COMMON MISCONCEPTIONS

Levers, gears and pulleys

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What children need to know

English National Curriculum statutory statement: To recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

- Mechanisms are designed to make 'work' easier because less force may be required to make an object move
- Levers, gears and pulleys are different mechanisms and can be used for specific purposes
- How to use mechanical systems in products they design and make (English Design Technology curriculum)

Common misconceptions – often children may think:

- The term 'force' means someone makes you do something you do not want to do. It is also associated with the Armed Forces by some children in schools.
- Movement stops when things 'run out of push' rather than because there are other forces acting on them. They may think that to keep an object moving you need to keep giving the object a force (push). This common misconception is because of the invisibility of the other forces at work. To help overcome this idea, the use of arrows to define size and direction of forces is needed in diagrams. This is particularly important as force is a 'vector quantity' and therefore should have both its size and its direction identified.
- A stationary object has no forces acting on it. The reason the object is stationary is because the forces acting on it are balanced.
- The best place to put the fulcrum is in the centre of the lever. The mechanism will in fact have a bigger effect when it is closer to the object being moved.
- A greater force on a mechanism always has a greater effect on the object. In fact, a mechanism can allow a smaller force to have a greater effect.
- Mass and weight are the same thing. Mass is a measure of the amount of matter in an object; weight is a measure of the force exerted by the object due to gravity. It is important to define these measurements and the difference must be clear when introducing pulleys.

Introduction

When looking at this area of the curriculum to support teachers with whom we work, our local PSTT Fellows found it to be poorly covered and Year 5 teachers reported they found this a difficult objective to teach and assess. Cited barriers included lack of resources and weak subject knowledge. As a team, we have tried to put together some ideas and resources to help Year 5 teachers successfully teach this objective, making links to the Design Technology curriculum and real life contexts.

Our experience tells us that attempting to teach about all three mechanisms in one lesson is unrealistic, may lead to shallow learning and feed misconceptions.

We recommend splitting the objective and considering the three mechanisms separately in order to cover the objective effectively. We drew on our knowledge of lessons and research of resources we have tried or found and provide a range of useful starting points. Providing opportunities for children with opportunities to explore mechanisms practically will help them develop a deeper understanding of mechanisms and their associated forces.

Levers teaching ideas

Set up a carousel of self-discovery activities for the children to develop an understanding of how levers work. Children initially investigate how each 'thing' works.

Figure 1. With load near the fulcrum, it is easier to move the nail.

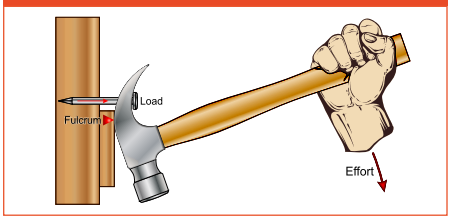


Figure 2. Nutcrackers combine 2 levers. Load and effort are on one side of the fulcrum.

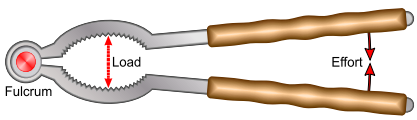
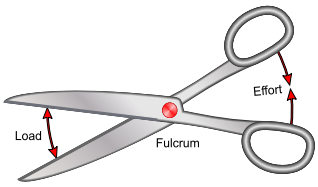


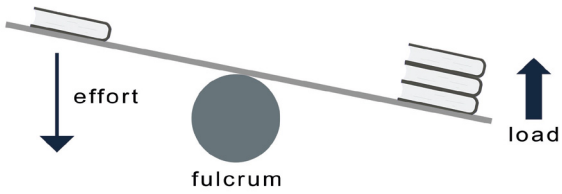
Figure 3. Scissors combine 2 levers. Load and effort are opposite sides of the fulcrum.



For example:

- *syrup tin, 1 p, 10 p, teaspoon, longer spoon, screwdriver – children try to open the tin with each device (top tip: wash out the tin before use)*
- *claw hammer and plank of wood with nails in*
- *pliers, scissors, or wire cutters and wire*
- *can with ring pull (fizzy drink or e.g. beans)*
- *bottle and bottle opener*
- *stapler*
- *tweezers*

Figure 4. Create a simple lever to lift a large pile of books with a smaller one



Encourage the children to focus on what the 'load' is in each case, where there is a fulcrum (pivot point) and where effort must be applied (Figures 1–3). This will help them see that often they apply a small force to move a bigger load whilst at other times, a large force is applied but only a small load is created (e.g. when using tweezers). Children could then go on to build their own levers (Figure 4). Try setting a challenge such as moving a bigger pile of books with a smaller pile of books. Explore moving the pivot point using:

- *Wood (shelf or board for the beam)*
- *Rolling pins (to act as the fulcrum, providing the pivot point)*
- *A set of books that are the same size e.g. dictionaries (you will need lots!)*

Gears teaching ideas

Children should spend time observing gears working including:

- *looking at a bicycle (turned upside down)*
- *whisking eggs in different ways*
- *looking inside a clock, watch or wind-up toy*

and where possible, explore commercially produced plastic gears set (your EYFS may well have a set already!).

Children could then explore the most effective way to whisk egg whites to peaks stiff enough to hold over their heads! They could use a range of tools such as:

- *Balloon, rotary whisk or fork*

Pulleys teaching ideas

Children need to experience making and testing mechanisms using different numbers of pulleys (2, 3 and 4 pulley systems) to evaluate their effectiveness, using readily available resources. Teachers have reported a lack of quality pulleys and the cost of purchasing these as their biggest barriers. Should you wish to invest, we recommend metal pulleys (not plastic) and perhaps making some links with your local secondary school science department, who may be able to loan some to you for a lesson or two. However, an effective pulley system can be easily created from the following resources:

- *Wire coat hangers*
- *Curtain rings*
- *String*
- *Weights*
- *Broom handles*

PSTT has a great resource: Titanic Science which sets practical investigations in a historic context, a number of which are ideal when exploring mechanisms. Our free resources, Chain Reaction and Wooden Models, provide extensive support on teaching about mechanisms.

Story links

Finally, we are huge advocates of using stories to give our science more context. For this topic, we would suggest:

- *The Minpins by Roald Dahl*
- *The Lighthouse Keeper's Lunch by Rhona and David Armitage*
- *The Tin Snail – Teaching Science Through Stories*

Support for teachers

Many of our partner organisations provide free resources to help teachers with these topics, including:

STEM Learning hold a huge collection of resources; Royal Society of Chemistry (Ancient Egypt topic plans link in well); The Institute of Physics (Marvin and Milo activities); The Wellcome Trust's Explorify materials (gears).

PSTT's 'Wow Science' website provides links to these and many other completely free resources for teachers, including: The Institute of Engineering and Technology, ReachOut CPD and Practical Action. Wow Science has also reviewed a number of games and activities for children that teachers may find useful.