Making science misconceptions work for us

The Australian Curriculum: Science is based on scientific concepts that develop across Foundation to Year 10. In teaching these concepts, it is important to build on learners' understandings (Teaching for Effective Learning (TfEL) 4.1). Students will bring prior knowledge, beliefs and understandings of these concepts to their science learning. These beliefs and understandings have been developed over students' lives as they experience and seek to make sense of the world. Sometimes students have formed understandings of concepts that are not consistent with generally accepted scientific knowledge.
These understandings can be referred to as misconceptions, alternative conceptions or naïve knowledge. Teachers will generally be more effective if they are aware of the students' misconceptions.

A student's prior knowledge, beliefs and understandings influence their learning of science concepts. For example:

1. New knowledge may simply become an extension of what a student already knows. This happens when the new knowledge does not directly conflict or contradict their pre-existing knowledge and beliefs. For example, when a student learns about a new insect that lives in the school yard this becomes an extension of their pre- existing knowledge about insects.
2. New knowledge may conflict with what a student already knows or believes. For example, a student, who has observed the sun moving across the sky during the course of a day, is presented with the idea that the sun remains still and the Earth rotates daily about an axis. This is a direct conflict to the student's pre-existing beliefs.

When a student is presented with an idea that conflicts with their pre-existing beliefs, they may respond in a number of ways:

- Discredit the source of the new idea. For example, "What would they know? That is a plastic ball, not the Earth."
- Affirm their existing thinking. For example, "It's obvious. Everyone knows that the sun moves across the sky because they see it every day."
- Make an exception. For example, "It's different in this case. This is just how it is at school."
- Develop an explanation for the new idea that leaves their pre-existing understanding of the concept intact. For example, "Maybe this happens here but…The Earth might be round, but the sun still moves around it."

The way a teacher responds to students' misconceptions makes a difference to how students think about the new ideas they are presented with. A teacher might avoid a student's existing beliefs altogether or tell the student clearly that they are wrong and need to think differently. Neither of these approaches has been shown to be widely effective. Evidence suggests that it can be more effective to work with both the new idea and the existing misconception at the same time.
This may involve:

- Investigating contexts where the pre-existing ideas work and other contexts where they don't.
- Incorporating opportunities for students to compare their old ideas with the new concept.
- Providing ample opportunities to practice the new science concept to lessen the likelihood of learners reverting to their old ideas, when the new concept would be more useful.

If we return to the Earth and sun example, we want students to know that although the sun appears to move across the sky and we can use this to estimate the time of day; in reality the sun remains still while the Earth rotates. We need to think like this to explain seasons, phases of the moon and other understandings of the Earth in space.
Rather than avoiding or marginalising students' existing misconceptions, this approach uses the misconceptions as a springboard for further learning. The aim is to focus on knowing when different ways of thinking can be useful rather than replacing one type of thinking with another.

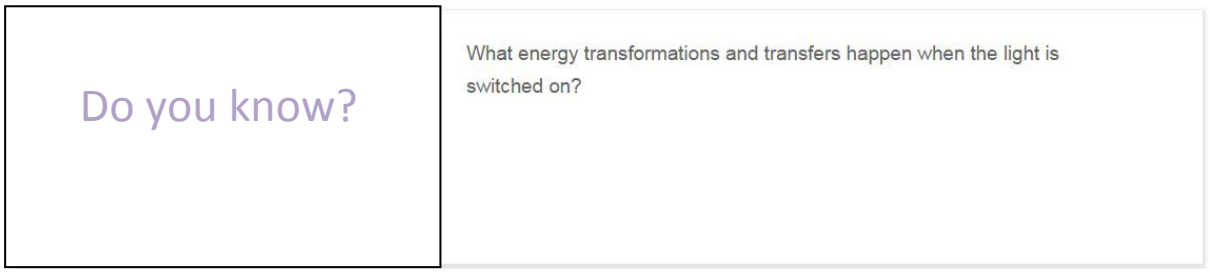
Here we introduce a tool, Science Misconceptions, designed to help teachers identify and work with the misconceptions students bring to their science learning by:

- Being clear about their own understandings of the concepts they are teaching.
- Presenting some common misconceptions of the concepts.
- Suggesting questions for eliciting students' misconceptions.
- Scaffolding strategies for using students' misconceptions as a springboard for developing deeper and more accurate scientific concepts.

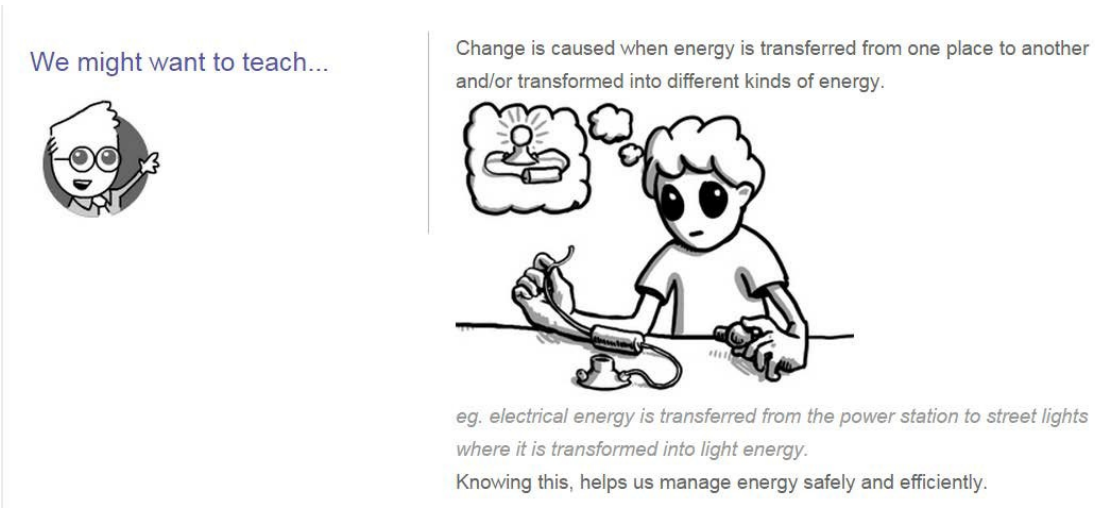
Supporting teachers to work with concept learning

The tool allows teachers to access it through the year level and science understanding of the curriculum relevant to their learners. It provides:

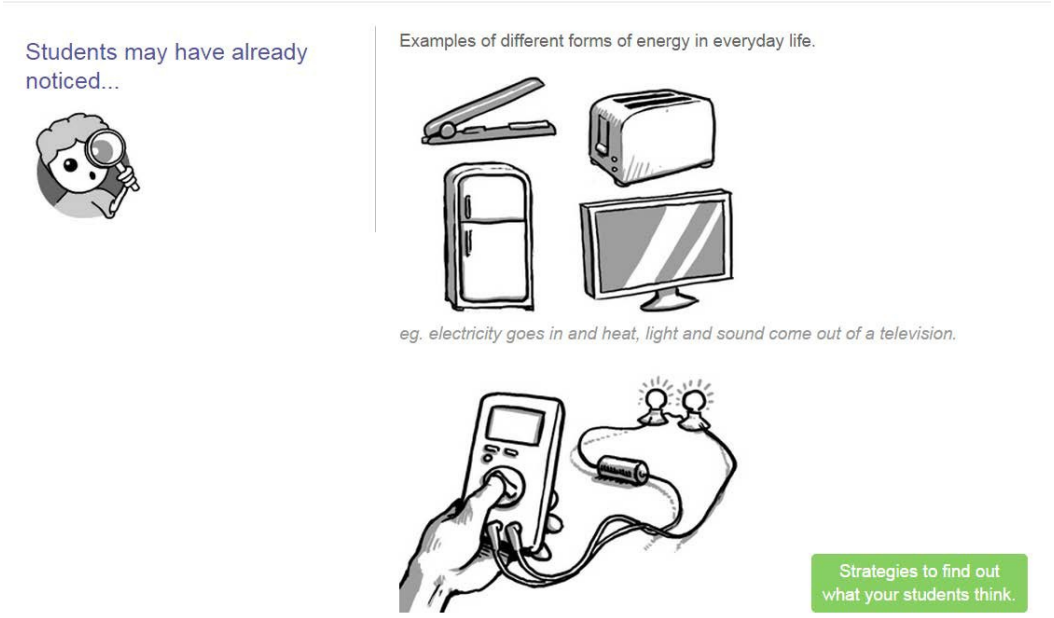
- An opportunity to check their own conceptual understanding via a question framed to elicit common misconceptions.



- A statement of the (**what** to teach) science concept from the Australian Curriculum Science Understanding strand and (**why** we would want our student to learn this) its relevance to real world and further learning.



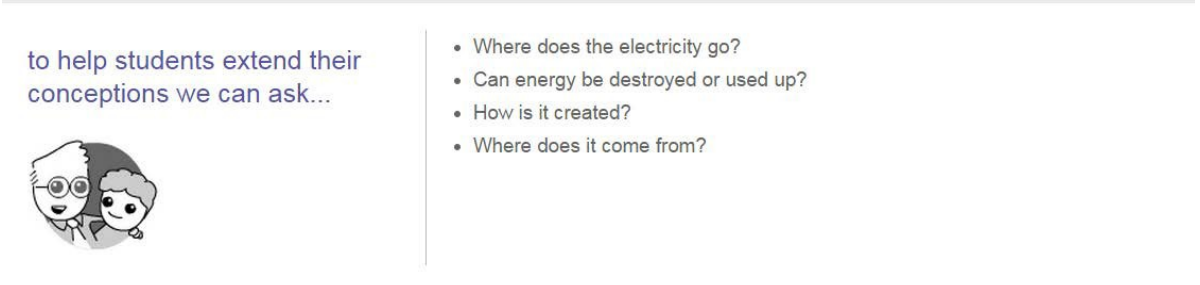
- An example of an observation that students might have made from their experiences, both in and out of school.



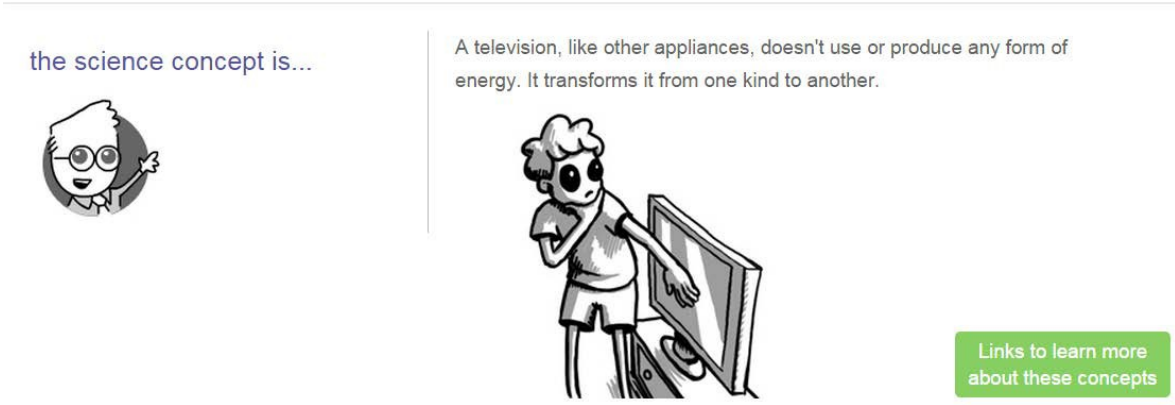
- Strategies for eliciting their current thinking about this.
- Only one example of an alternative conception or misconception of the understanding of a science concept is stated, however, there could be many. Here the teacher seeks out their own students' misconceptions. They might ask the following questions:
    - What about your students?
    - What have they observed?
    - What do they think?

  There is an opportunity to contribute to an online bank of students misconceptions.

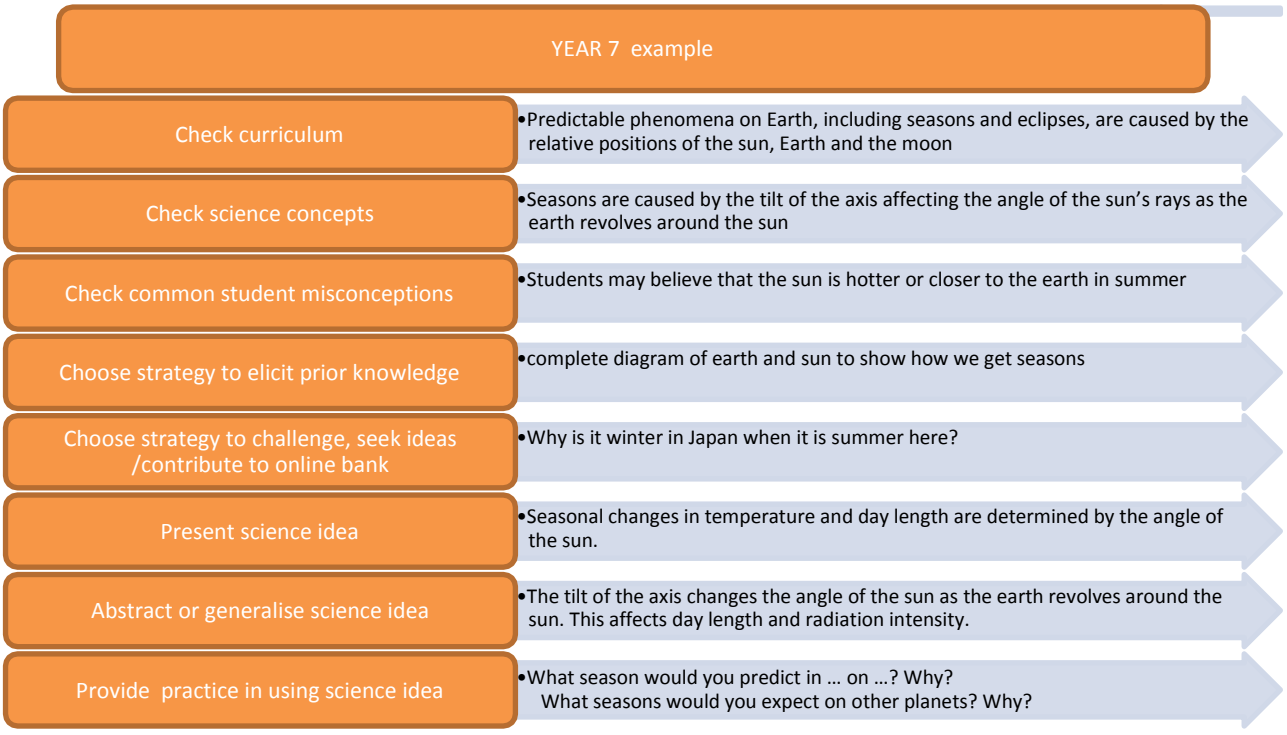
- Pedagogical questions for extending students' thinking where no strong misconception exists.
  OR
- Pedagogical questions to challenge the thinking of students with a strong misconception.



- A restatement of the concept to show how it is more useful than the misconception and links are provided to further develop the understanding of a concept.



While we have described a linear path through the tool, the tool supports teachers to move between different sections as needed.
An example of how it might be used in teaching Year 7 science concepts is also included.



Thus the tool aims to support teachers to focus on the concepts in the curriculum, to elicit students' misconceptions and design learning in response to them.

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