Exemplar 33

A unit of work on machines—wheels, gears, chains and belts

third to sixth classes

Initial problem: Can wheels help us to make things move?

Background

Reducing the amount of surface contact between the vehicle and the surface on which it travels makes movement easier.

Assessment: Among the techniques that may be used are

- teacher observation: willingness to try different ideas; willingness to work with others
- portfolio: annotated drawings of work.

Resources

Dowels, pencils, blocks of wood, rubber bands, straws, glue, cylinders, forcemeter, metre stick, washers, thread spools, marbles, straws, brass pins, empty cereal boxes or strong cardboard for the chassis.

Lesson 1: Making movement easier

Starting points

Explore different ways of moving things from place to place, for example sliding (pushing or pulling).

Children should try moving small blocks of wood over the same surfaces. Attach a paper clip to each block and secure with tape. Fasten a rubber band to the paper clip. Move the block by pulling the rubber band. Measure with a ruler the length to which the rubber band is stretched. If available, use a forcemeter (instead of the rubber band) to measure the force required to move the block.

Children can discover the force needed to move the block when loaded with different objects, such as bricks.

Development of lesson

Compare the force required for sliding and rolling.

Objects that are round, such as a ball, tyre, barrel or drum, can be moved by rolling.

Children can select different cylindrical objects filled with sand and with lids securely fixed.

Fasten a paper clip to one end of the cylindrical tin with tape and attach a rubber band to the clip. Stand the tin upright and slide the tin along the surface.

Measure with a ruler the length to which the rubber band is stretched. Repeat the experiment with the tin on its side.

Compare the force used to slide the tin with that used to roll it.

Link work with previous experiments involving gravity by asking children to compare the forces required to slide and roll objects uphill and downhill.

Children should infer from their experiences that rolling round things is easier than sliding them. Moving objects downhill is easier than moving them uphill, because of the downward pull or force of gravity.

Lesson 2: Investigating rollers and wheels

Rollers: moving a load using rollers

Ask the children to consider how they will move a brick by rolling rather than by pushing or pulling.

Try making rollers from different objects, such as dowels, pencils, thread spools or a lid placed on some marbles.

The children should mount the brick on the rollers. Attach a rubber band to the brick and pull, so that it begins to move on the rollers. The children should observe, or measure with a ruler if possible, the extent to which the rubber band is stretched while the brick is moving.

Ask the children to consider how they will continue to move the brick, i.e. having to move the rollers from the back to the front. Consider the disadvantages of this system.

Exploration

Children observe and investigate wheeled toys, such as cars, trucks, dumpers and tricycles.

They should note the size and number of wheels in use on the various wheeled vehicles and the ways in which the wheels are fixed on toy motor cars and other toys.

The children should also observe how wheels are fixed on any models made from children's construction sets, for example Meccano or Lego Technic.

	Lesson 3: Making wheels, axles and a chassis	Lesson 4: Wheel-belt systems
Starting points	Ask the children to design and make a car or wheeled machine that can be used to move loads. **Making wheels, axles and a chassis** Develop craft handling skills of cutting out circles from cardboard, punching holes in milk carton tops, gluing hubs made from bobbins or corks to wheels. Children explore freely how a range of wheels and axles can be made. They may wish to explore how the wheels will be attached to the axle. Brass pins, glue and crosspieces may be suggested. The children may also consider the number of wheels to give to the vehicle. Examples of different wheeled vehicles or machines should be examined, for example scooters, tricycles, prams and lorries. Children should make large and small wheels and investigate the advantages and disadvantages of using pairs of these wheels in their designs.	Discuss where wheels joined by a belt or a chain may be found; children may suggest a bicycle, vacuum cleaner, fridge or food mixer. The teacher will hammer four nails into a board. For the initial activity place two empty thread spools onto two nails. The spools will act as wheels. Stretch a rubber band around the spools. Mark each spool with a crayon dot. Children should be encouraged to predict what will happen to the second wheel when the first wheel is turned in one direction. The prediction can then be tested. The children should watch the dot on the rim of each spool and record whether the spool moves to the left or to the right.
Development of lesson	**Designing wheeled vehicles** Children develop a design plan for the wheeled vehicle, taking into account the materials available. The design may be built initially from construction sets. Children review the design if necessary. **Making the wheeled vehicle** The children may suggest making the vehicle in different stages, such as • wheels • axles • joining wheels and axles • making a chassis • fixing wheels and axle to the chassis. They may identify several problems with their design: • cardboard wheels may be weak and need to be strengthened • friction between the axle and the chassis, giving rise to lack of movement • friction between the wheels and the chassis The children may suggest resolving these problems by • adding straw spokes to the wheels to strengthen them • making a bracket for the underside of the chassis to which the axle can be placed • adding a spacer between the wheels and the chassis.	Predict what will happen if the rubber band is crossed over. The children can test this. Record the results. Increase the number of spools used on the board. Connect the spools in different ways with rubber bands. Start each belt system with the left-hand spool. Join two spools, one of which is much larger than the other. Mark a starting point on each spool. Predict what will happen to the large spool if you turn the small wheel once, twice, or three times. The children should consider what will happen to the small wheel when the large wheel is turned. They make predictions and then carry out the test. Work on wheel-belt systems will lead on to a study of wheels with cogs and gears. Examine an egg-beater to observe how the gears are connected. Observe how the big gear makes the smaller gears turn. Children should notice what happens when the handle is turned. Record how many turns the small gear makes for each turn of the large gear. Compare the number of teeth that the small and the large gears have.
Concluding activity	**Evaluating the design:** Children evaluate design in terms of movement and ability to carry a load. Consider ways of moving the vehicle: using wind power (attach a balloon), using rubber bands or attaching batteries and a motor.	