BOWLAND
MATHS
Professional development

The Case Studies and Mathematics

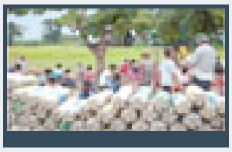
'Where is the maths in these Case Studies?'

Module overview

In the Case Studies, as in life, the situations are unstructured and the problems that arise have many alternative solutions. Pupils need to learn to *represent* and then *analyse* such situations using mathematics, *interpret and evaluate* the results, and *communicate* and *reflect* on their findings. This module is designed to help you consider how you can integrate and develop these Key Processes into your teaching.

This guide is intended for use alongside the *Bowland Maths DVD* or website, which include a short introductory video for each of the activities; longer videos of lessons and teacher discussions and links to all the handouts and ICT-based problems.

Introductory session — 1 hour

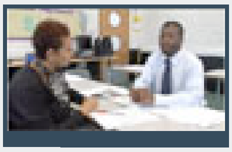


- Look at a situation: Where is the maths?
- Look at the KS3 Key Processes
- Discuss some pedagogical implications
- Observe a lesson
- Plan a lesson using one of the problems.

Into the classroom — 1 hour

- Introduce the situation then ask pupils to identify problems
- Simplify and represent the problem
- Review the representations pupils use
- Analyse and solve the problems
- Pupils communicate and reflect on their different approaches
- Review the Key Processes that pupils have been through

Follow-up session — 1 hour



- Reflect on the lessons, and the ways maths emerged
- When should we introduce mathematical techniques?
- Integrating Case Studies into a scheme of work
- What about the tests?

Resources Needed

Handout 1	Building a school with bottles in Honduras
Presentation	BottleSchool (PowerPoint - optional)
Handout 2	The modelling cycle
Handout 3	The modelling cycle: questions to ask yourself
Handout 4	Building a school with bottles: the Key Processes
Handout 5	When should we introduce mathematical techniques?
Handout 6	Typical maths activities in the Case Studies
Handout 7	Types of problem used in the Case Studies
Handout 8	What about the tests?
Handout 9	Photographs for mathematical discussion
Handout 10	Some mathematical questions on the photographs
Handout 11	Suggested further reading

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Introductory session

The Case Studies and Mathematics

'Where is the maths in these Case Studies?'

Activity 1 Look at a situation: Where is the maths? 15 minutes

It is not always easy for pupils to see any connection between the real world and mathematics lessons. As a result, they don't use the mathematics they learned in secondary school, even though thinking with mathematics could help them understand the world better – and make better decisions. The module begins with a real life context and looks at the mathematics that can arise from it.

Look at the photographs called *Building a school with bottles in Honduras* on Handout 1. This is presented as a context - no problems are posed.

Make a list of things you notice about the situation.
What mathematical questions occur to you?

You might begin by asking questions that start:
- How many ...?
- What would happen if ....?

Now set yourself a problem and use mathematics to tackle it.

Activity 2 Look at the KS3 Key Processes 15 minutes

Handout 2 - *The modelling cycle* shows the steps involved in modelling a real life situation. This flowchart shows the Key Processes used in the KS3 Programme of Study for mathematics (See: http://curriculum.qca.org.uk/subjects/mathematics/keystage3/).

Try to relate the work you have just done to *the modelling cycle* flowchart on Handout 2. How well does it fit?

Simplify and represent the situation:
- What specific problems did you pose?
- What simplifications and representations did you create?
- What choices did you make of information, methods and tools?

Analyse and solve the model you've made:
- What variables did you use?
- What information did you collect, or estimate?
- What relations between them did you formulate?
  What did you need to calculate, and how?

Interpret and evaluate the results:
- What did you learn about the situation? Were the results plausible?

Communicate and reflect on your findings:
- How could you best explain your analysis to someone else?
- What connections can you see to other problems?

1 Building a school with bottles in Honduras

Look at the pictures and:

- Make a list of things you notice.
- Write down some mathematical problems that occur to you.
- Now try to solve one problem!

First we collect old plastic bottles .....

and fill them with sand.

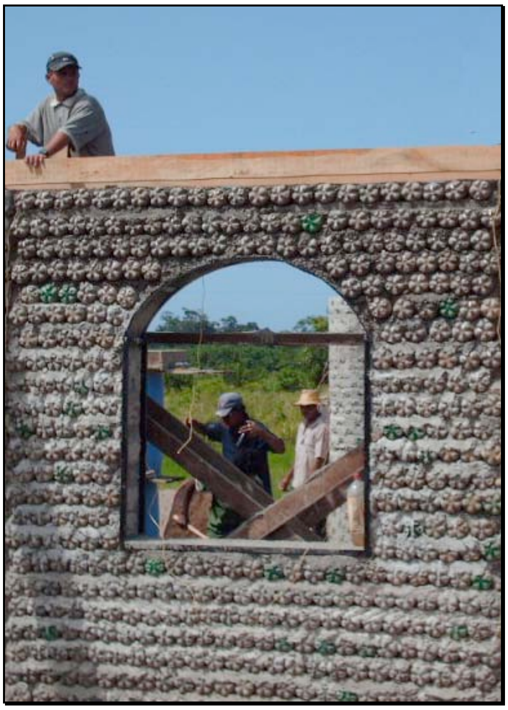
and make some foundations with rocks....

and start to build....

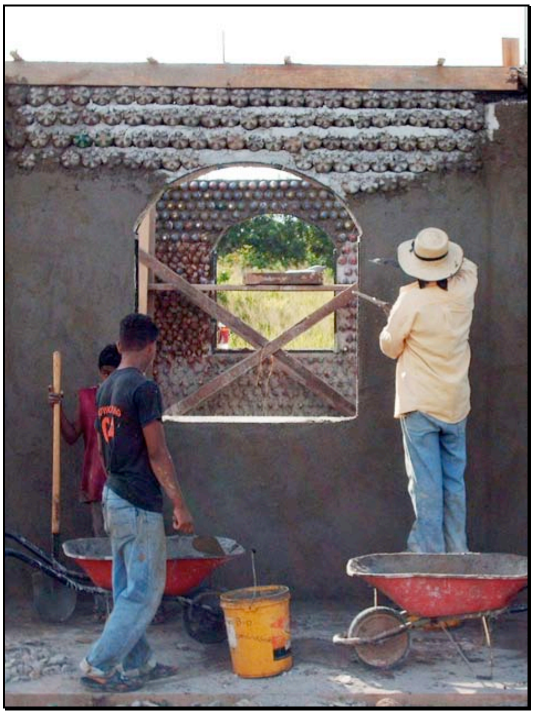
and build....

and build....

Add windows...



and plaster the walls.

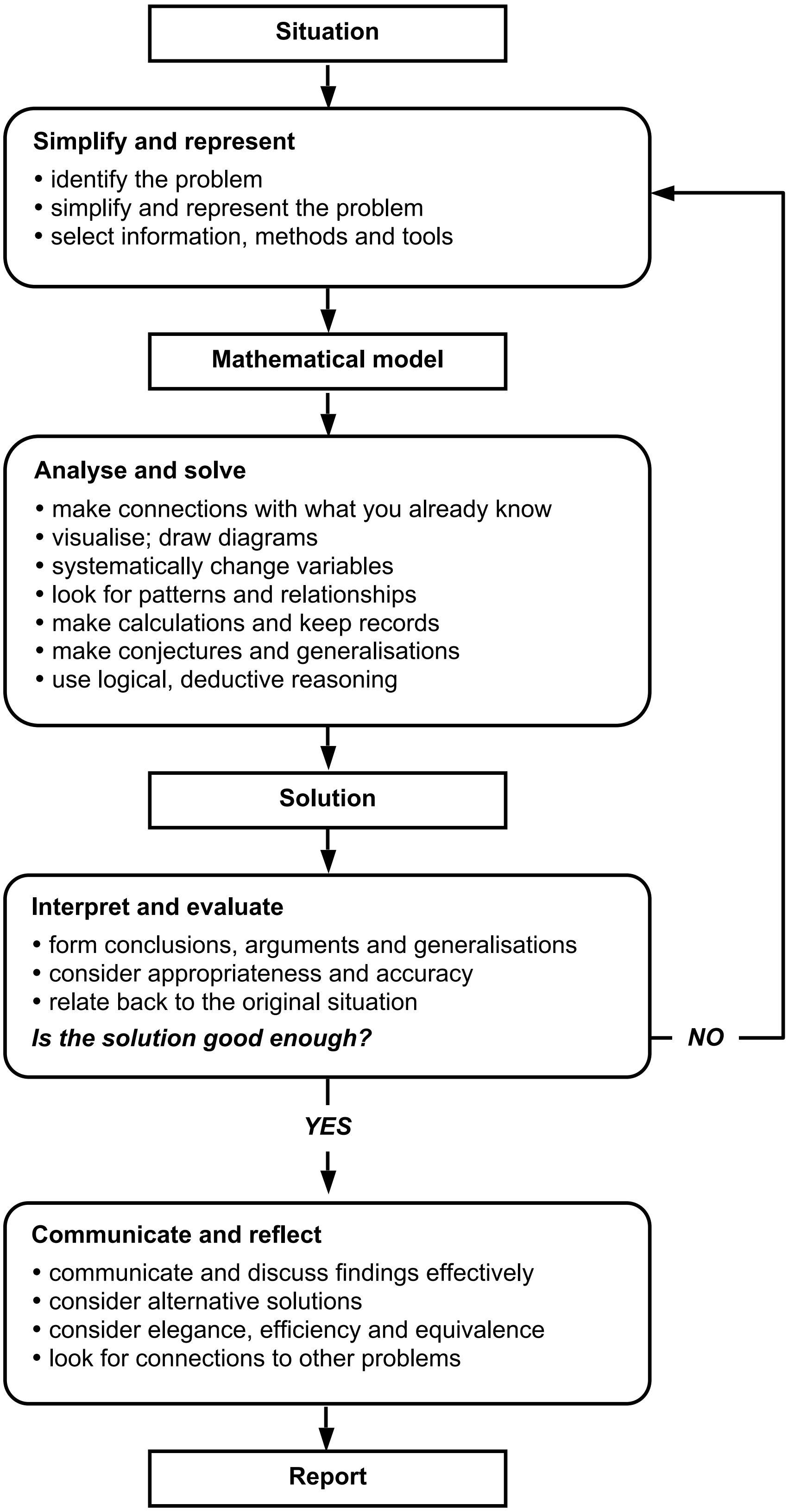


This building is in Honduras and is now a centre for a secondary education programme that is designed to equip and motivate young people to help their communities and to reduce poverty. The programme is particularly designed to help students develop a capacity for problem solving.

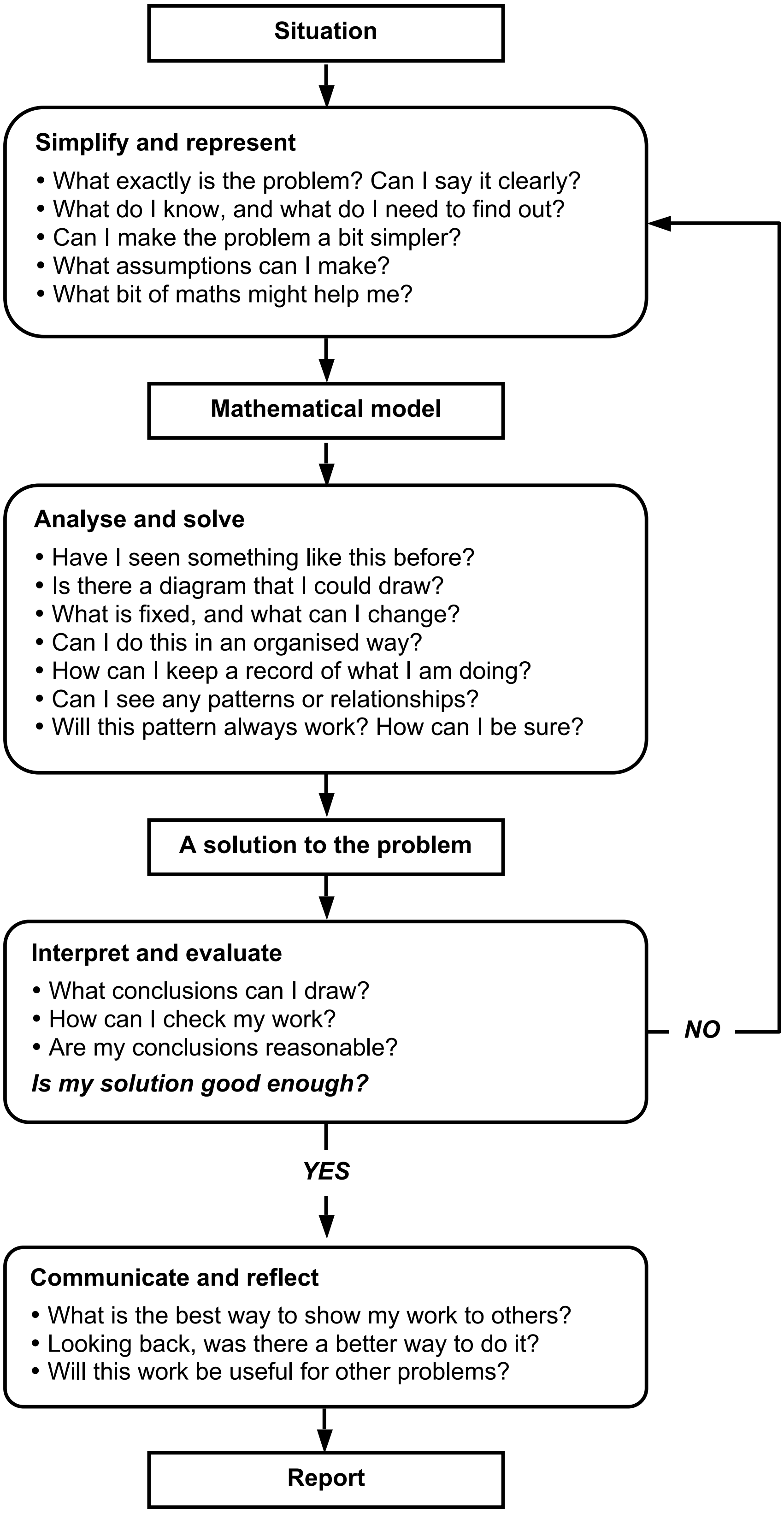
Photographs with kind permission from:
Bayán Asociación de Desarollo Socio-Económico Indígena, La Ceiba, Honduras.

2 The modelling cycle

The narrow boxes represent states of the modelling process. The wide boxes describe the actions that move from one state to the next. These match the Key Processes in the Programmes of Study.



3 The modelling cycle: questions to ask yourself



5 When should we introduce mathematical techniques?

Some teachers are discussing a case study that will take 3-5 maths lessons.
They decide that pupils will make more progress if they have a sound knowledge of *X*, where *X* represents any technique or area of knowledge.

The teachers are trying to decide whether to teach *X* before, during or after working on the case study:

Before? "I'll teach them about X in the week before we do the case study, so that when we come to do the case study, pupils will be able to apply this technique/knowledge."	**Advantage**: pupils will have techniques polished and ready to use. **Danger:** case study becomes an exercise in technique, rather than an opportunity to develop autonomous problem solving strategies.
During? "We'll start the case study, and if pupils get stuck, we'll break off working on the case study for a lesson or two, and I'll give them practice with X.	**Advantage**: You can respond to needs as they arise. **Danger:** if pupils expect you to bale them out when the going gets difficult, you reinforce dependence and undermine autonomy
After? "We'll attempt the whole case study and I'll see how pupils get on. Afterwards, I will introduce them to X and refer back to the case study to show them what a powerful idea it is."	**Advantage**: The experience of working on a case study may motivate and enable pupils to perceive the value of techniques when they are taught. **Danger:** Pupils may still not be able to use techniques autonomously, unless they are given further opportunities to apply them in further case studies.

9 Photographs for mathematical discussion

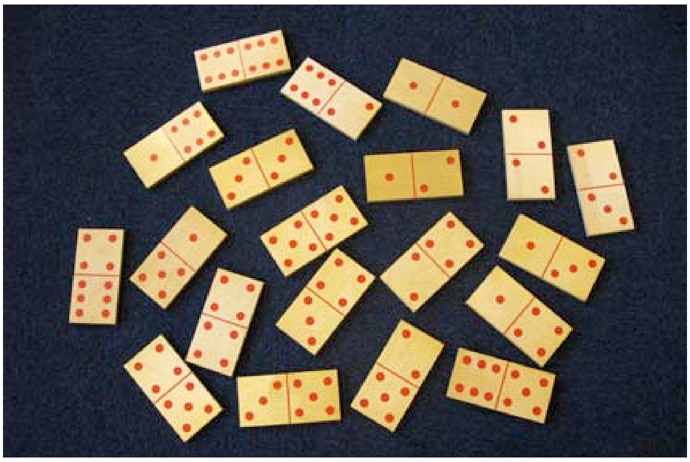
Look at each of the photographs below and, for each one:

- Make a list of things you notice.
- Write down some mathematical problems that occur to you. They might, for example, start like this:

  How could I describe ..... ?
  How many ...?
  What would happen if I changed ....?

Now do some mathematics based on the photograph!

Dominoes



Calendar

Stack of barrels

A pavement in Germany

Trike with square wheels

Russian dolls

These photographs were taken by Malcolm Swan.

Further photographs leading to interesting mathematical discussions may be obtained from Richard Phillips at http://www.problempictures.co.uk/

10 Some mathematical questions on the photographs

Dominoes

This appears to be part of a set that includes (1,1) to (6,6) - no blanks.

- Which domino is missing?
- How can you organise the dominoes systematically?
- Can you make a chain with the complete set? How can maths help?
- Can you make a ring with the complete set?
- How many spots are there altogether in a complete set?
  What is a quick way of counting them?
- How many dominoes are there in a complete set from (1,1) to (n,n)?

Calendar

- How are the numbers arranged on the cubes?
- Can you draw nets and make the cubes?
- What impossible dates can be made from these cubes?

Stack of barrels

- How many barrels are in the stack?
- If you make a taller stack 4, 5, ... barrels high, how many barrels will you need?
- Generalise?
- How else could you stack these barrels? What other pyramids are possible?

A pavement in Germany

- What shapes can you see?
- Are all the paving slabs identical? What shape are they?
- Can you work out any angles?
- Can you draw one of the slabs accurately?
- Can you find other pentagons that tessellate?
- What other shapes can paving slabs be?
  Make up some an interesting shape of your own and show how it can tile.

Trike with square wheels

- Does the trike run smoothly?
- Can you make a simple model?
- What is the height of each 'bump' on the track?
- Can you draw the shape of the 'bumpy road' accurately?
- What would happen if you had triangular wheels or hexagonal wheels?

Russian dolls

- Do the tops of the heads lie on a straight line?
  What does this tell you?
- If you divide each doll's height by its width, what do you get?
  What does this tell you?
- If you were to make some bigger dolls in this set - how big would they have to be?