



Lucy Cavendish College
University of Cambridge

Problem Solving Workshop 2021

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In today's session

- Introduction to the Half Term Problem Solving Workshop
- What is problem solving and why is it important?
- What do you need to problem solve effectively?
- General framework to approach problem solving
- Methods for tackling specific types of common problems
- Developing a problem solving mindset
- Final points



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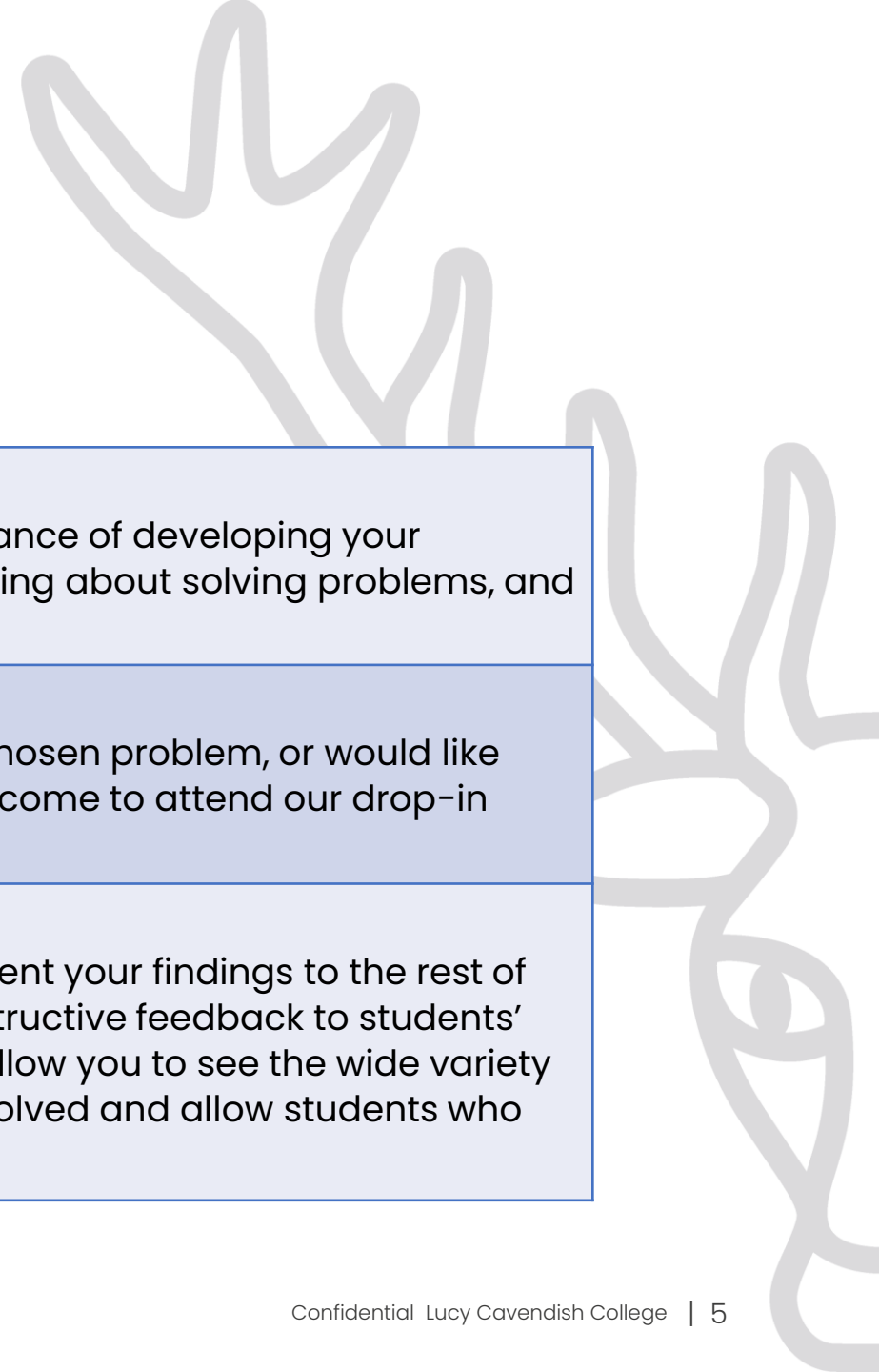
Introduction to the Half Term Problem Solving Workshop



Context and goals of the programme

1. Improve your problem-solving skills
2. Help you settle into your post-16 studies
3. Offer the opportunity for academic enrichment and skill building over half-term
4. Introduce you to an important aspect of the university admissions process
5. Continue to offer support throughout Year 12 (S5/Y13 – N.I.)

Programme



Monday 25 th October, 11am-12:30pm	Problem Solving Skills Session In this skills session, we will discuss the importance of developing your problem-solving skills, various methods for going about solving problems, and relevant aspects of metacognition.
Wednesday 27 th October, 3pm-4:30pm	Drop-in Clinic If you are struggling with any aspect of your chosen problem, or would like some help with your presentation, you are welcome to attend our drop-in clinic to ask any questions.
Friday 29 th October, 11am-12:30pm	Presentations In this session, you will have the option to present your findings to the rest of your cohort. You will be asked to provide constructive feedback to students' presentations. We hope that this session will allow you to see the wide variety of methods through which problems can be solved and allow students who are presenting to develop their oracy skills.

Activity

1. Choose a problem
2. Solve the problem
3. Reflect on your experience
4. Prepare a presentation
5. Deliver the presentation





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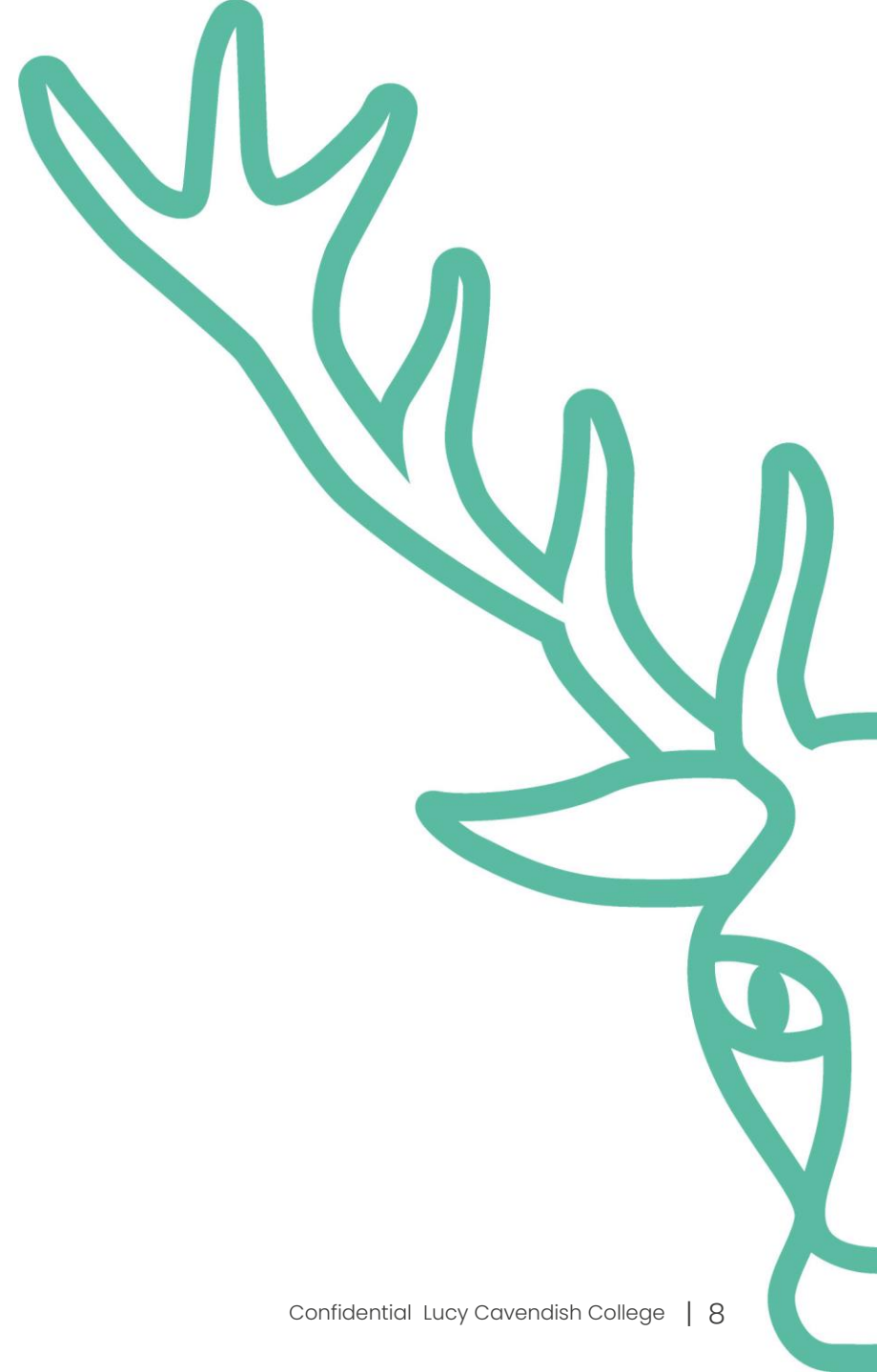
What is problem solving and why is it important?





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What is your current definition
of problem solving?



What is your current definition of problem solving?

Problem solving is the ability to find a solution to a complex situation or challenge

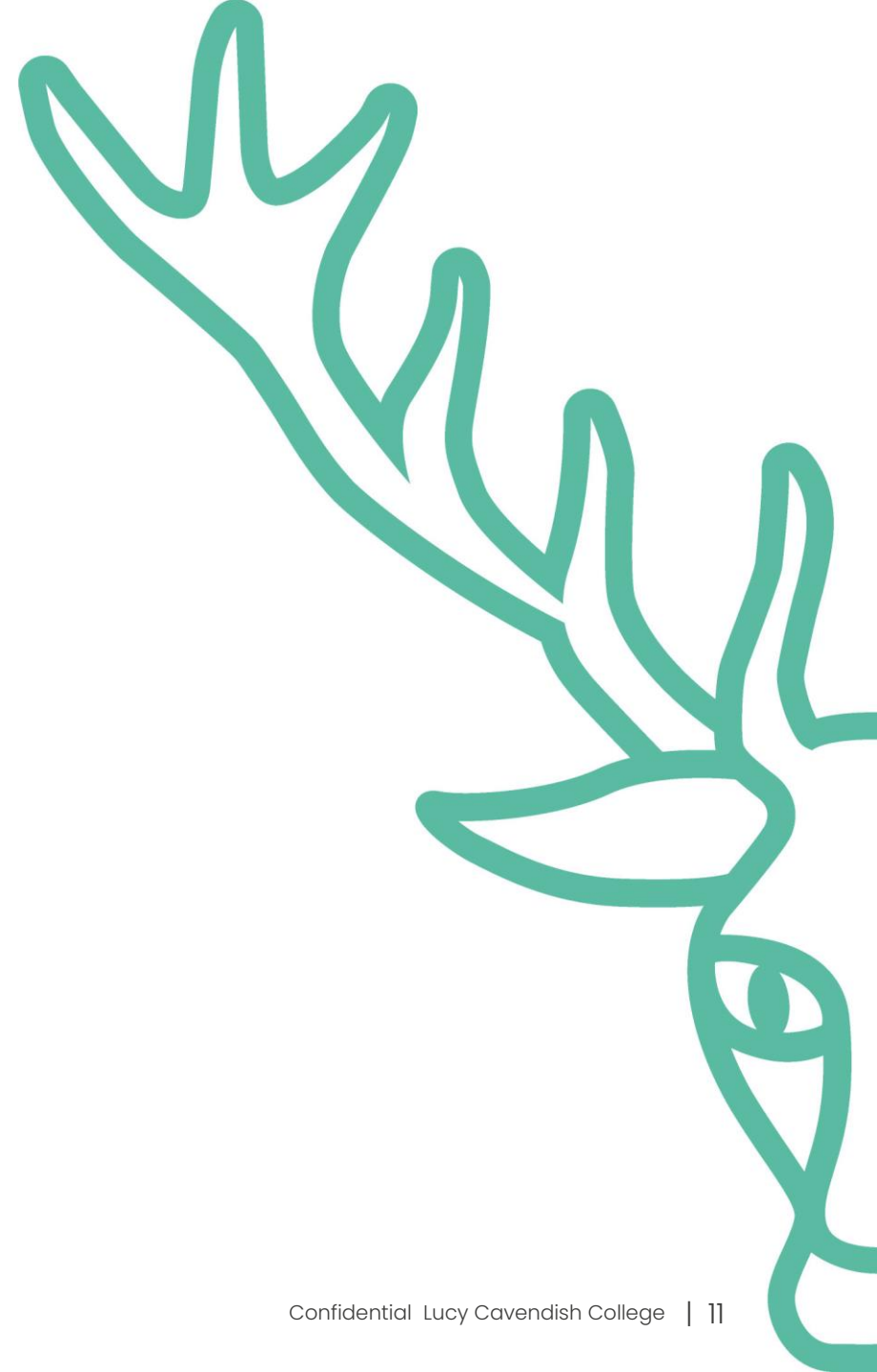
It is worth also considering our own view of what a problem is...

- Are we missing the 'big problem'?
 - It is human nature to notice and focus on small, easy to solve problems but much harder to work on the big problems that may be causing some of the smaller ones
- It's useful to consider the following questions when faced with a problem
 - Is the problem real or perceived?
 - Is this problem really an opportunity?
 - Does the problem need solving?



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When do we work on problems and problem solving?



Why is problem solving important?

Problem solving is one of the **most important skills to develop** because you can use it in so many different situations.

- We solve problems **every day** without really thinking about it
- Real life and modern society are full of problems **large and small**
- Develops learning and skills
 - Problem solving promotes links between concepts and topics, developing **understanding** rather than rote learning
 - Requires **higher-level thinking**
 - Contributes to conceptual development
 - Promotes the use of and provides an opportunity to practice key skills



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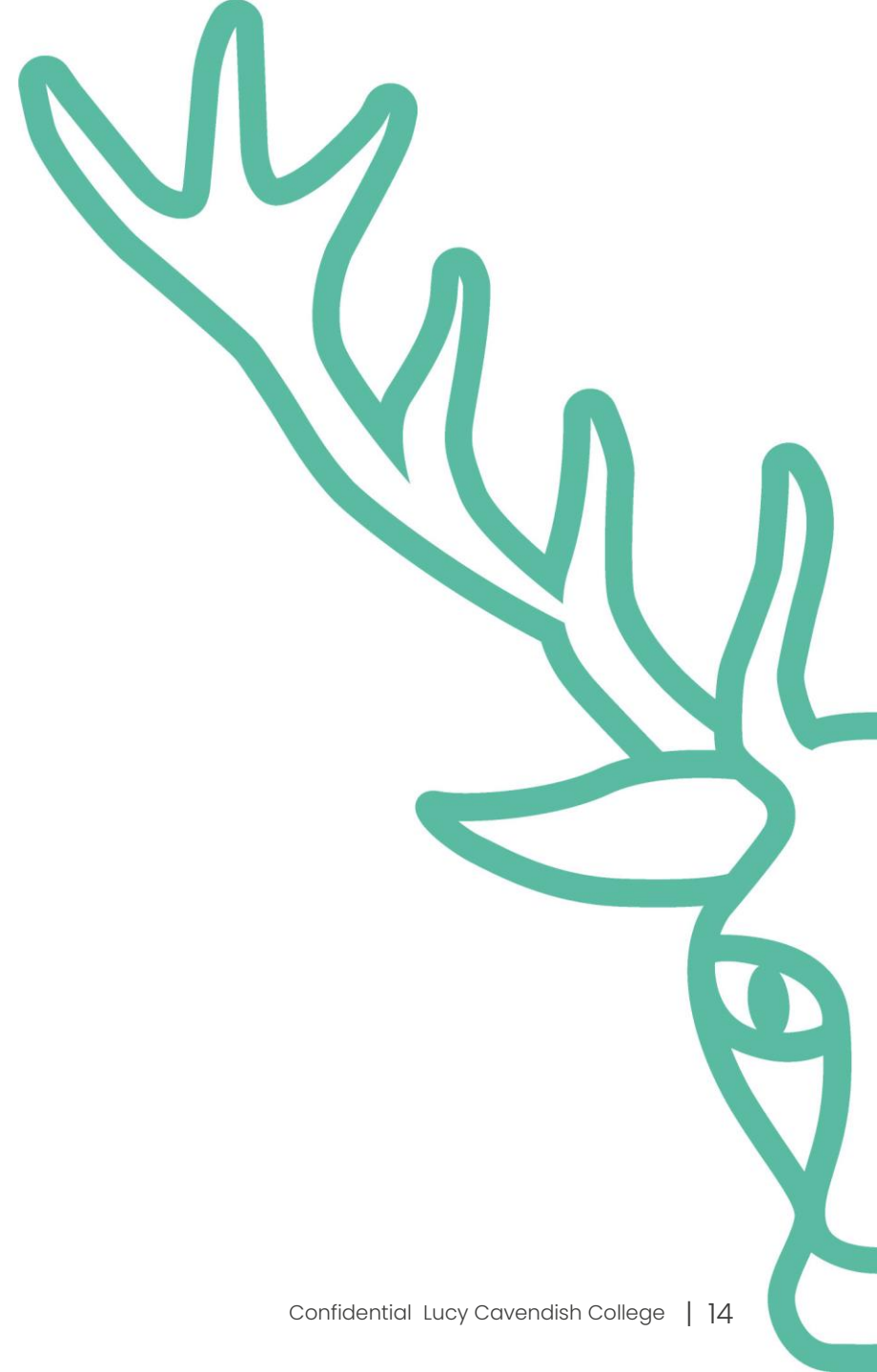
What do you need to problem
solve effectively?





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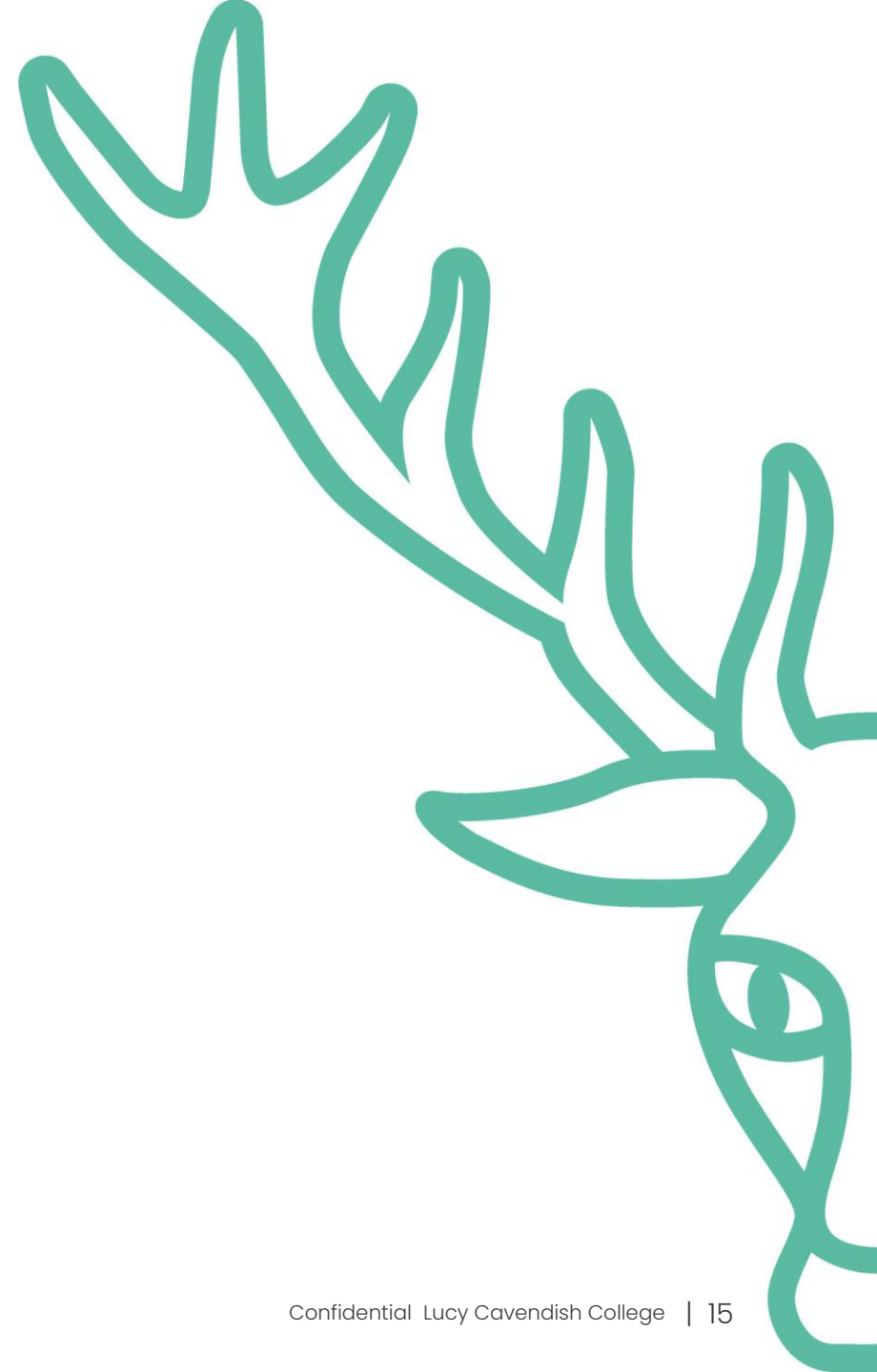
What are some examples of
problems we face?



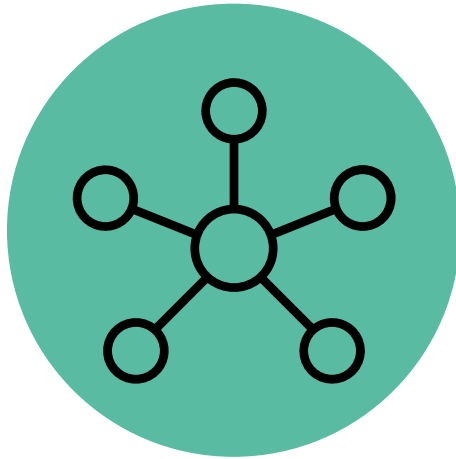


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What would we need to try
and tackle this problem?



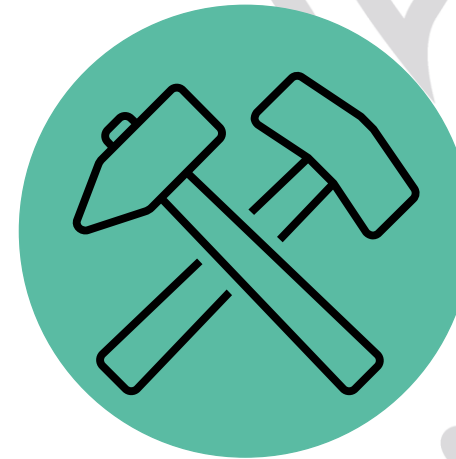
Problem solving toolkit



Resources

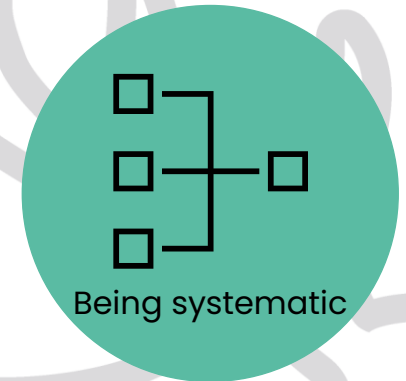
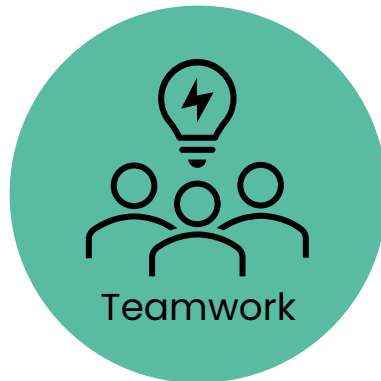
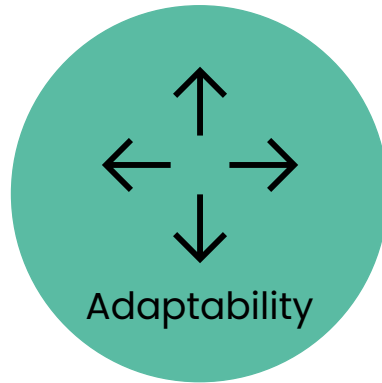
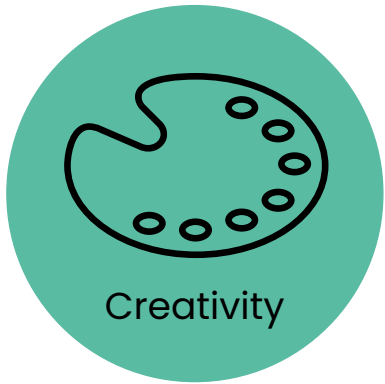


Knowledge



Skills

'The ability to solve problems is not just knowing some straightforward rules' (Polya, 1957)



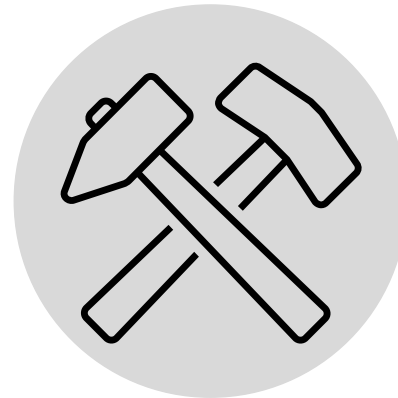
Benefits from



Problem solving



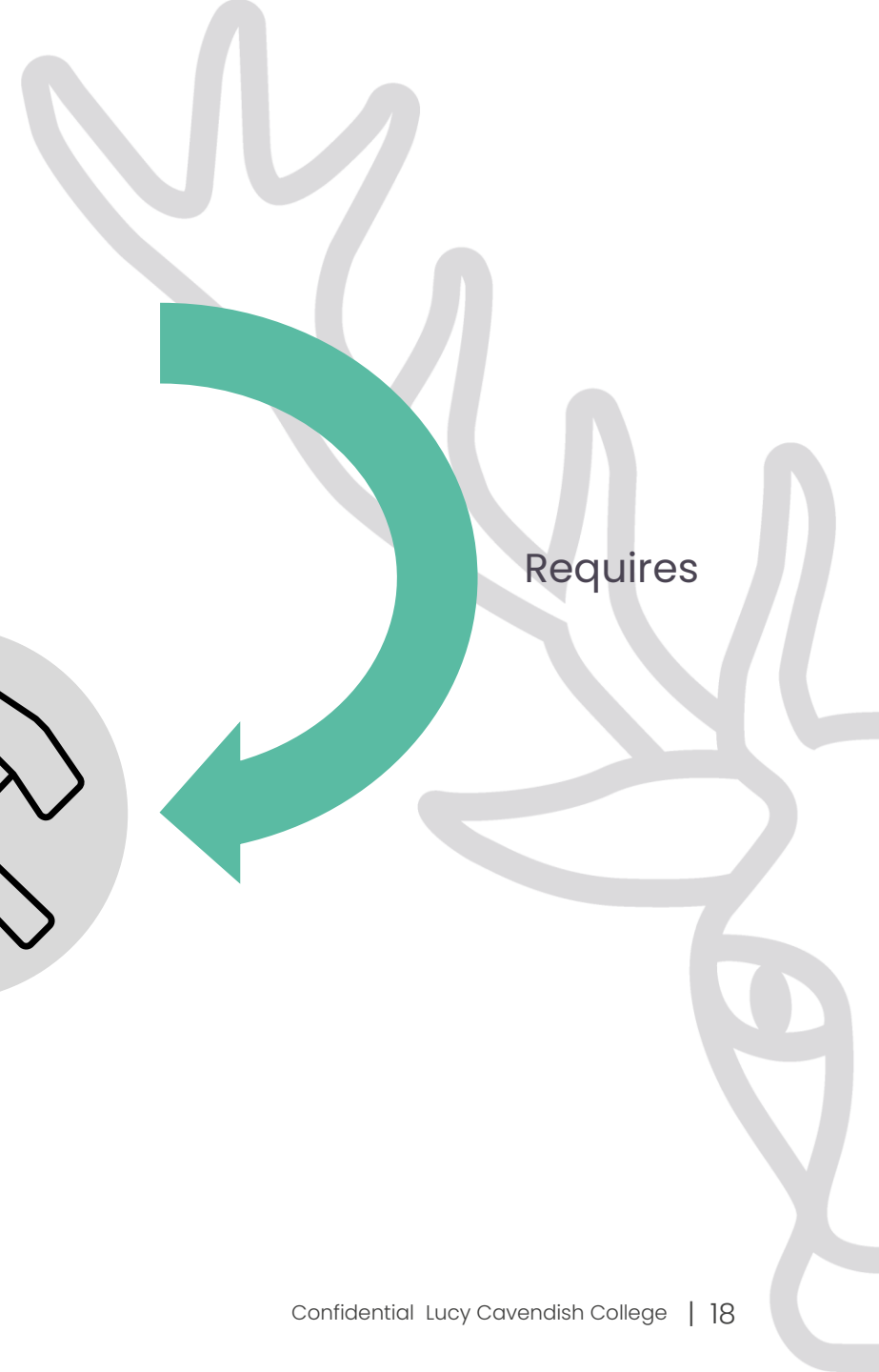
Knowledge



Skills



Requires





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General framework to approach problem solving



4 stages to problem solving (Pólya, 1945)

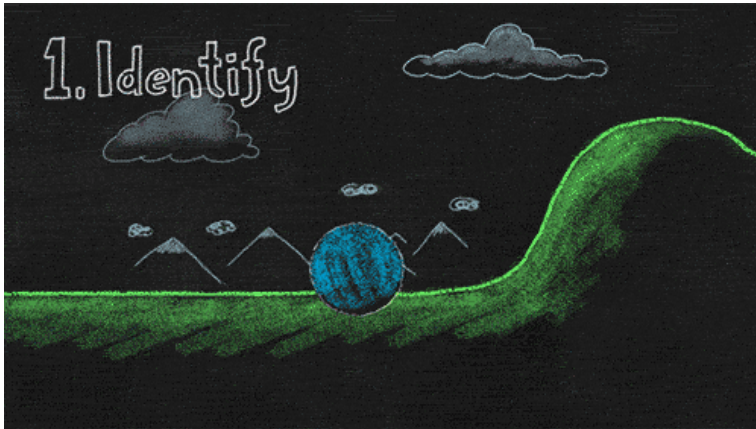
- 1 Understand the problem
- 2 Devise a plan
- 3 Carry out the plan
- 4 Look back

4 stages to problem solving (Pólya, 1945)

- 1 Understand the problem
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We do not often move neatly through these four stages: sometimes we jump stages or revisit stages as part of a process of clarification and restarting the problem.

Stage 1: Understand the problem



- Make sense of the problem
- Identify, access and apply required knowledge

Can I put the problem into my own words?

Can I create a mental image of the problem?

What do I know?

What do I need to find out?

What am I uncertain about?

What is the problem?

What exactly am I being asked to do?

What topic is this?

Stage 2: Devise a plan

- Work out the first few steps before leaping in!
- Identify possible knowledge and skills gaps that may need addressing
- Consider novel approaches and/or solutions

Can a model help me solve this problem?

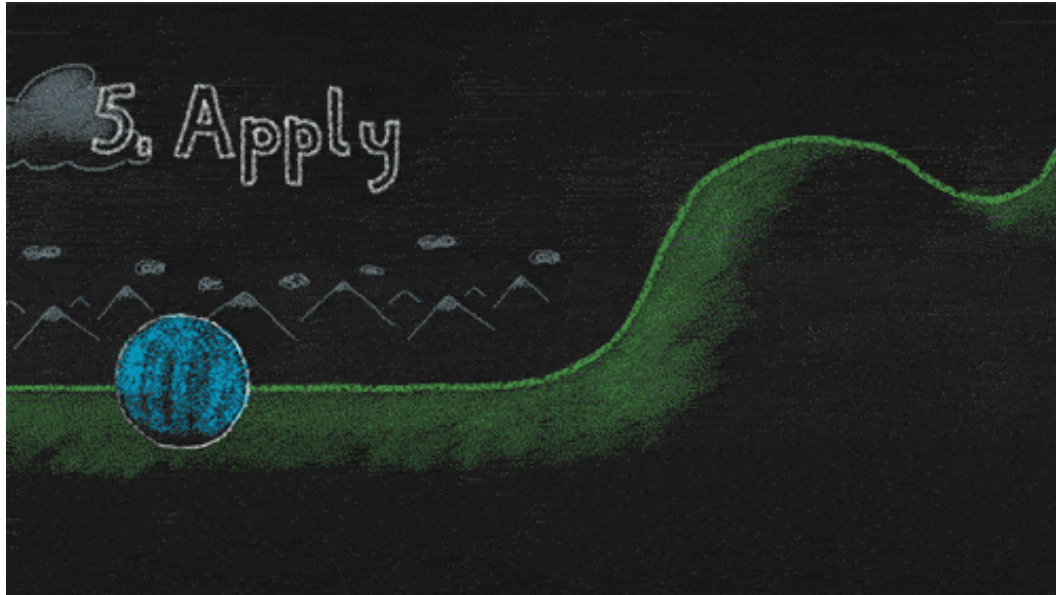
Is there some notation that will help?

Is there another way of representing the information?

Is there a diagram I could draw to help?

Have I seen something like it before?

Stage 3: Carry out the problem



- Consider novel approaches and/or solutions
- Identify possible
- When you think you might know what's wrong, try a few different options
- You won't know whether something works unless you try it out

Stage 3: Carry out the problem

- Consider novel solutions
- Consider different thinking strategies
- Identify possible
- When you think you might know what's wrong, try a few different options
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Stuck?

- Try special cases or a simpler problem
- Work backwards
- Guess and check
- Be systematic
- Work towards subgoals
- Imagine your way through the problem
- Look for patterns: are there things that keep happening which could be causing the problem?
- Are you repeating things that prevent you from moving forwards?
- Has the plan failed? Know when it's time to abandon the plan and move on

Stage 4: Looking back



- Have I answered the question?
- Sanity check for sense and consistency
- Check the problem has been fully solved
- Read through the solution and check the flow of the logic
- What have you learnt?
- What could you do differently?

Throughout the problem solving process, it's important to keep an eye on how you're feeling and make sure you're in control

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Am I getting stressed?

Is my plan working?

Am I spending too long on this?

Could I move on to something else and come back to this later?

Is my work becoming chaotic? Do I need to slow down, go back and tidy up?

Am I focussing on the problem?

Do I need to stop, put my pen down and think?

Metacognition

- Metacognition means knowing:
 - What you already know
 - What you don't know
 - What you need to do to learn the things you don't know yet
- People with good metacognitive skills often perform well academically



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Methods for tackling specific types of common problems



4 stages to problem solving (Pólya, 1945)

- 1 Understand the problem
- 2 Devise a plan
- 3 Carry out the plan
- 4 Look back

We do not often move neatly through these four stages: sometimes we jump stages or revisit stages as part of a process of clarification and restarting the problem.

Problem solving methods:

Relevant selection

- Real world problems are often overloaded with information, much of which is unimportant
- The first step in solving the problem is to decide which bits of the information available are important
- It may be that the question has presented you with information which is not important, perhaps redundant, and possibly distracting

Problem solving methods:

Relevant selection

In order to qualify for a bonus, employees must fulfil certain criteria:

£1,000 bonus:	Absences less than 5%
	Production targets exceeded by at least 10%
	Rejects are less than 5% of output
£500 bonus:	Absences less than 10%
	Production targets met
	Rejects are less than 8% of output

Workers performed as follows:

	<i>Smith</i>	<i>Jones</i>	<i>Patel</i>	<i>Owololu</i>	<i>McKay</i>
<i>attendance (%)</i>	95	90	100	96	97
<i>over production target (%)</i>	+5	+6	+12	0	-4
<i>product accepted (%)</i>	98	96	95	93	96

Who qualifies for a bonus?

- A** Nobody
- B** Smith
- C** Patel and Smith
- D** Owololu, Patel and Smith
- E** Jones, Owololu, Patel and Smith

Problem solving methods: Relevant selection

On the first criterion
(absences less than 10%) all
but Jones qualify: S P O M

On the second criterion
(production targets met) all
but McKay qualify: S J P O

On the third criterion (rejects
less than 8%) all qualify: S J P
O M

So only S P and O fulfil all
three: **D**

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- A Nobody
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- C Patel and Smith
- D Owololu, Patel and Smith
- E Jones, Owololu, Patel and Smith

Problem solving methods: **Finding procedures**

- Sometimes you will find that even if you have selected all the relevant information, no solution presents itself
- You then must find a method or procedure which you can use to generate a solution

Problem solving methods: **Finding procedures**

Three thermometers are each accurate to within 2 degrees above or below the temperature they actually read. One reads 7° , one reads 9° and one reads 10° .

What is the minimum range in which the true temperature lies?

A $5^\circ - 12^\circ$

B $7^\circ - 9^\circ$

C $8^\circ - 10^\circ$

D $8^\circ - 9^\circ$

E $7^\circ - 10^\circ$

Problem solving methods: **Finding procedures**

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- C** $8^\circ - 10^\circ$
- D** $8^\circ - 9^\circ$
- E** $7^\circ - 10^\circ$

The method here is to search for the acceptable highest and lowest temperatures for the conditions to be met, realizing that the middle value is irrelevant.

As one reads 7° , the temperature cannot be above 9° and, as another reads 10° , the temperature cannot be below 8° .

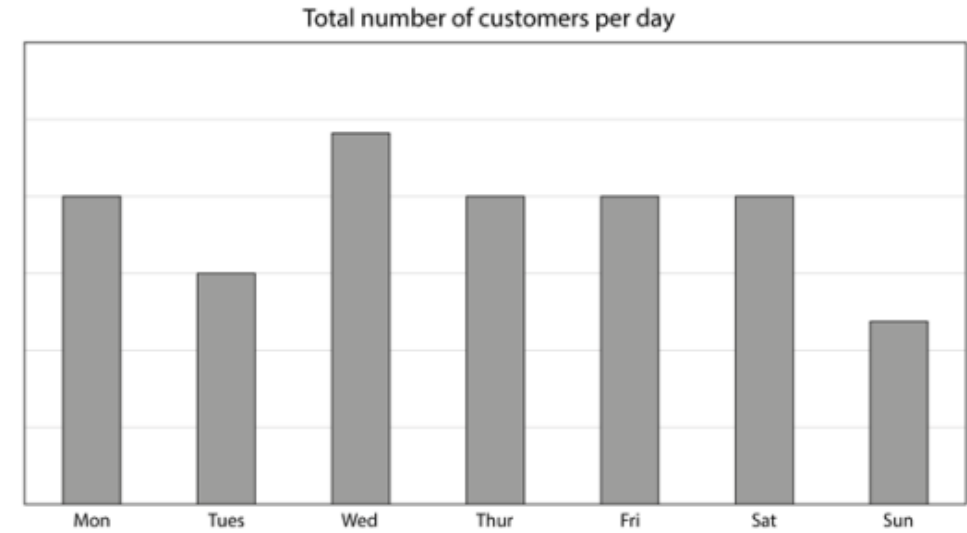
The answer is **D**.

Problem solving methods: **Identifying similarity**

- Sometimes you will be presented with information or data represented in more than one way
- To answer these questions, you will need to understand the relationships between these and to identify any similarity in the data they represent

Problem solving methods: Identifying similarity

Graham recorded the number of visitors to his shop each day last week and presented the results in the bar chart below:



When he calculated the number of customers per hour he found that he had the same number for five of the days, but the values for Tuesday and Friday were slightly higher. The opening hours of the shop are as follows:

Day	Open	Close
Monday	8am	6pm
Tuesday	?	?
Wednesday	8am	8pm
Thursday	8am	6pm
Friday	?	?
Saturday	8am	6pm
Sunday	10am	4pm

Which one of the following could be the opening hours of the shop for Tuesday and Friday?

- A Tuesday 9.30am - 5.30pm, Friday 8.00am - 6.30pm
- B Tuesday 9.00am - 4.30pm, Friday 8.30am - 6.00pm
- C Tuesday 9.00am - 4.30pm, Friday 8.00am - 6.00pm
- D Tuesday 9.00am - 5.00pm, Friday 8.00am - 6.30pm
- E Tuesday 10.00am - 5.00pm, Friday 8.30am - 6.00pm

Problem solving methods:

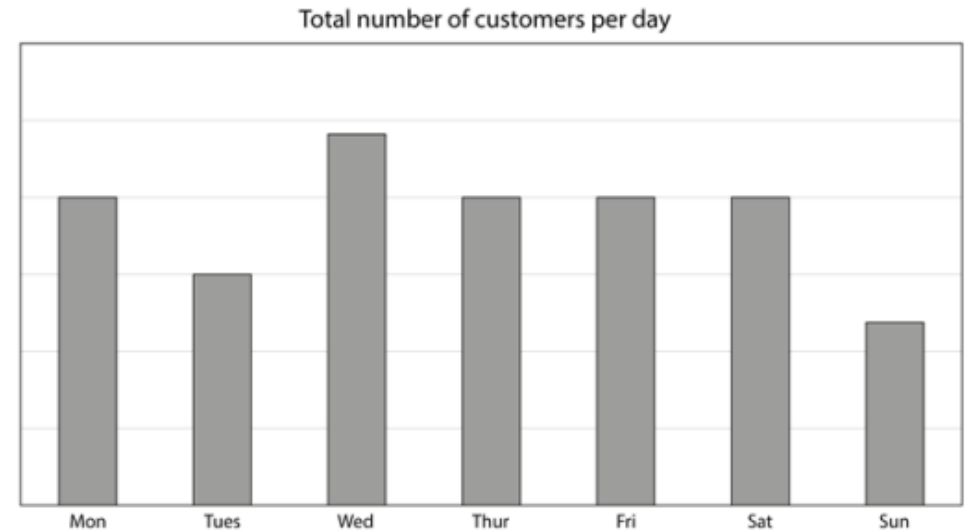
Identifying similarity

The bar for Tuesday is three quarters the height for Thursday, so the shop must be open for less than 7 and a half hours if the average number of customers per hour is to be higher.

The shop must also be open for less than 10 hours on Friday.

The only option that satisfies these conditions is **E**.

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- E Tuesday 10.00am - 5.00pm, Friday 8.30am - 6.00pm

Problem solving methods: **Brainstorming**

- Brainstorming is a way of generating ideas
- It is a good method to try if you are attacking a specific problem, whether alone or as part of a group
- You need to **think freely** about the subject at hand
- You then work with the ideas
 - Can any be improved?
 - Do they lead you to another idea?
- Once several ideas have been generated, you sift through them to see which work and which don't

Problem solving methods: **Asking idea-generating questions**

- Who?
- What?
- When?
- Where?
- Why?
- How?

These questions would then lead on to other questions, or a wider examination of the subject.

Problem solving methods: **Asking idea-generating questions**

Why?

Why?

Why?

Why?

Why?

- Sakichi Toyoda's 5 Why Technique
- Helps us identify the root cause



Problem solving methods: **Shifting perspective**

Here you try and look at things from another point of view:

- If you are female, what might a male perspective be? Would it be different? Why?
- If you are looking at a conservative argument, what might a liberal view be?
- If you were examining something scientifically, how would a social scientist approach the situation? What methodology would they use? What theory would they engage with?
- If you are looking at something in detail, try to step back and see it from a broader perspective, and vice versa.



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Developing a problem solving mindset



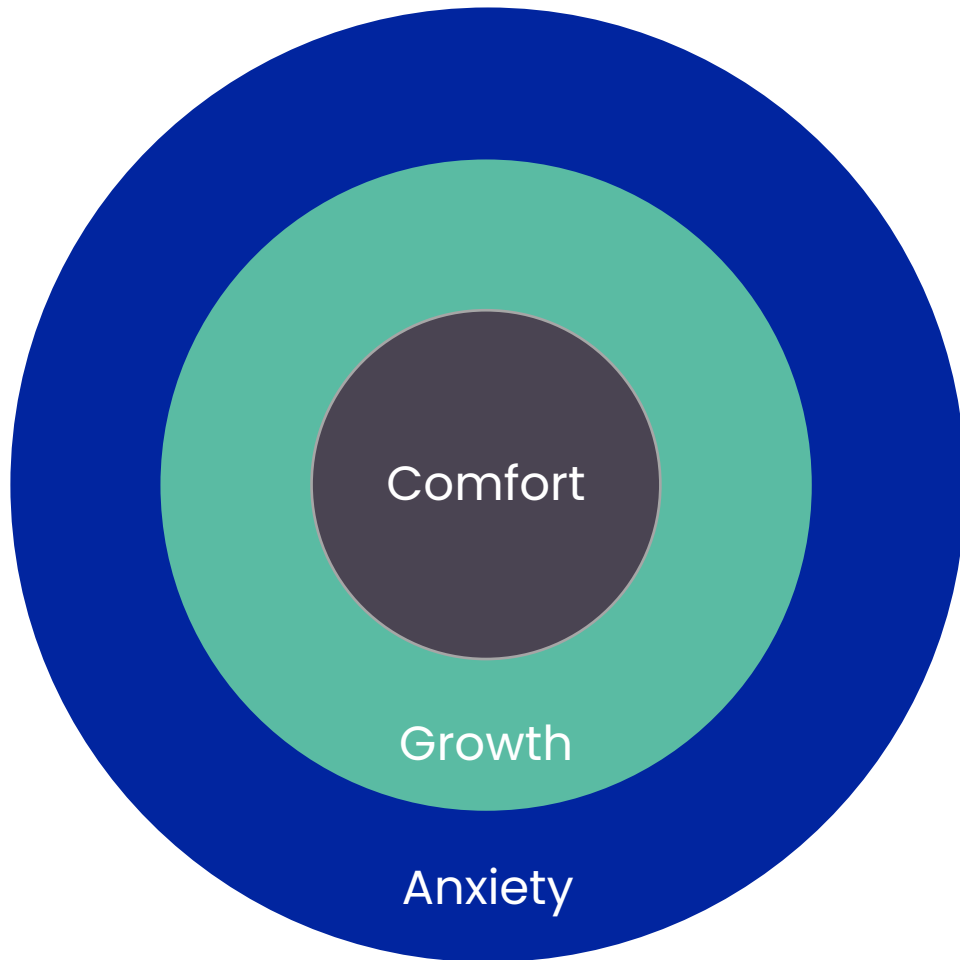
Developing a problem solving mindset

- Perseverance and resilience
- Reflection
- Curiosity and a love of learning
- Confidence
- Recognising multiple solutions may be possible

Resilient learners...

- Are willing to seek help
- Know how to ask questions
- Know how to get help
- Take responsibility for their own understanding
- Actively seek understanding
- Embrace challenges
- Engage with opportunities that ask for thinking and reasoning
- Know it is good to help others and collaborate when learning
- Know that learning can be challenging
- Know it is okay to make mistakes
- Refuse to feel 'stupid' when solving problems
- Learn from feedback and self-evaluation
- Have a growth mindset

Growth mindset



Growth mindset is the belief that you can grow your talents and abilities with effort.

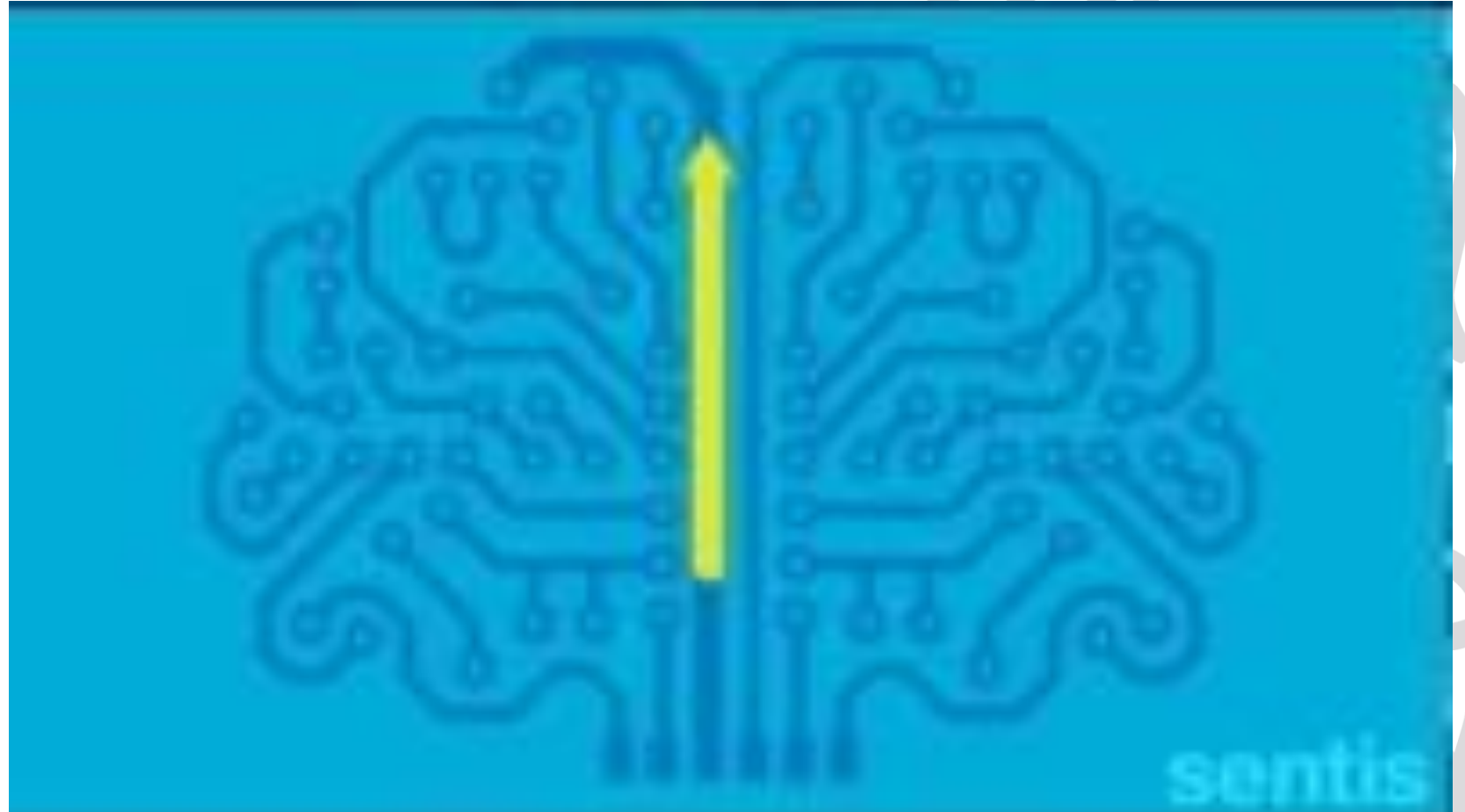
- Ability is not fixed: we can build our abilities
- Focus on the importance of learning and the process: effort is necessary for success
- Understanding that setbacks are a part of growth

Students with a growth mindset progress better over time than those with a fixed mindset.

Growth mindset and neuroplasticity

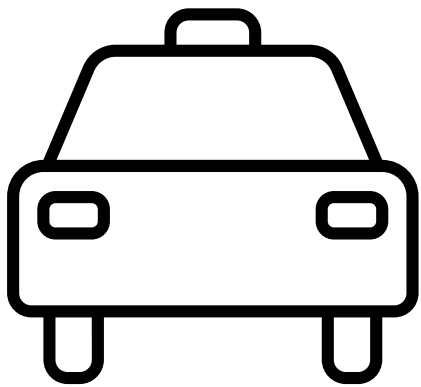
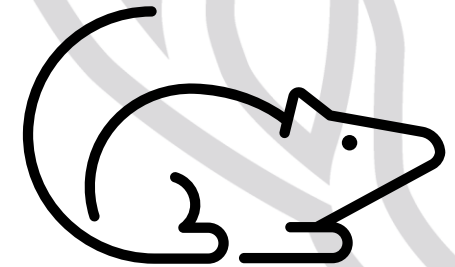
Certain experiences cause new connections in the brain to form or strengthen, making the brain smarter by literally rewiring it.

- Neurons are each connected to thousands of other neurons
- The strength, number, and location of those neurons affect how the brain works
- Amazingly, **these connections change all the time as a result of our experiences**
- Certain experiences cause new connections to form or strengthen, making the brain smarter by literally rewiring it



Growth mindset: evidence

In a study with rats, researchers put some rats in empty cages and others in stimulating cages with puzzles and other rats. The rats in the stimulating environments were smarter, and their brains even weighed more!



London taxi drivers have to give their brains a workout when they navigate the complicated streets of London. Research suggests this has an impact on the brain. The part of the brain responsible for spatial awareness (the hippocampus) is bigger in taxi drivers compared to other Londoners. The longer a person has been a taxi driver, the bigger the hippocampus.



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Final points



How do I become a better problem solver?

- Solve lots of problems!
- Practice a range of problem-solving methods
- Metacognition – be aware of what you're good at and what you're not; when you get frustrated and when you're 'in the zone'
- Problem solving is linked to your mindset



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Any questions?

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