# Quality Questioning

Sue Brookhart, November 10, 2015

## Session Summary

The most helpful formative assessment relies on evidence of the quality of student thinking, as opposed to evidence of some amount of achievement as in a percent-correct score on an assessment. In other words, "how well" do they think, not "how much." This session will describe how to create questions that assess student thinking, concentrating on formative uses. Participants will learn:

- How to write open questions and even some kinds of closed questions that elicit evidence of student thinking
- How to interpret student answers in terms of what they are thinking, not just degree of correctness

The session will end with a brief comment on how these principles can be extended to create performance tasks that assess student thinking.

## Session Outline

- Generating principles for quality questioning
  - A Tale of Two Lessons, pp. 2-6
- Writing open questions
  - Examples to classify, pp. 7-8
  - Lead questions
  - Follow-up prompts and probes
- Interpreting student responses
- Reversing the effects of the I-R-E (Initiate-Respond-Evaluate) questioning sequence
- Teaching students to ask effective questions

# A TALE OF TWO LESSONS

Two third grade classes are having a science lesson on dissolving. In their previous lesson, both classes mixed a variety of solids and liquids together and the teacher asked the children to observe what happened. Both teachers have written detailed plans with the following clear learning objective – "Children should learn that some solids dissolve in water and that although the solid cannot be seen, it is still present." Both teachers have good classroom control and both have sufficient good quality equipment readily available. Their lessons proceed as follows.

**Teacher A**

Teacher: Right. Watch me as I show you what I want you to do today for science. Here is a beaker. I'm going to put in some water to about half way. I've got some salt here. I'm going to add a spoonful of salt to the water and stir it. Before I do that, tell me – is salt a solid or a liquid?

*Two pupils wave their hands in the air and teacher nods in the direction of one of them.*

Pupil W: A solid.

Teacher: Good. So I'm going to add this solid salt to the water. Is water a solid or a liquid?

*Ten pupils put their hands up. Teacher picks one of the lower achieving pupils to answer.*

Pupil X: A solid.

Teacher: Is it?

Pupil W: No, it's a liquid.

Teacher: That's right. So I add this solid salt to this liquid water and stir. Look the salt has mixed in with the water. You can't see it any more, but it's still there. We can use another sense to make sure of that – we could taste it. Salty water isn't harmful so we can taste it safely.

*Teacher dips finger in solution and tastes it.*

Teacher: Ugh! Salty. Now, when a solid mixes in with a liquid like this, so you can't see it any more, we say it has dissolved. And we call the mixture a solution. What I want you to do today is to mix some different solids with water to see if they dissolve. You will try three different solids, sugar, flour and sand.

*Teacher organizes the class into groups. Pupils collect equipment and work through the task, recording their results by putting a check or an X against the name of each solid to show whether it has dissolved or not. Teacher goes round to each group to make sure they are following the instructions and keeping to the task.*

Teacher: OK. You've all finished. What did you find out? Did the sand dissolve and form a solution with the water?

*Pupils all wave hands in the air. Teacher selects one to answer.*

Pupil Y: No.

Teacher: Good. And what about the sugar?

*Pupils all wave hands in the air again. Teacher selects one to answer.*

Pupil Z: It dissolved.

Teacher: Right. And the flour?

*Pupils all wave hands in the air. Teacher selects Pupil X to answer.*

Pupil X: Yes.

Teacher: Are you sure? Did it dissolve?

Pupil X: No.

Teacher: No, it didn't. So the only solid that dissolved in the water and made a solution was the sugar. Check that you've all got a check mark by sugar. Neither the flour nor the sand dissolved. Check that you put an X by them. Change it if you need to. Well that was pretty straightforward wasn't it? Well done. You've worked well today. Now clear away your equipment and you can go out to play.

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**Teacher B**

Teacher: Right. In our last science lesson we mixed some different materials together and described what happened. Some of you used this word.

*Teacher writes 'dissolving' on the board.*

Teacher: I've looked at your work and some of you seemed to be using the word dissolving in different ways. What we are going to do today is think about what we mean by dissolving. At the end of this lesson I will be looking for children who have a very clear idea of how we know when something has dissolved. OK. The first thing I want you to do is to imagine that a friendly alien has just landed on Earth and wants you to explain what dissolving means. Remember that the alien knows nothing about it. Work with your partner and decide what you would say. You have three minutes. Go.

*Teacher does not interfere with pupils while they are talking in pairs.*

Teacher: Right – I'd like to hear your ideas. Let's start with you two.

*Teacher indicates a pair of pupils.*

Pupil M: We thought that when something dissolves it disappears.

Teacher: Thanks, I'll write that on the board. Let's see if there are any other ideas.

*Teacher indicates another pair of pupils.*

Pupil N: We said that you have to mix things up to make them dissolve.

Teacher: So you're saying that dissolving is mixing things up. Have I got that right?

Pupil N: Yes, that's what we thought anyway.

Teacher: OK. That's another idea. I'll write that down.

*Teacher continues taking in a few more ideas and writing them on the board.*

Teacher: Thanks for that. You've come up with lots of ideas about the word dissolving. We'll look at our ideas again at the end of the lesson and see whether we still agree with them. Right, now what I want you to do is to try mixing three different solids – sugar, sand and flour – with some water. Get three beakers of water and add in a spoonful of each substance and stir them. While you do it, I want you to think about these three things:

*Teacher writes these three questions on the board.*

1. *What do the three materials look like before you mix them with the water?*

2. *Can something still be there, even if you can't see it?*

*3. What do you think the mixtures would look like if you left them to stand for a day?*

Teacher: You will be doing the practical work in groups. Each group needs to write out the three questions, so you can make quick notes beside them while you're doing the practical work. Try to make note of everyone's ideas. I will come around and see what you have said.

*Teacher moves among the groups referring to the three questions and challenging pupils to respond.*

Teacher: OK. You've all finished. Let's look at your ideas.

*Teacher takes in ideas and, with reference to previous work done with the class, establishes that all the materials they added to the water are solids.*

Teacher: What about the second question? Can something be there even if we can't see it? What did you think about that one?

*Teacher indicates a pair of pupils.*

Pupil P: We thought about other things that we know are there but we can't see them, like air.

Pupil Q: Yes. We thought that when the sugar mixes in, it might still be there in the water but we can't see it.

Teacher: OK – so you think the sugar is still there, even though we can't see it. Could you put your hand up if you agree with that?

*Most pupils put hands in the air.*

Teacher: Some of you didn't agree. Can I ask you (indicates pupil) to tell us why?

Pupil R: Yes. We weren't sure.

Pupil S: Part of me wants to say the sugar's still there, but another part of me says it can't be there if I can't see it.

Teacher: Um – yes it's hard isn't it? If you just use your eyes, it looks as if the sugar has disappeared. I wonder if it's worth thinking about other senses we could use to find out if the sugar's still there.

Pupils R & S: Oh – yeah! We could taste it.

Teacher: Right – good thinking. Sugar and water are safe to taste so will you two come and taste it.

*Pupils taste sugar solution and declare it to be sweet.*

Teacher: So we seem to be saying that the sugar is there because we can taste it, even though we can't see it. Now what about that last question? What do you think these mixtures will look like after one day? I know you've made some notes. Can you draw three quick sketches to show me what you think they'll look like?

*Teacher quickly walks round the class, seeing what is being drawn.*

Teacher: OK. Most of you seem to think the sugar and water and the sand and water mixtures will look the same as they do now. I've got some here that I mixed up yesterday. Let's see if you're right.

*Teacher produces prepared mixtures.*

Teacher: Looks like you're right. Now when it came to thinking about the flour and water mixture, you drew different pictures. Some of you thought it would stay as a cloudy mixture and some of you thought it would separate out. Let's see what happened.

*Teacher produces a flour water mixture, which has separated out.*

Teacher: So the flour and water didn't stay mixed. Now, you've got two minutes to think about which of the three solid materials dissolved in the water and how we can tell when something has dissolved.

*Teacher collects in responses and class works together to produce the following definition of dissolving for the visiting alien, 'Dissolving is when a solid mixes with a liquid so that you can't see any solid bits anymore. Even though you can't see the solid stuff, it is still there. When something has dissolved it stays mixed and doesn't separate out.' Class agrees that only sugar has dissolved. They compare this to their original ideas.*

Teacher: Turn to your partners and tell them something you've learned about dissolving today.

*Teacher collects in a couple of responses.*

Teacher: So do you think we've got a better idea of what we mean by dissolving?

Pupils: Yes.

Teacher: Scientists have to think hard about the words they use and what they mean, and today you've done just that. Well done. You've worked hard. Now clear away your equipment and you can go out to play.

From: Goldsworthy A. (2000) *Raising Attainment in Primary Science GHPD*, Reed Educational and Professional Publishing Ltd. 

**EXAMPLES OF TEACHER QUESTIONS - Elementary**

**Kindergarten reading, "Little Red Hen," characters and sequence of events**

- Who were the characters in the story? How would you describe them?
- What would you do if asked to help?
- How would you feel if you were the Little Red Hen?
- What lesson did the animals learn at the end of the story?

**First grade science, after reading "A Busy Buzzy Bee" (nonfiction).**

- What fact did you think was the most interesting and why?
- If you were a bee, what job would you prefer to do? Explain why.

**Second grade, Lesson on telling time to the nearest quarter hour**

- What are some ways that you have heard someone state the time?
- Why is it important to be able to tell time in a variety of ways?
- How many different ways can you find to divide a circular clock?

**Third grade science, Lesson on types of storms and how to stay safe during storms**

- What is the difference between a tornado and a hurricane?
- How are a blizzard and an ice storm similar? How are they different?
- How might a thunderstorm affect your spring or summer activities?
- What are some ways to stay safe during a storm? What would happen if you did not [mention the way the student named]?

**Fourth grade reading and social studies. In preparation for reading as story about a girl who lived in the Dust Bowl during the Great Depression, students did internet research about the depression and the Dust Bowl.**

- How is our life different from the lives of people who lived in the 1920's and 1930's?
- What were some solutions for the problems facing people during the Great Depression?
- How would you and your family react if weather conditions here became so bad around here that conditions were unlivable?

**Sixth grade Mathematics, Lesson on percents > 100% and < 1%**

- What do you think a percent like 101% might mean?
- What do you think a percent like 1/2 % might mean?
- When might we use a percent greater than 100% in school?

**EXAMPLES OF TEACHER QUESTIONS - Secondary**

**Ninth Grade Computer Science, Lesson on performing calculations and constructing graphs in Excel**

- How would you decide whether a pie chart or a bar graph would better represent your data?
- Why is it useful to create formulas and functions in Excel? [This was in response to a student question, "Why can't we just use a calculator?"]
- What advantages are there in being able to use cell references, and not just numbers, in formulas?
- How might you use a spreadsheet like this in your daily life?

**Ninth Grade Language Arts, Lesson on judging the credibility of an internet source**

- If you wanted to obtain more information about this web site, who could you contact?
- What other resources could you use to back up or reinforce information presented on this web site?
- How can you tell if the information contained on this web site is true or false?

**High School English, Lesson on poetry**

- What is poetry?
- Should poetry be left to your own interpretation? Why?
- Should the author's meaning for the poem be forced on the reader as the only legitimate interpretation? Why?

**High School Social Studies, Lesson on copyright laws**

- Why do you think we have copyright laws?
- What might happen if you use copyrighted material without permission?
- Do you feel that it is wrong to download music from the internet without paying for it?

**High School Chemistry, Lesson exploring the concept of "parts per million"**

- In your own words, what does "concentration" mean? Give an example of something that is very concentrated. Why is it concentrated?
- In your own words, what does "dilution" mean? When have you diluted something?
- If you have a 10% solution of food coloring, how many parts are food coloring and how many parts are water?