Active Assessment : thinking, learning and assessment in science

Stuart Naylor and Brenda Keogh

Description:
Putting the learner's ideas at the heart of the learning process.

Abstract:
Many teachers are convinced about the value of assessment for learning but may be unsure of how to implement this in their own teaching. Closing the gap between theory and practice can seem daunting. This article describes a project that has attempted to put the theory into practice in science classrooms. The Active Assessment project aims to build on the theory, to recognise the challenging issues facing teachers and to suggest some practical ways forward.

Assessment, thinking and learning

During the past three years about 6,000 teachers have attended professional development courses as part of the Active Assessment project. These courses have attempted to describe the connections between thinking, learning and assessment and familiarise teachers with a wide range of Active Assessment strategies. As the project comes to an end it is a suitable time to reflect on the principles that underpin the project and what we have learnt from it.

The project's origins go back to the early 1990's when we were developing and researching Concept Cartoons (Naylor and Keogh, 2000). Evidence from our research showed that many teachers used Concept Cartoons for assessment in science lessons. In some cases, teachers used Concept Cartoons as part of a traditional summative assessment process, because the Concept Cartoons seemed to be an effective way to probe understanding and were more engaging than the usual test questions. However, in other cases they found that it was valuable to use Concept Cartoons for assessing pupils' ideas at the start of a lesson. What was revealed about the pupils' ideas created a learning agenda for the rest of the lesson and helped to clarify the next steps in learning and teaching. The Concept Cartoons got learners thinking, talking and sharing their ideas, and in this way they made the learners more active in the assessment process and helped to connect formative assessment with the learning that would follow (Keogh and Naylor, 1999).

This view of assessment as a process that helps to make learning more effective is quite a shift away from the more traditional view of teacher-led assessment that generally comes at the end of the learning process. There is value in both aspects of assessment. However, in terms of promoting thinking and learning there is more to be gained from assessment at the beginning of (or partway through) the learning process than from assessment at the end when all the teaching has finished. The gap between the two perspectives was brought home to us when a teacher phoned late one evening to discuss a problem that she had:

> *I've been using Concept Cartoons for assessment but I seem to be doing something wrong. When I use the Concept Cartoons I can't stop the children learning. What should I do?*

For this teacher, the conceptual shift in moving away from a view of assessment as purely summative, and towards a view where assessment makes a positive contribution to learning, was proving a challenge. She hadn't yet recognised these different perspectives on assessment, and saw pupils continuing to learn while they were being assessed as a problem, not as a bonus.

Becoming more aware of the links between thinking, learning and assessment led us to adopt the phrase *'Active Assessment '* to describe this connection (Naylor, Keogh and Goldsworthy, 2004). By Active Assessment we mean using approaches which actively involve learners in purposeful assessment activities and which potentially result in further learning. We mean using thought-provoking activities for assessment, so that thinking and learning are integral parts of the process. In addition to Concept Cartoons, typical Active Assessment approaches would be true-false statements, card sorts, predict-observe-explain or graphic organisers. Examples of suitable activities are given in the appendix.

Of course we are not the first people to be aware of this connection between assessment, thinking and learning. White and Gunstone, in their inspirational book *Probing Understanding*, noted that '*good testing devices are good teaching devices'* (White and Gunstone, 1992: 39) and that the same approach can be used successfully for teaching and assessment. More recently Black and Wiliam indicated that '*a good test can be a learning as well as a testing occasion'* (Black and Wiliam 1998:12) and that the same approach can be used successfully for learning and assessment. Other researchers, such as Wynne

Harlen and Rosalind Driver, have helped to lay the foundation for a view of assessment in which better learning is the primary purpose for assessment.

Our research into Concept Cartoons gave us further insights into this connection between assessment, thinking and learning. From reflecting on our own teaching, and observing many other teachers using Concept Cartoons, a set of principles seemed to emerge which helped to tie these together.

Some Active Assessment principles

Assessment should help to create a sense of purpose

One of the things that we notice when teachers use Concept Cartoons is that they usually get pupils engaged in discussion very quickly, and they get pupils wanting to find out more. In this way they help to create a purpose for the rest of the lesson.

We found that other assessment strategies used at the start of a lesson can have the same effect. High levels of engagement don't guarantee learning, but we can guarantee that pupils won't learn much if they are not engaged. So the types of assessment activities that generate high levels of engagement are more likely to lead to learning. The ideal types of activities are those which get pupils sharing and discussing their ideas, so that they don't view the activity as assessment.

Self assessment helps to create a sense of purpose

The process of self (and peer) assessment also helps to provide a purpose for the rest of the lesson. It leads to subtle, yet vital, shifts in the responsibility for learning. In many typical science lessons pupils view their role as carrying out a set of procedures that only the teacher understands. Self assessment can change this view. If a lesson begins with pupils finding out more about their own issues and problems in understanding, then the rest of the lesson can be presented by the teacher as a series of opportunities for them to resolve their difficulties and develop their understanding. In this way pupils recognise that their ideas make a difference to the lesson and start to share the responsibility for their own learning. So activities which help pupils to become more aware of their own ideas also help to integrate assessment and learning.

Finding out pupils' ideas is helpful

It is well known from research that learners construct their own understanding in science, based on their experiences, and that their ideas may be in conflict with scientifically accepted viewpoints (for example Harlen, 2006). Finding out about their ideas, or *elicitation*, is therefore often viewed as an essential step in effective teaching, since it enables the teacher to take their ideas into account.

However, finding out about pupils' ideas isn't just for the teacher. It is important for pupils to do this too. Finding out more about their own and other people's ideas helps them to explore and clarify their own understanding, to recognise the boundaries of their knowledge and to become more aware of alternative possibilities. Ollerenshaw and Ritchie usefully describe elicitation as '*helping children to find out and clarify what they think'* (Ollerenshaw and Ritchie, 1997: 66). This definition shifts the focus of elicitation from the teacher to the pupil, recognising the value of pupils' involvement in the process.

Collaboration improves both formative assessment and learning

Collaborative activities seem to provide less information to the teacher about an individual pupil's progress. This may appear to be a serious drawback for any assessment procedure. However collaborative discussion, debate and argument are immensely valuable in terms of getting pupils to reflect carefully on their own ideas, to take alternative possibilities seriously and in this way to kick start the learning process. Many teachers of science will know that

learning often depends as much on getting pupils to let go of their existing ideas as providing them with access to more productive ideas.

Letting go of their existing ideas is best achieved by pupils thinking carefully about why they hold these ideas and how much evidence there is to support them. Collaborative debate and argument is a very effective way to do this. So activities which get pupils discussing and arguing about their ideas also help to integrate assessment and learning.

Putting principles into practice: issues raised by teachers

Recent work on assessment for learning, such as Black, Harrison, Lee, Marshall and Wiliam (2002), Harlen (2003) and Black and Harrison (2004), has been widely publicised and has had a major impact on national policies as well as on classroom practice. Generic guidance on questioning styles, wait time, classroom climate and so on has been included in CPD courses and published materials. With such a wealth of guidance available, an obvious question to ask is why we felt the need to do further work in this area and develop what we now call Active Assessment. To answer this we need to turn to the questions raised by teachers during our work with them, and look at how our experience with Concept Cartoons and other Active Assessment approaches helped to shape our responses.

"Personalising learning sounds too difficult"

Pressures of accountability mean that it is a rare school that does not have schemes of work in place for each year group. Teachers are expected to plan lessons in detail, often some time in advance of the lesson. How then, they ask, is it possible to take the pupils' ideas into account when the lesson is already planned? Isn't it necessary to know what their ideas are before planning the lesson, and how would this information be obtained? The days are long gone since teachers could walk into a lesson, begin by exploring the pupils' ideas and construct a lesson plan there and then.

Teaching a class also raises other issues in terms of personalised learning. Although the well-known phrase *start from where the learner is* (Black and Harrison, 2004: 4) sounds appropriate and non-contentious, teachers felt that they need to *start from where the **learners are.*** This sounds a whole lot more demanding, but it describes the job of a class teacher more accurately. In any topic pupils will have a range of ideas, and dealing with this range of ideas can be daunting. How do you deal effectively with individual ideas at the same time as teaching the rest of the class? As one teacher expressed it to us:

> *How can you plan and teach 36 different lessons at the same time? . . . there is no way you can possibly provide for every child individually.*

"It takes too long to find out pupils' ideas"

Finding out more about the pupils' ideas near the start of a lesson or topic sounds fine in theory and seems to fit in well with assessment for learning. But this was often perceived as time-consuming. Many teachers were concerned that if more time was spent on finding out pupils' ideas, less time would be available for developing their ideas. This investment of time was often seen as a problem. How could investing time in this way be viewed as cost effective, given the demands of the science curriculum and the limited time available for science teaching and learning? Surely it would be better to spend the maximum amount of time on teaching and learning about the topic, rather than devoting time to simply finding out pupils' ideas?

"We need a wider range of strategies"

Access to a wide range of formative assessment strategies is important. No two classes are identical, so having a choice of strategies to meet the demands of different circumstances is essential. Having a wide range of possibilities to select from also makes it less likely that pupils (or teachers) will become bored by overuse of a small number of strategies.

Texts such as White and Gunstone (1992) or Black and Harrison (2004) offer some useful strategies for formative assessment. However many teachers told us that they need more wide-ranging guidance regarding how to access the pupils' ideas, and that comprehensive lists of strategies were difficult to find.

"We need subject-specific examples"
Generic formative assessment strategies, such as increasing wait time in response to questions, no hands up and giving comments not grades on pupils' work, are invaluable (Black et al, 2002). They make a big difference to classroom practice and help to create an effective learning environment. However this did not appear to be sufficient for many teachers of science, whether primary or secondary. It became apparent that many teachers felt a need for examples that were contextualised in the lessons that they would be teaching – lessons on pushes and pulls, particle theory, electrical circuits or interdependence and adaptation. However useful the generic strategies, teachers found that they could not always translate them easily into a specific science lesson. They told us that they need more subject-specific examples of formative assessment strategies, which built on generic approaches in a science context, and that these were not easy to come by.

Active Assessment as a way forward
We recognised how important it was to attempt to meet the concerns that teachers expressed, however challenging that seemed to be. Our experience with Concept Cartoons convinced us that it should be possible to provide support to make the formative assessment process manageable. This is what we have attempted to do through the Active Assessment project, as we set out below.

Personalising learning
An Active Assessment approach starts with the premise that teachers will generally want to provide broadly the same lesson for the whole class. The teacher will use one or more Active Assessment strategies at the start of, or partway through, the lesson. These short activities engage pupils in considering alternative viewpoints, looking for evidence and weighing up different arguments – in other words, they start to create problematic situations for pupils. This generates a desire to seek answers to their own uncertainties, and finding these answers becomes the purpose of the rest of the lesson. The teacher can target those areas where there is uncertainty or disagreement across the class. This helps to create a sense of ownership of the problem, where the focus is on the class as a whole, not on the individual pupil.

For example, suppose that groups of pupils do a card sort or use true-false statements about the Earth and solar system (see Appendix). They may all confidently agree that *The Moon reflects light from the Sun* is a correct statement. Because they are confidently right in their judgement (though on other occasions they may be confidently wrong!) there would be little point in spending any further time on this during the lesson. However they may fail to reach agreement about *The Sun is further away from the Earth during the winter*, or *The Moon appears to change shape because of the Earth's shadow on the Moon*.

The disagreement about these statements would be the ideal starting point for a lesson that explores a range of evidence about the seasons and about the phases of the Moon. Pupils can be given access to the typical activities used for this area of the curriculum, such as finding out the times of sunrise and sunset in different seasons, or identifying the difference in temperature in the N and S hemispheres in different seasons. They can find out about what happens in an eclipse, set up models of the Earth-Sun-Moon system or watch an animated video clip which shows the phases of the Moon. The uncertainty identified at the start of the lesson now provides a context and purpose for the activities that follow.

Or suppose that pupils are asked to compare and contrast light and sound. From general knowledge about thunderstorms they will probably be familiar with the idea that light travels faster than sound. However they may be unable to agree on whether a mirror will reflect sound as well as light. This would be an ideal starting point for a lesson which explores what happens when sound waves meet a polished surface: are they absorbed or reflected, and what variables might determine what happens? In this way the start of the lesson identifies a whole class problem, based on pupils' uncertainties, while the rest of the lesson provides evidence to resolve it.

In both examples, the Active Assessment strategy gets pupils talking and thinking, provides valuable assessment information and begins the learning process. Through using Active Assessment strategies pupils clarify their own ideas and discover whether everybody else in the class shares these ideas. Having their ideas challenged through collaborative group discussion, recognising the range of ideas across the class (peer assessment), and becoming more aware of their own areas of uncertainty (self assessment), makes pupils more interested in exploring their ideas further.

Even though some pupils know more than others, the fact that the class as a whole can't agree provides a rationale for a whole class lesson. Although individual pupils in the class have different ideas, these lessons do not require the teacher to set up individual learning pathways in response to their individual ideas. Personalisation comes from the connection that individual pupils make between their ideas and the follow up activities.

Time spent on assessment

Some activities can enable both assessment and learning to go on concurrently, as we discovered with Concept Cartoons. As pupils engage in the activity they have their ideas challenged and begin to develop their ideas through collaborative interaction. This is part of the learning process, just as sharing their ideas is part of the assessment process. These activities help to address the understandable concern about assessment taking time away from learning, since learning can be going on at the same time as formative assessment.

However there is a more fundamental point here. There is plenty of evidence to show how learners can ignore empirical evidence and hang on to their existing beliefs (see White and Gunstone, 1992, for some intriguing examples). Pupils may appear to accommodate new ideas but be resistant to letting go of their existing ideas. So the issue for teachers may be more to do with getting rid of old ideas than teaching new ones. Getting pupils to let go of their existing ideas is best achieved by getting them thinking carefully about why they hold their ideas and how much supporting evidence there is. Time spent in clarifying the ideas that pupils hold is an essential part of the process of getting them to consider alternative ideas seriously and change their ideas if necessary. In other words, this type of assessment makes learning in science more effective. That has to be a good investment of time.

A range of strategies and subject-specific examples

To meet this need we have collated material from sources such as White and Gunstone (1992), reworked examples which appear elsewhere to emphasis the assessment dimension (Wellington and Osborne, 2001, for example) and created some new approaches of our own (Naylor, Keogh and Goldsworthy, 2004). The range of strategies that we have found to be most valuable includes some which will be familiar to teachers of science, such as annotated drawings, card sorts and true-false statements. There are also other approaches that may be less familiar, such as deliberate mistakes, graphic organisers, odd one out and predict-observe-explain. Two examples of Active Assessment strategies are shown in the appendix.

Providing an extensive set of Active Assessment strategies means that teachers have choices, so if one strategy doesn't seem suitable for a particular lesson then it is likely that

another one will be. It also helps to identify how assessment and learning can be integrated, by illustrating how this might happens in a range of topics. Variety is valuable for both teachers and learners. It promotes creative thinking and avoids lessons becoming routine. We have illustrated a wide range of approaches in science contexts, though in fact most of the strategies can be used equally successfully in other subject areas (see, for example, Keogh, Dabell and Naylor, 2007).

The end of the project

The funded Active Assessment project came to an end in July 2007. It has been a learning experience for us as well as for the teachers who have attended courses. Working with the teachers has enabled us to understand better what their concerns are, to make more sense of the Active Assessment principles, and to develop a clearer understanding of how these principles can be implemented in science lessons.

For example, we now have a much clearer view of the value of disagreement between learners as a starting point for learning. Although working towards consensus in discussion is valuable, it is disagreement or uncertainty that drives the discussion. When everyone agrees, what is there to discuss? Conversely, where learners have opposing views there is an obvious need to reason, to look for evidence and to find out more in order to reconcile their views.

We have become more convinced of the unmanageability of the teacher attempting to take pupils' individual ideas into account. Any form of differentiation is a challenge for teachers, especially when classes are bigger than we would like and pupils are not always enthusiastic learners. To attempt to add onto this another layer of differentiation, adjusting activities according to the ideas that individual pupils hold, is out of the question in many circumstances. By contrast, involving pupils more in understanding and negotiating learning targets helps to make the process more manageable as they take more responsibility for their own learning. As one teacher recently described Active Assessment, *it helps to make learning more self-directed and more enjoyable*.

We also recognise that Active Assessment strategies don't work on their own without some sort of suitable follow up. For example, the true-false statements referred to earlier are really useful as the starting point for a lesson – but they aren't the whole lesson. They may start the learning process in a very engaging way and indicate the way forward, but that learning process needs to continue for learning to be completed. Unless they are followed up by suitable activities in the rest of the lesson then their value is questionable. Where they are followed up appropriately they can make a substantial difference to how the rest of the lesson proceeds. This was highlighted by one teacher who noted that *Active Assessment not only motivated students at all levels to reflect on the topic covered, but it has helped me to redesign starters and plenaries.* Another teacher put this more bluntly: *For the first time I can see some point to lesson starters. You have given me hope!*

Feedback from many of the teachers that have been on the courses and who now use Active Assessment strategies in their teaching has been very positive. Many of them take the view that using Active Assessment strategies helps them to see how to integrate assessment, thinking and learning in their science lessons and makes assessment for learning more manageable – starting from where the learners are, rather than from where the learner is. Perhaps the most significant comment from course evaluations was from a secondary head of department, who said:

> *When I used the Active Assessment strategies I found that more pupils were thinking more of the time. The numbers varied from class to class, but typically I would say there was a shift from about 20% to about 70% of them thinking.*

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Appendix
Two examples of Active Assessment strategies (adapted from Naylor, Keogh and Goldsworthy, 2004)

Compare and contrast graphic organiser

Bird		**Bat**
	How they fly	
	How they perch	
	How they breed	
	How big they are	
	What their mouths are like	
	What covers their bodies	
	etc	

True-false statements on the Earth and beyond

- Day and night are caused by the Earth spinning on its axis
- The Earth goes round the Sun every 24 hours
- The Moon reflects light from the Sun
- The Earth reflects light from the Sun
- The Sun is further away from the Earth during the winter
- Lunar eclipses are more frequent than solar eclipses
- One half of the Moon is in constant darkness
- The Earth rotates anti-clockwise

Brenda Keogh and Stuart Naylor both work as writers, consultants and INSET providers for Millgate House Education Ltd.
Email:
brendakeogh@millgatehouse.co.uk
stuartnaylor@millgatehouse.co.uk

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