

# Using a backward design approach to embed assessment in teaching

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**ABSTRACT** Backward design provides a framework for curriculum planning that can be used at unit, course or school level. The approach places assessment at the heart of the planning process. In this article the ideas of backward design are outlined and their application to a current curriculum development project, *York Science*, is described.

With a new National Curriculum, new GCSEs and new A-levels on the horizon in England, many teachers will be thinking about their current schemes of work and wondering how much they will need to adapt them to meet the demands of the new curricula. Some may use this as an opportunity to take a harder look at their schemes, giving them more than the ‘tweak’ needed to meet new content demands. Planning a scheme of work for a new topic is challenging; this was recognised when the first National Curriculum was introduced in 1989. At that time, publishers produced textbooks but there were no detailed schemes of work of the kind we have become used to. So, alongside the attainment targets and programme of study, the Department of Education and Science (DES) supplied non-statutory guidance that included a section titled ‘Constructing a scheme of work’ (DES, 1989). However, this guidance made no mention of the national tests that were introduced for the end of each key stage and that would be based on this curriculum. When planning the teaching for a new examination course, many teachers will *begin* by looking at the sample assessment materials; after all, they show what students will need to be able to do at the end of the course. The assessment makes explicit what the learning outcomes really mean.

## Backward design

Thinking about assessment early in the planning process helps to clarify the intended outcomes, which in turn helps to determine the most appropriate learning activities; this has been described as curriculum planning by reverse

engineering. The term ‘backward design’ was introduced by Grant Wiggins and Jay McTighe to describe the curriculum design process in their book *Understanding by Design* (Wiggins and McTighe, 2005) (see *Websites*). As would be expected from the title, the authors’ aim is to help teachers design a curriculum that puts the development of deep and enduring understanding at its core.

Wiggins and McTighe identify what they term the ‘twin sins of traditional design’:

- activity-oriented planning, ‘hands-on without being minds-on’;
- planning for ‘coverage’, concentrating on teaching the content.

They suggest that, while these approaches might lead to classrooms that look productive, in the first case physical activity and talk, and in the second case teacher exposition and student note-taking, the result is the same: students who cannot see the intellectual purpose of the lesson.

To avoid these sins, they propose a curriculum planning process that is based on two key ideas:

- a focus on teaching and assessing for understanding and learning transfer;
- designing a curriculum ‘backward’ from those ends.

The backward design approach puts the focus clearly on learning outcomes, and on the questions and tasks that will provide evidence of that learning. The process is divided into three stages.

- **Stage 1: Identify learning intentions**  
What do we want students to know, understand and be able to do? What are the

enduring understandings that we want students to gain? What learning do we want students to be able to transfer?

- **Stage 2: Evidence of learning**

How will we know that a student has or has not achieved the learning outcomes? What questions and tasks will provide evidence of achievement, or identify students who have not yet succeeded in the intended learning? What are the criteria for success?

- **Stage 3: Developing learning activities**

What instructional activities and instructional sequence will enable as many students as possible to succeed at the kinds of task that provide evidence of the intended learning?

### An iterative process

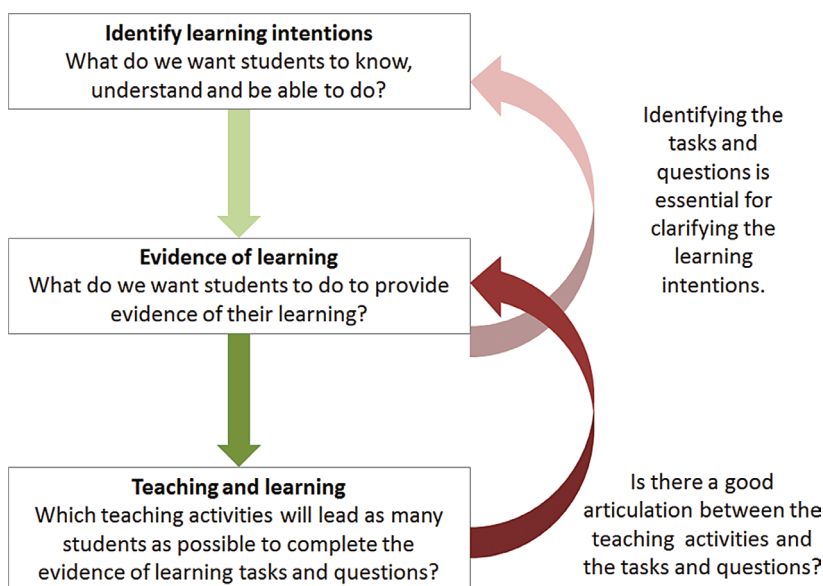
Although there are three stages identified in this process, Figure 1 shows that there is not a linear progression from Stage 1 to Stage 3 and on to implementation. The process is iterative, with work on one stage feeding back into revisions and improvements of the others. For example, writing questions and tasks in Stage 2 is likely to identify ambiguities in the original list of learning outcomes, which must then be revisited. A favourite teaching activity might be proposed, but there may be difficulty in saying exactly what students are expected to learn from it. If the

intended learning outcomes cannot be identified, this suggests that the activity may need amending. This approach is also recommended to those developing innovative activities for teaching science; as part of the process, the developer should be clear about the intended learning outcomes of the activity and the questions and tasks that will provide evidence of that learning.

### Big ideas and essential questions

When thinking about the learning intentions for a sequence of lessons, Wiggins and McTighe suggest that curriculum designers need to think beyond the specific statements in national standards or specifications to ensure that students gain a sense of the ‘big ideas’ of the subject. Big ideas have the power to explain a wide range of phenomena that students will meet both in lessons and in their future lives. Having the big ideas in mind when planning teaching, and making them explicit to students, should help to bring meaning to what might otherwise appear to be a collection of discrete facts.

What are the ‘big ideas’ in science? Not everyone is likely to agree on the answer to that question but, for science teachers who want to read what some leading science educators and scientists think are the big ideas in science, a good place to start would be *Principles and Big Ideas of*



**Figure 1** The three stages in the process of backward design based on the work of Wiggins and McTighe (2005)

*Science Education* (Harlen, 2010) and the Science Community Representing Education (SCORE) report *Guidelines for the Content of Key Stage 4 Qualifications* (2013).

To keep the big ideas in mind during the early part of the planning process, Wiggins and McTighe suggest that designers include an ‘essential question’ that might be answered (probably only partly) over the sequence of lessons – an essential question is one that will ‘*foster inquiry, understanding, and transfer of learning*’ (Wiggins and McTighe, 2005: 22) (Box 1).

McTighe and Wiggins (2013) distinguish between essential questions and ‘hook questions’ that might be used to engage students in the learning. For instance, at the beginning of a topic about nutrition they suggest an essential question might be ‘What should we eat?’, but the hook question for the sequence of lessons might be ‘Can what you eat prevent zits?’. Both these kinds of question are useful – they can be used to help students understand why they might want to know the science we are trying to teach; as Millar (2012: 28) has suggested, ‘*Science teaching can too often be described as “giving students answers they don’t understand to questions they have never asked”*’.

The process described briefly here, and in much more detail in Wiggins’s and McTighe’s materials, is not a recipe but a way of thinking about curriculum planning – at a subject level

or even at a school level. Although Wiggins and McTighe do not recommend using their framework at the level of planning an individual lesson (for instance, it is not necessary to think of a new ‘big question’ for every lesson), the backward design approach of thinking about the learning intentions for each lesson and what will count as evidence of learning *before* determining the teaching activities is just as appropriate at the lesson planning stage as it is when planning a longer teaching sequence.

### Not just exams and tests

Of course ‘evidence of learning’ does not just mean answers to questions in examinations or end-of-topic tests; teachers will be looking for evidence of students’ progress in their learning throughout the teaching sequence. As Dylan Wiliam (2011: 46) has written, ‘*assessment is the central process in instruction*’. Putting assessment at the centre of lesson planning comes easily with the backward design approach:

- 1 Identify the learning intentions for the lesson.
- 2 Identify the questions and tasks that will be used during the lesson to elicit evidence of learning – some items may be needed at the beginning of the lesson to establish prior knowledge and understanding within the class, and there may be a need for assessment items during the lesson to check progress and others at the end of the lesson to determine what should happen next in the learning sequence.
- 3 Identify the teaching activities that will develop the students’ learning and enable them to succeed in the questions and tasks identified in Stage 2.

Looking for evidence of learning during the course of a lesson is at the heart of formative assessment. Teachers need to be able to react to the information that such assessment provides to determine how the lesson proceeds; for teachers to be able to do this they need to have a clear idea of what the outcomes of a successful lesson will look like and how they might get there (Hattie, 2012).

### Putting backward design into practice

In the Science Education Group at the University of York, our most recent project, *York Science*, is using the ideas of backward design to develop resources for key stage 3 (age 11–14) science. The aim of the project is to develop teaching materials

#### BOX 1 Characteristics of a good essential question

A good question is essential if it is meant to:

- 1 cause genuine and relevant inquiry into the big ideas and core content;
- 2 provoke deep thought, lively discussion, sustained inquiry and new understanding as well as new questions;
- 3 require students to consider alternatives, weigh evidence, support their ideas and justify their answers;
- 4 stimulate vital, ongoing rethinking of big ideas, assumptions and prior lessons;
- 5 spark meaningful connections with prior learning and personal experiences;
- 6 naturally recur, creating opportunities for transfer to other situations and subjects.

(from Wiggins and McTighe, 2005: 110)

that help teachers to improve the quality of their students' learning in science. Based on experience and research evidence, we think that the two principal keys to improving learning are:

- having clear and precise learning outcomes in mind for every teaching episode;
- monitoring students' learning *during* the teaching process, so that you (or they) can immediately act on what you find.

Wiliam (2011) calls the second of these *embedded formative assessment*. We are working with science teachers to produce teaching resources and advice that enable teachers to put these principles into practice. Like Wiliam, the *York Science* team thinks that '*sharing high-quality questions may be the most significant thing we can do to improve the quality of student learning*' (p. 104).

After deciding what we want students to learn in a particular topic, we ask the more precise question 'What do we want a student to be able to do to show they have learned the things we want them to learn?' These 'things' could range from recalling and using information, to showing understanding of a concept, to being able to carry out a certain task skilfully. The next stage is to write questions and tasks that provide clear and convincing evidence of students' learning. In *York Science*, we call these questions and tasks 'evidence of learning items'. An effective

item focuses on a specific learning intention, so that students' responses are a good indicator of learning.

As an illustration of this thinking, let us look at an example. The (new) National Curriculum for Science (Department for Education, 2013a) states that in year 6 '*Pupils should be taught to... explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes*' (p. 33). A student needs to have a good understanding of this to make sense of the ray model that is prescribed in the programme of study for key stage 3 (Department for Education, 2013b). So, at the beginning of teaching about light in key stage 3, a teacher will want to know whether students understand how a person sees luminous and non-luminous objects. To obtain evidence of that understanding, they will need to set questions or tasks that give students an opportunity to explain how someone sees an object.

An example of a question from the *York Science* project that would give that evidence is shown in Figure 2. The figure is displayed on a whiteboard and students are asked to think about their answer. This is an example of a diagnostic question – the three incorrect choices are all commonly held ideas so this question not only identifies which children have the correct idea but also shows the thinking of those who do not have

## In the dark

Imagine you go into a cupboard under the stairs and close the door. There are no windows and the door is a very tight fit.

You switch off the light.

After sitting there for a while, what will you be able to see?



- A After a while, you will be able to see everything, but very dim.
- B The only thing you will see is the cat's eyes shining.
- C You will see the mirror shining dimly, but everything else will be dark.
- D You won't be able to see anything at all, no matter how long you wait.

Figure 2 What can you see in the dark?

a scientific understanding of how we see. The *York Science* project is using research evidence about children’s ideas about science to develop many such questions.

When setting diagnostic questions like these, a teacher might use a voting system or show of hands to find which answer the students think is correct. However, the ‘confidence grid’ in Figure 3 can give the teacher more evidence of the students’ thinking. The grid could be printed and each student ticks the boxes on the sheet, or students could be asked to work in groups to decide where they put the ticks, or the grid could be displayed on a whiteboard and students asked to put sticky notes into the grid to show their confidence in answering each part.

You can read more about how a teacher has used this question, and how she went on to use the idea of the confidence grid for other topics, on the *York Science* website ([yorkscience.org.uk/using-diagnostic-questions](http://yorkscience.org.uk/using-diagnostic-questions)), where there are also more examples of questions and tasks. You can also find some examples of questions from the *York Science* project in an article in the December 2013 issue of *School Science Review* (Whitehouse, 2012).

Working with teachers

We are working with teachers in a number of partner schools, mostly in the Yorkshire region. These teachers are evaluating the resources

and trialling them with students in class. The feedback has been very encouraging. One teacher who has used some of the materials said that ‘*The materials have caused me to reconsider my approach to lesson planning, and have been an excellent aid.*’ He went on to say that some of the questions (including the one in Figure 2) had caused him and his colleagues to realise that they had taken some understandings about light for granted.

The head of science in another school has talked along similar lines, describing how using the questions has revealed that some ‘*very able students had very weak understanding of key concepts and ideas*’. The materials have also informed a discussion within his department about whether curriculum has become too focused on content at the expense of the underlying concepts.

The key stage 3 coordinator in another of our partner schools has recognised the value of the backward design approach and we are supporting him in the redevelopment of the school’s key stage 3 scheme of work using *York Science* resources. This work has reinforced our view that there is a real need for a complementary professional development programme centred on the importance of assessment in the teaching process. For this reason we are developing a set of interactive professional development resources to go alongside the bank of questions and tasks.

	I am sure this is right	I think this is right	I think this is wrong	I am sure this is wrong
A After a while, you will be able to see everything, but very dim.				
B The only thing you will see is the cat's eyes shining.				
C You will see the mirror shining dimly, but everything else will be dark				
D You won't be able to see anything at all, no matter how long you wait				

Figure 3 A confidence grid

The project is developing evidence of learning items to cover all the important ideas in key stage 3 science. These tasks and questions can be embedded within the teaching and used formatively during lessons. Teachers using a

backward design approach to embed formative assessment in their teaching will need questions and tasks that provide high-quality evidence of learning. We hope that the *York Science* resources will become part of the teacher's toolkit.

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- Understanding by Design®: [www.authenticeducation.org/ubd/ubd.lasso](http://www.authenticeducation.org/ubd/ubd.lasso).

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