STEM

Carol Davenport *highlights key ideas for understanding levers and motivating ways of teaching the topic in a cross-curricular approach*

Figure 1 Grouping household tools to help with teaching about levers

LINKING SCIENCE WITH DESIGN AND TECHNOLOGY IN A STIMULATING APPROACH TO TEACHING ABOUT LEVERS

The 2014 changes to the National Curriculum for England include the introduction of levers, gears and pulleys into primary science. Although simple mechanisms have been part of the design and technology (DT) curriculum for some time, this is the first time that the science behind the mechanisms has been included at primary school level.

These changes are a great opportunity to link the two subjects together, and to reinforce children's understanding of science through different types of enquiry in science and through designing, making and evaluating a product in DT (Box 1).

What are simple mechanisms?

Simple mechanisms have been used for thousands of years, mainly because they make our lives easier. The mechanisms allow us to use a smaller force to greater effect, to change the direction in which a force acts, or to change the speed at which a force is acting. Think about using a wheelbarrow: this is a lever that allows you to lift a heavy weight more easily.

Box 1 Levers in the primary curriculum

Key stage 2: Science year 5:

- **recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.**

Key stage 2: Design and technology – Technical knowledge:

- **understand and use mechanical systems in their products** ***[for example, gears, pulleys, cams, levers and linkages]***

Initial activities

When introducing the topic of simple mechanisms the first thing that we can do is to ask the children to observe a range of objects that make use of the different mechanisms. We have to encourage children to look carefully, to identify features of the objects and to describe the characteristics of those features, which is great for encouraging careful observation – a skill often overlooked.

Key words: STEM Physics Curriculum planning Types of activity

Box 2 Key vocabulary for learning about levers

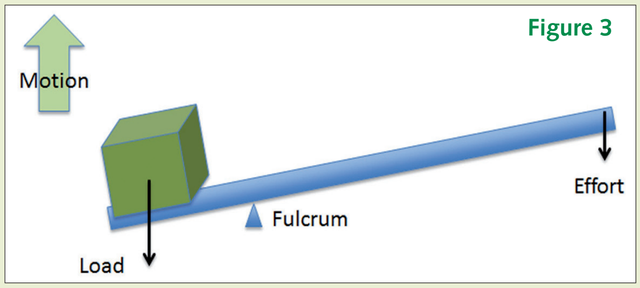


Figure 3

The LOAD is the object, or more correctly the weight of the object, that we are moving. This is measured in newtons.

The EFFORT is the force that we apply in order to move the load. This is also measured in newtons.

The FULCRUM is the point about which the lever pivots (rotates).

To start with, provide a selection of household tools and ask the children to put the tools into groups, focusing on the classification skill. At this point, there is no right or wrong answer, although children tend to go for structured groups: used in kitchen/ used in house, stored in a toolbox/ stored in a drawer, or sometimes wooden/plastic/metal (Figure 1). You could use pictures of tools if you don't have the real things available, but being able to handle the objects is helpful.

Next we need to support children to develop their specialist vocabulary further. To do this, working in pairs, they choose two tools and use a graphic organiser called a 'comparison alley' to compare and contrast them (Figure 2). One object is placed on each side of the alley, and the children write down all the things that the objects have in common within the alley (compare), and all the things that are unique to the object next to it outside the alley (contrast). In comparing two objects the children will be able to identify more specific features, and begin to name them more clearly.

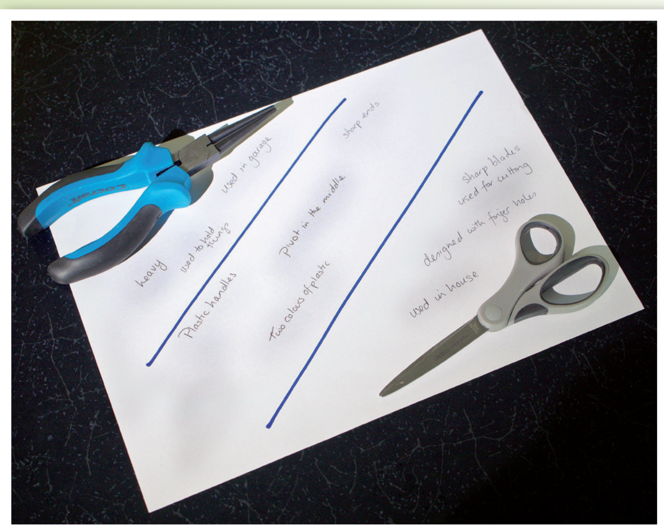
Both of these activities allow children to develop 'working scientifically' skills, such as careful observation, classification and identifying patterns.

Key vocabulary

Once children have explored a variety of different objects that make use of levers, we can introduce the key vocabulary (Box 2).

If you look online for information about levers, you will often see references to 'classes' of levers. Levers are put into different classes depending on the relative position of the load and effort in relation to the fulcrum. Figure 4 shows the three different classes of lever. Scissors and crowbars are examples of class 1 levers, while wheelbarrows and garlic presses are class 2 levers. Both these types of lever allow a small effort force to have a greater effect. Class 3 levers are a little different in that the load is smaller than the effort, and closer to the fulcrum. However, because of this, the end of the lever (with the load) moves faster than the effort. Using a rounders bat to hit a ball is an example of a class 3 lever, where the wrist acts as the fulcrum and the end of the bat moves much faster than your hand. We can also use class 3 levers when we want to manipulate delicate objects and don't want to apply a large force, for example using tweezers or tongs.

Figure 2 Using a 'comparison alley' to compare and contrast two household tools



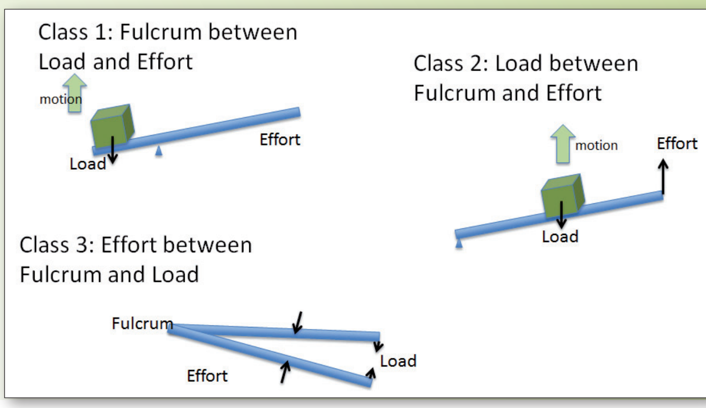


Figure 4 Different classes of levers

Once you have introduced different examples of levers, and the key vocabulary, you can set a 'lever treasure hunt', with the children identifying (and photographing) as many examples of real-life levers as they can find. If they have photographs, they can then print them out and annotate the pictures to show where the 'load', 'effort' and 'fulcrum' are.

Pattern seeking and investigation

The topic of levers is a great opportunity to introduce numerical science-based investigations and develop skills in working scientifically. It is likely that children will have played on a see-saw and already know that, if there is an adult and a child, then to balance it the adult has to sit nearer to the middle than the child. Using equipment, such as a maths number balance, children can investigate this relationship between the load and effort further. However, these have the disadvantage of a fixed fulcrum, which limits the range of investigations that can be done. Homemade see-saws can be made that allow all three variables to be changed – load, effort and fulcrum position – using simple equipment that is fairly

Figure 5 A homemade see-saw consisting of a ruler, bulldog clip, and washers

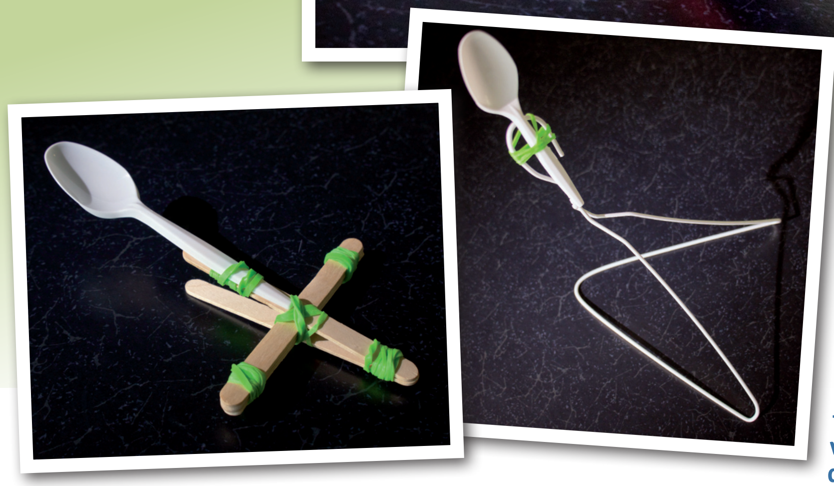


Figure 6 Catapults can be made from a range of everyday objects

cheap and readily available (Figure 5).

Wooden rulers have the advantages of not bending and of having a ready-made measurement scale. The fulcrum used here is a bulldog clip with the legs removed, but you could use a pencil instead. The washers can be purchased by the bag from a hardware store.

Three possible questions that children could investigate are:

- *'If I increase the number of washers for the load, how many washers do I need to add to the other side of the lever to make it balance?'* **This is an example of a pattern-seeking investigation with both the load and the effort the same distance from the fulcrum.**
- *'How does the effort (number of washers) needed to balance a load change when the distance of the load from the fulcrum is moved?'* **Here, the independent variable is the distance of the load from the fulcrum, and the number of washers (effort) is the dependent variable. This investigation can be repeated for different positions of the fulcrum to see whether the pattern remains the same.**
- *'How does the load that can be lifted by the effort, change when the position of the fulcrum is altered?'*

You can use the results of the investigations in numeracy lessons, allowing children to analyse data that they have collected themselves and to consider the best way to present their data. The children may notice a relationship between the variables:

load x distance of load from fulcrum = effort x distance of effort from fulcrum

which they could use to calculate the mass of an object, perhaps a potato, using the equipment.

Linking science and DT

In DT, children are expected to use technical knowledge to design, make and evaluate different products. At the simplest level, this could be a game, for example a simple type of catapult to launch ping-pong balls into buckets using a 'see-saw' effect. There are also more complicated catapult-type devices that can be made (Figure 6), providing opportunities for science investigation as well as construction, evaluation and possible redesign for DT.

For a more open-ended project, children could investigate another type of device for launching objects, a trebuchet. These were used in mediaeval battles to throw large rocks at or over castle walls. After developing their research skills to find out more about the different types of trebuchet, the children can make models of them and investigate which is the most effective design.

Heath Robinson machines

A Heath Robinson machine is a very complicated machine used to carry out a very simple job. They are named after the cartoons of W. Heath Robinson, who was known for drawing improbable contraptions to do things like making toast or turning on a light switch. A more modern-day example of Heath Robinson machines are some of the contraptions that Wallace builds in the Wallace and Gromit films, which, as well as making for entertaining viewing, provide an engaging context for the children to explore further. Watching the video to the song *This too shall pass* by the band OK Go will provide inspiration for possible mechanisms that could be used. Why not challenge your class to design and build a complicated machine for a simple job. You may well be surprised at their ingenuity and understanding of levers when they are asked to explain how they work!

Useful websites

Think Physics website for catapult instructions: **thinkphysics.org/activity/ase-2015-simple-mechanisms-primary**

Imagination Factory for more ideas for teaching levers, as well as pulleys and gears: **museumvictoria.com.au/pages/6995/imagination-factory-concept-activities.pdf**

OK Go video for inspiration for Heath Robinson machine: **www.youtube.com/watch?v=qybUFnY7Y8w**

Connections Academy for suggestions on how to build a Heath Robinson machine: **www.connectionsacademy.com/blog/posts/2014-04-25/Build-Your-Own-Rube-Goldberg-Machine.aspx**

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