

Webinar 2

Lesson tweaks for **transferable learning**

Dr Tony Sherborne



Carrotgate

A student investigated the effect of sugar solutions on pieces of carrot. ..

| Concentration | % change in mass |
|---------------|------------------|
| 0.0 | +24 |
| 0.2 | +12 |
| 0.4 etc | +1 etc |

Suggest why the student calculated the % change in mass



Kitty B

@kittydb12



When you've been doing osmosis with potatoes for two years and aqa decides to throw some carrots in there

Surface learning

Content

Water may move across cell membranes via osmosis. Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane.

activate

acquire

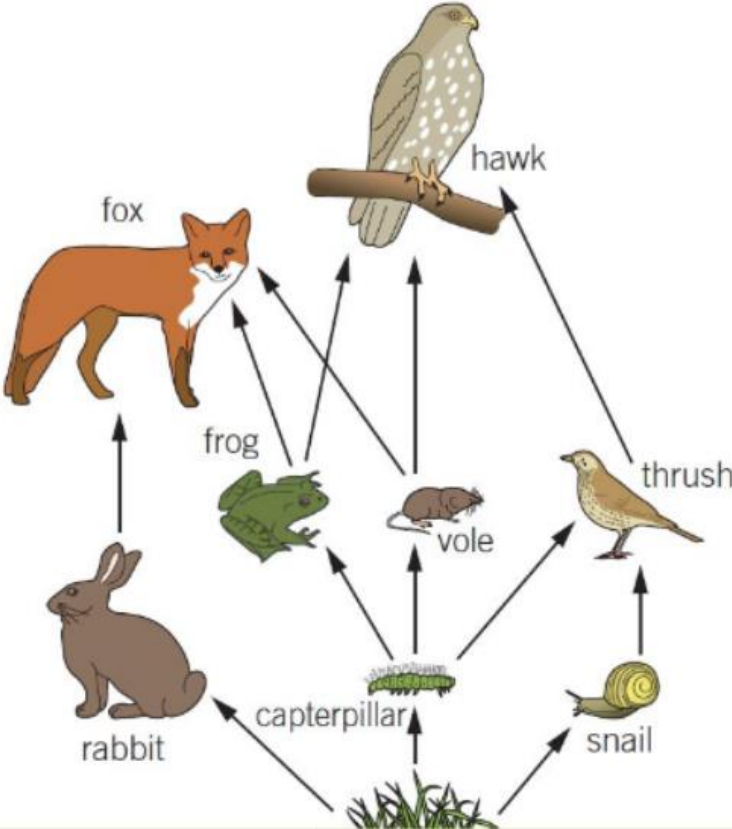
apply

assess

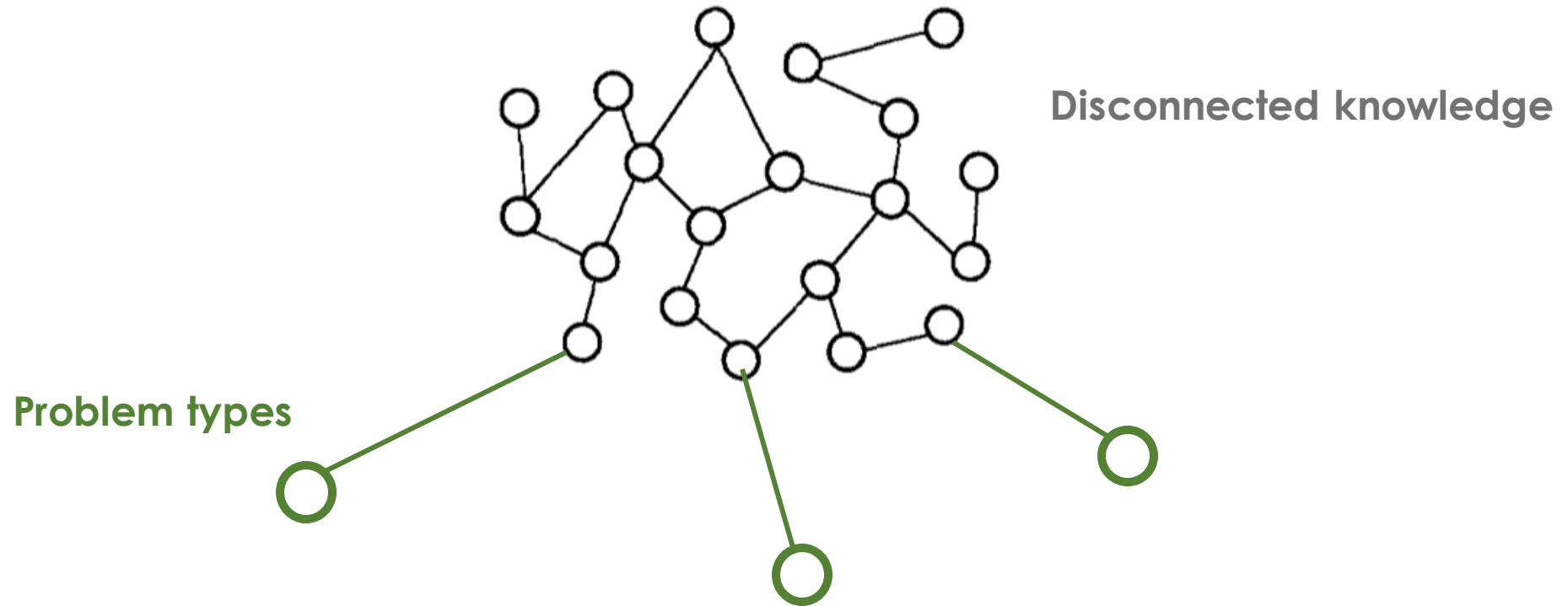
analyse

Something to think about...

What do you think would happen if snails were taken out of this food web?



Surface learning



Deep, transferable learning

- AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures.
- AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.

activate

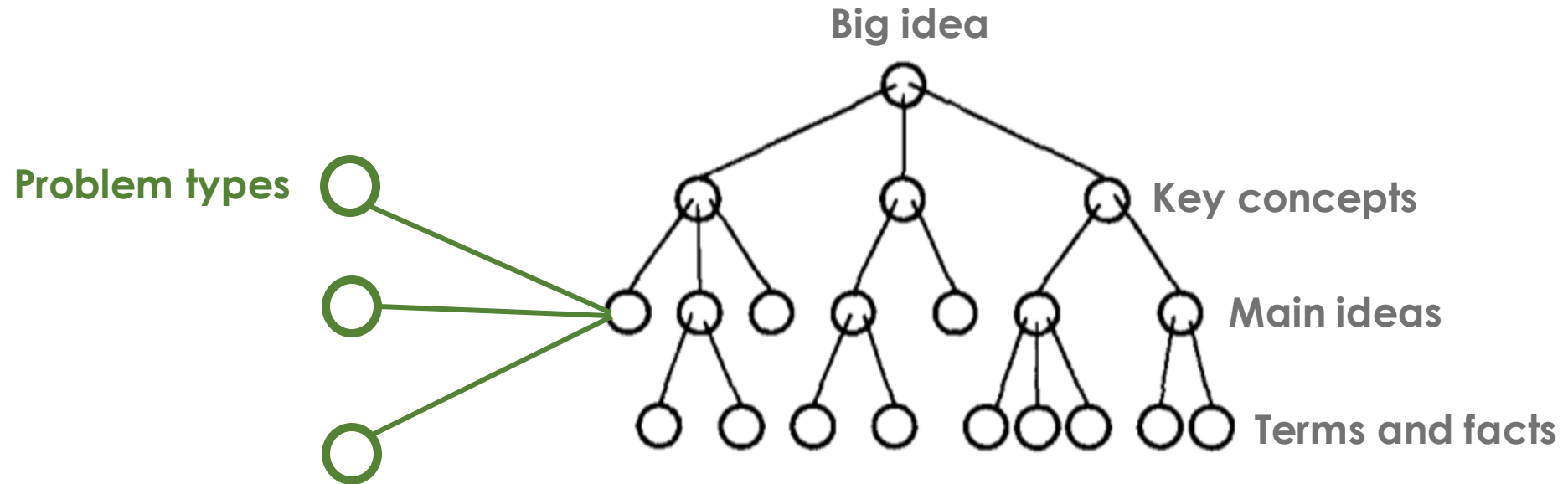
acquire

apply

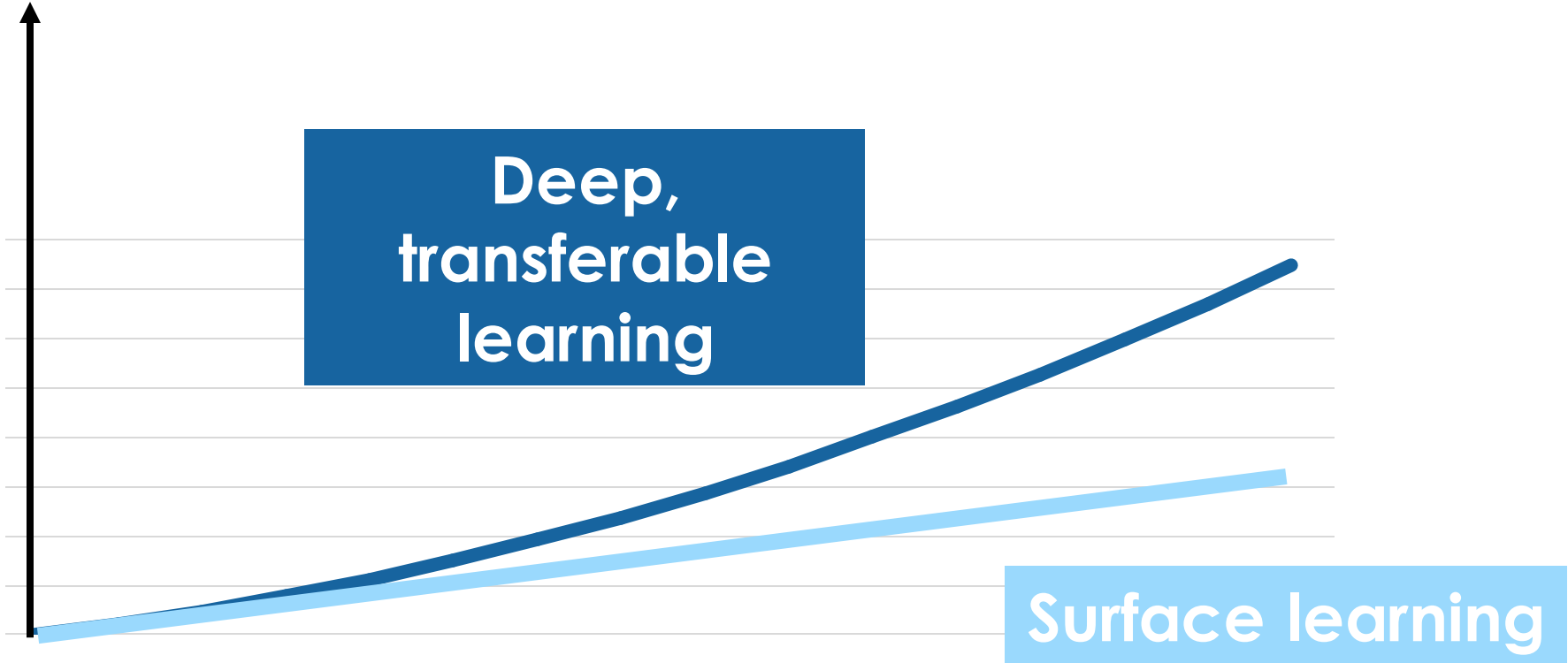
assess

analyse

Deep, transferable learning



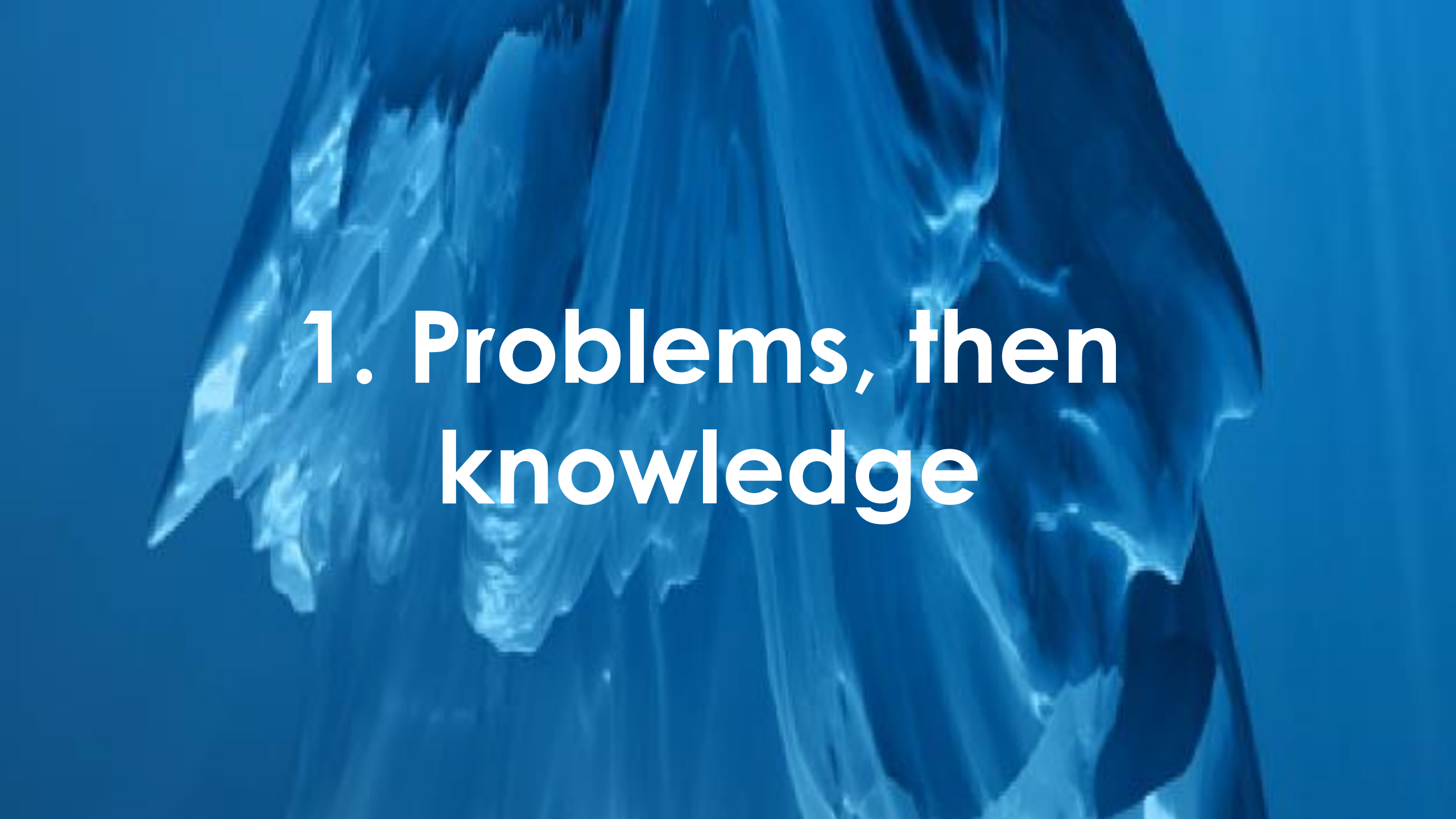
Achievement of low/middle ability students



~~5 lesson tweaks~~

5 curriculum design habits

1. Problems, then knowledge
2. Teach problem-solving strategies
3. Build self-explanation skill
4. Differentiate scaffolding
5. Assess with transfer tasks

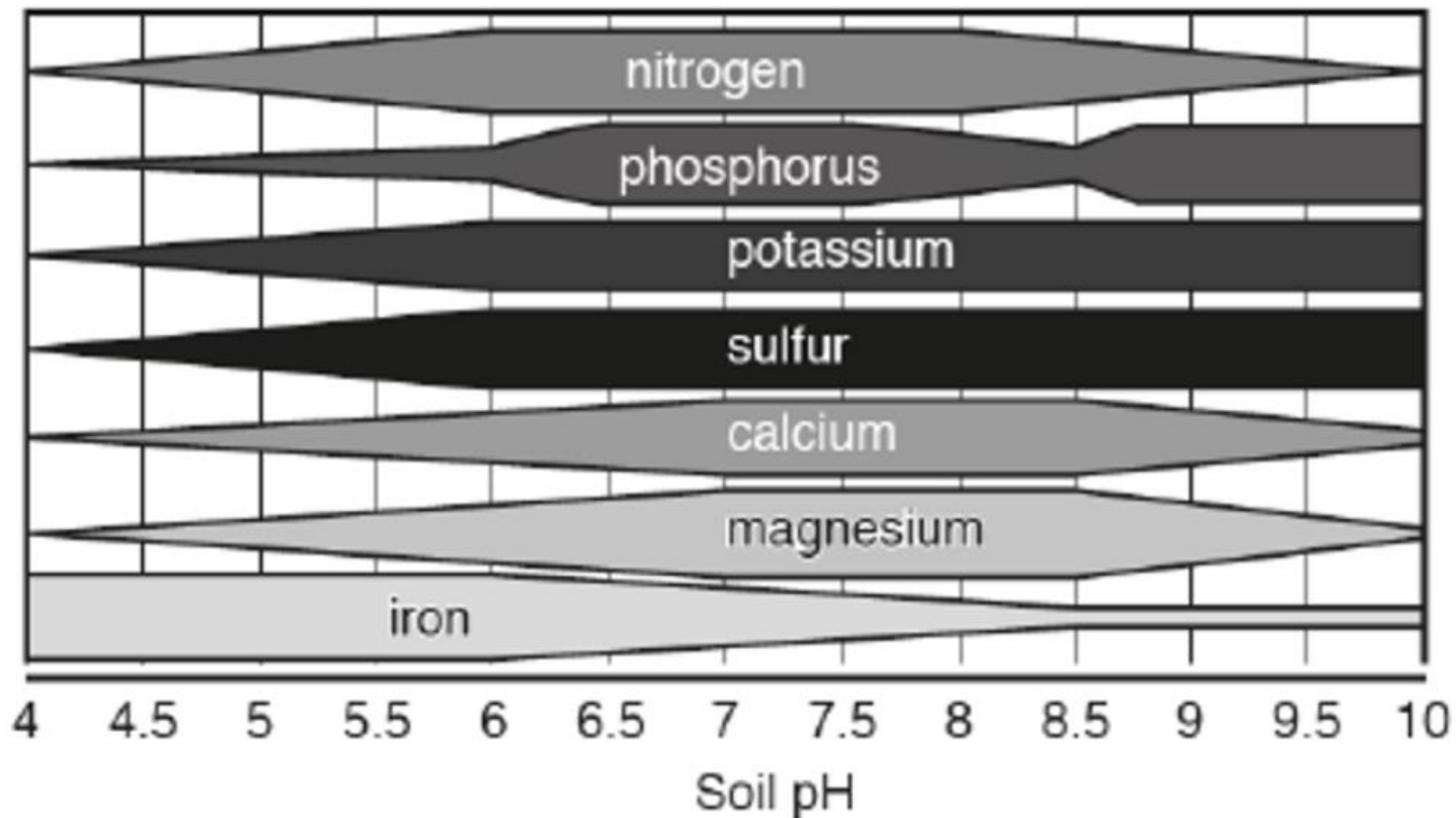


1. Problems, then knowledge

Why?

Plants take mineral ions from the soil. The availability of mineral ions for plants growing in soil is affected by the pH of the soil.

The chart shows the availability of mineral ions in soils of different pH. The thicker the bar, the more available the mineral ion.

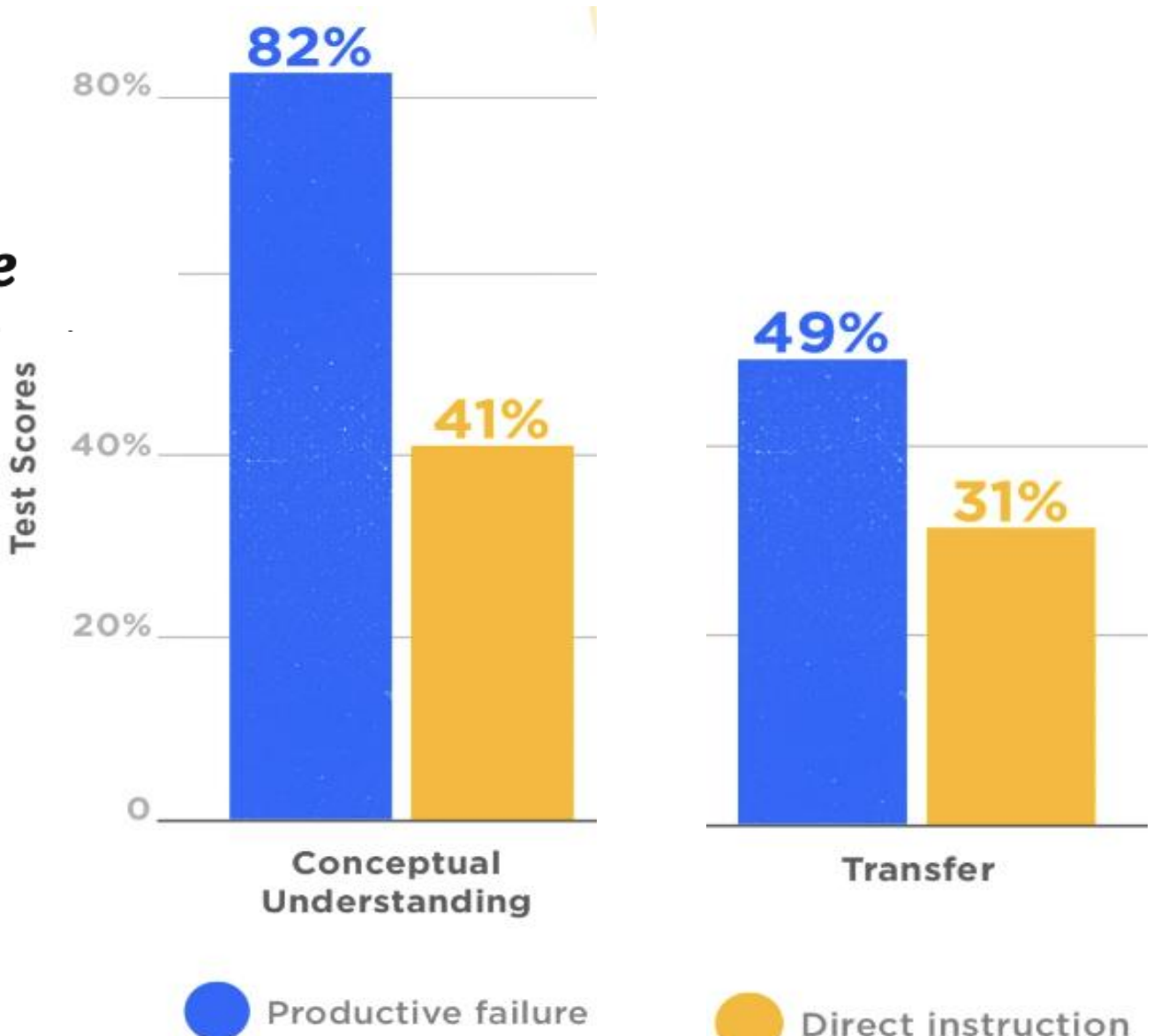


Magnesium is required by plants for photosynthesis. Growing plants in **very** alkaline soils may result in less biomass. Use the chart to explain why.

Let students experience productive failure

The New York Times

Learning the Right Way to Struggle





Problem-solving goals

acquire

Plan an investigation on how temperature difference affects cooling and show the results on a graph.

apply

Determine how a variable affects the rate of temperature change from a graph.

analyse

Draw conclusions from graphs about the affect of several variables on rate of temperature change.

Lead to knowledge goals

Temperature difference: When two objects are at different temperatures, energy moves from the warmer to the cooler until they are at the same temperature. The bigger the difference, the faster energy moves.

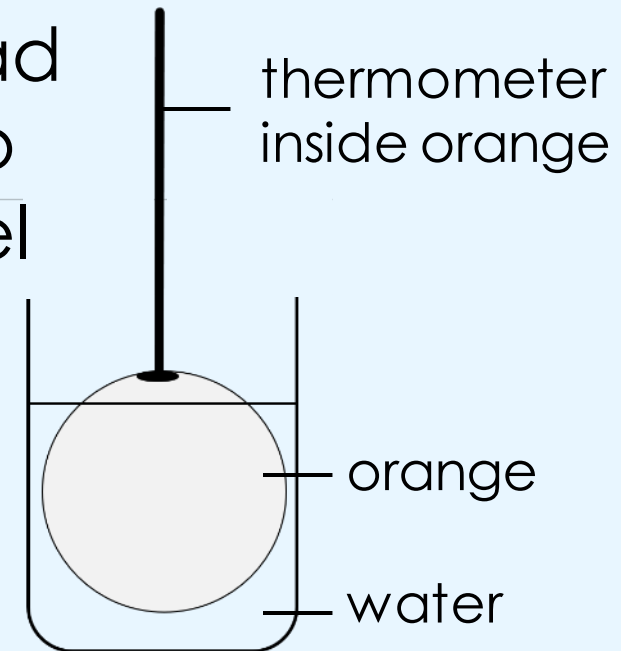
acquire

Very structured, guided problem

What determines how quickly an object cools?



“ I don't have dead bodies for you to test! Use a model – an orange,”



Activity: What affects the rate of cooling?

acquire

Now the theory makes more sense

Each particle has energy, so the oranges differ in how much energy they have in their thermal store.

Large orange



more particles =
more energy



Small orange:

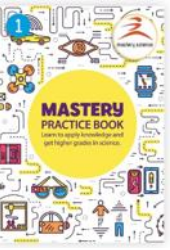
fewer particles =
less energy



Does this help explain why the small orange cooled down quicker?

apply

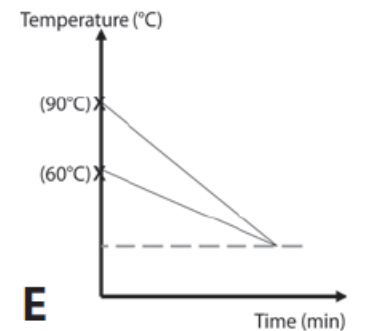
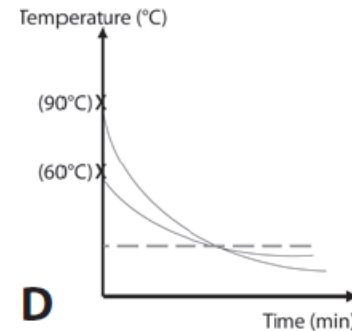
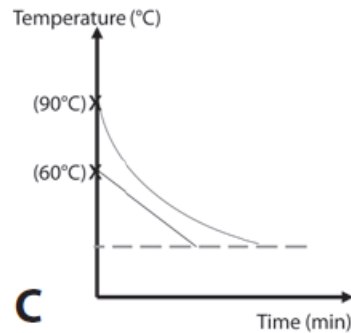
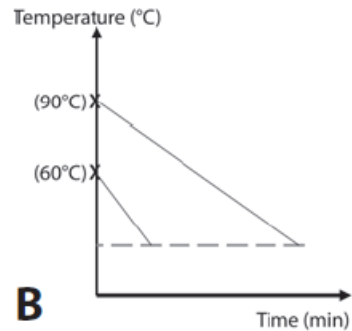
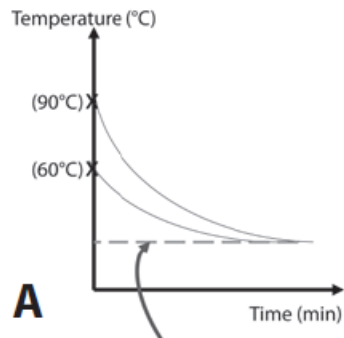
Introduce new situations



3.5 Temperature Graphs



- 1** Two beakers of hot water are left to cool.
Which set of graphs shows how the temperatures change with time?



analyse

Add information to interpret, and justification

Using a food flask safely

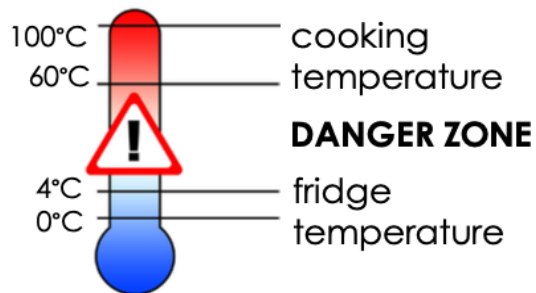
SS1a

Every morning, Luca heats his curry, puts it in an insulated flask, and hopes it stays hot until lunchtime.



One day he sees this on a website:

The danger zone!
When food is between the temperature of 4 and 60°C, bacteria start to multiply rapidly.



If you leave food in this danger zone it will soon be unsafe to eat.

Luca wants to work out how to prevent his curry staying too long in the danger zone. He investigates 4 different factors and plots the results on the graphs on SS1b.

Your task

1. Use ideas about energy to explain how the temperature of the surroundings affects the time that the curry is in the danger zone (graph 2).
2. What should Luca do to minimise the time his curry stays in the danger zone?



2. Teach problem-solving strategies

Why?

- Many students don't learn to apply spontaneously
- It acts as scaffolding
- It teaches metacognition
- It has worked across many subjects

7.3 Types of cell transport

Plants need minerals A,B and C for healthy growth. The table shows the concentration of these minerals in plant root cells and in the surrounding normal conditions.

| Mineral | Concentration in plant root cells in mol/dm ³ | Concentration in surrounding soil in mol/dm ³ |
|---------|--|--|
| A | 0.7 | 0.5 |
| B | 0.2 | 0.4 |
| C | 0.8 | 1.0 |

Heavy rain can leave the soil waterlogged, which decreases oxygen reaching the root cells.

For which mineral will the movement into the cells be reduced?
Explain your choice.

Problem
types for
each
concept

3 steps to applying knowledge



Detect

What concept is the problem about?



Recall

What knowledge do I need?



Solve

How do I answer the question ?

Gradual release of responsibility

apply

Experience

Demonstrate

Guide

Empower



Example

Your turn



Practice



Demonstrate



Example



Detect

Plants need minerals A,B and C for healthy growth. The table shows the concentration of these minerals in plant root cells and in the surrounding soil in normal conditions.

Find the
key
information



| Mineral | Concentration in plant root cells in mol/dm ³ | Concentration in surrounding soil in mol/dm ³ |
|---------|--|--|
| A | 0.7 | 0.5 |
| B | 0.2 | 0.4 |
| C | 0.8 | 1.0 |

Heavy rain can leave the soil waterlogged, which decreases oxygen reaching the root cells.

For which mineral will the movement into the cells be reduced?

Explain your choice.

Demonstrate



Example



Recall

Identify the relevant ideas

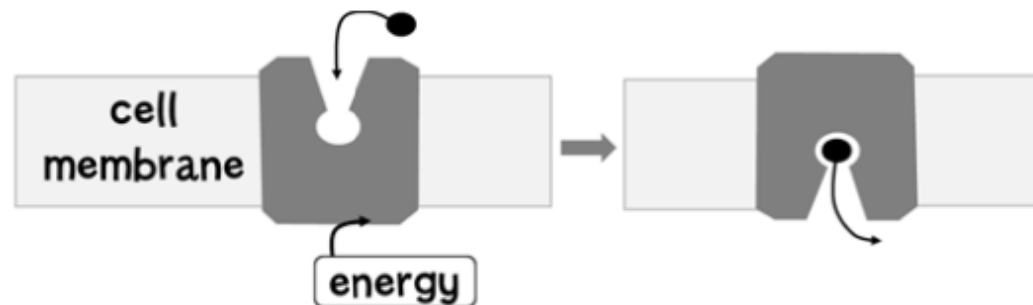
2. How substances move in/out of cells by active transport.

There is a higher concentration of particles inside. Therefore diffusion will not move this substance into the cell.

The cell uses active transport instead.

a protein in the membrane helps the substance across

but it takes energy to flip the protein



Demonstrate



Example



Recall



Claim



Evidence



Reasoning

Mineral A: its movement will be affected by a reduction in oxygen.

The concentration of A inside the root cells is higher than the soil.

So it cannot move in by diffusion, but must move by active transport.

Active transport require energy which comes from respiration. Aerobic respiration provides the most energy but requires oxygen.

If the cell receives less oxygen, it will start switch to anaerobic respiration, which produces less energy. So the active transport of A is reduced.

Your turn



Isomorphous problem

| Mineral | Concentration in mmol/dm ³ | |
|-----------|---------------------------------------|--------------|
| | Outside cells | Inside cells |
| Calcium | 120 | 5 |
| Chloride | 3 | 28 |
| Potassium | 6 | 135 |
| Sodium | 139 | 11 |

Scientists studied the movement of minerals that normally flow into human cells.

They measured the initial concentrations of ions outside and inside the cells.

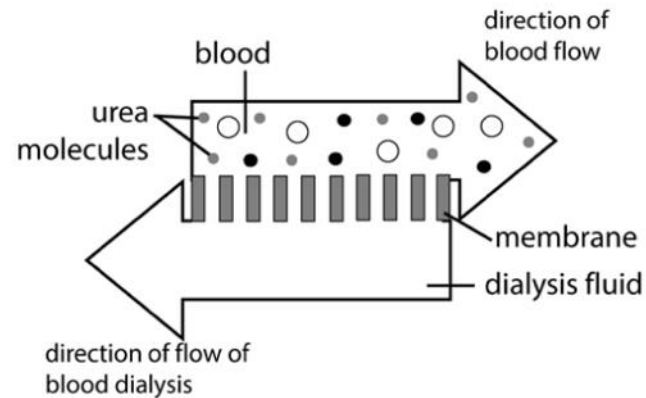
Then they added cyanide, a poison that stops respiration.

Explain the effect of stopping respiration on the movement of each mineral.

Your turn

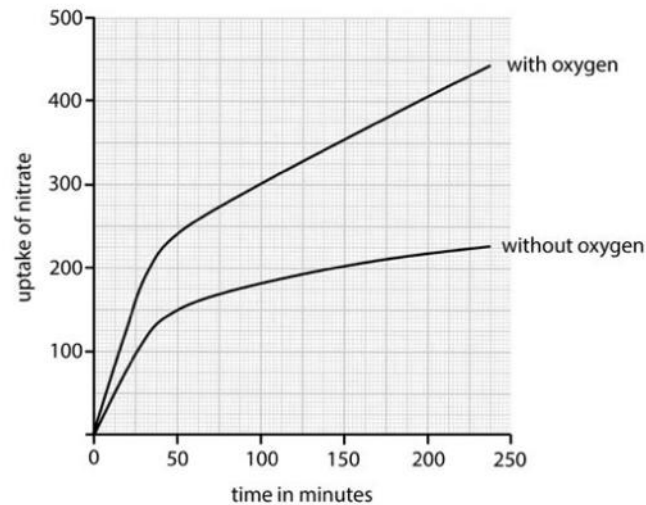


Increasingly
different
problems



In kidney disease urea builds up in the blood. The diagram shows how a treatment works.

Explain how a moving stream of dialysis fluid can help the patient.



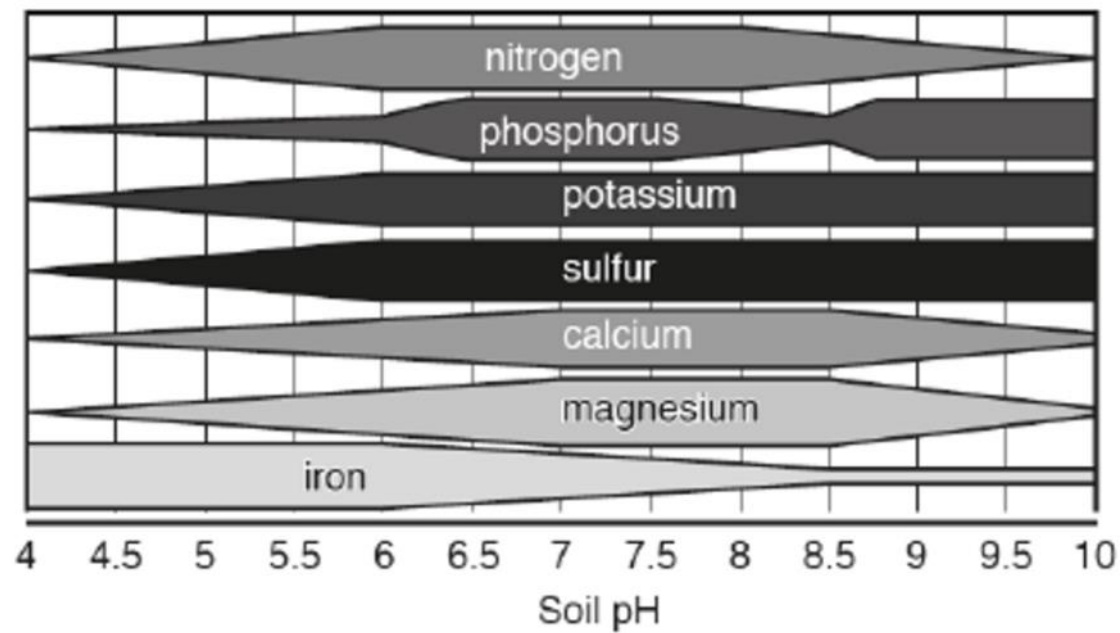
A student does an experiment to find out whether nitrates are absorbed by plants using diffusion or active transport.

Which method(s) of absorption does the data support? Explain your choice.

Exam questions

Plants take mineral ions from the soil. The availability of mineral ions for plants growing in soil is affected by the pH of the soil.

The chart shows the availability of mineral ions in soils of different pH. The thicker the bar, the more available the mineral ion.



Magnesium is required by plants for photosynthesis. Growing plants in **very** alkaline soils may result in less biomass. Use the chart to explain why.

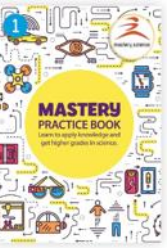


3. Build self-explanation skill

Why?

- Not everyone learns from worked examples
- It depends on whether they 'self-explain'
- They may learn most from 'just-in-time' use during problem-solving

Use self-explanation prompts



A speeding car overtakes a police van that is travelling at 10 m/s . The police give chase and accelerate at 3 m/s^2 for a quarter of a kilometre. What is the final speed of the police van?

Which values
do I know,
which are to
find out?

How to find the right equation of motion to use

I need an equation that includes the values and only one unknown.

| Which equation? | s | u | v | a | t |
|--|---|---|---|---|---|
| $a = \frac{\Delta v}{t} = \frac{v - u}{t}$ | x | ✓ | ✓ | ✓ | ✓ |
| $s = v \times t$ | ✓ | x | ✓ | x | ✓ |
| $v^2 - u^2 = 2as$ | ✓ | ✓ | ✓ | ✓ | x |

this is the only equation
without time, t

Which method works best (in your opinion?)

Method 1. Rearrange the equation first then substitute values.

Make v the subject

to get v^2 on its own,
add u^2

$$v^2 - u^2 = 2as$$

$\left(\begin{array}{c} \curvearrowright \\ + u^2 \end{array} \right) \quad \left(\begin{array}{c} \curvearrowright \\ + u^2 \end{array} \right)$

$\longrightarrow v^2 = u^2 + 2as$

to change v^2 to v ,
take square root

$$v^2 = u^2 + 2as$$

$\left(\begin{array}{c} \curvearrowright \\ \sqrt{} \end{array} \right) \quad \left(\begin{array}{c} \curvearrowright \\ \sqrt{} \end{array} \right)$

$\longrightarrow v = \sqrt{u^2 + 2as}$

Method 2. Substitute values first then rearrange the equation.

$v^2 = 10^2 + (2 \times 3.0 \times 250)$ I can also solve an equation by substituting in the numbers and then solving for the unknown.

If the object is decelerating, the acceleration is a negative number.



4. Differentiate scaffolding

Why?

- Cognitive load varies for each student
- To create 'challenge' vary scaffolding
- Keep high ceiling, vary floor level

scaffolding



fading

worked example

partial completion example

first your turn - isomorphic

your turn problems with hints

your turn problems without hints

Mixed up problems



5. Assess with transfer tasks

Why?

| Assessment type | Scientific idea knowledge | Enquiry skills | Scientific thinking ability | Metacognitive ability |
|------------------------|----------------------------------|-----------------------|------------------------------------|------------------------------|
| Quiz | Yes | Partly | | |
| Long answer | Yes | Partly | Partly | Partly |
| transfer task | Yes | Yes | Yes | Yes |

Transfer tasks

(authentic assessment)

“Examine student performance on worthy intellectual tasks”

Reward deep, transferable learning

Motivating

Vs

Traditional tests

“Simplistic substitutes you can't make inferences from beyond the task”

Rewards surface learning and teaching to the test

Dull and stressful



Microplastics

★★★★★ 4 reviews

Microplastics are now everywhere - they're even been found in Antarctic snow. Scientists are investigating possible risks to human health. In this activity, students come up with ideas to stop microplastics from getting into our oceans. It's designed to fit into an 11-14 unit on substances and particles.

Microplastics can be done in 1-2 lessons, to practice higher-order thinking and prepare students for the demands of 'AO3' at GCSE.

Blueprint curriculum links

- Concepts: Mixtures
- Skill: Choose a method
- Learning stage: Analyse

The lesson resources are delivered as a zip file. After you checkout, you will be sent an email with the link to download them.

Work with a scientist

This activity is ideal for use with a scientist in the classroom, or online. We can help you set up a partnership - just complete the form (only open to UK schools).

Related activities



Carbon Neutral
£0.00 GBP



Rewilding
£0.00 GBP

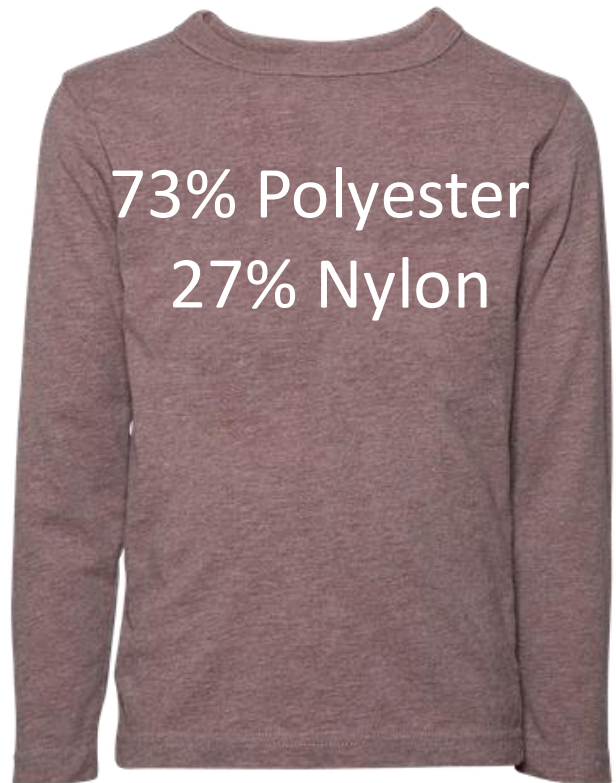


Energy savers
★★★★★ 1 review
£0.00 GBP



Scientists are worried about pollution from microplastics.

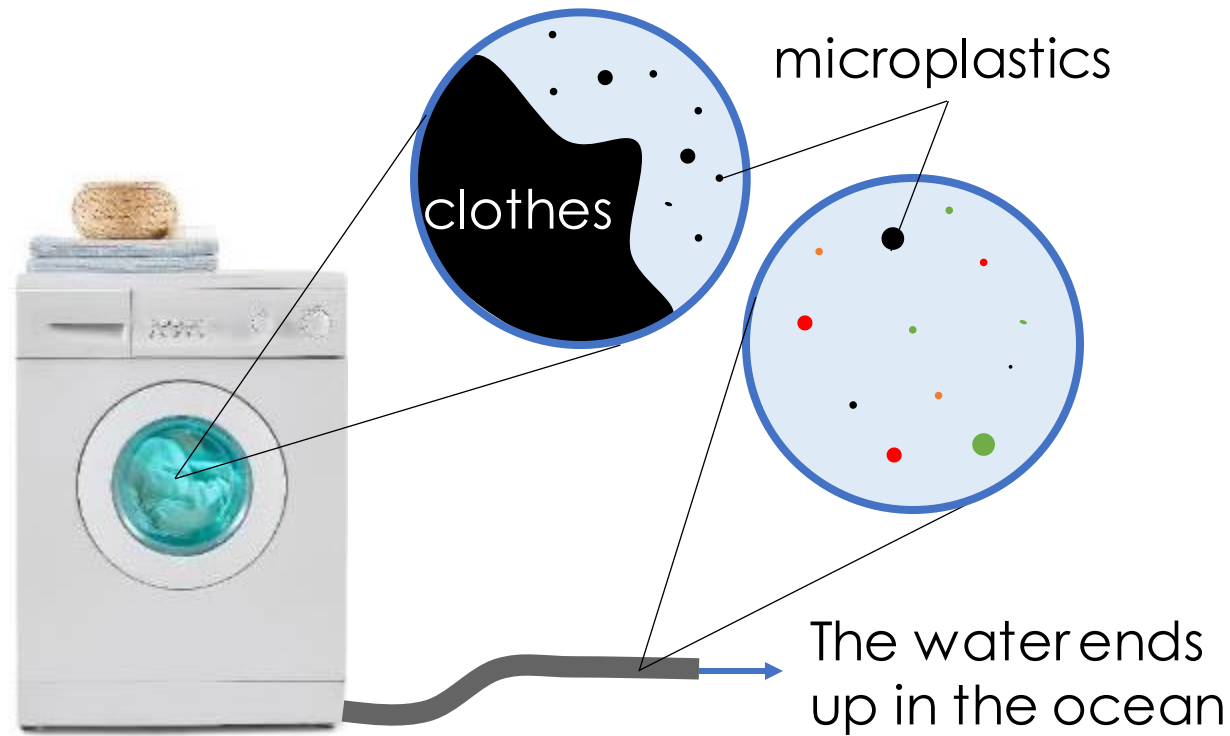
We know they harm sea animals, and they could be harming us.



One source of microplastics is our clothes.

Many of our clothes are made from synthetic fabrics - plastics.

Every time you wash synthetic fabrics in your machine, they shed hundreds of thousands of microplastics.



Microplastic are tiny – they range in size from:



0.001 mm



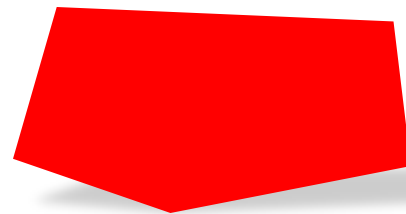
Smallest
microplastics



Mitochondrion

to

5 mm



Largest
microplastics



Grain of rice



Engineers like me are trying to design a filter to put into washing machines to block the microplastics escaping and getting into the ocean.

Can you help me complete my design?



MICROPLASTIC FILTER

1. Introduce your invention in a sentence: What is it and what job does it do?

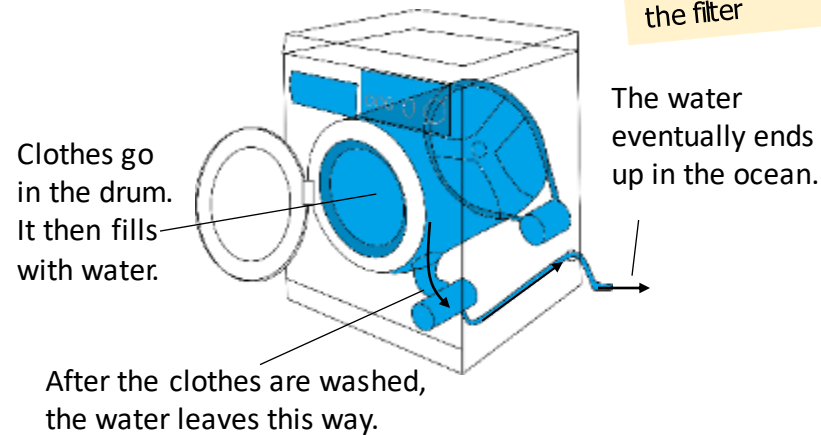
2. Describe your invention in detail.

Should the filter be paper or plastic?
What size should the holes be?
Draw your invention.

3. Explain how your invention works.

Include a diagram to show how it filters out the microplastics.

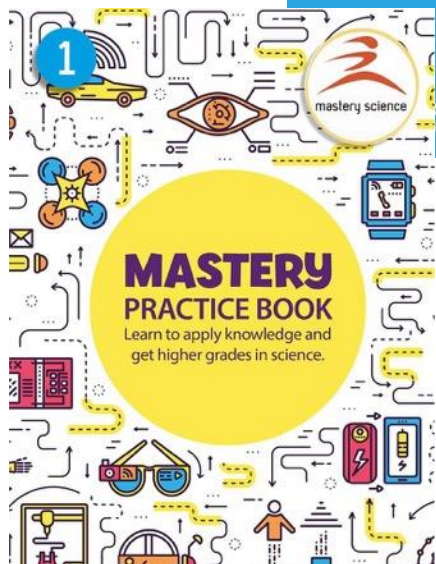
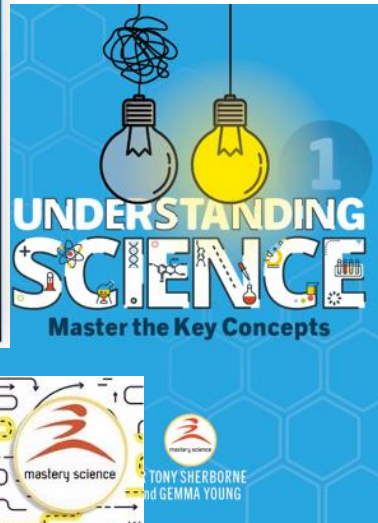
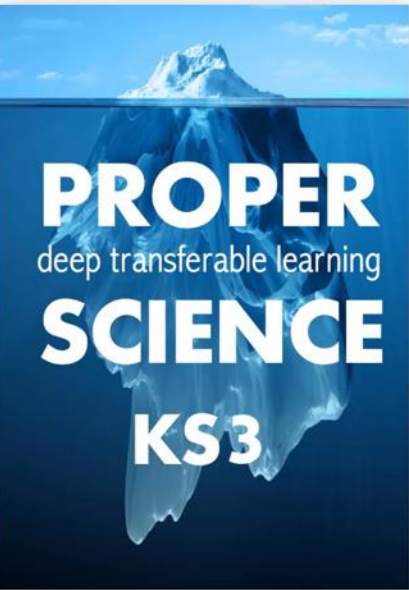
4. Give reasons why your invention should be made.



Microplastic facts

They are tiny – they range in size from 0.001 mm to 5 mm.
They get eaten by sea animals, where they can block their intestines and kill them.
We eat contaminated seafood. Scientists don't yet know if microplastics harm us.

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Until 1st September.

**Provide feedback before, during and after 1 year*