

BikeReady Lesson 3

Demonstrate skills for using gears

PLANNING FOR LESSON 3

Skills focus

Using gears.

- Not all bikes have gears – think about single-speed and BMX bikes.
- Not all bikes have gears that are visible – some have internal hubs.
- Learning to avoid maximum crossover in the chain.

Reflection on skills training session

Share new learning with classroom teacher

Identify experiences students enjoyed when taking part in cycle skills training on using gears. Record your findings on a SOLO Strip.

Draw pictures (take photographs or video) in response to the following prompts.



- What did you enjoy when you were taking part in the cycle skills training? [SOLO Multistructural – rectangle]
- Why do you think it was like that? [SOLO Relational – speech bubble]
- What does it make you wonder about cyclists and/or cycling? [SOLO Extended abstract]

Add to the class list of all the enjoyable experiences students encountered during cycle skills training.

Identify any **new terms and vocabulary** introduced into the cycle skills training session. Highlight new terms and vocabulary.

E.g. gear, cog, rotate, big, small, set, teeth, cog train, force, ratio, turn, work, energy, transfer, distance, pulley belt, axle, bicycle chain, driver gear, follower gear, gear wheel, pedal

Add the terms and their meanings to the class/group glossary. Identify unfamiliar terms and use them in a Frayer Vocabulary Chart.

Opportunities for community engagement

*Make connections with people and organisations in the local community with experience in **using pulleys and gears to transfer motion**.*

Make connections with people and organisations in your local community who might volunteer to visit or host students wanting to find out more about using pulleys and gears to transfer motion.

For example, invite workers whose job involves moving heavy loads to talk to students about how simple machines are used to help transfer motion, such as when moving heavy machinery.

Alignment to NZC learning areas

Refer to NZC Learning Areas Overview. Refer to the resource for Achievement Objectives and Learning Intentions (L1 to 4).

English	Listening, Reading and Viewing			Speaking, Writing and Presenting		
The Arts – Drama	Understanding the Arts in Contexts	Developing Practical Knowledge		Developing Ideas		Communicating and Interpreting
Health and Physical Education	Personal Health and Physical Development A – A3 Safety Management			Healthy Communities and Environments S – D2 Community Resources		
Mathematics and Statistics	Number and Algebra					
	Number strategies and knowledge		Equations and expressions		Patterns and relationships	
Science	Nature of Science					Physical World
	Understanding about science	Investigating science	Communicating in science		Participating and contributing	Physical inquiry and physics concepts
Social Sciences	Identity, Culture and Organisation		Place and Environment		Continuity and Change	The Economic World
Technology	Technological Practice		Technological Knowledge		Nature of Technology	

CLASSROOM ACTIVITIES

Acquire surface and deep understanding needed to support cycle skills training sessions.

Building student understanding about doing work when cycling.

3.1. Forces – When bikes speed up, slow down, change direction and change shape

[Bringing in ideas]

[Links to NZC Learning Areas: Science – Physical World.]

Forces are either pushes or pulls. Forces do 4 things to bikes – speed them up, slow them down, change the direction they are moving in, or change the shape of a bike.

For example, we use push forces on the pedals to speed up the motion of the bicycle. We use pull and push force on the handlebars to change the direction of the bicycle's movement. We use pull forces on the brakes to slow down the motion of the bicycle.

In the cycle skills training your instructors may describe the forces acting on the bicycle and its motion (or movement) by using some of the following science terms (refer below).

Ask students to work in pairs.

Draw an image or design an avatar to represent each type of force.

Watch an online video showing a cyclist having fun and keeping safe on a bike. Ask them to pause the video when they identify one of the states of motion listed below.

Science terms and vocabulary	Draw an image representing each state of motion
Motion <ul style="list-style-type: none"> • Stationary (stopped) • Moving at constant speed • Moving at increasing speed (accelerating) • Moving at decreasing speed (decelerating) • Moving forwards, backwards, upwards or downwards 	

In pairs:

Students find an image of their favourite bike, from fiction or real life.

Print a copy of the bike.

Annotate the bike image with arrows showing how and where the different forces will operate.

<i>Science terms and vocabulary</i>	<i>Insert picture of favourite bike</i>
<p>Forces</p> <ul style="list-style-type: none"> • <i>Gravity force</i> – the force by which a planet or other body draws objects toward its centre. It keeps all of the planets in orbit around the sun. Gravity force explains why you land back on the ground after you go over a jump at a BMX track. It explains why a bike falls to the ground when you drop it as you jump clear. • <i>Tension force</i> – a force produced when an elastic body is changed in shape. E.g. shock-absorbing springs provide resistance to forces creating movement in mountain bikes. • <i>Support force</i> – a force that supports something against gravity. E.g. the support force of the track pushes up on the wheels of the bicycle. • <i>Thrust force</i> – a force pushing a vehicle forward. • <i>Friction force</i> – a force that opposes things sliding past each other. 	<p>Annotate the image to show the forces involved in moving the bike</p>

Observe a group of cyclists or watch a video. Prepare a commentary that describes the motion of the bicycle using science terms.

Next to each of the following situations, write the correct motion term.

Situation	Bicycle motion
A cyclist wheeling their bike back to the shed	
A cyclist removing a bike from a carry rack	
A cyclist sitting on a bike adjusting their helmet	
A cyclist braking in front of an instructor	
A cyclist during a race	
A cyclist rolling down a hill	
A cyclist biking up a steep hill, stopping at the top and then racing down the other side	
A cyclist travelling the same speed	

Complete a sentence:

When cycling	Draw an annotated picture to show how you might experience the following motion during the skills session.
I moved at constant speed	
I moved at constant speed and then decelerated	
I accelerated, then moved at constant speed	

3.2.1. Doing work when having fun on bikes

[Relating ideas]

[Links to NZC Learning Areas: Science – Physical World]

We might think we are having fun when we go on a bike trip to a local park, but scientists would describe the bike trip as doing work. When scientists talk about changing the distance an object travels over time, they describe it as transferring energy (or doing work).

In the skills training session, students worked to change the movement of their bikes over time.

Cyclists transfer energy and do work when they cycle from one place to another.

Cycling is doing work.

Doing work is energy transfer.

Work done = Force exerted × distance covered.

Ask students to:

Go for a walk around the school grounds or local community and find examples of people using simple machines or devices to help them change the position of different objects.

Take photographs of the work being done – include the machine or device used, the person and the object being moved.

Use the images to make an art gallery exhibition space (either virtual such as a webpage, blog or wiki; or on a classroom wall) showing how machines help us do work in everyday life.

For example, wheel and axle (office chairs, carts, supermarket trolley, baby stroller, wheeled carry-on luggage and toy cars), force multipliers, lever (seesaw, pry bar, lever-action door latches), inclined plane, pulley, screw, wedge (scissors, a screw, a knife).

Write promotional material to support the exhibition, e.g. a brochure or postcards. Include a small exhibit card to go with each artwork. Use scientific language in the descriptions and titles.

3.2.2. Exploring gears

[Relating ideas]

[Links to NZC Learning Areas: Science – Physical World]

Using machines to spread out the effort needed to move objects.

Introduce the idea of gears as simple machines.

[Gears \(DK Findout!\)](#)

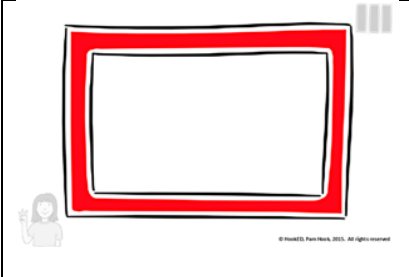


Ask students: what are gears? What are they used for? What do gears do? How do gears do this?

For example: gears are wheels with teeth. They transfer energy in the form of motion from one place to another. Gears can speed things up or slow things down.

What did you notice or learn about gears when you took part in the skills training lesson?

Use a SOLO Strip to make meaning of the idea (explain why) and then extend the idea some place new (wonder).

For example:

		
<p>What did you notice in the skills lesson about using gears on bicycles?</p> <p><i>SOLO Multistructural</i></p>	<p>Why do you think it is like that?</p> <p><i>SOLO Relational</i></p>	<p>What does it make you wonder about using gears on bikes?</p> <p><i>SOLO Extended abstract</i></p>

Scientists use special language when they talk about gears. Try and use this vocabulary in the activities that follow.

Science terms

Driver gear – the gear that ‘drives’ the motion of the other gears; the gear with the applied force, e.g. the gear on the foot pedal of a bike.

Follower gear – the gear that ‘follows’ the motion of the rest of the gears; the gear doing the useful work e.g. the gear on the rear wheel of a bike.

Idler gear – the gear turned by driver gear that turns follower gear.

Gear train – many gears in a row.

Geared up – large driver and small follower, which speeds the gear train up.

Geared down – small driver and large follower, which increases the torque (turning force).

Find answers to these questions by playing with kitset model gears and axles if available.

- Ask students to count the number of teeth on different-sized gears. Next link the gears and count the number of times each linked gear turns. Can you see a similar effect for a geared bicycle?
- Bring a bike with gears into the classroom. When the driver gear (attached to the bike pedal) makes one turn, how many turns does the follower gear (attached to the rear wheel) make?
- What gears would you choose if you had to tow a heavy load behind your bike?

Extension

Some students will want to take this further and learn about gear ratios. (Refer to the notes below.)

Transferring motion from the pedal to the rear wheel

When the number of teeth in the driver and the follower gears are the same, one turn of the driver gear creates one turn of the follower gear.

Gear Ratio = $\frac{\text{number of teeth in follower}}{\text{number of teeth in driver}}$

G.R. = F_t / D_t e.g. 1/1 or 1:1 (read as 1 to 1)

Gearing down – low gear ratio

Putting the bike in high gear makes it harder to cycle but you go faster. When the number of teeth in the driver and the follower gears are different; then one turn of the driver gear creates a different turn of the follower gear. In the example below, one turn of the driver gear will turn the follower gear three times. The larger follower gear increases the turning force.

G.R. = F_t / D_t e.g. $\frac{1}{3}$ or 1:3 (read as 1 to 3)

Gearing up – high gear ratio

Putting the bike in low gear makes it easier to cycle but you go more slowly. This is because more teeth are in the driver gear than in the follower gear. For example, if the number of teeth in the driver and follower were reversed, then three turns of the driver gear are needed for one turn of the follower gear. The smaller follower gear reduces the turning force.

G.R. = F_t / D_t e.g. 3/1 or 3: (read as 3 to 1)

3.3. Using gears to spread out the effort needed to move a bike

[Extending ideas]

[Links to NZC Learning Areas: Science – Physical World]

Ask students to work in groups of two or three to investigate cycling as doing work – from a scientist's perspective.

Use a kitset with model gears, axles and pulley belts (chains) along with full-sized bikes, chains and gears etc. Investigate how work is done and energy is transferred by people using the following types of bicycles:

- a scooter
- a tricycle with a fixed-wheel pedal
- a bicycle with a pedal connected to the wheel via a simple belt pulley or single-gear chain
- two wheels connected by a pulley belt
- two wheels connected by a variable belt pulley
- a bicycle with a pedal connected to a complex or multiple-gear chain.

Encourage students to notice that although the pedals start off attached to the front wheel (close together) on the tricycle, the distance increases between where the effort force is applied (on the pedal wheel) and where the load is experienced (on the rear wheel) in the later examples.

The gap can be filled with a series of gears, or more likely gears on a sprocket with a chain.

Notes

Gears can make pedalling easier (the wheels turn less for each turn of the pedal).

The effort is spread over a greater distance.

Gears can make pedalling harder (the wheels turn more for each turn of the pedal).

The effort is spread over a shorter distance

The overall effort in moving the bike a given distance remains the same.

Scooter	<p><i>What do you notice?</i> The cyclist is doing work. Pushing off from the ground moves a scooter across a flat surface.</p> <p><i>How and why does this work?</i> The push force directly rotates the wheels moving the scooter. Mark a point where the wheel of the scooter touches the ground. Notice what happens to the wheels as the scooter changes position.</p> <p><i>Create a model to represent this mechanism.</i></p> <p>Make a prototype showing how energy is transferred on a scooter.</p>
Fixed-wheel tricycle	<p><i>What do you notice?</i> The cyclist is doing work. The turning pedal moves the trike across a flat surface.</p> <p><i>How and why does this work?</i> The push force on the pedal turns the wheel axle one rotation which rotates the front wheel of the trike one rotation. <i>Create a model to represent this mechanism.</i></p> <p>Make a prototype showing how energy is transferred on a fixed-wheel tricycle.</p>
Pulley belts	<p><i>Create a model to represent this mechanism.</i></p> <p>Make a prototype showing how energy is transferred on a:</p> <ul style="list-style-type: none"> • pulley belt – where a force on one drive wheel axle acts on a similar-sized drive wheel axle at a distance • variable pulley belt – where a force on one drive wheel axle acts on a different-sized drive wheel axle at a distance • pulley belt – changing the direction of a force.
Bicycle chain	<p>A chain is used instead of a pulley belt to avoid the possibility of any slipping.</p>
Fixed chain bicycle	<p><i>What do you notice?</i> The cyclist is doing work. The turning pedal moves the bicycle across a flat surface.</p> <p><i>How and why does this work?</i> The pedal turns the driving gear wheel. The driving gear wheel moves the chain. The pulley belt (chain) moves the back wheel gear. The back wheel gear moves the back wheel.</p> <p><i>Create a model to represent this mechanism.</i></p> <p>Make a prototype showing how energy is transferred in a fixed-chain bicycle mechanism with the kitset pieces.</p>

<p>Variable chain bicycle</p> <p>e.g. single-speed and multiple-speed bicycles</p> <p>[two sets of different-sized gears]</p>	<p><i>What do you notice?</i></p> <p>The cyclist is doing work. The turning pedal moves the bicycle across a flat surface.</p> <p><i>How and why does this work?</i> The pedal turns one of the driving gear wheels. The driving gear wheel moves the chain. The chain moves one of the back wheel gears. The back wheel gear moves the back wheel.</p> <p><i>Create a model to represent this mechanism.</i></p> <p>Make a prototype showing how energy is transferred in a variable chain bicycle mechanism.</p>

How cycle gears work:

[Drives and Gears \(Exploratorium\)](#)

Model kitsets suitable for exploring gears:

[K'Nex Education Gears](#)

[Every Educaid](#)

Mathematics and Statistics

New Zealand Maths Resources:

[Gearing up](#)

[The Right Gear; Use rates and ratios](#)

WRAP UP

Session reflection

What do you know you don't know about using pulleys and gears to transfer motion when biking?

What have you learnt that is new to you about using pulleys and gears to transfer motion?

What do you wonder about using pulleys and gears to transfer motion?

Use the student responses to make decisions about follow-up sessions.

Key competency self-assessment rubric

Thinking	Managing self	Participating and contributing	Relating to others	Using language symbols and text
Develop a critical eye (situational awareness) for unsafe environments and unsafe actions when out on your bike.	Act appropriately when on and around bikes. Act in ways that create and maintain 'bike fun and safe environments'.	Display an awareness of local issues around riding bikes. Be actively involved in community issues around having fun and keeping safe when riding bikes Contribute to physical environments and local events to make them 'bike fun and safe'.	Interact with others to create 'fun and safe' biking environments at school and in the local community.	Interpret messages in communications about 'bike fun and safe environments'. Use language symbols and text to communicate messages about 'bike fun and safe environments'.

For more about key competency self-assessment rubrics, see Appendix B.