Year 4

Conceptual narrative Science: Forces and motion

In the physical sciences sub-strand, there are two main conceptual threads being developed from Foundation through to Year 10, energy and forces and motion.

Big ideas

Forces can act at a distance and act in direct contact.

What concepts do I want my students to understand?

- Forces, such as friction, magnetism, gravity and electrostatic forces are exerted at a distance or on contact, to affect the movement of objects.
- Some interactions result from phenomena like forces that can’t be seen with the naked eye.

Appendix 1 shows how the three interwoven strands, Science Understanding, Science as a Human Endeavour and Science Inquiry Skills, work together to build the sophistication and complexity of the science concepts from Foundation to Year 10.

This conceptual narrative illustrates one of the nine science concepts from the Australian Curriculum: Science Content structure. It tells the story of the concept in isolation of the eight others. However, there are situations when it is advisable to teach both concepts (energy and forces and motion) together, because they complement each other.

Note: Not all concepts are specifically addressed in each year level.

Introduction

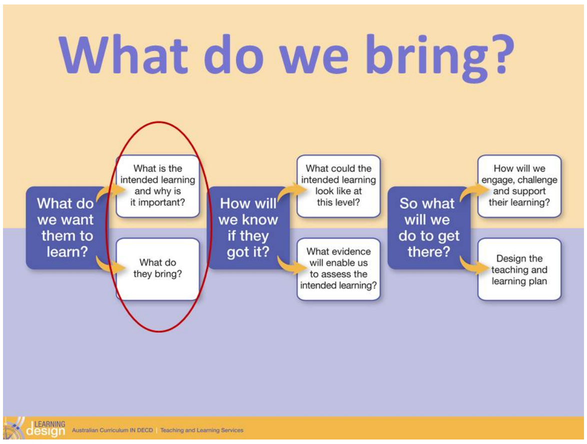
What might my students already know about this concept?

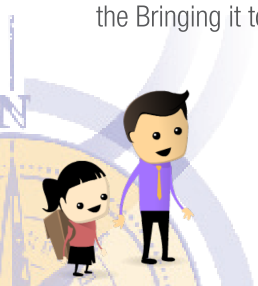
Students are likely to know that a force is a push or a pull, and that forces can change the shape and motion of an object. They may also know that the size and shape of an object affects its movement.

What content could I use to explore this concept?

In Year 4 we want students to understand that forces can act in direct contact, for example friction. We could explore this by pulling a block of wood or having a marble race over different surfaces and investigating the amount of friction. We want students to understand that forces can act at a distance for example gravity. We could explore forces acting at a distance through the attraction of paper clips to a magnet, or how gravity affects the motion of objects that are dropped, bounced, or thrown.

Now to bring the essence of scientific understanding to life, let’s think about this concept through the six questions from the Bringing it to Life tool (BitL).





In Year 4, we want our students to understand that forces can act at a distance and act in direct contact.

Year 4 example

In this example, we will investigate the effect of friction on different surfaces, and the role it plays in motion. I would ask my students to decide who has the best shoes in the class for sliding down the slippery grass slope.

What do you notice?

How can I help my students make observations?

Using the BitL questions, I could ask:

- *What do you notice?*

At Year 4, I want my students to make observations and then be able to classify them into groups. I want them to notice that different shoes are made with different soles, for different purposes. Some are rough and some are smooth. Questions I could ask are:

- *What do you notice about the different surfaces on the soles of different shoes?*
- *Do the soles of different shoes feel the same?*
- *Do the soles on the shoes look the same?*
- *What is interesting about your shoes?*

What patterns and relationships can you see?

How can I help students to see patterns and relationships? What questions might my students ask?

Student's curiosity leads them to ask questions. These questions help students to order their findings into a pattern to be able to make comparisons or find relationships. These questions support students to be more precise and foster analysis and classification of the observations.

Using the BitL questions, I could ask:

- *What patterns and relationships can you see?*

I want my students to see that different soles affect the amount of friction produced. Questions I could ask are:

- *What similarities and differences are there between the different shoes in the class?*
- *What different materials are used to make different soles?*
- *What criteria could you use to group the shoes?*
- *Which features change when the shoes get old?*
- *What questions do you have?*

What do you think if?

How can I help students to identify and formulate investigable questions?

Students ask testable questions that help them to narrow the focus of the inquiry. These questions provide opportunities for students to make predictions.

Using the BitL questions, I could ask:

- *What do you think if…?*

In Year 4, I want my students to be able to use their prior knowledge to predict the relationship between the surface of their shoes and the friction they produce. Some questions I could ask are:

- *What do you think might happen if we made the surface smoother?*
- *What do you think might happen if we change the materials used for the shoe sole surface?*
- *What do you think might make the shoe slide better?*

How can you explore?

These questions support students to develop science inquiry skills and problem solve.

Using the BitL questions, I could ask:

- *How can you explore?*

At Year 4, I want my students to write investigable questions about friction and how it relates to shoes that stop or slide. I also want my students to take safety and fairness into account while planning for and conducting their investigation. Some questions I could ask are:

- *What are you doing to investigate?*
- *How can you keep yourself and others safe while testing the idea?*
- *How will you keep the test fair?*

How can you review and communicate?

How can I help students share their observations and questions?

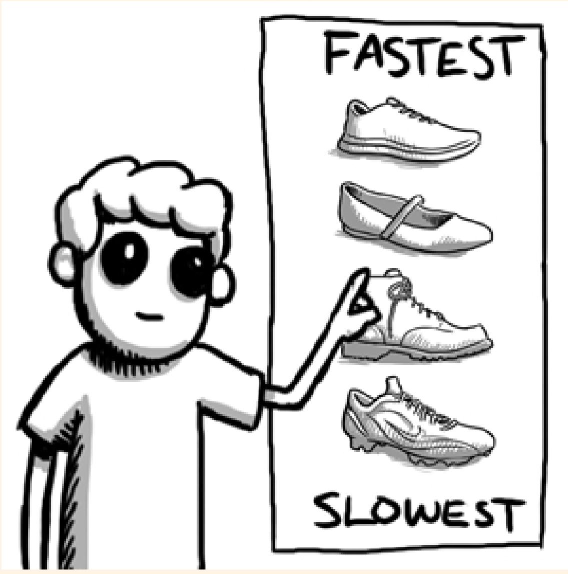
These questions stimulate student's reasoning and help them analyse, draw conclusions and make generalisations about the concepts.

Using the BitL questions, I could ask:

- *How can you review and communicate?*

I want my students to represent and explain their understanding and observations of how friction can be increased or reduced by choosing the appropriate shoes, or changing the surface.
I could prompt my students with questions like:

- *How might you represent your data about the friction that different shoe surface produce?*
- *What suggestions could you make to improve your investigation?*
- *Was your conclusion different to what you predicted?*



So what? What next?

How can I help students apply the concepts in a range of authentic contexts?

These questions support student's reasoning, to expand or change their ideas from their experience and evidence and generalise to new contexts.

Using the BitL questions, I could ask:

- *So what? What next?*
- *When do we need to know how some forces act by direct contact, like friction?*
- *Who uses the force of friction in their daily lives or work? How?*
- *How might you use your learning about friction in your daily life?*
- *Why do shoes have different surfaces?*

Concluding comments

What concepts might students develop through working with the BitL questions in this way?

By exploring this science understanding through these questions, we can help our students to be able to think, work and process scientifically. Students can connect science to their world and consider why they need to learn that forces such as friction act by direct contact and other forces such as magnets and gravity, act from a distance.

Appendix 1

Appendix 1 shows how the three interwoven strands, Science Understanding, Science as a Human Endeavour and Science Inquiry Skills, work together to build the sophistication and complexity of the science concepts from Foundation to Year 10.

This conceptual narrative illustrates one of the nine science concepts from the Australian Curriculum: Science Content structure. These concepts develop in depth and breadth of understanding from Foundation to Year 10. This conceptual narrative tells the story of the concept in isolation of the eight others. However, there are situations when it is advisable to teach both concepts (energy and forces and motion) together, because they complement each other.

Note: Not all concepts are specifically addressed in each year level.

Physical sciences

In the physical sciences sub-strand, there are two main conceptual threads being developed from Foundation through to Year 10. They are the concepts energy and forces and motion. Let's look at the concept forces and motion.

Foundation

In the Foundation year, students look at the way objects move, and how they move depends on their size and shape. For example, different balls like footballs, tennis balls and table tennis balls roll differently depending on their size and shape.

Year 2

In Year 2, students learn that movement is caused by either a push or a pull, and that it takes a bigger push to move a brick than a lunch box. They also learn that you can change the shape of some objects when a push or pull force is applied.

Year 4

In Year 4, students group forces as contact forces and non-contact forces. Examples of forces acting on contact are, a bat striking a ball or friction, where one object rubs against another object, like when you get a carpet burn. An example of a non-contact force is the pull of a magnet on paperclips.

Year 7

Year 7 is when students look at common situations where a balanced or unbalanced force cause changes to an object's motion. An example of a balanced force is a tug-of-war where the force exerted by the two teams is equal and it is clear that neither team will win. We say the forces on the rope are balanced, when the rope stays still. However, if the forces on the rope are unbalanced we can see a different effect. If in the tug-o-war and one side exerts greater force than the other, then the forces on the rope are unbalanced and the rope starts to move in the direction of the greatest force.

Year 10

At Year 10, students use Newton's laws to describe and predict motion and use mathematics to quantify this. Force is equal to, the mass times the acceleration, and speed is equal to distance divided by time. These are equations that students use to describe the effects of interactions between objects. They extend the application of force to other scales, including forces between atoms and between stars and planets.

So from Foundation to Year 10, students broaden and deepen their understanding by building on from their learning about forces and the motion of familiar objects, to consider a wider range of forces and then use laws and mathematical models to describe, predict and generalise.