Best Evidence Science Teaching

Approaches
Response activities

Diagnostic questions provide evidence of students' learning in science, and are a key means of identifying students' difficulties and misunderstandings. It is important that the information they provide is used to inform subsequent teaching to help students progress. But what is an effective way to respond to a specific misunderstanding? And how can response activities be used to adapt teaching to maximise students' learning?

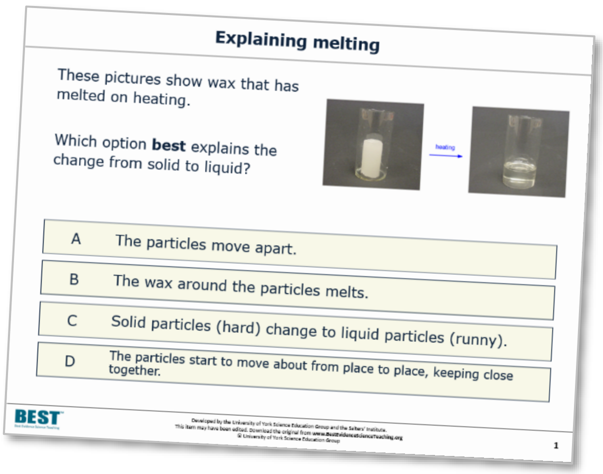
Responding to the evidence provided by diagnostic questions

There is very strong research evidence that formative assessment and the effective use of feedback both have large positive effects on learning outcomes (Education Endowment Foundation, 2018; Hattie, 2008; Black and Wiliam, 1998). Assessment is formative if it provides feedback to the learner and to the teacher which is then used to help decide what to do next. The key to this is using the evidence gained to contribute directly to the learning process by informing what should happen in response.

> *The most powerful single modification that enhances achievement is feedback. The simplest prescription for improving education must be 'dollops of feedback'.*
>
> John Hattie, *Australian Journal of Education* (1992)

The diagnostic questions provided in the *Best Evidence Science Teaching (BEST)* collection are designed to be embedded into science lessons and used formatively. You can read more about them in our approaches article entitled 'Diagnostic questions'.

However, deciding exactly what to do next in response to the information provided by a diagnostic question can be difficult. Consider the example shown on the right. It presents photographs of wax before and after melting, and students must select the answer that best explains the change from solid to liquid.



Explaining melting

These pictures show wax that has melted on heating.

Which option **best** explains the change from solid to liquid?

A	The particles move apart.
B	The wax around the particles melts.
C	Solid particles (hard) change to liquid particles (runny).
D	The particles start to move about from place to place, keeping close together.

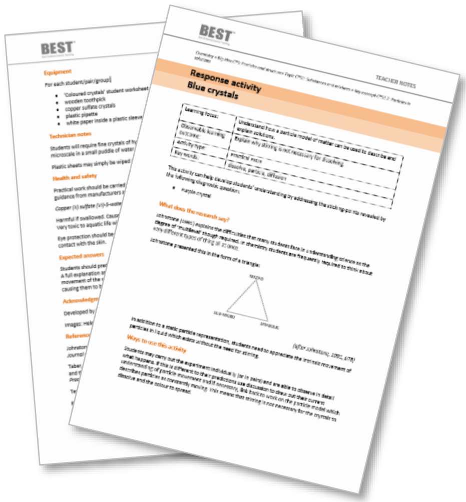
When this question was trialled with a class of 11-year-old students, the response rates were:

- A – 11 students
- B – 5 students
- C – 7 students
- D – 7 students

What would *you* do next if you got this pattern of responses from *your* class?

Every diagnostic question in the *Best Evidence Science Teaching (BEST)* collection is provided with teacher notes that describe what the answers reveal about students' misunderstandings, and suggest approaches for responding. Most diagnostic questions in the BEST collection are paired with specific **response activities**.

Response activities



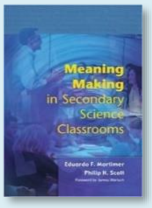
A response activity can be used to address a misunderstanding or to build a more secure understanding of a concept. Response activities can encourage **meaning making** through discussion that challenges misunderstandings, and can consolidate **scientific thinking** through hands-on activities and purposeful practical work.

Some useful formats for response activities are presented and discussed in the appendix of this article.

The response activities in the BEST collection are developed from research evidence to address specific learning needs. Teacher notes give clear guidance on using the activity, together with a summary of the relevant research.

Discussion as response

A discussion that gives students the opportunity to reason, discuss, argue and explain their thinking will help them develop a more robust scientific understanding.



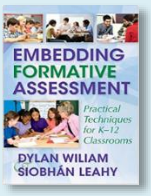
> *Talk enables the students to engage consciously in the dialogic process of meaning making, providing the tools for them to think through the scientific view for themselves.*
>
> Eduardo Mortimer and Philip Scott, *Meaning Making in Secondary Science Classrooms* (2003)

Collaborative small-group discussions in science lessons are advocated as a means of helping students develop and reflect on their thinking about commonly misunderstood ideas. Research has identified features of small-group discussions that have a positive impact on understanding, which include the nature of the discussion stimulus and the provision of concrete guidelines for teachers and students on running effective discussions (Bennett et al., 2005; Bennett et al., 2010; Cheung et al., 2015).

Hattie ranks collaborative learning as one of ten teaching interventions most likely to improve student achievement (Hattie, 2008). There is also some evidence that structured small-group discussions encourage participation from a broader range of students (Cheung et al., 2015; Sharples et al., 2011; Hanley, Slavin and Elliott, 2015; Nunes et al., 2017).

Response activities in the *Best Evidence Science Teaching (BEST)* collection include structured small-group discussions and whole-class dialogic discussions, each with stimulus material and suggestions for how to structure the talk. Whole-class dialogic discussion is high quality teacher-led talk that enables students to reason, discuss, argue and explain, rather than merely respond.

How can response activities be used to adapt teaching to meet a learning need?



> *The shorter the time interval between eliciting the evidence and using it to improve instruction, the bigger the likely impact on learning.*
>
> Dylan Wiliam and Siobhan Leahy, *Embedding Formative Assessment: Practical Techniques for K-12 Classrooms* (2015)

Response activities are designed to be used immediately after a diagnostic question, when students' answers to the diagnostic question suggest that they hold misconceptions and that a response activity to challenge these would be helpful.

The *Best Evidence Science Teaching (BEST)* collection provides **progression toolkits**, in which diagnostic questions and associated response activities are linked to observable learning outcomes arranged in a progression pathway. In planning for a lesson a teacher can use a progression toolkit to identify and prepare one or more response activities to use in a lesson. During that lesson the most relevant activity can be used to respond to students' understanding, as revealed by a diagnostic question. Diagnostic questions can also be used at the end of one lesson to inform planning for the next.

Acknowledgement

Article written by Peter Fairhurst (UYSEG).

References and further reading

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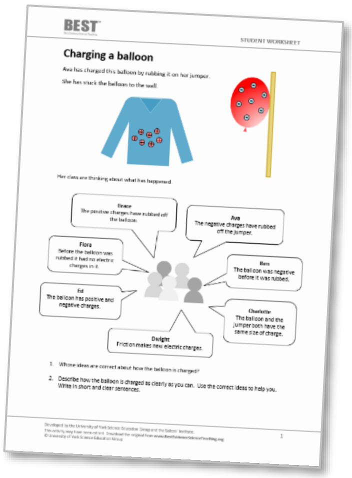
Appendix: Useful formats for response activities

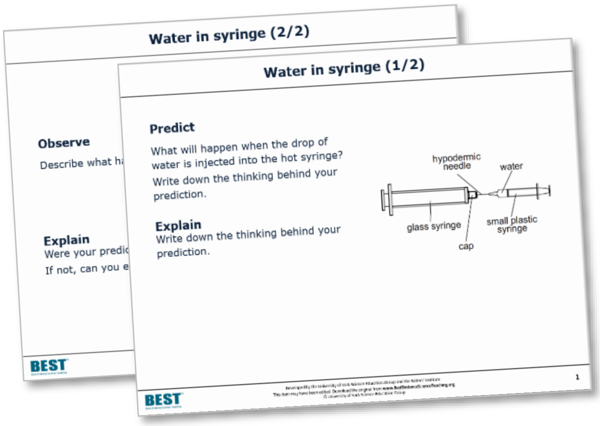
Paired or small group collaboration on a task



This is a classroom task that students complete in pairs or small groups. They follow instructions on either a PowerPoint slide or a worksheet, and the focus of the activity is discussion that is structured around an activity. The teacher can listen into the conversations of each group to pick up insights into how the students are thinking.

At the end of the activity, a structured whole-class discussion is used to give students the opportunity to compare and consolidate their thinking.

Structured practical work

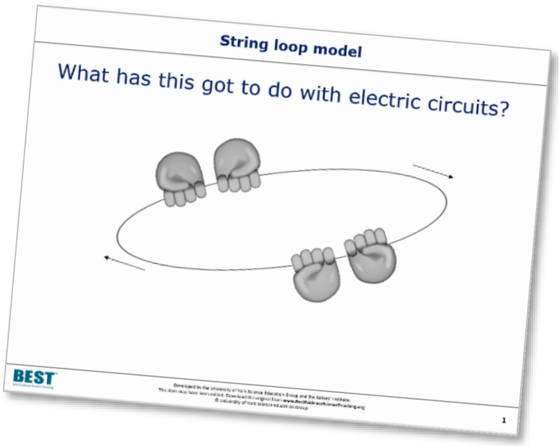


This response activity is very like a small group task based around a practical activity. The practical work is carried out to challenge misunderstandings and / or to develop the students' scientific understanding of a concept.

The focus is around discussion of an idea. Often students are asked to work in small groups to make and justify a prediction. A practical, or demonstration, is then carried out to challenge or confirm students' thinking, and each group is given the opportunity to improve their original explanation.

At the end of the activity, a structured whole-class discussion is used to give students the opportunity to compare and consolidate their thinking.

Whole class, dialogic teaching



This response activity is a structured whole-class discussion based on a demonstration or a model.

A set of clear learning points and question prompts are provided in the teacher notes. These are formed from research evidence of student thinking, that help challenge common misunderstandings or develop a more secure understanding of a concept.