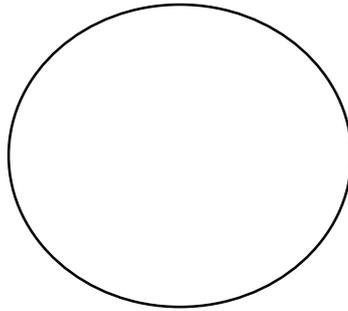
5. Draw what you see in the sieve.



AT1 L2
observe
compare

O2

Draw what you see in the bowl.



Name _____ Year ____ School _____
B G

SOIL

6. How are they different?

O3

AT3 L2
sims. and
diffs.
between
materials

AT1 L3
relevant
observation

7. Why is some soil left in the sieve?

AT1 L3
explain
observation

8. What have you found out about the parts of the soil?

AT3 L3
properties
of
materials

AT1 L3
say what
has been
found out
