CURIOSITY INTO CREATION:

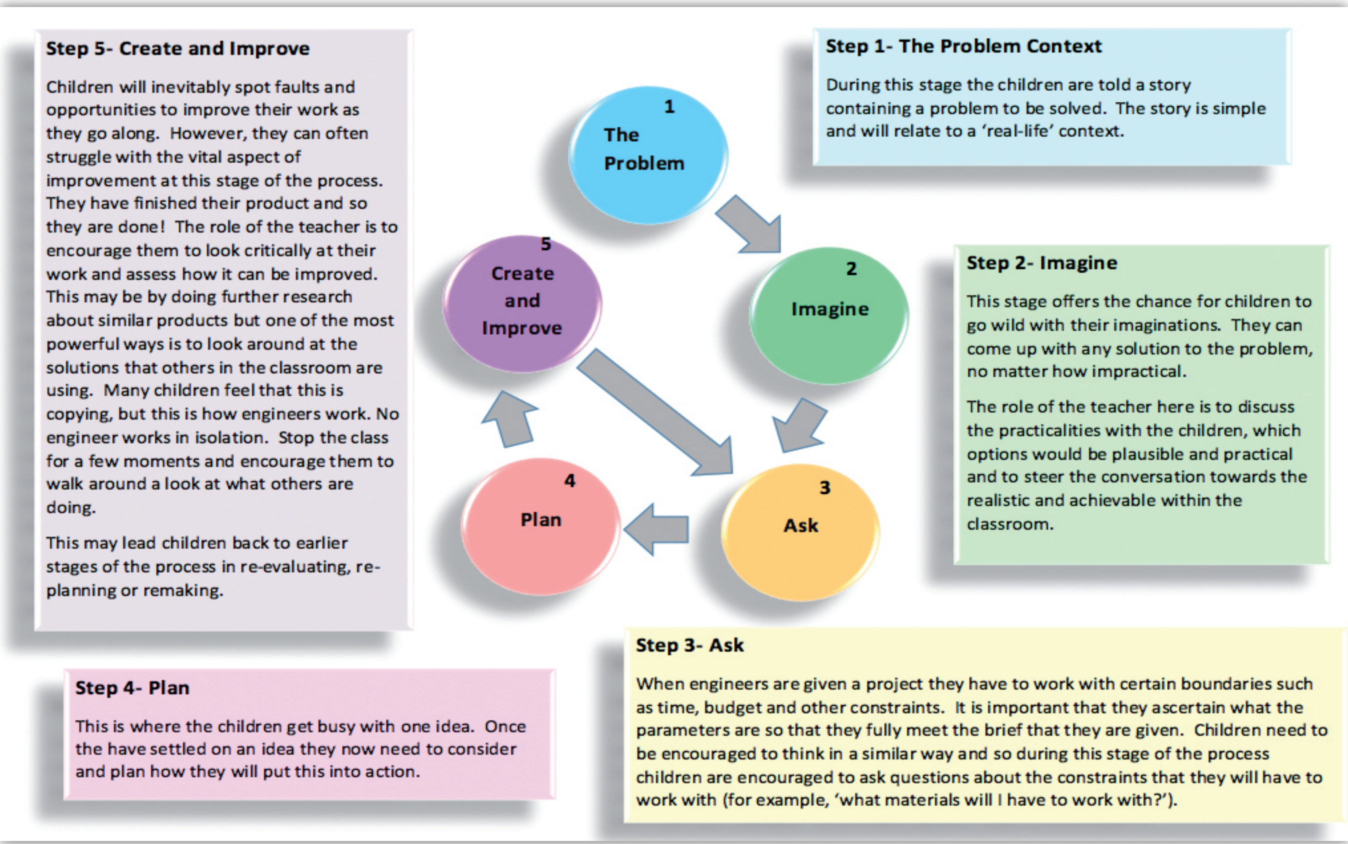
can we teach science through engineering?

Fay Lewis, Juliet Edmonds and **Laura Fogg-Rogers** explore how curiosity supports change and challenging ideas to create workable solutions

Take a look around you. The chances are that almost all the things you see would not be here without the work of engineers. Engineers are vital to the way we live, our everyday experiences and activities, but despite this engineering receives little focus (if any!) in the primary classroom.

We know that interest in STEM (science, technology, engineering and mathematics) wanes as children reach the end of primary school (Murphy *et al.*, 2005). However, providing positive experiences can keep the doors open for STEM-based career choices (EngineeringUK, 2015; Jarvis and

Figure 1 (below) The engineering design process adapted for the science classroom (based on EngineerEU materials, www.engineer-project.eu)



Key words: Curiosity Engineering Design process

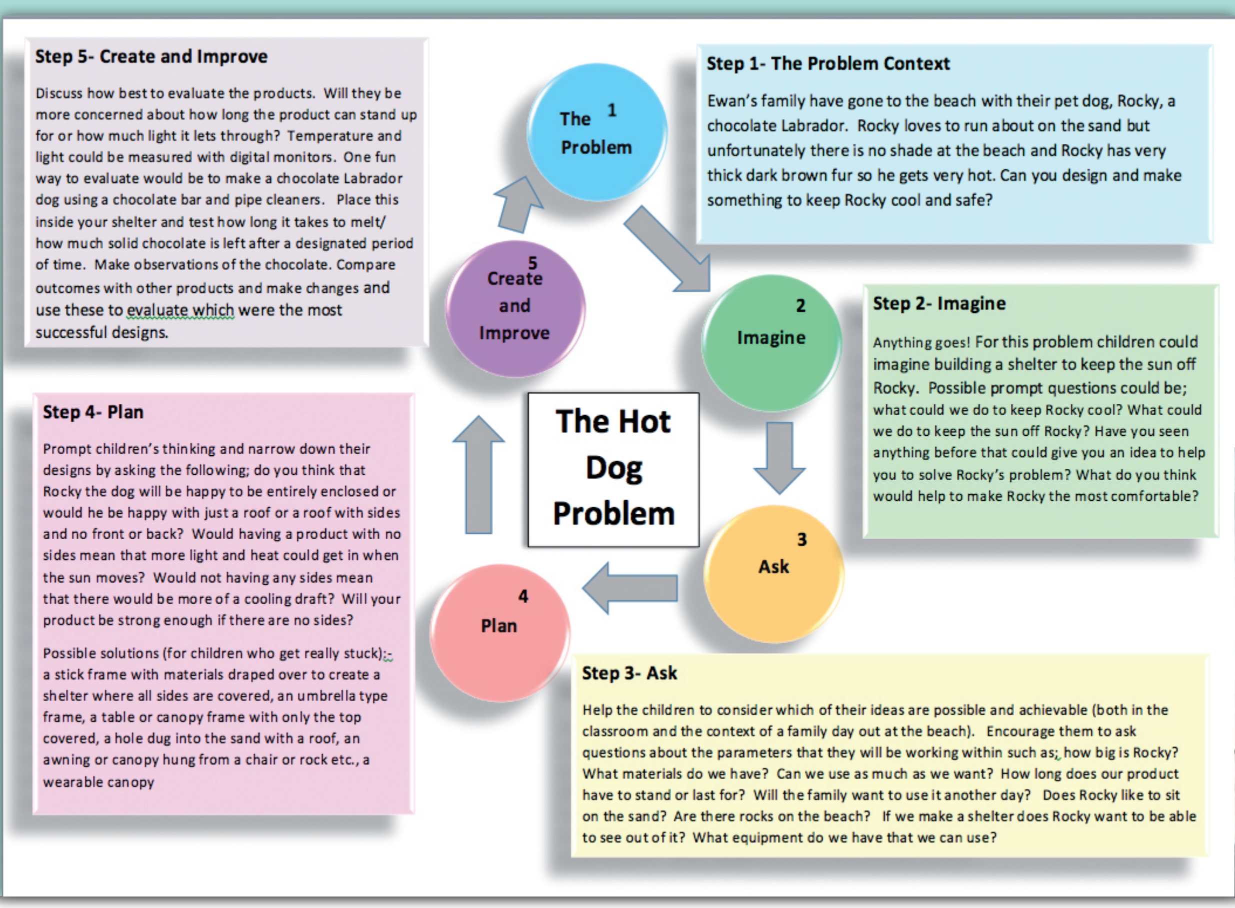


Figure 2 Flowchart of a specific example of the design process – protecting a dog on the beach on a hot day

Pell, 2005) and teachers are a key factor in influencing children to consider engineering as a career (Perkins, 2013).

But how can teachers achieve this and is it even possible within such a crowded curriculum? One solution may be to teach science through engineering. The two subjects are intrinsically linked: it would be impossible to design a bridge without understanding forces or to make a toaster without understanding how circuits work. Thus, this can offer teachers a purposeful, contextualised approach to the science curriculum.

What does the learning experience look like?

Engineers use a design process throughout their work, starting with a problem to solve; this aspect of contextualised problem solving is vital to this approach. A 'real-life' problem context provides purpose to the work and learning and can help to keep girls engaged with their learning in STEM subjects (High Level Group on Science Education, 2007). The science that the children learn and apply throughout the engineering process will be important to their success and of immediate use, motivating learning that draws upon their curiosity and imagination. An adapted version of the engineering design process (Figure 1) can be used with children to discover and explore scientific concepts, produce a product and learn how engineers work. The flowchart breaks down what happens at each stage of the process. This process may last for just one lesson or an entire science focus.

Where does the science come in?

Scientific knowledge and skills can be covered at any stage of the process. This may be in the form of a full investigation, researching an issue or concept, demonstrations of concepts, testing of theories or just short discussions. Asking questions is paramount and links with finding the solutions and the 'working scientifically' demands of the National Curriculum.

At any stage during the cycle children may be applying previously learnt scientific understanding. This may be new knowledge or skills that have been taught specifically for the project or may be a consolidation of previous learning.

They may also come to a point where they can go no further without new knowledge, especially when they encounter issues and wish to improve their products. Imagine that a group of children are planning to make gloves to keep their hands warm when building a snowman. They may need to do a short investigation about waterproofing/absorption qualities or thermal conducting/ insulating properties. They need this knowledge in order to improve their design and to help them to decide which materials to use. Any teaching input or investigations about this new knowledge have a real and valuable purpose.

What does this look like in practice?

The flowchart in Figure 2 sets out how the approach could be used for a specific example, in this case a family who have visited the beach on a hot day with their dog (see www.rspca.org.uk/adviceandwelfare/seasonal).

Box 1 lists ideas for the science concepts and skills that can be covered using this approach.

Summary

Using engineering to teach science can change children's attitudes towards it as well as greatly improving their understanding of relevant concepts. (Lachapelle et al., 2010). Ultimately, using this approach integrates STEM into one learning experience using real-world application and preparing children for careers that use the STEM subjects in integrated ways.

Box 1 Science knowledge and skills covered during the 'dog on a beach' challenge

Research

- Examine a range of products designed to provide shade (sunshades, whitewashing of windows, windscreen shields, blinds, darkened windows, parasols, blinds, natural shade from trees, hats, baseball caps, sun visors).
- Test the effectiveness of these products and evaluate the materials that they are made from.
- Write a leaflet on keeping your dog safe.

Investigate

- Test the absorbency/waterproofness, amount of light or heat passing through each material. Examine the thermal insulation (how much a material keeps out heat) or thermal conductivity properties (how much heat a material transmits). (This concept is potentially very challenging. Materials may absorb more energy but the temperature rise varies according to the material. The ability of heat to pass through depends upon thermal conductivity. The ability for heat to be re-radiated depends on a number of factors.)
- Discuss the most effective material to use. Is the material that keeps out the most light useful if it is not waterproof?

Measure/observe

- Practise using thermometers and reading scales.
- Take a walk around the school or classroom. Which is the warmest spot? Who has the hottest hands?
- Monitor light levels over time.
- Measure and record how much light different materials reflect. Once children have been taught to do this effectively they can evaluate their products more accurately.

Recording data

- Record and chart changes in light and temperature over time in a line graph, either manually or using a data-logger.
- Do a test with a dropper to find out the amount of water absorbed by different materials and record in a table or bar chart.
- Chart the amount of light absorbed by different materials in a table or bar chart.
- Record and chart temperature inside built structures made of different materials.

Knowledge and vocabulary

- Vocabulary could include: reflection, absorption of light, thermal insulation and thermal conductivity, absorption of water and waterproofness, opaqueness, transparency and translucence, strength of materials, flexibility, rigidity, translucent, transparent.

Classification/grouping

- Sort materials according to strength, thermal insulation properties, flexibility and opacity. Use sorting hoops and look for materials that share properties.

Some other problems to try

- I can't get to sleep at night because of the noise from the traffic.
- I need a bag for my wet swim kit.
- I need an alarm to let me know when my brother/sister is coming into my bedroom.
- I need some shoes to protect my feet from the hot sand at the beach.
- It is too cold to grow plants outside the classroom. I need a container to grow them in.
- How could we grow potatoes in space?

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