THE UNIVERSITY OF MELBOURNE
MELBOURNE GRADUATE SCHOOL OF EDUCATION
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Shaping minds, shaping the world

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The ESTEME model: Using engineering to assess and extend STEM learning

Overview

- Outline of the ESTEME project
- The approach to STEM taken
- The needs of ESTEME stakeholders
- The ESTEME model
- Teacher feedback on the model
- Changes in student perceptions of STEM

The ESTEME project

- A small, HEPPP funded, partnership project between 7 local primary schools and the Engineering, Science and Education schools at the University of Melbourne
- The goal of the project is to help make partnership schools ‘leaders in STEM education’
- Schools within the partnership are very diverse

ESTEME activities

- Action research projects
  - Each school nominated a STEM leader to lead a STEM-focused action research project in each school
  - STEM leaders were supported by University academics in their research
- Teachmeets
  - Each school hosts 2 teachmeets per year
- Engineering day
  - Melbourne School of Engineering hosted approximately 400 grade 5/6 students over 2 days for tours of their wet labs, and a range of engineering activities

The approach to STEM taken

- Of the 7 partner schools, 6 schools' research projects were science focused, 1 schools' project was mathematics focused
  - Initially, schools viewed STEM as discreet subject areas
- The most enthusiastic support for ESTEME from outside of the Melbourne Graduate School of Education came from Engineering
  - The engineers were happy to help schools with 'S' and 'M', but they really wanted to also help with 'T' and 'E'

→ We needed to develop an approach to STEM which was not just 'S' & 'M'

What is STEM? (a conference theme?)

- It reminds me of ‘numeracy’
- These terms come from a policy level
- Driven by arguments about increasing productivity
- In the ESTEME project, we took a pragmatic approach:
  - What do ESTEME partners want to achieve in the project?
  - What is our vision for student STEM learning?
  - How can we shape STEM to address those needs?

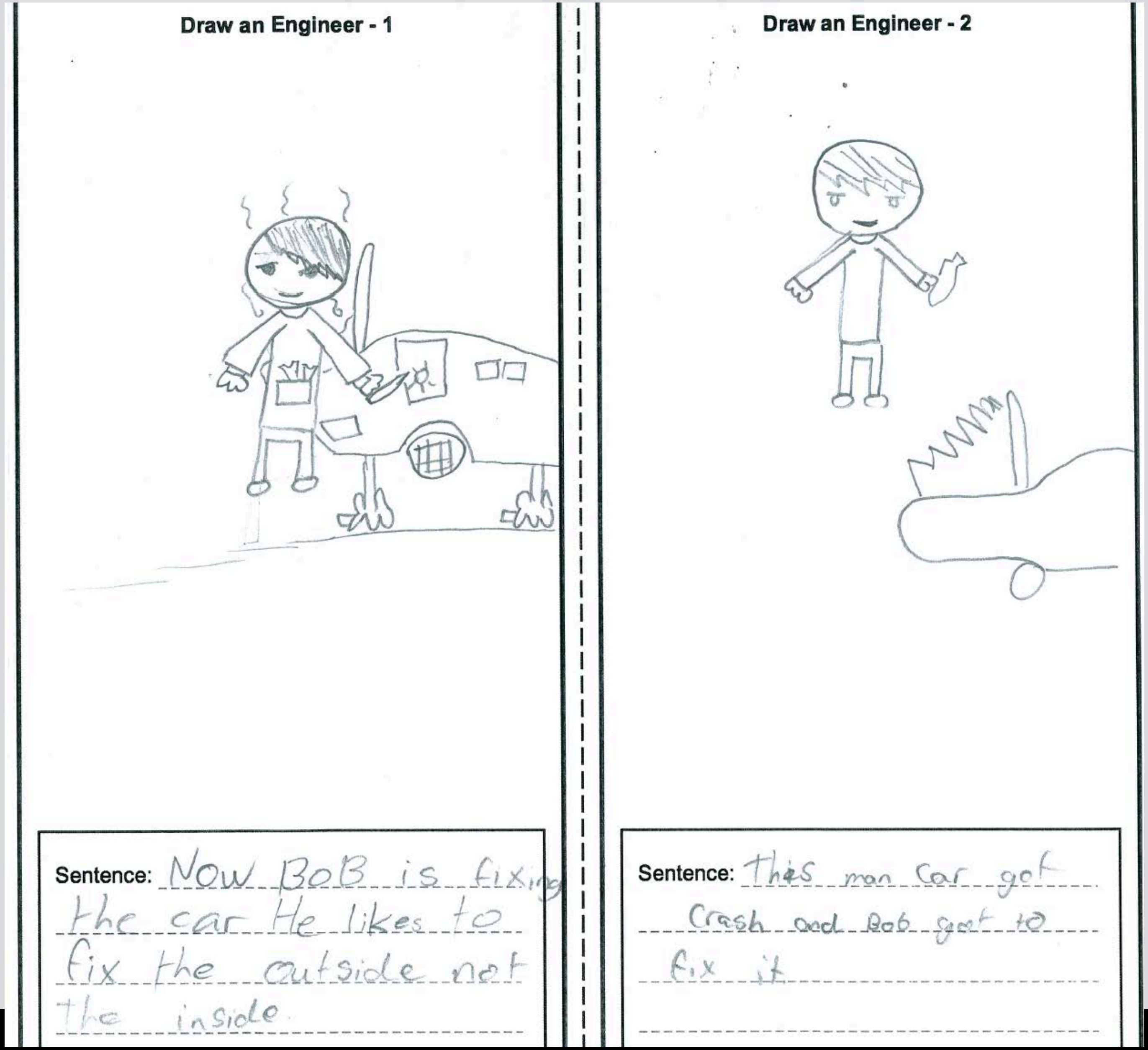
The needs of ESTEME stakeholders

- Engineers:
  - to promote engineering
  - Attract the right kind of students
- ESTEME partnership schools:
  - Needs are diverse
  - Hands-on engaging tasks
  - Methods for assessing students' understanding of science concepts
- Education academics (mainly with maths/science backgrounds):
  - Try to make STEM more than 'S'
  - Manage the relationship between different communities of practice

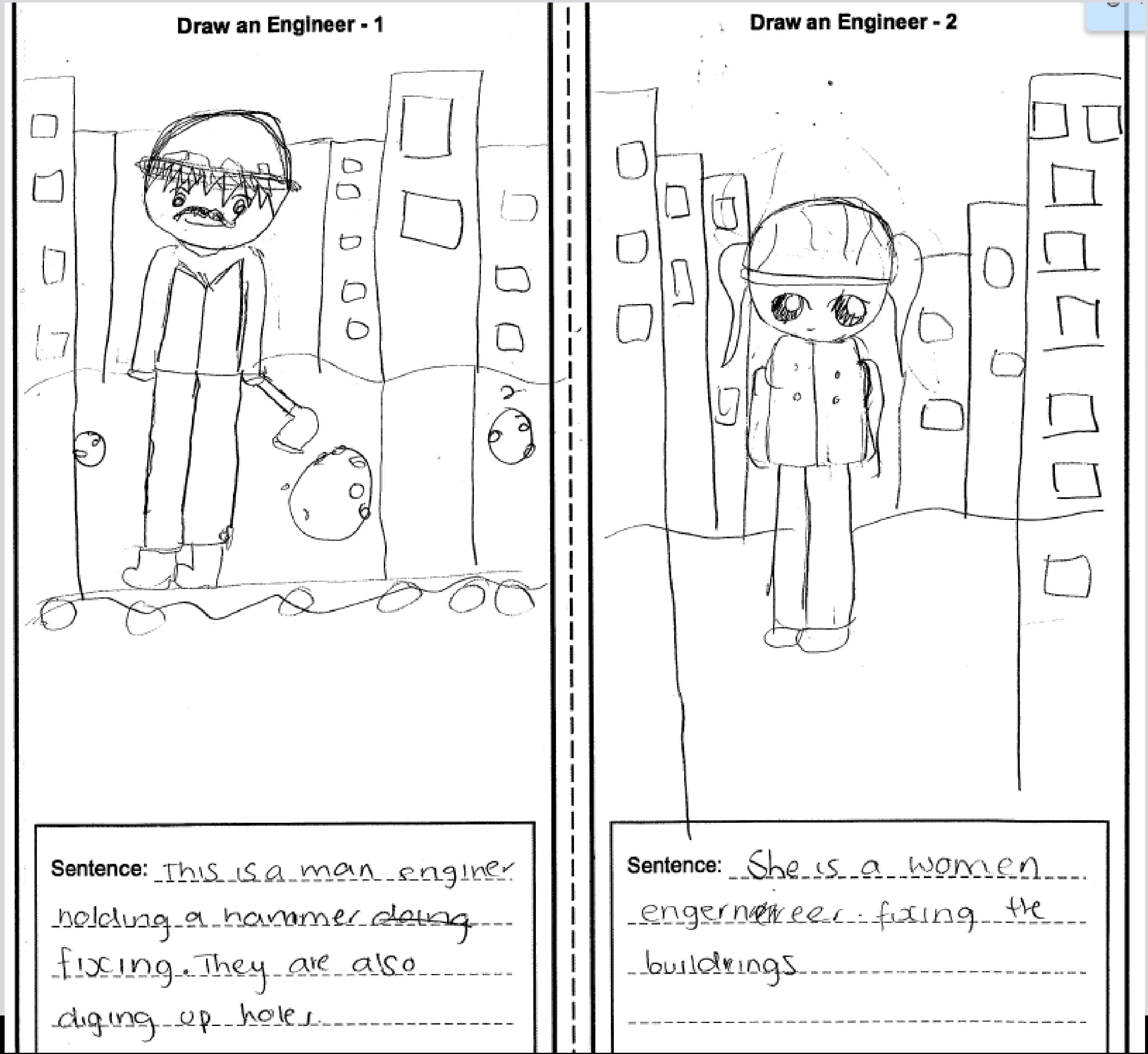
Students' perceptions

- As part of the ESTEME action research projects, we've collected students' drawings of engineers from across the seven schools involved in the project
- Students were asked to draw two engineers
- We have student drawings from prep to grade 6

The most common example



The second most common example

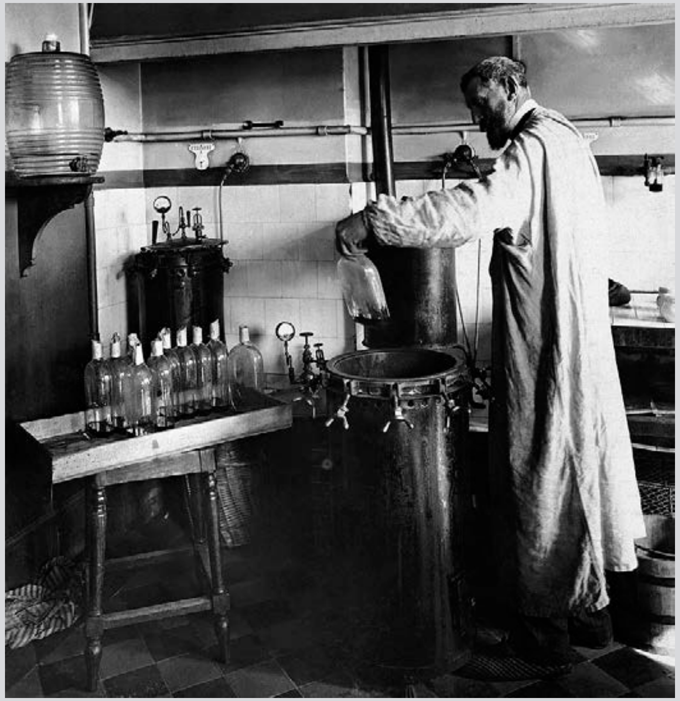


The model that developed

- Engineering became a key element of the model
- The model tried to adapt teachers' current practices, rather than introducing a new approach
- The model needed to enable teachers to assess students' understanding of science concepts and mathematical problem solving
- The model is pragmatic rather than ideal

What is an engineer?

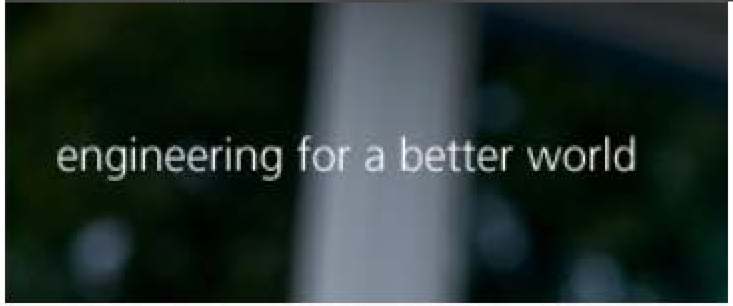
- "An **engineer** is a professional practitioner of engineering, concerned with applying scientific knowledge, mathematics, and ingenuity to develop solutions for technical, societal and commercial problems" (Wikipedia).
- Think about pasteurisation:
  - Who 'discovered' it?



Engineering pasteurisation

GEA Liquid Processing

Core Competencies | Processes | Technologies | Units | Components | Service & Support | Brochure & Video | Company



Home > Technologies > Heat Treatment >

Low-temperature Pasteurisation

Compared to high-temperature pasteurisation , low-temperature pasteurisation is a process where a relatively low temperature (72°C) is used to kill harmful bacteria and at the same time achieve a product which is very similar to the raw product as regards taste and nutritional value.

Pasteurisation unit

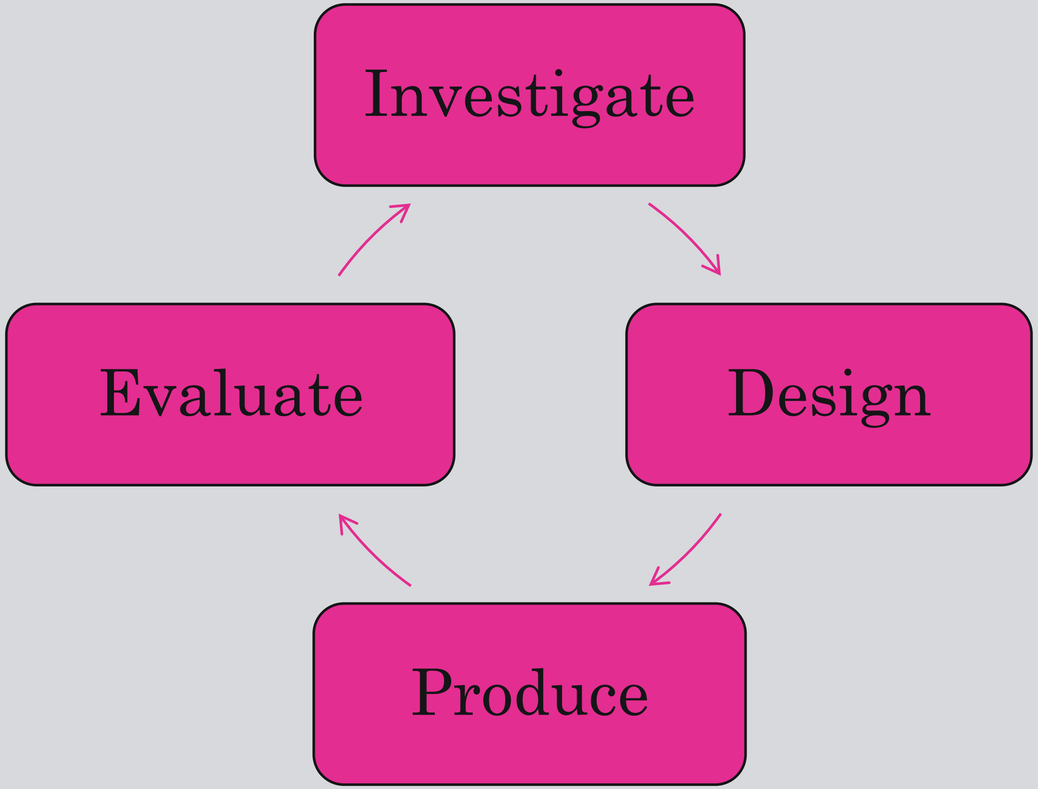
During the low-temperature pasteurisation process, the product (e.g. milk) is pumped from a balance tank to a plate heat exchanger where it is heated to 72ºC for 15 seconds before being cooled to around 5ºC. The heating in the plate heat exchanger is achieved by means of hot water, while ice water or glycol are used to achieve the cooling effect.

The connection between science and engineering posited by ESTEME

- While scientists may discover a process or property which could be applied, it is often engineers who have to take those ideas and scale them up to real world application
- As we try to apply our scientific understanding to a situation, we usually encounter the kinds of problems that engineers are trained to solve
- Engineers often employ a design process to address these problems

IDPE - A design process acronym

- The acronym can be used to develop an engineering approach in primary schools:
- I – investigate
- D – design
- P – produce
- E – evaluate



Investigate

- Engineers don't just start building a bridge. When you engineer a bridge, the first step is to investigate what's been done before
- For bridge building you'd need to investigate:
  - The site
  - Different types of bridge design
  - Different materials

Design

- This part involves developing a plan
- You need to have an idea of what your finished product will need before you start making it
- Usually, pictures/models help
- Often potential problems are identified and addressed during this stage of the process

Produce

- Once the plan is in place, it’s time to make/build the design
  - In our bridge building example, at this point the civil engineer would take on a supervisory role.

Evaluate

- Evaluating involves assessing whether your design was a success or deciding what could be improved on in the future.

Running through a complete IDPE cycle can take a lot of class time

ESTEME schools were using an inquiry cycle to teach science

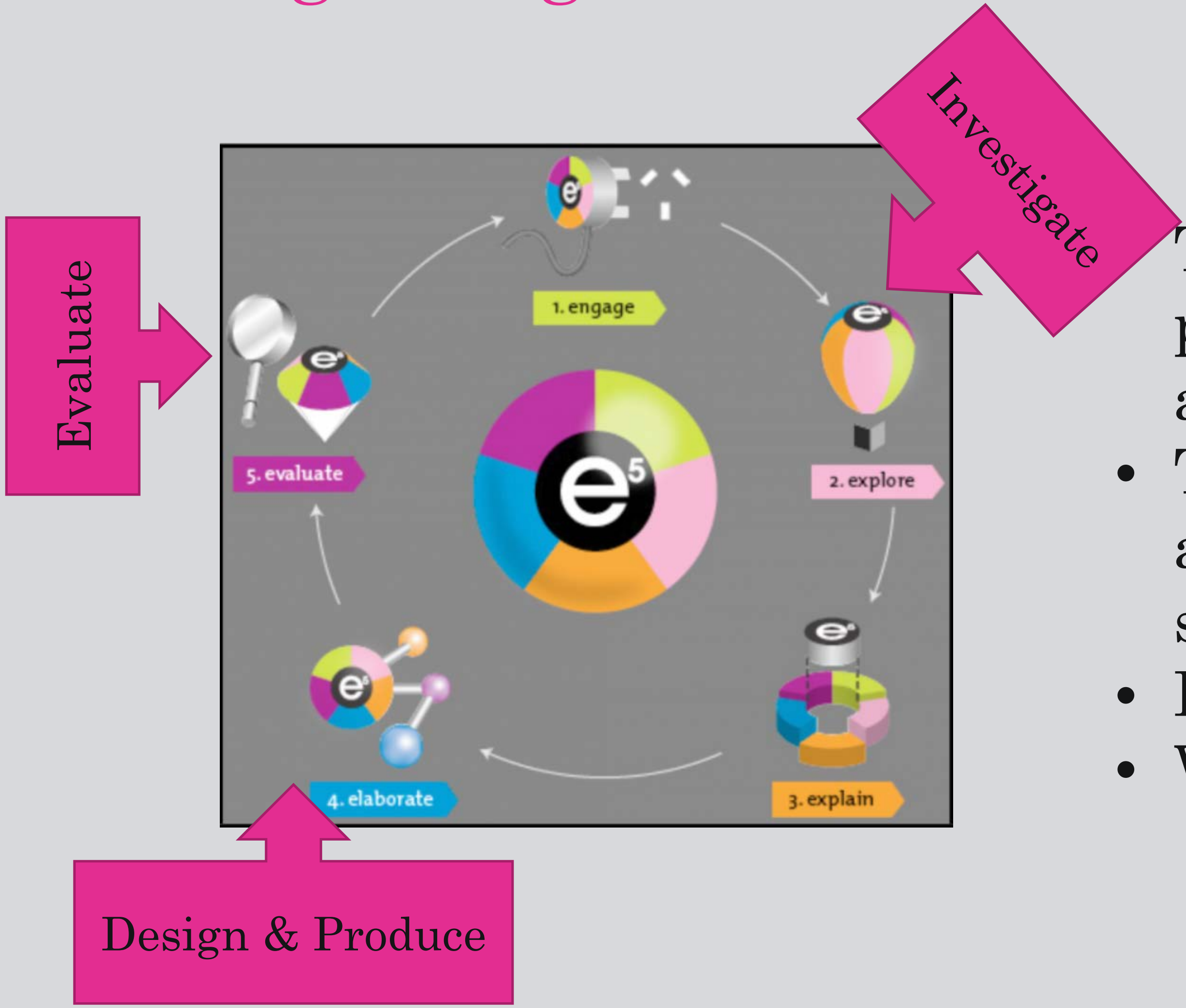
These are often a hard part of a unit to come up with

The ESTEME model uses engineering to assess if scientific ideas have been understood

- “Electrical circuits provide a means of transferring and transforming electricity” (ACSSU097) Grade 6 level content descriptor.
- At the end of a science unit about electrical circuits, students’ understanding could be tested with a design problem:
  - ACME toys is going to create a new range of deluxe doll houses.
  - Each group will be assigned a different room of a house.
  - Each room will be sold with 2 AA batteries.
  - Design your room and include lights and other electrical parts which will make the doll house realistic.

- Can you design and produce something like these without demonstrating an understanding of scientific concepts developed in a science unit about electrical circuits?

Integrating Science and a design process (IDPE)



The ‘investigate’ phase of the design process is covered by the science activities

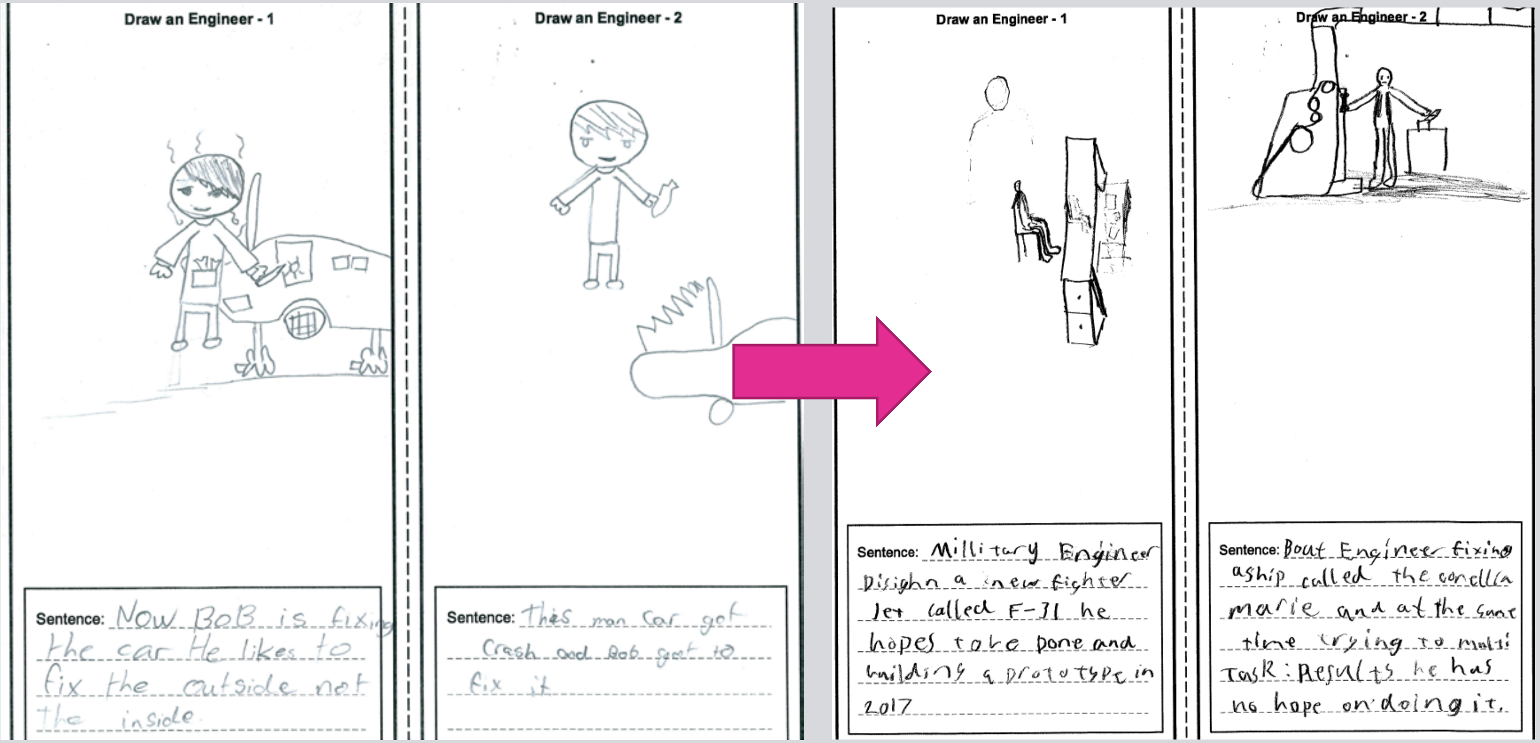
- The design activities can be used to assess students’ understanding of the science concepts
- Less planning is required
- We can make links to engineering

Teacher feedback

- Student understanding of science concepts, design process, and mathematical problem solving could be assessed using the model, but trying to assess all three of these areas at the same time was difficult
- The model did not increase teacher workload significantly
- Teacher perspectives on STEM changed
- Design process did not match the inquiry approach that teachers were used to
  - More like problem-based learning
  - It took teachers a bit of time to get used to
  - Final feedback suggests that teachers found the problem-based approach helped shape the inquiry-based approach used in science

Changes in student perceptions

- In one school, 47 grade 5/6 students engaged in units which used the ESTEME model



	Pre test	Post test
Fix	35%	17%
Cars	26%	14%
Specific type of engineer (civil, structural etc.)	0%	24%