A sample lesson plan

The following suggestions describe one possible approach to using the photographs with students. This approach is intended to introduce them to the modelling cycle. The timings below are very tentative. This lesson outline may well stretch into two lessons in practice!

Introduce the situation, then ask students to identify problems 5 minutes

> *The aim of today's lesson is to see if you can use mathematics to analyse a situation.*
> *To start with, you may not think the situation has anything at all to do with maths or science.*
> *I want to see if you can be creative and find ways of using the things you have learned at school.*

Introduce the situations carefully and vividly. Use the PowerPoint presentation on an interactive whiteboard, if possible.

> *These photographs were taken in Honduras. They show some people building a school out of old one-litre plastic bottles, just like the ones you buy lemonade in. They first fill them up with sand and then use them as bricks.*
> *This is a great way of using waste materials!*
> *What questions could we ask about this situation?*

Give students two minutes to note down any problems that spring to mind, then collect their ideas on the board. For example:

> *How many bottles (or how much sand) will it take to build one wall?*
> *How many bottles to build the whole building?*
> *How do the corners work?*

Ask students to identify which problems may be solved using mathematics and ask each group to choose one of these problems to work on.

Simplify and represent the problem 10 minutes

Explain that situations are sometimes too complicated to analyse as they stand. We have to simplify them before representing them with maths. Thinking with mathematics almost always involves this process.

> *How might we get started on the problem? Can we try a simpler problem first?*
> *What resources could we use to help us think about the problem?*
> *Would squared paper, isometric paper, a tape measure, a ruler help?*
> *What kinds of diagrams might help?*

Describe the resources that are available for working on the problem. Where appropriate, leave these at the side of the room, so that students can choose whether or not they use them.

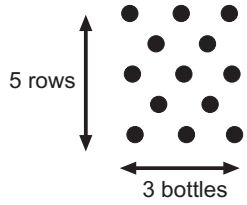
Allow students 10 minutes to plan how they will work on the problems.

> *Right, now I'm giving you ten minutes to work on the problem in pairs. Then I'm going to ask some of you to come out and talk about the different approaches you are using.*

Review the representations students use 10 minutes

Ask students to describe the methods and notations they are using. For example:

> *"We are simplifying the problem by looking at smaller walls and seeing if we can find a way of counting how many bottles will be needed. We are showing the bottles as black blobs.*
>
> *This diagram shows that when there are 5 rows of bottles and the longest row contains 3 bottles, then 13 bottles are needed."*



Of course, students may use all kinds of simplifications and notations and some may be more helpful than others. Spend some time discussing their advantages and disadvantages insofar as they are clear at this stage.

Analyse and solve the problems 20 minutes

Allow students time to work on the problems in pairs. As they do this, go round and offer general strategic guidance such as:

> *Take you time, don't rush.*
> *What do you know?*
> *What are you trying to find out?*
> *Don't ask for help too quickly - try to think it out between yourselves.*

To those who are struggling, ask appropriate questions such as:

> *Where have you seen something like this before?*
> *Drawing this diagram out each time is taking you too long. Can you use a simpler representation?*
> *What are you keeping fixed? What are you changing? Can you do this in a systematic way?*
> *Can you see any patterns or relationships here? Can you explain them?*
> *How can you keep a record of what you are doing?*
> *Can you explain to me how this step follows this step?*

For those who have made progress, move them towards interpretation and evaluation:

What have you found out so far?
Convince me that your solution is a good one.
How accurate is your answer? Is it accurate enough?
Can you find another way that would give other ways of looking at the problem?

Students communicate and reflect on their different approaches. 10 minutes

When most students have made significant progress with the problem, invite a few pairs of students to come to the front and communicate their ideas to the rest of the class. It does not matter if some have not yet reached any conclusions. They can still share their approaches and ideas.

Let's stop and share some of the different approaches we have used and consider what maths has been helpful and what unhelpful in each approach. Not everyone has finished, so I don't want to know about your answers; I want to hear your reasoning.

Tell us about:

- *the problem you are solving;*
- *how you have represented the problem as a mathematical model;*
- *how you are analysing your model to get answers;*
- *any conclusions you have reached so far. Do your answers make sense?*

We decided to find out how many bottles you would need for a building. We counted the bottles in one row, then the number of rows – but that wasn't easy to see. Then we multiplied those numbers. Then we said there were 4 walls, hopefully the same size. Then we began to worry about doors and windows...

As students present their ideas, ask other students to comment on the advantages and disadvantages of each approach. If an explanation seems sound but is garbled, try:

Can you say that again please?
You seem to have a good idea there but I want you to explain it as clearly as you can.
Clear communication is important in mathematics.

Review the processes that students have been through 5 minutes

Introduce students to a simplified version of the modelling cycle and discuss the process they have been through. Try to make them a little more aware of the value of modelling.

Using mathematics and science involves all these processes. It is not just about learning simple techniques like how to add fractions! It is also about looking at situations in the world, simplifying them and analysing them to understand them better.

This is what professional mathematicians and scientists do in their work.