INTRODUCING FORMATIVE ASSESSMENT

HANDOUTS FOR TEACHERS

Contents

Acknowledgement:

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Handout 1: The importance of formative assessment

There are two main purposes of assessment:

- *Summative assessment* - to summarise and record overall achievement at the end of a course, for promotion and certification. Most 'high stakes' tests and external examinations are designed for this purpose. Summative assessment is also used to evaluate the relative effectiveness of a particular course, teaching method, or even an institution. Summative assessment is sometimes called *Assessment **of** Learning.*
- *Formative assessment* - to recognise achievements and difficulties at the beginning or during a course, so that teachers and students can take appropriate action. This type of assessment forms an integral part of all learning. Formative assessment is sometimes called *Assessment **for** Learning.*

The potential of formative assessment to improve learning

There is a wealth of research evidence that sets out the case for formative assessment. This is summarised by Black and Wiliam in several accessible publications (see below), most of which are freely downloadable from the Internet. These researchers set out to find out whether or not improving formative assessment improves learning.

> *"We checked many books and nine years' worth of more than 160 journals, and earlier reviews of research. This process yielded 580 articles or chapters to study. We prepared a review using material from 250 of these sources. All… studies show that… strengthening… formative assessment produces significant, and often substantial, learning gains. These studies range over ages, across several school subjects, and over several countries…" (Black and Wiliam, 1998)[1].*

Recommended reading

Black, P., & Wiliam, D. (1998). Inside the black box: raising standards through classroom assessment. King's College London School of Education.

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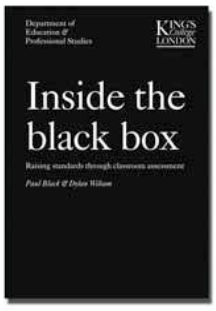

This short booklet offers a summary of the extensive research literature into formative assessment. It shows that there is clear evidence that using formative assessment raises standards, and suggests how formative assessment can be improved. This booklet is essential reading for all teachers.

[1] Paul Black and Dylan Wiliam, "Assessment and Classroom Learning," Assessment in Education, March 1998, pp. 7-74.

Handout 2: Difficulties with formative assessment

The research literature suggests that formative assessment practices are beset with problems and difficulties, as outlined briefly below.

Definition

Within FaSMEd formative assessment has been 'defined' as a deliberate *process* of gathering information about students' understandings and using this information to adapt teaching. However, there is still a general lack of clarity about what formative assessment actually is. For example, there are some (particularly publishers) who use the term to refer to an instrument such as a diagnostic test. In reality, each of these perspectives is perhaps an oversimplification; the process perspective underplays the importance of the instrument and the instrument definition appears to ignore process. Further, definitions of formative assessment generally do not take into account the importance of the subject area (e.g. mathematics or science) when in fact formative assessment within different subject areas can look very different.

Difficult and time-consuming

Doing formative assessment well is difficult. Whilst it is relatively easy to gather data in terms of, for example, students' responses to questions in classroom or students' self reported confidence levels, it is much more difficult to interpret this data in terms of the students' actual understanding. This requires the teacher to consider carefully responses of the students in terms of their own knowledge about mathematics, the curriculum, prior experience of the class and the learning trajectory of the individual student and to make an inference about the student's understanding. The teacher then needs to provide useful feedback to each student, which again requires considerable expertise and thought. It is almost impossible for teachers to provide detailed descriptive feedback for each student more than occasionally. Providing meaningful feedback is time-consuming and requires significant and sustained dedication from the teachers.

Planning and coverage

Formative assessment, by definition, requires the teacher to act on the information he or she receives from the students, usually by adapting teaching. This might mean abandoning previous plans for the lesson and make in-the-minute decisions about what to do next.

Teachers sometimes complain that, if they are serious about reacting to the data they collect about their students' understandings, then they may have to dwell longer on certain topic areas than envisaged, which means that they may not have time to cover the whole syllabus.

Accountability

In many countries, schools work within a culture of accountability and senior managers require evidence of some kind of objective measurement of students' performance at each level. Formative assessment, by its fleeting nature, does not provide that kind of accountability. This means that school managers have limited ways in which they can monitor formative assessment and hence they feel uncomfortable about teachers using it.

Expectations

Many parents do not know what formative assessment is. In many cultures, parents tend to expect formal (summative) tests and grades throughout the school year.

To a large extent, a formative assessment classroom requires commitment to the process by students as well as teachers. Students need to take responsibility for their own learning by responding to feedback from the teacher or their peers. In many classrooms, students are reluctant to do so, wanting rather to be told what to do and expecting grades and marks.

How far are the difficulties summarised here valid in your context?

If any are, then what could be done about them?

"I know it makes sense to assess students as we go along, but how can I, in the midst of a lesson, know what each of my 30 students is thinking?"

How would you answer this teacher?

Handout 3: Principles and strategies for formative assessment

Formative assessment may be defined as:
"… all those activities undertaken by teachers, and by their students in assessing themselves, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. Such assessment becomes 'formative assessment' when the evidence is actually used to adapt the teaching work to meet the needs." (Black & Wiliam, 1998)

Make the objectives of the lesson explicit[2]

Share the objectives with students and from time to time ask students to produce evidence that they can achieve these objectives.

> "Make up an example to show me that you know and understand Pythagoras' theorem."
> "This lesson was about you deciding what methods to use. Show me where you did this."

Students may find it difficult to appreciate that some lessons are concerned with understanding concepts, while others are more concerned with developing mathematical practices.

Making objectives explicit doesn't mean writing them on the board at the beginning of the lesson, but rather referring to them explicitly while students are working. If the objectives are to develop mathematical practices, then in plenary sessions ask students to share and compare approaches, rather than answers.

Assess groups as well as individual students

Group activities allow many opportunities to observe, listen, and question students. They help to externalise reasoning and allow the teacher to see quickly where difficulties have arisen. Moreover, working in groups helps students to peer-assess and function as instructional resources for one another.

Watch and listen before intervening

Before intervening in a group discussion, wait and listen. Try to follow the line of reasoning that students are taking. When you do intervene, begin by asking them to explain something. If they are unsuccessful then ask another student to help.

Use divergent assessment methods ("Show me what you know about...")

Convergent assessment strategies are characterised by tick lists and can-do statements. The teacher asks closed questions in order to ascertain whether or not the student knows, understands or can do a predetermined thing. This is the type of assessment most used in written tests.

Divergent assessment, in contrast, involves asking open questions that provide students with opportunities to describe and explain their thinking and reasoning. These questions allow students to surprise us - the outcome is not predetermined.

Change teaching to take account of assessment

As well as providing feedback to students, good assessment feeds forward into teaching. Be flexible and prepared to change your teaching plans in mid course as a result of what you discover.

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[2] These principles are adapted from: *Improving Learning in Mathematics*, Department for Educational and Skills, 2005

Give constructive, useful feedback

Research shows that responding to students' work with marks or levels is usually ineffective and may even obstruct learning: it results in students comparing marks or levels and detracts from the mathematics itself. Instead, use qualitative oral and written comments that help students recognise what they can do, what they need to be able to do and how they might narrow the gap.

Five key strategies

Research[3] suggests that formative assessment uses five key strategies:

1) Clarifying/ Understanding/ Sharing learning intentions and criteria for success,
2) Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding,
3) Providing feedback that moves learners forward,
4) Activating students as instructional resources for one another,
5) Activating students as owners of their own learning.

Which of these principles and strategies do you use in your own teaching?

Which are most difficult to implement?

What other principles or strategies would you add to the list?

[3] Wiliam, D., & Thompson, M. (2007). Integrating assessment with learning: what will it take to make it work? In C. A. Dwyer (Ed.), The Future of Assessment: Shaping Teaching and Learning (pp. 53-82). Mahwah, NJ: Erlbaum.

Handout 4: Problem-solving in the classroom

Situations and problems arising in the real world are usually messy and complicated. To address them, and come to some sort of solution, we need to sift through the information given to choose what is needed, simplify and model situations, select appropriate knowledge and processes and test whether solutions appear to be reasonable.

Classroom problem solving tasks aim to help students learn the skills they will need in the real world. They often prove more difficult than the individual elements of mathematical content would suggest, as students are required to choose and combine techniques in non-routine ways. There are usually a range of 'good enough' answers, making it difficult to assess problem-solving. However, formative assessment approaches can give the teacher a good idea of the students' understanding.

The following phases of problem solving provide a useful way of analysing students' work on these tasks:

- Formulate questions, choose appropriate representations and techniques.
- Reason logically, construct hypotheses and arguments, compute accurately.
- Interpret and evaluate results obtained.
- Communicate and reflect.

Handout 5: *Counting trees* and **Handout 6:** *Cats and kittens* present examples of two tasks, each with four sample responses.

Read through both tasks then choose one task that will be most suitable for a class you will soon teach. If you are working on this module in a group, it will be helpful if each participant chooses the same task, as this will make the follow-up discussion easier.

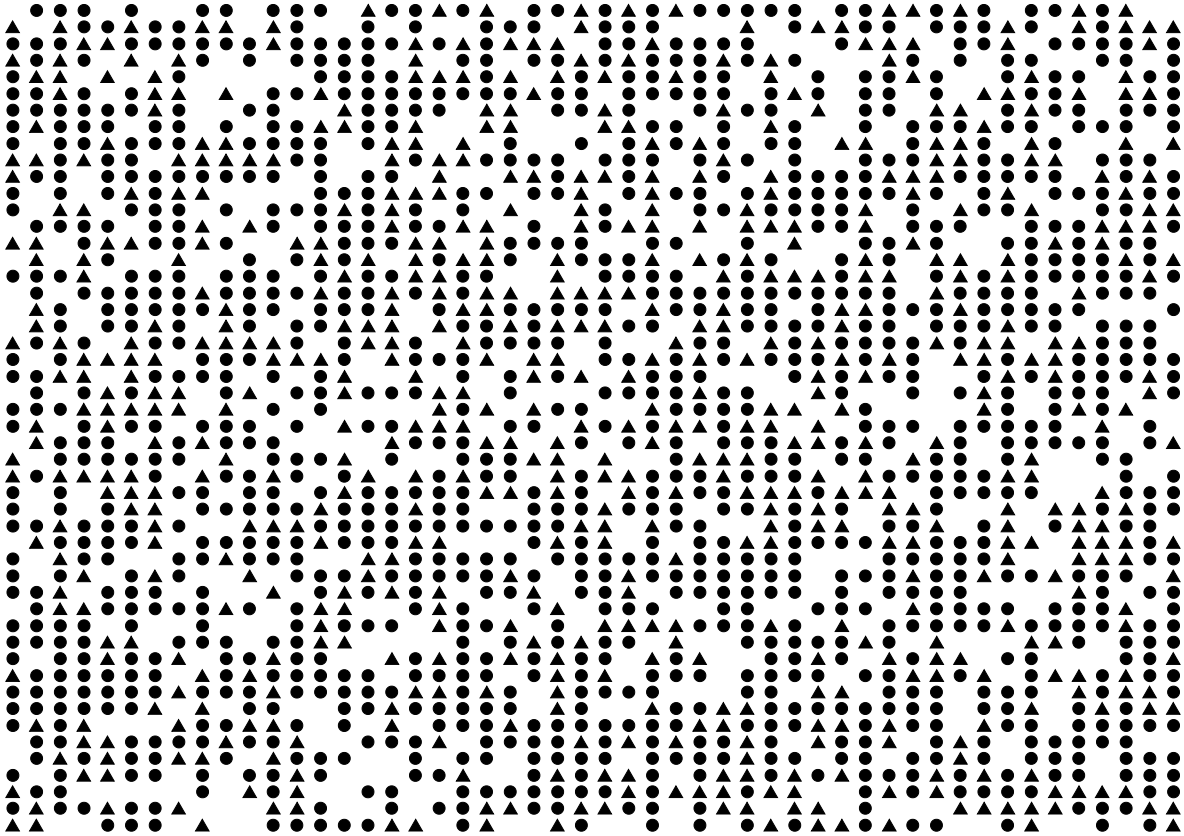
Consider the four student responses. Think about what each student's response tells you about his or her capacity to use each of the processes required in problem solving: represent, analyse, interpret and evaluate, communicate and reflect? Consider what you can infer from their responses about what they do and do not understand.

The handouts offer some comments on students' responses to each of the tasks. They provide a space under each comment for you to suggest questions you could ask each student to help them improve their responses. Try to frame this help in the form of oral questions you could ask in the classroom.

You may find it helpful to refer to the generic questions given on **Handout 7**: *Suggestions for questions.*

Handout 5: Counting trees

Counting Trees



This diagram shows some trees in a plantation.

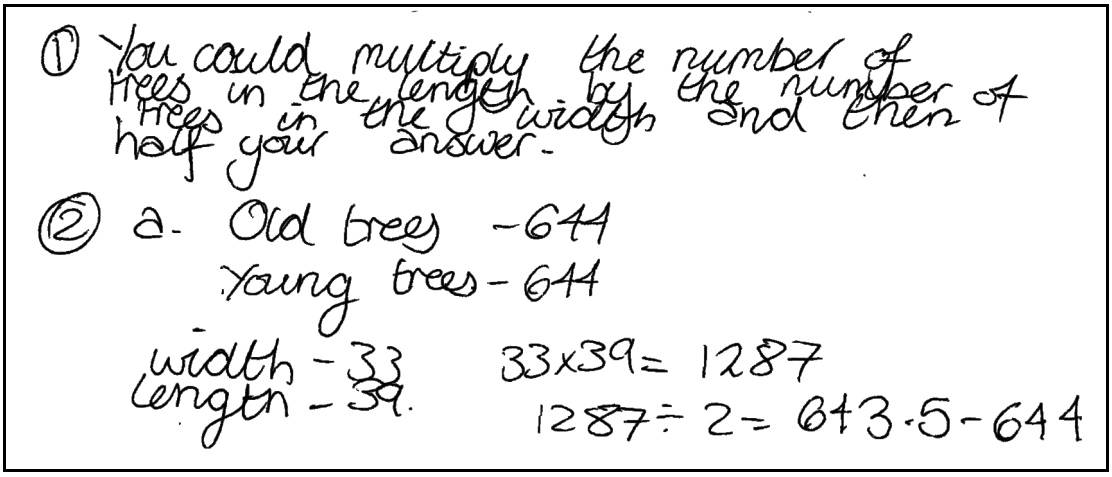
The circles ● show old trees and the triangles ▲ show young trees.

Tom wants to know how many trees there are of each type, but says it would take too long counting them all, one-by-one.

1. What method could he use to estimate the number of trees of each type? Explain your method fully.
2. On your worksheet, use your method to estimate the number of:
   - Old trees
   - Young trees

Note: this task is also discussed in the professional development module *Students becoming assessors.*

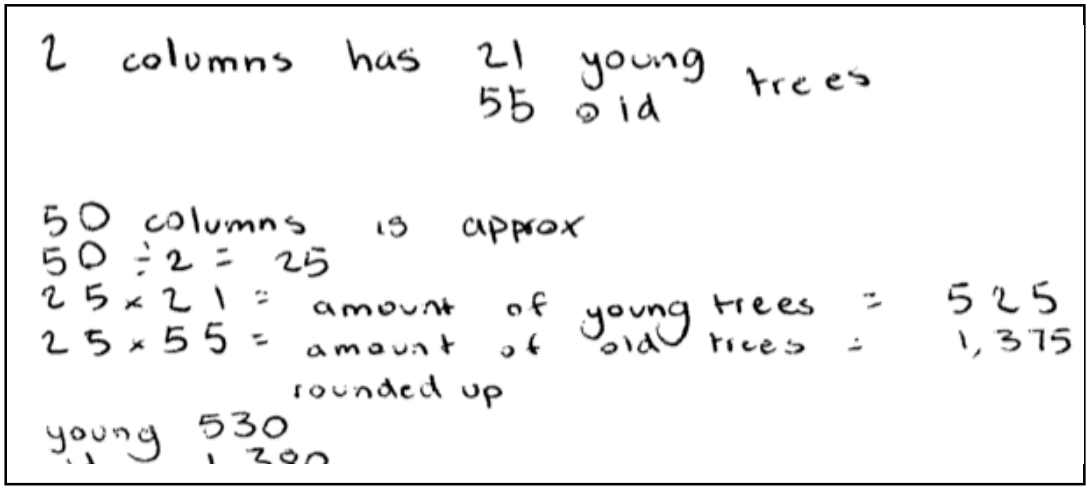
Sample response: *Laura*



Laura attempts to estimate the number of old and new trees by multiplying the number along each side of the whole diagram and then halving. She does not account for gaps nor does she appear to realise that there are an unequal number of trees of each kind.

What questions could you ask Laura that would help her improve her response?

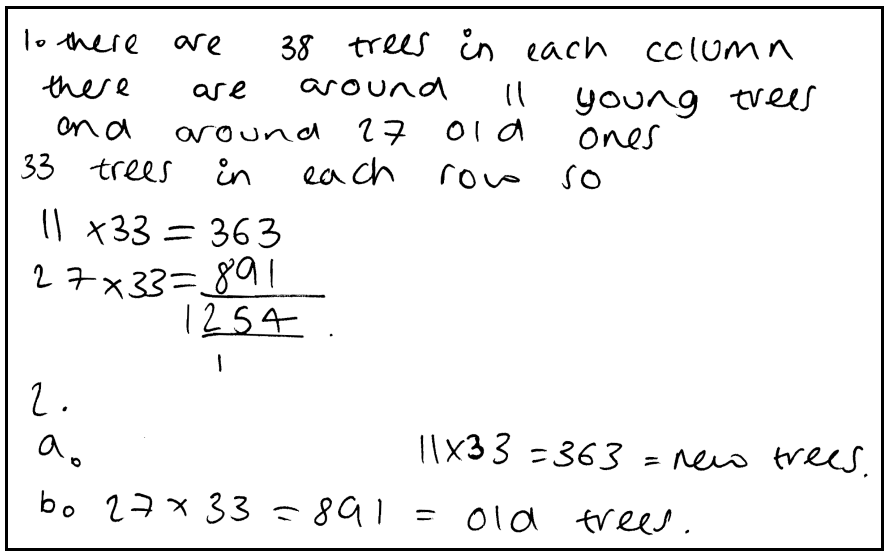
Sample response: Woody



Woody uses a sample of two columns and counts the number of old and young trees. He then multiplies by 25 (half of 50 columns) to find an estimate of the total number.

What questions could you ask Woody that would help him improve his response?

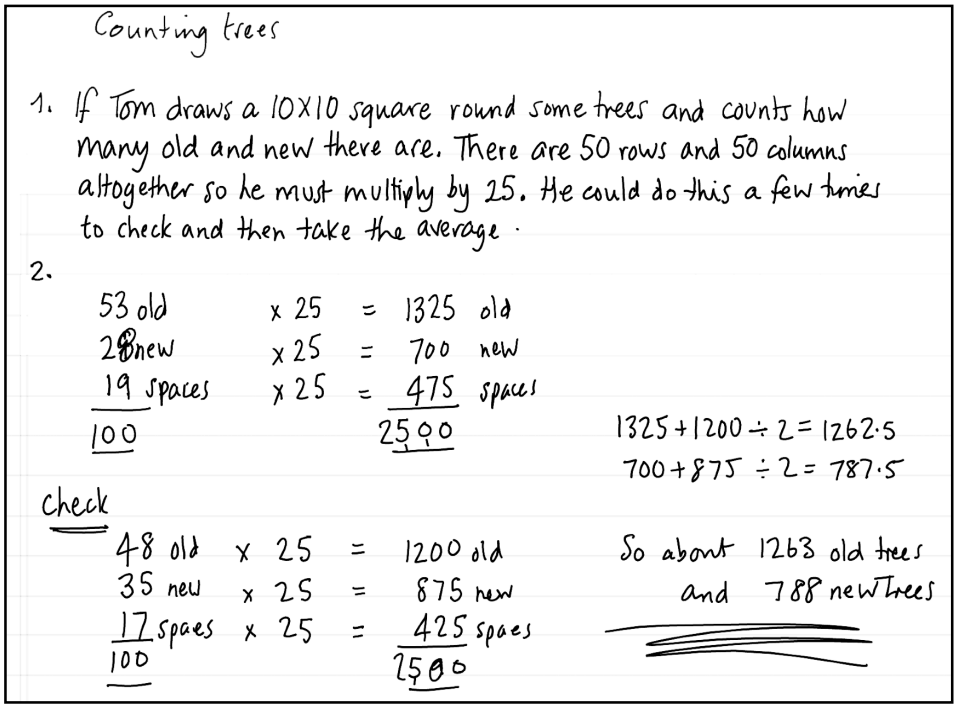
Sample response: *Jenny*



Jenny realises that sampling is needed, but she multiplies the number of young trees and old trees in the left hand column by the number of trees in the bottom row. She ignores the columns with no trees in the bottom row, so her method underestimates the total number of trees. She does, however, take account of the different numbers of old and new trees.

What questions could you ask Jenny that would help her improve her response?

Sample response: *Amber*



Counting trees

1. If Tom draws a 10X10 square round some trees and counts how many old and new there are. There are 50 rows and 50 columns altogether so he must multiply by 25. He could do this a few times to check and then take the average.

2.

53 old x 25 = 1325 old
28 new x 25 = 700 new
19 spaces x 25 = 475 spaces
100 2500

1325 + 1200 ÷ 2 = 1262.5
700 + 875 ÷ 2 = 787.5

Check

48 old x 25 = 1200 old
35 new x 25 = 875 new
17 spaces x 25 = 425 spaces
100 2500

So about 1263 old trees and 788 new trees

Amber chooses a representative sample and carries through her work to get a reasonable answer. She correctly uses proportional reasoning. She checks her work as she goes along by counting the gaps in the trees. Her work is clear and easy to follow.

What questions could you ask Amber that would help her improve her response?

Handout 6: Cats and kittens

Here is a poster published by an organisation that looks after stray cats.

Work out whether this number of descendants is realistic.

Here are some facts you will need:

Length of pregnancy

About
2 months

Age at which a female cat can first get pregnant

About
4 months

Number of kittens in a litter

Usually
4 to 6

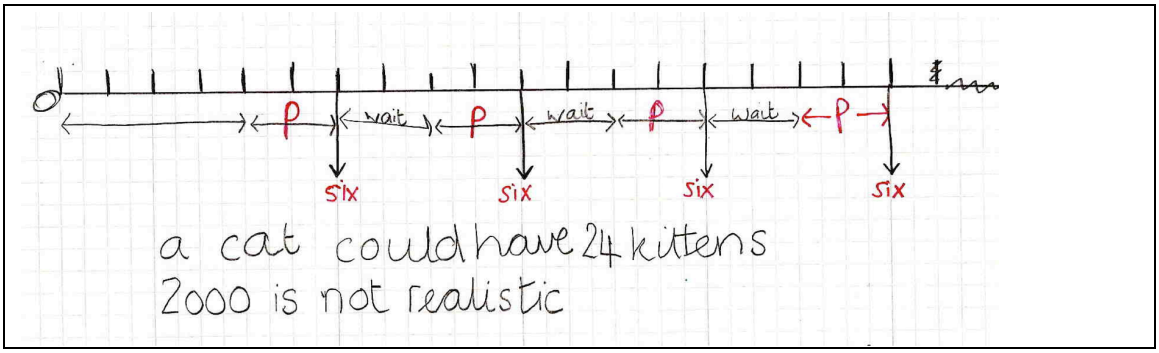
Average number of litters a female cat can have in one year

3

Age at which a female cat no longer has kittens

About
10 years

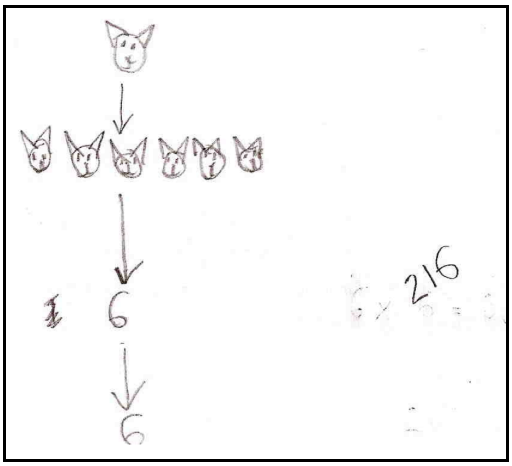
Sample response: *Alice*



Alice chose to represent the task using a timeline. She has only considered the number of kittens from the original cat. The computation required is accurate.

What questions could you ask Alice that would help her improve her response?

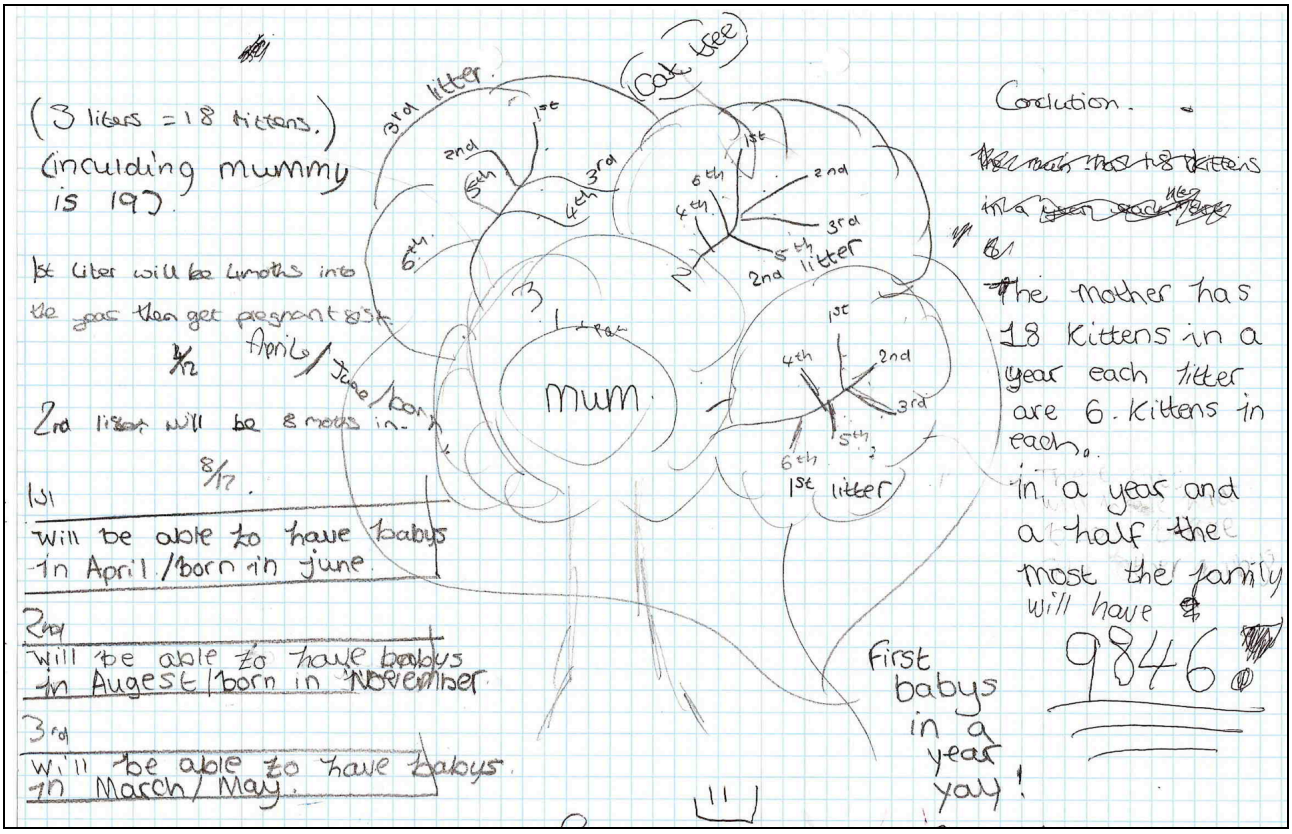
Sample response: *Wayne*



Wayne appears to favour a minimalist approach! He starts with what would be a time consuming pictorial representation which he then abandons in favour of a numerical representation.

What questions could you ask Wayne that would help him improve his response?

Sample response: *Ben*

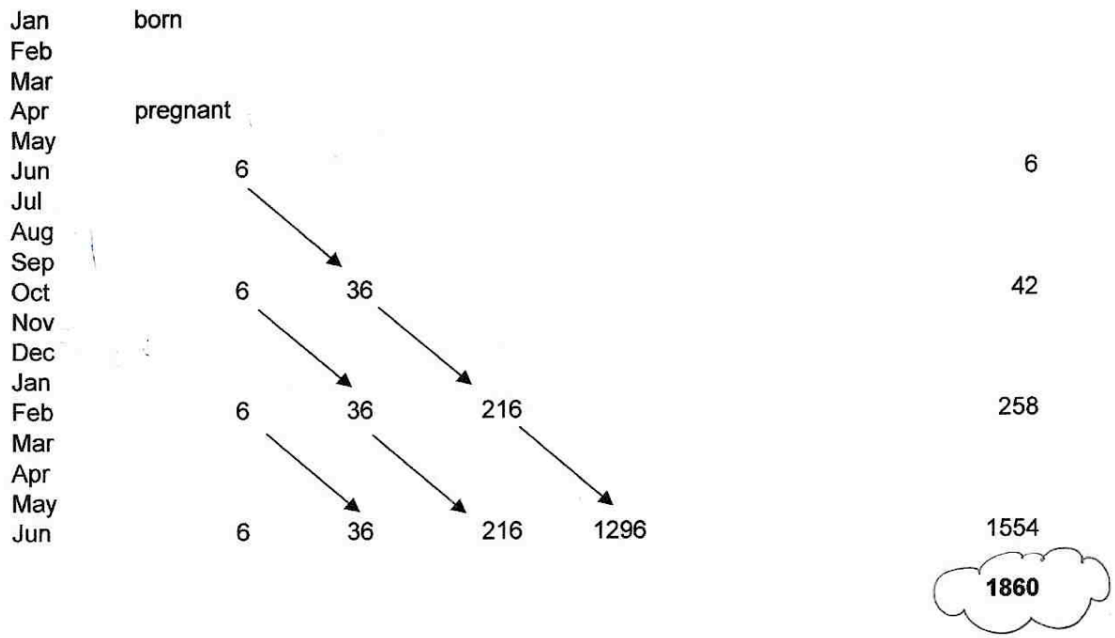


Ben has decided to draw a 'cat tree', and tries to control for time (with some errors). The communication is reasonably clear, allowing the reader to follow the argument, but the final answer of 9846 is not explained and does not follow from the reasoning, since, again, only the kittens from the original cat are considered. The number of kittens per litter is made explicit.

What questions could you ask Ben that would help him improve his response?

Sample response: *Sally and Janet*

Two students worked on this task, discussing and sharing their methods. They used a spreadsheet.



We think 2000 is a bit much in 18 months because even if each litter was 6 and nothing dies there would be 1860 though that rounds to 2000 so maybe its OK. The cat people want owners to have their cats newtured so that they use the bigger number so that people say that is a lot of cats and rush to the vets.

Sally and Janet used a spreadsheet to control for both time and multiplication and their method is clear and effective.

What questions could you ask Sally and Janet that would help them improve their response?

Handout 7: Suggestions for questions

Formulate questions, choose appropriate representations and tools.	What questions might you ask about this situation? How can you get started on this problem? What techniques might be useful here? What sort of diagram might be helpful? How can you simplify this problem? What is known and what is unknown? What assumptions might you make?
Reason logically, construct hypotheses and arguments, compute accurately	Where have you seen something like this before? What is fixed here, and what can you change? What is the same and what is different here? What would happen if I changed this.. to this...? What will you do when you get that answer? This is just a special case of ... what? Can you form any hypotheses? Can you think of any counterexamples? What mistakes have you made? Can you suggest a different way of doing this? What conclusions can you make from this data? How can you check this calculation without doing it all again? What is a sensible way to record this?
Interpret and evaluate results obtained	How can you best display your data? Is it better to use this type of chart or that one? Why? What patterns can you see in this data? What reasons might there be for these patterns? Is this approach going anywhere? Can you give me a convincing argument for that statement? This is just a special case of ... what? Do you think that answer is reasonable? Why? How can you be 100% sure that is true? Convince me! What do you think of Anne's argument? Why? Which method might be best to use here? Why?
Communicate and reflect	What method did you use? What other methods have you considered? Which of your methods was the best? Why? Which method was the quickest? Where have you seen a problem like this before? What methods did you use last time? Would they have worked here? What helpful strategies have you learned for next time?

Handout 8: Formative assessment in action

Writing the sorts of comments and questions on students' work you did in Activity D is time-consuming and difficult.

In the video the teachers discuss how they made comments.

To what extent do their comments resonate with your experience?

In the second video, the three teachers ask students to respond to the feedback they have written and then to work in small groups to construct a joint solution to the problem.

In the video, you will see:

- Andrew exploring how students respond to his feedback on the "counting trees" problem;
- Amy listening to, then questioning, individuals as they try to share their ideas and produce joint solutions to the "security camera" problem;
- Dominic listening to presentations from students on their methods and reasoning for the "cats and kittens" problem;
- Amy concluding her lesson by asking students to describe how they have used her feedback to improve their work.

What different kinds of assessment can you see?

What is the purpose of each kind of assessment?

What do both the teachers and students learn?

Handout 9: The effects of feedback on student learning

In the video, Andrew's students discuss their responses to the feedback comments their teacher gave.

Which of their comments strike you as particularly important?

What are the implications of their comments?

Read the following two extracts from Black and Wiliam (1998)[4] and respond to the questions that follow.

The dangers of giving marks, levels, rewards and rankings

"Where the classroom culture focuses on rewards, 'gold stars', grades or place-in-the-class ranking, then pupils look for the ways to obtain the best marks rather than at the needs of their learning which these marks ought to reflect. One reported consequence is that where they have any choice, pupils avoid difficult tasks. They also spend time and energy looking for clues to the 'right answer'. Many are reluctant to ask questions out of fear of failure. Pupils who encounter difficulties and poor results are led to believe that they lack ability, and this belief leads them to attribute their difficulties to a defect in themselves about which they cannot do a great deal. So they 'retire hurt', avoid investing effort in learning which could only lead to disappointment, and try to build up their self-esteem in other ways. Whilst the high-achievers can do well in such a culture, the overall result is to enhance the frequency and the extent of under-achievement."

What are the implications of this for your practice?

[4] Black, P., & Wiliam, D. (1998). Inside the black box : raising standards through classroom assessment. London: King's College London School of Education 1998.

What would happen if you stopped giving marks or levels on pupils' work?

Why are so many teachers resistant to making this change?

The advantages of giving clear, specific, content-focused feedback

"What is needed is a culture of success, backed by a belief that all can achieve. Formative assessment can be a powerful weapon here if it is communicated in the right way. Whilst it can help all pupils, it gives particularly good results with low achievers where it concentrates on specific problems with their work, and gives them both a clear understanding of what is wrong and achievable targets for putting it right. Pupils can accept and work with such messages, provided that they are not clouded by overtones about ability, competition and comparison with others.

In summary, the message can be stated as follows: Feedback to any pupil should be about the particular qualities of his or her work, with advice on what he or she can do to improve, and should avoid comparisons with other pupils."

What are the implications of this for your practice?

Does this kind of feedback necessarily take much longer to give?

Handout 10: A formative assessment lesson plan

The following suggestions describe one possible approach to a formative assessment lesson on problem solving. First, students are given a chance to tackle a problem unaided. This gives you a chance to assess their thinking and to identify students that need help. This is followed by formative lesson in which they collaborate, reflect on their work and try to improve it.

Before the lesson 20 minutes

Before the lesson, perhaps at the end of a previous lesson, ask students to attempt one of the assessment tasks, *Counting Trees, Cats and Kittens or Security Cameras* on their own. Students may need calculators, pencils, rulers, and squared paper.

The aim is to see how able you are to tackle a problem without my help.

You will not be told which bits of maths to use.

There are many ways to tackle the problem - you choose.

There may be more than one 'right answer'.

Don't worry if you cannot understand or do everything because I am planning to teach a lesson on this next in the next few days.

Make sure that students are familiar with the context of the problem.

Counting Trees

- Does anyone know what a tree plantation is?
- How is a plantation different from a natural forest?
- The plantation consists of old and new trees
- How might the arrangement of trees in a plantation differ from that of a natural forest?

Cats and Kittens

- This is a poster made by a cats' charity, encouraging people to have their cats spayed so they can't have kittens. The activity is about what happens if you don't have your cat spayed and whether the statement on the poster is correct.
- Is it realistic that one female cat would produce 2000 descendants in 18 months? You are given some facts about cats and kittens that will help you decide.

Remember to show your working so I can understand what you are doing and why.

Collect in their work and provide constructive, qualitative feedback on it. This should focus on getting students to think and reason - a Key Process agenda. Don't give grades, scores or levels! Write *only* questions below their work. Focus feedback on such issues as:

Representing:
Can you think of a different way of tackling his problem?
What sort of diagram might be helpful?
What assumptions have you made?

Reasoning:
How have you got this result?
Have you checked your calculations?
What would happen if ...?

Interpreting:
How can you test the accuracy of your estimate?
What other sample could you have chosen?

Communicating:
I find it difficult to follow your thinking here.
Can you present your reasoning so that someone else can follow every step?

Try to identify particular students who have struggled and who may need support. Also look out for students that have been successful. These may need an extension activity to further challenge them.

Resources needed for the lesson

You will need the following resources:

- One copy of the problem sheet per student
- Mini whiteboards
- Large sheets of paper for making posters and felt-tipped pens
- Calculators and rulers

Counting Trees

- Spare, large copies of the trees picture for groups to work on together.

Cats and Kittens

- A supply of graph paper or squared paper (if requested)

Re-introduce the problem to the class 5 minutes

Begin the lesson by briefly reintroducing the problem:

Do you remember the problem I asked you to have a go at last time?

I have had a look at your work and I have written some comments at the bottom of it.

Today we are going to work together trying to improve on these initial attempts.

First, on your own, carefully read through the questions I have written on your work. Use your mini-whiteboards to note down answers to these questions.

It is helpful to ask students to write their ideas on a large sheet of paper or mini whiteboard using felt-tipped pen. This helps you monitor their work and also helps students to share their ideas later in the lesson.

Students work alone responding to your feedback 5 minutes

Allow the students some time to reflect on your comments and write their responses.

Students work in pairs to improve their solutions 10 minutes

Ask students to now work in pairs or threes. Give out a large sheet of A3 (at least) paper and a felt-tipped pen to each group.

> *Now I want you to share your work with a partner.*
> *Take it in turns to explain how you did the task and how you now think it could be improved.*
>
> *Now I want each pair to work together, comparing their ideas and the feedback I have given. Together, I want you to try to produce an answer to the problem that is better than each of you did separately.*

Go round the room, listening, assessing their thinking and making interventions asking strategic questions. Consult a copy of the progression steps for the relevant problem and decide which questions would be most appropriate for moving their thinking towards higher levels of performance. Use strategic questions like:

> *What is known and what is unknown?*
> *What are you asked to find out?*
> *How can we simplify this problem?*
> *What assumptions have you made?*

Students share their approaches with the class 15 minutes

Ask students to present their ideas and approaches to the class. Focus on their methods rather than their answers. As they respond, use the progression steps to assess their responses. In particular, focus on the quality of the reasoning and communication.

> *"We decided to count the different types of trees along each side, then multiply these numbers together."*
> *"We drew a time line along the top of the paper and then drew cats underneath to show when they gave birth."*

As students present their ideas, ask other students to comment on:

- Representing: Did they choose a good method?
- Analysing: Is the reasoning correct – are the calculations accurate?
- Interpreting: Are the conclusions sensible?
- Communication: Was the reasoning easy to understand and follow?

Students continue with the problem/ or an extension of the problem 20 minutes

Encourage students to return to the problem and continue working on it using some of the ideas that have been shared. If they have already produced a good solution, either ask them to find an alternative method, a more convincing reason, or to explore an extension.

> ***Counting Trees***
> *If I now showed you a very large jar of Smarties, how could you estimate the fraction that are red? Write down you method. Can you use what you learned from "Counting Trees"?*
>
> ***Cats and Kittens***
> *Can you find a simpler, more elegant way of presenting your calculations to "Cats and Kittens"? Can you use a diagram of some kind?*

Collect examples of students' work for the follow-up discussion. Try to assess how much students have learned from the sharing session.

Handout 11: Exchanging experiences

What worked well and less well in terms of formative assessment?

What did you learn about the students' understanding from the initial activity?

How did the students respond to your feedback?

What worked well and less well in terms of problem solving?

What are the implications of this lesson for your future teaching?