



TRIPLE SCIENCE
SUPPORT PROGRAMME



Overview

For students to learn best, they need to be actively involved in their own learning. One of the most powerful interventions in teaching is assessment for learning (AfL), in which student learning is assessed, teaching is adjusted to take account the results of the learning, feedback is provided on how to improve, and there is a learning gain on the part of the student.

A leader in the AfL field, Wiliam¹ has come to define it as:

'An assessment functions formatively to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have made in the absence of that evidence'

You will find more information on his [website](#).

For practical purposes, it can be helpful to use the five 'Strategies of Assessment' described initially by Leahy *et al*² to ensure aspects of AfL are integrated and embedded across science teaching. These five areas cover finding out where the students are in their learning, signposting where they are going to next, and how are they going to get there; the phrase that Sadler³ colloquially coined as 'closing the gap'. They are:

1. Clarifying sharing and understanding learning intentions and success criteria.
2. Engineering effective classroom discussions activities and learning tasks that elicit evidence of learning.
3. Providing feedback that moves learning forward.
4. Activating learners as instructional resources for one another.
5. Activating learners as owners of their own learning.

We will unpack these in more detail, and look at how good AfL is about being adaptive to the learners' needs. We therefore need to know what these needs are, and what to do about it.

Clarifying, sharing and understanding learning intentions and success criteria

The basic premise here is that the students have the same idea as their teacher what is going on in the classroom, and what they should be learning as a result of doing. Many students are not going to know this unless it is clearly [signposted](#), and we use distinct learning intentions (or objectives), and intended learning outcomes [ILOs] to provide this direction. Some schools use 'We Are Learning To' [WALT] and 'What I'm Looking For' [WILF] to flag these. Often we break the ILOs down into [success criteria](#) that are manageable for the students, and phrased in student-friendly language. A good idea from primary education is the use of WAGOLL, 'What A Good One Looks Like', to make these visible.

Clarke⁴ offers us several different ways to share and even co-construct success criteria with students for maximum impact:

1. Doing it wrong so the students correct you, or not completing them, so that they do.
2. Show a finished product, so that they can see what a good one looks like
3. A comparison of two products is even better as it gives an indication of quality (why is this one better than that one?).
4. Sloppy success criteria giving rise to incorrect methods or work. The students then decide together how to make the success criteria better.
5. Retrospective creation of success criteria is useful when the product or process is so big it's not immediately obvious what went into it. This is especially useful in breaking down aspects of enquiry.
6. Revisiting existing success criteria, to see if you can make it better.

If we help them understand what excellence looks like for the learning intention, they are more likely to be able to achieve it. We have to make sure the students understand the learning intentions behind the activities they undertake in the classroom and laboratory, so that they have a [learning goal](#), rather than doing 'busy-work'.

Another way to present, share and work to the success criteria is to contain it within a [rubric](#); a ladder of expectations that also assist monitoring and feedback against those levels. Rubrics are widely used in the US, and are becoming more common here in the UK, developed from both 'Level Ladders' and SOLO rubrics such as this [titration rubric](#) example on Pam Hook's excellent wiki. Detailed and task-specific rubrics such as this are valuable, but we can also use more [generic](#) ones that encourage the learner to apply (for example) enquiry procedures to their work, whatever the topic.

Eliciting evidence of learners' achievement

To be able to move learning on, we have to know where the students currently are. There are a variety of formative assessment techniques⁵ that we can deploy, depending on whether we want to ask questions, observe students as they work in groups, listen to their explanations or scrutinize their work. We do this to identify misconceptions, mental models and potential learning barriers, and to adjust our instruction to focus the subsequent learning.

[PEO Probes](#) [Predict, Explain, Observe], Concept Cartoons and [Paint the Picture](#) are a good way to elicit and identify misconceptions. Activities that provide a stimulus for scientific discussion include card sorts, rich questions, [Thunks](#), Odd One Out and thought experiments, such as [Fermi questions](#). The temptation is to plan lots of these engaging instructional activities, but for AfL to be formative, we have to use them as opportunities to make decisions about our own as well as the students' next steps.

To succeed in this area then requires a range of skilful questioning techniques. Good questioning at the starting point may ultimately save teaching time if it lets you know about what you don't need to 'cover' again. Most teachers are now familiar with the Mary Budd Rowe⁶ research that indicated that teachers wait less than a second for a response. To develop competencies in the all the assessment objectives for GCSE we need to allow time for students to develop a better quality answer that involves some analysis, sequencing or evaluation. Alexander⁷ showed that open questions made up 10% of questioning exchanges, and that staying with the same student to probe and extend dialogue occurred in 11% of questioning exchanges, and provides a good overview of [dialogic teaching](#).

Action: Get a colleague to observe you and make note of your questioning style.

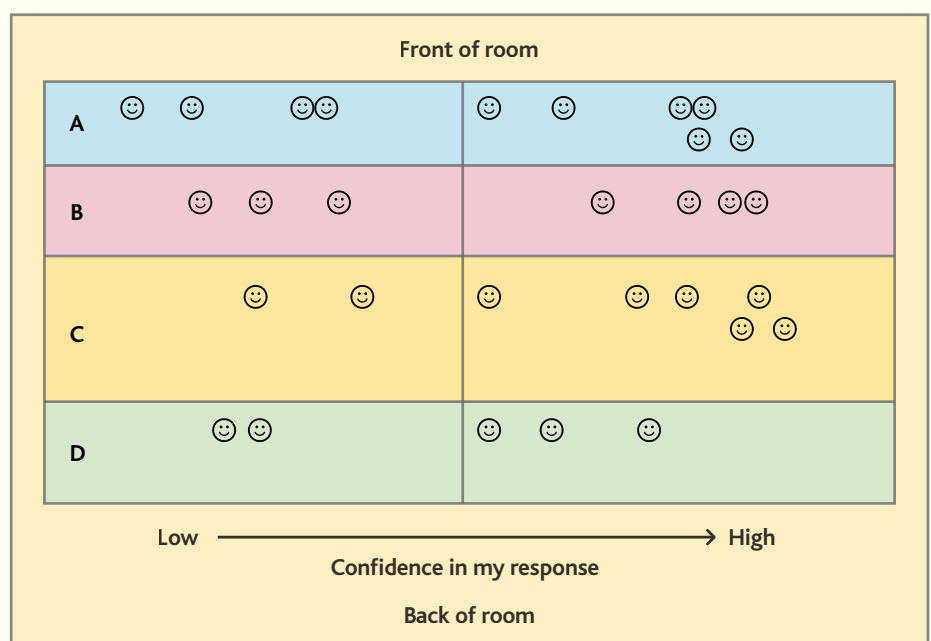
When you diagnose your interactions, you can find out if you are asking open vs closed questions, or you might be following the 'I-R-E waltz' in a pattern of Initiate-respond-evaluate. Researchers such as Mortimer & Scott⁸ advocated extending the questioning into initiate-respond-prompt-respond-prompt [I-R-P-R-P] so that immediate evaluation and therefore closing the response down did not occur too quickly. You could try Pose-Pause-Pounce-Bounce (pose a question, pause for wait time, pounce on a student to answer, then bounce their answer off to someone else: 'what did you think of Sarah's answer?'). A great source of other ideas is Doug Lemov's book [Teach like a Champion](#)⁹ such as:

1. Stretch It (listed as technique 3): even when a student has given you the right answer, keep on probing for more detail.
2. Right is Right (listed as technique 2): don't accept partially correct or incomplete answers.
3. Cold Call (listed as technique 22): you call on students regardless of hands-up.

By the use of judicious questions as 'hinge points'¹⁰ we can test whether to move on with the plan, or stay with a learning need. These can be both discussion and diagnostic questions, and offering multiple choice options can reveal a great deal about student thinking. They could make their responses on mini-whiteboards, ABCDE cards, voting systems such as [Socrative](#), pointing or moving to labelled Corners, and as a human scatterplot within the room¹¹ such as shown below. This can work well as multiple choice responses combined with a confidence line.

Providing feedback that moves learning forward

Feedback presents us with a dilemma as teachers. We tend to look on feedback as providing comment, clarification or criticism as well as next steps, but students tend to stop at the comment rather than act on the prompt. As Alfie Kohn said: 'never grade the students while they are still learning. They will stop learning as soon as they get the grade'. Whilst we are unlikely to change the current high-stakes accountability of GCSE grades, we can choose when and where we use them in formative feedback practices.



To be effective, the feedback has to focus the students' attention on what they need to do next; *Feedback should cause thinking*¹². We therefore have to allow class time to get this thinking to instigate improvement. Feedback during the learning instance is far more productive than at the endpoint, or realistically, when you have marked the books and returned them the following week. To enable this, try 'two-thirds teaching', where feedback can be given by peers whilst there is still a third of the lesson time to utilise it. This could be in the form two stars and a wish/question. Feedback grids can be used by the teacher and/or peers to indicate the extent to which the designated success criteria have been met:

Success Criteria	1	2	3	4	5	6	7
Met or not?	😊	😊	😊	😞	😊	😊	😞

Wiliam (2011) has distilled his decades of AfL research into three principles of feedback:

1. Feedback should be more work for the recipient than the donor. When we consider the amount of time we spend in crafting 'great' feedback for students, this is wise advice indeed.
2. It should be focused: less is more. Good feedback practices aim to increase the extent to which students own their learning, and so specific and good quality feedback matters more than 'lots'.
3. It should relate to the learning goals/success criteria, so that the students react to improve rather than emotionally.

A current strategy in many schools is the targeted use of 'three questions' at the end of marked work. A notation is made in the body of the work that a subsequent question challenges in some way, asking the student to work on this further. Sometimes this is done as [DIRT](#) [dedicated improvement reflection time] at the start of the next lesson. What about the students who have got everything 'right'? Even your higher achievers can be stretched in using this method, by making the focus on metacognition and/or self-regulation about their own learning. We need to remain watchful though for the strategic learners who don't put so much effort into the initial piece of work, knowing that they will have time to improve it after input from their teacher! You will find summaries of other ideas [here](#), and there are Seven Strategies that improve Metacognition in [this article](#).

Activating students as instructional resources for one another

Many research projects over decades have shown the value of cooperative learning has academic achievement and social and cognitive development¹³. Slavin *et al*¹⁴ discuss the impact on motivation, social cohesion, personalisation and cognitive elaboration (at all levels of achievement), but what seems to matter the most for it to be really successful is the presence of a meaningful group goal to work towards, and an accepted notion of individual accountability so that no-one mentally puts their feet up.

You can choose group structures that have different functions. For example, if you wanted to introduce cooperative learning, you may wish to focus on student arrangements that develop team building, and social and communication skills. Round Robin and Timed Pair Share emphasize turn taking, and Find Someone Who, Inside-Outside Circle and Corners are good for talk. Classics for knowledge building include Quiz-Quiz Trade, Jigsaw, Showdown with mini-whiteboards, and Numbered Heads Together. Structures that are good for procedural learning, processing information and thinking skills are Sage-N-Scribe, See One-Do One-Teach One, Fan-N-Pick, Blind Sequencing and Find My Rule. For presenting, try out Carousel Feedback and One Stray for structures that avoid presentations to the class, moving to Rally Table and Team-2-Team presentations. You can find lots more ideas in this really useful [compendium of structures](#).

The teacher remains the voice of authority in the room however, and students will often seek their approval or confirmation. C3B4ME is a practical way of ensuring this doesn't happen too quickly, where the students have to have consulted at least three other students or sources first. Sometimes the B's are taken to stand for brain, book and buddy, and you could put a poster on the wall saying 'there is more than one teacher in this room'.

Activating students as owners of their own learning

Students have different emotional drivers towards their studies. Some have learning goals; the learning itself is a challenge that they enjoy. Others have performance goals, where getting the grade is the important thing. All can benefit from recognising and improving how they learn, and how they approach and manage their learning. These are known as metacognition and self-regulation respectively.

The feedback that we use has profound implications for how this improvement and ownership is achieved. Hattie & Temperley¹⁵ described 4 'levels' of feedback, and Hattie¹⁶ then gave approximate percentages of these as:

1. Task (59%) – how well someone performs on a task, or product, usually information-based, for example, 'how their answer meets the success criteria, and how they might improve this further'.
2. Process (25%) – aimed at the processes used to complete the task, for example, strategies for error-detection, or effective data-gathering, for example, 'what is wrong, and why? What are the relationships between this-and-this part of the task?'
3. Self-regulation (2%) – enabling students to monitor and direct their learning, raise confidence and be willing to invest in making the effort, for example, 'what learning goals have you achieved? How did your ideas change during the task, and why?'
4. Self or praise orientated (14%) – praise, often generic, such as 'You're a great student! Well done!'

From this it can be seen that we tend to feedback on the task or product the most, perhaps because it is easier to do so. It takes longer to craft feedback that recognises and/or suggests future strategies, or integrates motivational aspects. Whilst reporting in grades is here to stay, what we have to do is build in lower-stakes formative assessments where the process of learning is valued and reported back on, rather than the product, and during that process, help create more self-regulated learners, improving resilience and persistence.

Using GCSE tests and questions formatively (ie ungraded) is a way to critically engage with content, working scientifically, and the varying cognitive demands of the GCSE assessment objectives in a non-judgmental way. Using techniques such as No hands up, Popsicle sticks and No Opt Out (Lemov's Technique 1, see above) are valuable in maintaining the expectation that it's not OK not to at least try, thus reinforcing aspects of effort and strengths. It is hard for many students to self-reflect on their learning in a positive way, so sensitivity is needed so that it is not viewed as rubbing salt into the wounds. This reinforces the earlier sections on feedback related to the learning goals so that it is objective, and to the positive learning environment that the supportive teacher creates.

Next Steps

1. Choose a particular section to focus on. Audit what your practice is like in this area; you might want to involve another colleague to observe your questioning practice for example.
2. Once you have analysed your current practice, try out one of the ideas here and evaluate its impact on student learning, including asking the students what they think about the intervention.
3. You could then try another technique within the same section, or in a different area to both deepen and extend your repertoire.
4. Look through the [hand-picked resources](#) which accompany this guide.
5. This guide has been a starting point and we hope that you have found it useful. For greater impact, the National STEM Learning Centre and Science Learning Network offer a [range of continuing professional development opportunities](#), both online and face-to-face, to help education professionals develop and embed good practice in assessment for learning.

References

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