

Cross-curricular approaches in science: what really works?

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SEERIH (Science & Engineering Education Research and
Innovation Hub)
The University of Manchester



Cross-curricular in practice:

Positive

The benefits, what works well

Minus

Any barriers or negatives

Interesting

Any other thoughts or reflections - could be examples



4

CHILDREN ARE OVERRELIANT ON TEACHER TALK AND DIRECTION, THEY LACK AUTONOMY AND INDEPENDENCE IN LEARNING SCIENCE

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CHILDREN EXPERIENCE 'FUN' SCIENCE ACTIVITIES THAT FAIL TO DEEPEN OR DEVELOP NEW LEARNING

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CHILDREN ARE ENGAGED IN PRESCRIPTIVE PRACTICAL WORK THAT LACKS PURPOSE

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CHILDREN DO NOT APPLY LITERACY AND NUMERACY SKILLS IN SCIENCE AT THE STANDARD THEY USE IN ENGLISH AND MATHEMATICS

THE 10 KEY ISSUES WITH CHILDREN'S LEARNING IN PRIMARY SCIENCE IN ENGLAND

by Dr Lynne Bianchi, Christina Whittaker & Amanda Poole
March 2021

Introducing...

Engineering Educates Farmvention Challenge



What is engineering Educates?

- A **NEW** national campaign to inspire 7-14 year olds to think as engineers, finding solutions to real world problems.
- Builds on the success of **Great Science Share for Schools**
- **CPD opportunities and resources** to support the development of engineering education



1

**LEARNER
FOCUSED**

2

**INCLUSIVE &
NON-
COMPETITIVE**

3

COLLABORATIVE



Flexible delivery



Within Curriculum
Half-day session
weekly, 5 weeks

STEM Week
A full week of
Engineering
Educates Challenges

Enrichment
Delivered through
extra-curricular
STEM club



ENGINEERING DESIGN PROCESS



Introducing the Farmvention Challenge

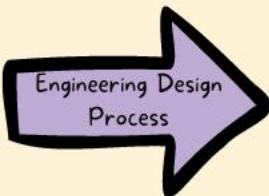


- Learners work through the **Engineering Design Process** developing engineering skills working like an agri engineer.
- Learners complete a series of challenges where they work to **find solutions** to real-world problems in farming.
- The challenges link to the Science, Mathematics, Design & Technology and Computing curriculum through **three pathways**.



Soil Defenders

for 7-9 year olds



Soil
Defenders

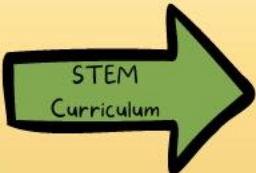
Introduction to
British Farming

Problems
with
soil

Animal
Deterrent

Seed
Machine

Spray -Stop-
Spray



Mathematics

Science

Design Technology
Technologies

Computing
Technologies



SOIL DEFENDERS



7-9 years

KEY CURRICULUM LINKS

Science



Maths



Design Technology



Computing



<https://www.engineeringeducates.org/engineering-educates-curriculum>



What's the farmer's problem?

"I need to sow my seeds evenly without compacting the soil too much, as this can mean the plants don't grow as well."



Soil Saver Challenge

What's the farmer's problem?
"I need to sow my seeds evenly without compacting the soil too much, as this can mean the plants don't grow as well."

The engineering design task
Can you find a way to make a simple seed dropping device which helps the farmer to solve his compaction problem?

Available resources:
For wheels & axles: cardboard, straw, dowel, skewers;
For the body and hopper: tissue box, cardboard tubes, plastic bottle/s;
For the seeds: seedcorns/marbles/beads;
Other useful materials:
corrugated cardboard, craft sticks, paper cups, masking tape, glue, scissors, rubber bands.

What is the design brief?
Use drawings and/or 3D models to create a prototype of a seed dropping device that reduces the chance of soil compaction.

Your design will need to meet the following criteria:

- Seeds should be dropped automatically (not by hand)
- It should touch the ground when seeds are being dropped
- Seeds should be dropped or 'planted' in a straight line
- Seeds should be a similar distance apart

Top tips to get started:
Think about the component parts of a seed drill system:

- What does the hopper and pipe do?
- What could you use for these parts of the system?
- What will stop seeds falling out?
- Where will you have seed storage?
- What will stop seeds falling out?

Glossary:
Seed drill: a device used to sow seeds for crops by inserting them in the soil and burying them to a specific depth while being dragged by a tractor.
Hopper: stores the seeds to be planted above the rest of the machine so that the force of gravity helps them fall through to be planted.
Pipe: a shaft for the seeds to travel through, from the hopper to the soil.
System: a set of related parts or components that work together to produce an outcome.
Axle: a rod on which one or more wheels can rotate, either freely or be fixed to and turn with the axle.
Axle holder: the component through which an axle fits and rotates.

More information and inspiration!
Take a look at these videos of other people's solutions to the problem to get some ideas:

- [Loop Roll Driller](#)
- [Tissue Box Touchdown](#)

Want to take it further?
Can you consider how you can improve your machine?

- hold more seeds?
- drop seeds further apart?
- plant larger seeds?

How well did you do?
Use the problem-solving score card to evaluate how well you performed in this design and make/construct.

Success Criteria	Score /5
Device drops seeds	
Seeds are evenly spread	
Easily operated by one person	
Made from recycled materials	
Seeds fall in a straight line	

Soil Defenders - Session 4

How could we sow seeds without compacting the soil?

Learning time: 2 hours
Suggested age group: 7-9 years old

Keywords: ploughing, planting, fertilising, harvesting, transporting, soil compaction, sowing, seed drill, hopper, pipe, coulters, tines, prototype, system.

Context:
Pupils continue to work within the engineering design cycle, with a focus on creating prototypes for a machine for seed sowing that avoids soil being damaged and compacted. In their design, they consider the different steps within the seed sowing process and how to respond to the farmers' need to make sure that seeds are dispersed evenly and in a straight line.

Engineering Focus: Working like engineers by creating a simple machine to sow seeds, thinking about the parts of a system and how they work together.

Curriculum links:
Pupils will be:

- Selecting from and using a wider range of materials and components, including construction materials, according to their functional properties.
- Applying understanding of how to strengthen, stiffen and to reinforce more complex structures as well as understanding and using simple mechanical systems in the products they create.

Resources:

- Soil defenders Session 4 PPT
- 5mm thick strong corrugated card (from a recycled box)
- 3mm skewers/dowel/straws
- Seedbeads/marbles
- PVA glue/Glue gun/Masking tape
- Scissors/craft knife/cutting mat
- cardboard boxes
- recycled boxes
- A4 sheet of light card to make templates
- Problem on a Page: Soil Saver Challenge handout

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Step-by-step plan

Recap what we know about the processes that take place on an arable farm over the year.
Support pupils in matching photos of processes on the arable farms to their place in the cycle of 'a year on a farm'. Begin by checking their understanding of each key word in the cycle (Slide 2) and then ask children to talk in pairs about what they can see the heavy machinery is being used to do and what process this might be. Key questions:

- From the photos - What have all these processes got in common? (All use heavy machinery)
- What problems do heavy machinery cause? (Soil compaction, pollution)

How are agricultural engineers inventing solutions to common problems on arable farms? A case study.
Watch the NRU 'Agricultural Video' through the link on our website. In addition, you can watch the video about how an engineering company called the **Small Robot Company** have developed **three small robots Tom, Dick and Harry** to solve some of the problems with arable farming. This introduces the pupils to how agricultural engineers are finding creative solutions to avoid using heavy machines that cause soil compaction and making the most of modern technology. Encourage pupils to discuss how the small robots solve some of the problems they have learnt about.

Innovating sowing seeds
Support pupils in looking at how seeds are planted today using larger machinery by watching a **video of a seed drill in action** and then taking a closer look at the parts of the system and their jobs (Slides 3 and 4).

Explain that engineers are experts at making things and making things work better by reducing or solving problems. Explain that in this session the pupils will be thinking as engineers to come up with ways that seeds could be sown without the use of heavy machinery.

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Soil Saver Challenge



Soil Saver Challenge

What's the farmer's problem?
"I need to sow my seeds evenly without compacting the soil too much, as this can mean the plants don't grow as well."

The engineering design task
Can you find a way to make a simple seed dropping device which helps the farmer to solve his compaction problem?

Farmers use special machines called seed drills to make sure that the seeds are planted evenly. These machines can be very heavy and cause the soil to become compacted which can make it hard for a plant's roots to reach enough oxygen and water. The heavier the machinery the more likely that compaction will happen. Your challenge is to come up with an idea for a lightweight alternative.

Available resources:
For wheels & axles - cardboard, straws, dowel, skewers;
For the body and hopper - tissue box, cardboard tubes, plastic bottles/box;
For the seeds - seed/nice markers/beads;
Other useful materials: corrugated cardboard, craft sticks, paper cups, masking tape, glue, scissors, rubber bands.

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- What could you use for these parts of the system?
- Where will you have seed storage?
- What will stop seeds falling out?

Diagram: A diagram of a seed drill system showing a hopper, a pipe, and a wheel. The hopper is connected to the pipe, which is supported by a wheel. The pipe is shown dropping seeds into the soil.

Glossary:

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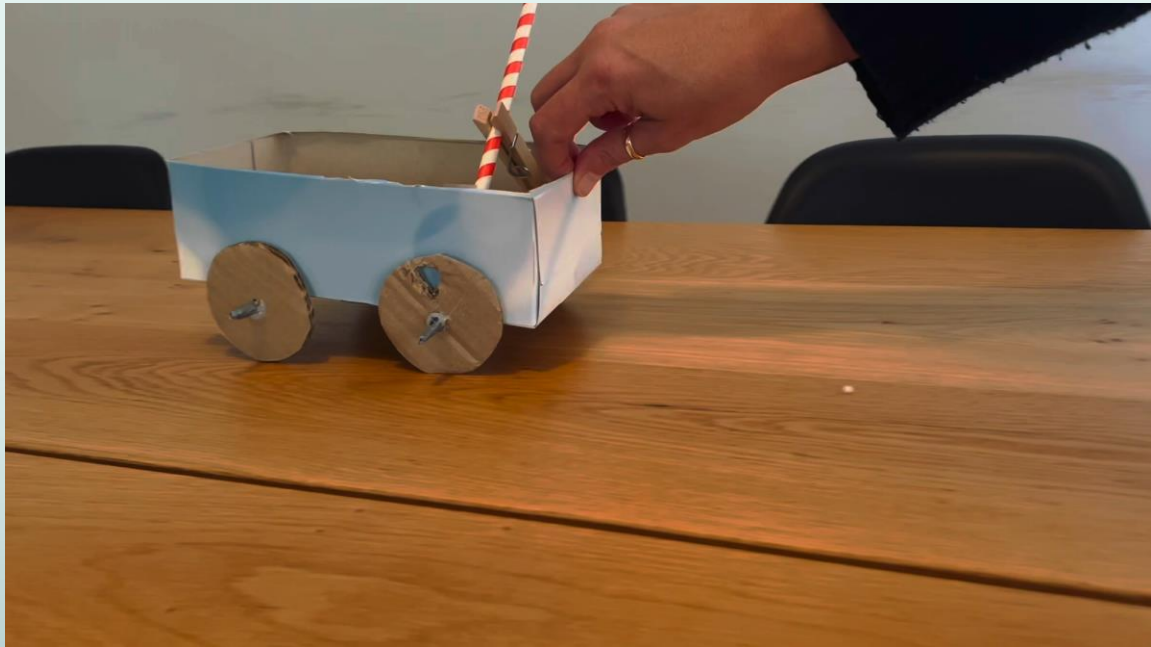
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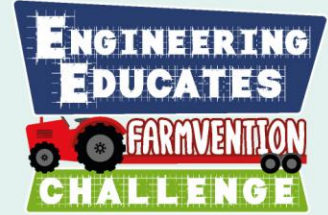
- [Log Roll Roller](#)
- [Tissue Box Triumph](#)

Unstuck Guide
If you are stuck for ideas take a look at the [Soil Saver Challenge Get Yourself Unstuck Guide](#).

So many possible solutions....



Can adapt your prototype to meet these farmers' needs?



I NEED THE SEED DROPPER TO HOLD LARGER SEEDS.



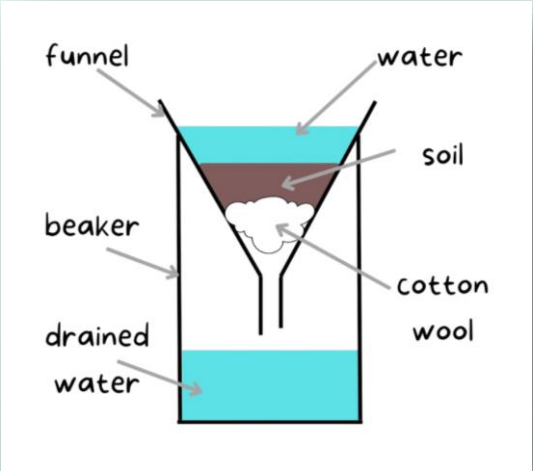
I NEED THE SEEDS TO BE DROPPED FURTHER APART.



I NEED THE SEED DROPPER TO CARRY MORE SEEDS.



Science of Soil



ENGINEERING EDUCATES FARMVENTION CHALLENGE

Does soil compaction affect the time it takes for water to drain through it?

SOIL DEFENDERS

Planning

Analysis - bar chart

Time for water to drain through (seconds)

Amount of soil compaction

Results

Amount of soil compaction	Time for water to drain through (seconds)
no compaction	
light compaction	
moderate compaction	
heavy compaction	

Conclusion

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ENGINEERING EDUCATES FARMVENTION CHALLENGE

Where is the soil most compact in our school grounds?

A Simple Penetrometer

knitting needle, rubber band, cotton reel, permanent marker

Results

Place	Distance between rubber band and mark (mm)

Measure soil compaction

1 Measure the distance between the rubber band and mark.

Analysis - bar chart

Distance between rubber band and mark (mm)

Place

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ERC Maidenhill STEM
@MaidenhillSTEM

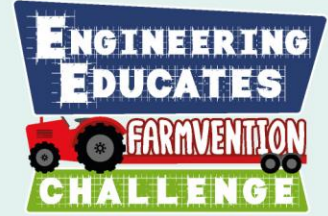
Primary 3a were investigating the effects of soil compaction. They timed how long it took water to pass through the soil at different levels of compaction as part of their [#EngEduFarmvention](#)



5:53 pm · 23 Feb 2023 · 456 Views



Session 5 - Computing



Soil Defenders - Session 5
How can automation make fertilising fields more efficient?

Learning time:
2 hours

Suggested age group:
7-9 years old

Keywords:
automation
efficiency
fertiliser
nutrients
slurry
Microbit
program
algorithms
debug
sequence
input
output

Context:
Learners think about how technology can improve new innovations in arable farming. After harvesting, the soil is depleted of nutrients, and farmers use slurry to add nutrients back into the soil, ready for new crops. Learners create a program on the micro:bit which simulates turning the slurry spray on and off so that waterways or neighbouring properties are protected from excess slurry going over the field boundaries.

Engineering focus:
Learners will be working as an engineer by improving design ideas. They will take the thoughts and ideas in their heads and put it into drawings or words so someone else can respond to it.

Curriculum links: Computing
Learners will be:
• designing, writing and debugging programs that accomplish specific goals, including controlling or simulating physical systems
• using sequences in programs
• working with various forms of input and output device.

Resources:
• Challenge Instruction Video
• computer with access to the Internet for MakeCode
• micro:bits (or micro:bit simulator at MakeCode)
• servos (optional)
If you don't have micro:bits in your school, you can still complete this lesson using the online micro:bit simulator at <https://makecode.microbit.org/>.

DISCLAIMER: These lesson notes have been written by The University of Manchester School of Engineering Education Research and Innovation under the Engineering Education Challenge and are not liable for the actions or activity of any persons who use this resource or in any of the suggested further resources. We assume no liability with regard to injuries or damage to property that may occur as a result of using this information. These activities are designed to be carried out by children working with an adult. This advice is fully responsible for ensuring the activity is carried out safely. You can access further advice from www.manchester.ac.uk.

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Step-by-step plan

Understanding the problem
Ask learners to talk about and share what might have happened in the photo on slide 2. Explain that the first picture is of a car which was parked too close to a field when a farmer was spraying the field with slurry to fertilise the soil.

1
Explain that farmers spray their fields with fertiliser and their challenge will be to create a technological solution to prevent the spray going beyond their field (slide 3). The task is to engineer a solution to turn off the spray as the tractor turns at the boundary of the field, and then automatically turn it on again. Explain that the micro:bit is a small computer that will simulate whether the tractor is spraying or not (slide 4 & 5).

Code Exploration
Explain to learners that we will be using the micro:bit's buttons to explore how these work with some simple code. Display the code on slide 6 and ask the learners what they think the commands might do when the program is run. Why do they think this?

2
MakeCode commands are quite easy to read as they use clear language terms. When run, this code will display a smiling face on the LEDs when button A is pressed and a sad face when button B is pressed. Both faces will disappear after 100ms and the screen will be clear again. Give learners time to add the above code to their micro:bits. Ask learners to run the code to see if their predictions were correct.

Challenge the learners to:
• change what is displayed by clicking on the individual LEDs
• add another 'on button pressed' command and get the micro:bit to display something different when buttons A+B are pressed together
• change the time the LEDs display for before the screen is cleared.

Then lead a class discussion to consolidate key learning about the code, namely:
• When a button is pressed this triggers the LEDs to display the pattern chosen.
• The 'pause' command can be used to change the duration the LEDs display for before the screen is cleared.
• The 'clear screen' command sets all the LEDs to off.

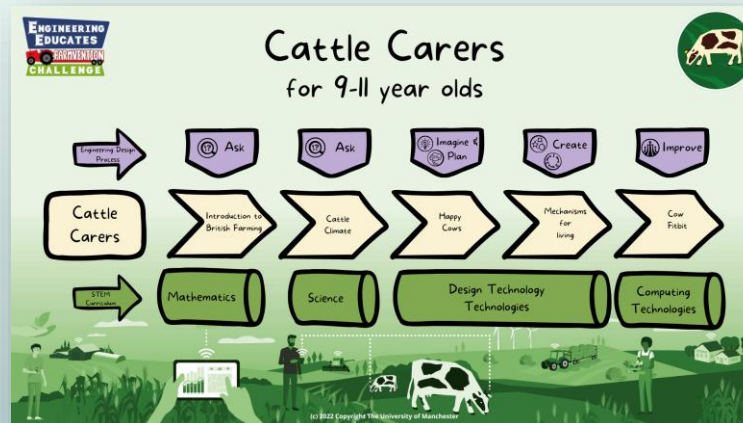
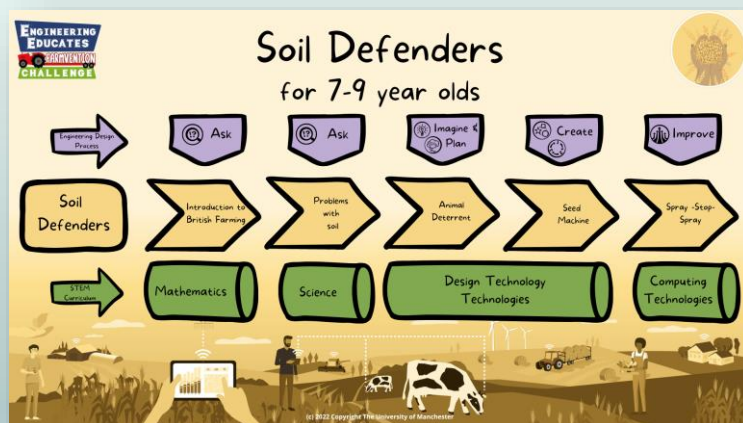
Image Credit: Andy Harris/Graham Horn

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Register for a free class set of micro:bits supplied by BBC



Which pathway will suit your learners?





4

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Next steps



www.engineeringeducates.org

- Download the resources
- Collaborate with other subject leads in school and incorporate into your curriculum
- Register for the newsletter
- Follow **@EngEduChallenge** on Twitter



Questions?

