

# Planning for extension - a process for designing from within the Australian Curriculum

John Munro

# **Session 3**

**Framework for planning  
extension based on how gifted  
learners learn: differentiate the  
teaching**

# Our pathway

Differentiating in gifted education provision

Framework for differentiating at each frame at each phase of learning

Apply to stimulate students' existing knowledge

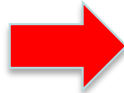
How to differentiate Phase 2 teaching

How to differentiate Phase 3 teaching

# Differentiating instruction for gifted and talented learners

Goal of differentiated teaching:

Gifted learning  
capacity



High ability /  
talented  
outcomes

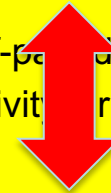
Match students' approach to learning with the most appropriate pedagogy, curriculum goals and opportunities for displaying the knowledge they gain.

Differentiation for gifted learners is described in ***A Nation Deceived: How Schools Hold Back America's Brightest Students*** (Colangelo, et al., 2004).

The 18 ways of doing it can be grouped as:

- locate the student in the class of older students through early entry to kindergarten, primary, secondary or tertiary education, grade-skipping, subject acceleration /partial acceleration;
- teaching at the gifted student's rate of learning, controlled by teacher or student (self-paced);
- curriculum compacting; modify curriculum, for example, include less introductory activities or drill, bigger increments in learning compared to the curriculum;
- telescoping the curriculum; teach at a faster rate and place in higher grade;
- mentoring;
- extracurricular programs and correspondence courses;
- provide advanced credit; credential gifted student's advanced knowledge in various ways; or
- student studies subjects at an earlier age.

Don't need to  
differentiate teaching



Need to  
differentiate  
teaching

Don't need to  
differentiate  
teaching

This set of options accelerates the gifted students through the curriculum, both through grade placement and curriculum modification as a way to provide differentiated learning experiences.



# Our approach to differentiation : extend Maker

## Maker's four criteria for differentiating the curriculum

### Content

- comparatively abstract, complex, varied
- involve issues of organisation, study of people, methods of inquiry.

### Process

- involve higher order thinking
- foster creative and critical thinking
- use problem solving
- involve group interaction
- have variable levels of pacing
- allow for debriefing of the process
- learn how to develop and manage independent learning skills using research tasks

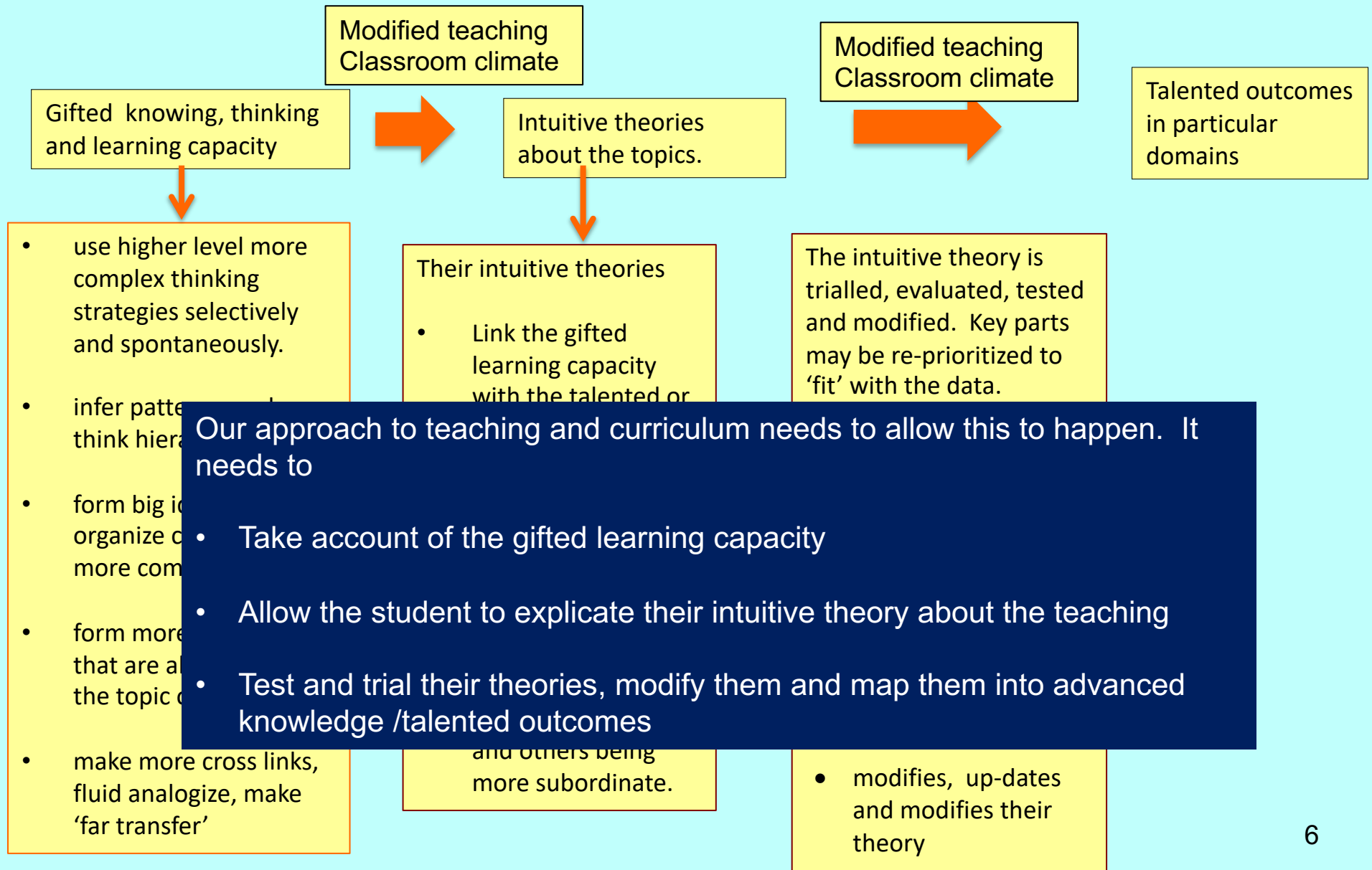
### Product

- involve real world problems
- be for real world audiences
- require real deadlines
- require transformation of learning
- involve appropriate assessment and evaluation
- involve extended or accelerated outcomes.

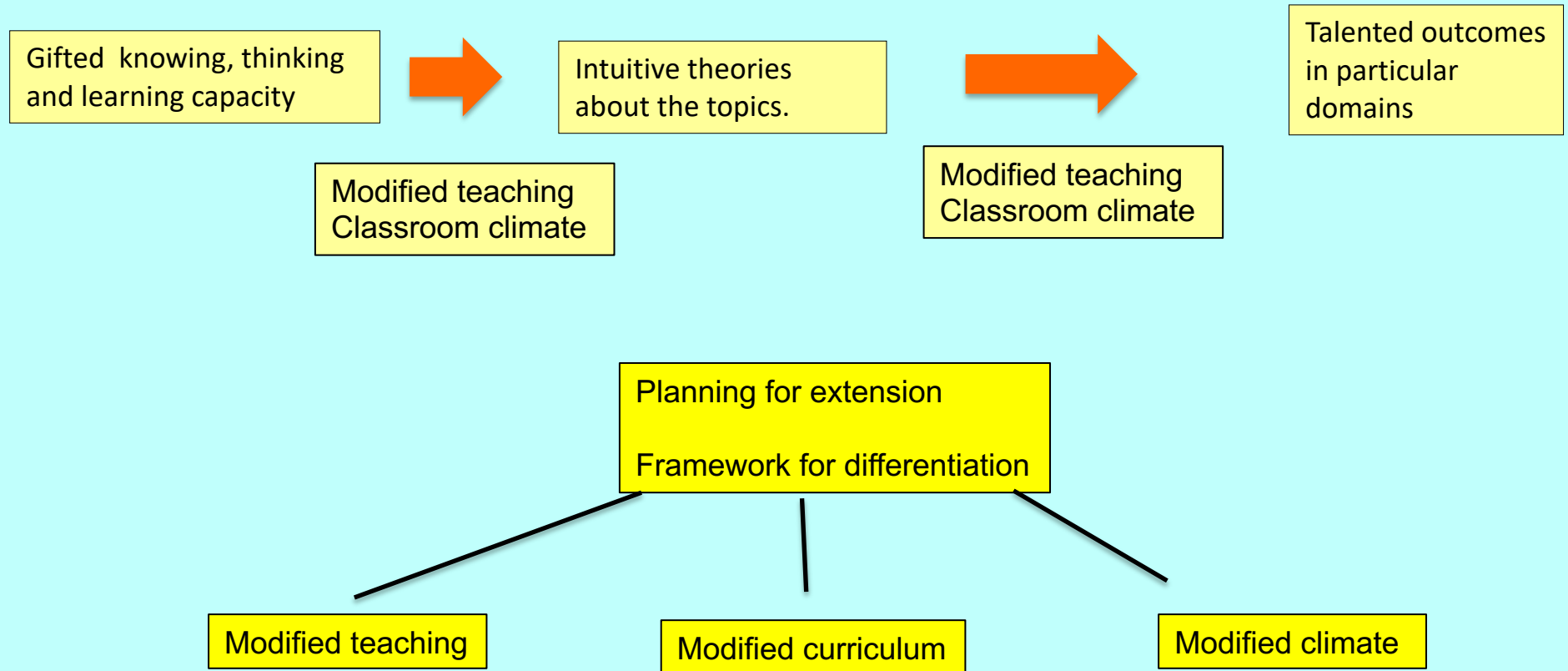
### Environment

- be flexible and open, be accepting and non judgmental
- encourage independent and intrinsic learning, complex and abstract thought.
- examine and assess students' existing knowledge and skills
- use pre-assessment to compact the curriculum for students who have mastered the core
- accelerate the pace to allow independent study on student interest.
- use flexible grouping to allow work with like-minded peers.
- use learning contracts to allow students to work independently, set goals and develop management skills, use learning centres that have activities that vary in complexity.

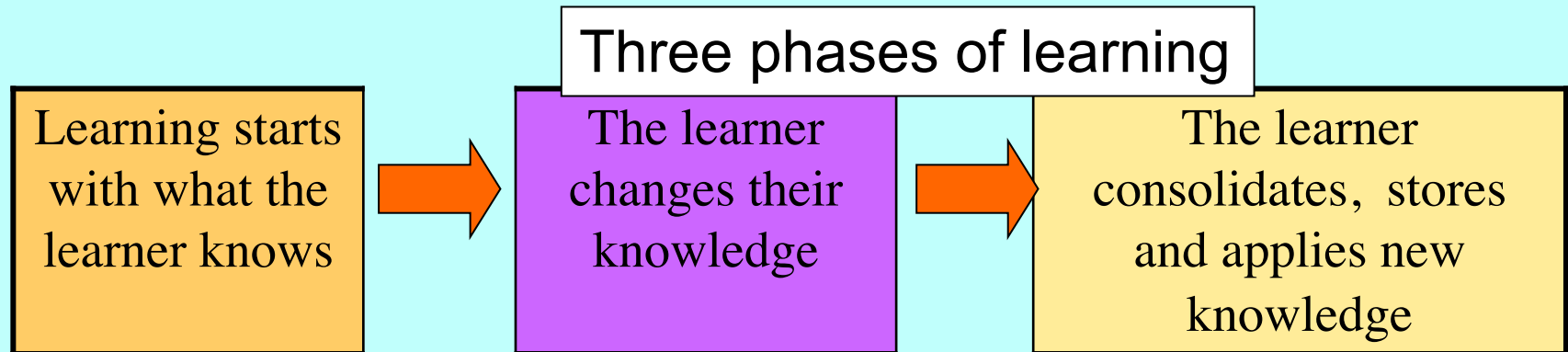
# How is a gifted learning capacity mapped into talented outcomes in classrooms ?



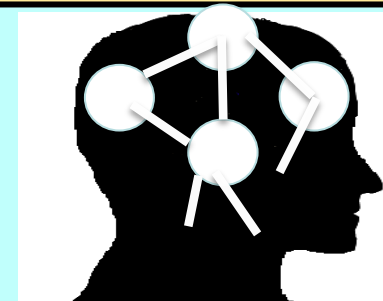
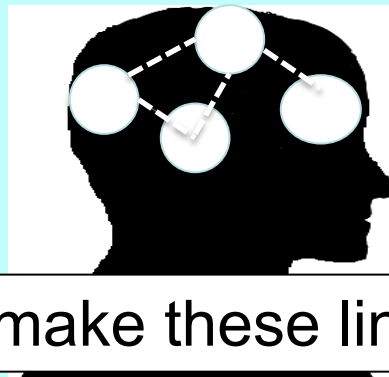
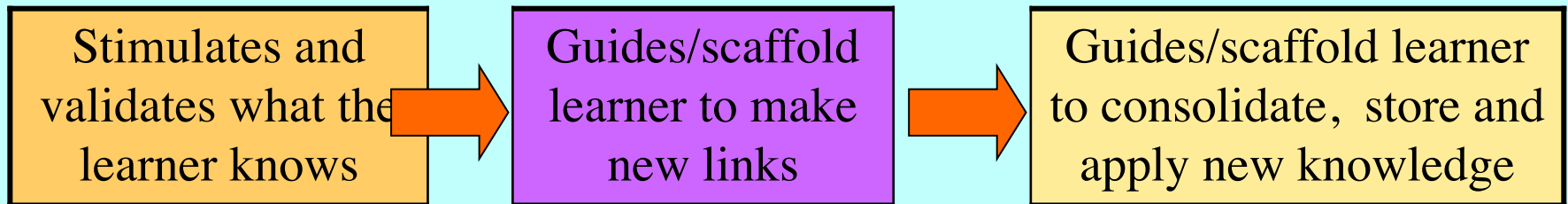
# How is a gifted learning capacity mapped into talented outcomes in classrooms ?



# Three phases of learning -teaching



## What effective teaching does



Gifted learners make these links without directed teaching

# How do we give students an opportunity to show their intuitive theories ?

Differentiation for gifted learners in the regular classroom: When to differentiate

Phases of knowledge change in learning a topic	Get existing knowledge ready	Learn new ideas in particular contexts, instances. Show comprehension of new ideas	Learn pattern, rule, more general idea, procedure. Apply, practise new ideas	Learn big idea. Synthesize	Review, consolidate	Automatize, use creatively, to solve problems
Differentiation activities	Identify higher level knowers/ thinkers	Differentiate your teaching /scaffolding to learn both for individual or group pedagogy differentiation.	Design more complex project or enquiry that students work through, relatively independently. They may test their intuitive theories; curriculum differentiation.		Review, consolidate, unanswered questions, possibilities	Solve more complex problem about topic
Gifted student activity	Show advanced existing knowledge	Show higher level comprehension of new ideas, answer more complex questions and tasks	Infer patterns, more general idea, procedure. Apply, practise new ideas	Infer, synthesize generalities, rules, big idea.	Review, consolidate	Use more complex understanding creatively to solve problems

# Framework for differentiating at each phase of learning

	Ways of thinking	Level of inference	
	Interpret, store teaching information	<ul style="list-style-type: none"> <li>identify ideas and links between them in the teaching information.</li> <li>Think in ways cued or scaffolded explicitly by the teaching.</li> </ul>	
Patterned understanding	Infer patterns in the ideas	<ul style="list-style-type: none"> <li>infer other specific ideas not included in the topic, identify what they share across a range of examples.</li> <li>infer patterns or more general ideas, identify what they share, summarize, imagine key aspects of the pattern, identify what they share, extend across contexts</li> </ul>	<i>Look at what these instances or contexts have in common. What is the pattern here?</i>
	Infer possible trends	<ul style="list-style-type: none"> <li>link two or more patterns</li> <li>analyse the new ideas</li> </ul>	<i>How / why did the trend affect/change the direction of the pattern?</i>
	Generate possibilities	<ul style="list-style-type: none"> <li>question, speculate about the patterns, generate possibilities;</li> <li>examine the new ideas from multiple perspectives, make far transfer links, use analogies, look for possibilities and options</li> </ul>	<i>How did the patterns effect/contribute to .... ? What might happen if ..? ,</i>
Big ideas understanding	Synthesize generalities, rules	<ul style="list-style-type: none"> <li>infer rules or general propositions, make far transfer links, identify their boundaries and</li> <li>synthesize the inferred rules, formulate and understand</li> </ul>	<i>Make X the main idea instead of Y. How does the interpretation change? What is the rule here ?</i>
	infer ethical issues	<ul style="list-style-type: none"> <li>link moral / ethical issues with the rules or general propositions</li> </ul>	<i>What / how/why should....?</i>
	Infer, synthesize big ideas	<ul style="list-style-type: none"> <li>infer how the 'big ideas' could be used to solve problems and generate creative outcomes.</li> <li>use 'big ideas' in topic fluently and automatically to solve problems and make decisions,</li> <li>infer and investigate broader possibilities and options.</li> </ul>	<i>"If this happens, then .., but because of .. I would.... What might you do if ... Why wouldn't you .. ? What if..." .</i>

By scaffolding students to act on their knowledge in these ways we are ore likely to get enhanced understanding and talented outcomes.

We use this to differentiate the teaching at each phase of learning-teaching



# Your turn 7 : Analysis of the content

**Padlet 5 Activity** - <https://padlet.com/markeoliver/be7gzauia14v3sux>

How could you use the **Framework for differentiating at each phase of learning** in your work?

- What could it contribute to
  - Your planning?
  - How you implement teaching?
  - How you engage in formative assessment of students' learning?
  - How you identify instances of gifted learning in your classroom?

# Apply to stimulate students' existing knowledge

What do we know so far about Roald Dahl?  
What images do you have of him?

infer using imagery:  
nonverbal high ability

What do you see in the picture? What  
/where do you think it is? What do the  
buildings look like?

What sort of a child was he? What  
words would you use to describe him?  
What are things he doesn't tell us?

Imagine Roald in this situation. How  
might he feel about it?

Were there any questions you had that  
haven't been answered about him?

infer using abstract  
ideas: verbal high ability

Read the title? Make a picture in your  
mind that links the two items. How do  
you think they are linked? What might  
this chapter be about?

How would you describe Roald's writing  
style and his ability to communicate? How  
well did it sustain your interest?

What ideas might be in this chapter?  
What ideas words might it contain?

What sorts of things might he like to do?  
What might he be good at as a child?

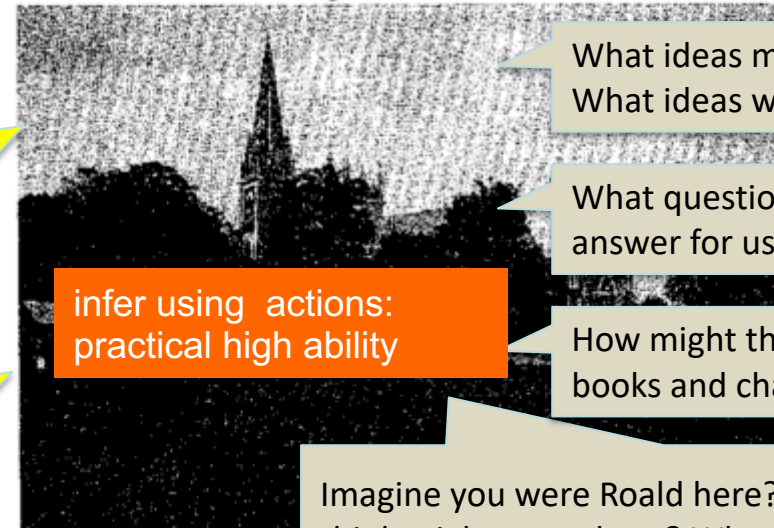
What questions might this chapter  
answer for us?

Why do you think Roald Dahl wrote this autobiography?  
What did you think he wants to tell us?

infer using actions:  
practical high ability

How might this chapter be like other  
books and chapters you've read?

Imagine you were Roald here? What things do you  
think might go on here? What things might you do?  
What issues might this chapter be about?





# Apply to stimulate students' existing knowledge in science

infer using imagery:  
nonverbal high ability

What do you see in this picture ?

What does the colour of these things tell you about what they might be?

If this is a picture of something in your body, what could it be?

Describe what these things look like? What might they be?

Most students can answer these questions.

Look for evidence of higher level inferences, far transfer, richer vocabulary links, indicators of intuitive theories

Say to  
Other

us

What might be some body facts? What are some things you have in your body?

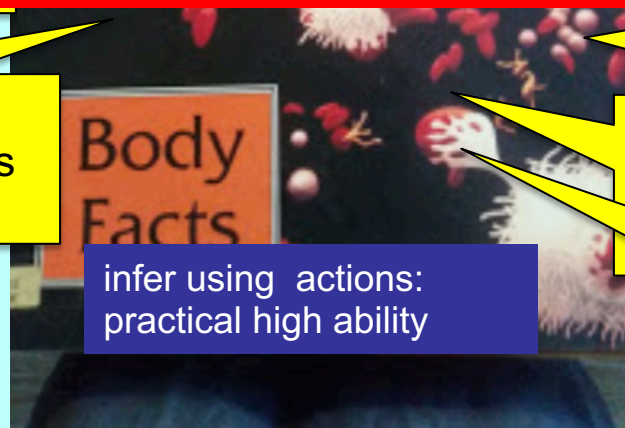
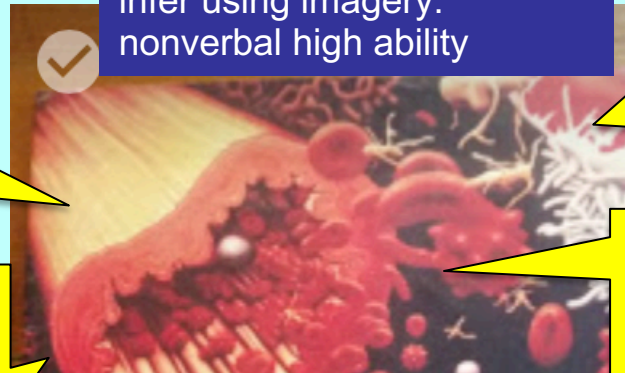
this text answer for us?

Why do you think the tube has a thick side?

infer using actions:  
practical high ability

What will you do to help you to understand what the text says?

What type of text do you think this could be?



# Teaching to stimulate students' existing knowledge for any topic.

Types of pre-teaching identification tasks	Questions, tasks, cues you will use
<b>Form possible mental images of the topics</b> Describe images, draw a picture / diagram of their ideas about the topic, make a model, link key aspects of the topic in Venn diagrams or flow charts	Imagine you were here. Put yourself in the forest. What living things might you expect to see here? What would you hear? Smell? What things might live in the soil here
<b>Suggest ideas, vocabulary for the topic</b> Select from a list the key concepts for a topic, key pictures, match word or/and pictures, label a diagram about the topic Suggest and list vocabulary student thinks might be mentioned in learning the topic.	What are some words that might come up in this topic? List as many as you can think of.
<b>Use a range of cognitive and metacognitive strategies</b> Ask students to say what they will do to learn, the ways in which they will plan how they will learn or solve a task.	
<b>Make fluid analogies, far transfer</b> Say what other topics they think of when they hear the topic, what the topic reminds them of.	

# Teaching to stimulate students' existing knowledge for any topic

Types of pre-teaching identification tasks	Questions, tasks, cues you will use
<b>Assess required domain knowledge</b> Use tasks that ask students to 'tell me all you know' about a topic Ask questions about the topic.	How is a biome different from an ecosystem?  What do the living things in this biome need to keep on living?
<b>Ask questions re the topic</b> Students suggest questions the topic might answer for them, the questions they might be able to answer having learnt the topic.	What are some questions the teaching might answer for you? What are some 'what if...' 'could' or 'might' questions it might answer?
<b>Enhanced meaning and vocabulary network</b> Draw a possible concept map of the topic	Say the topic in other ways. Suggest synonyms for possible words.

# Focus of teaching: Mungo Lady and Mungo Man

**History / Levels 3 and 4 / Historical Concepts and Skills / Chronology Community and First contacts**

Look at this country. What is it like? What does it remind you of?

I want to know what you think about this topic before we begin to learn it. I would like you to tell me

1. what things you think you might learn? Write them down. Say as many things as you can. You can take your time.
2. what words might be said about living at Lake Mungo 40,000 years ago?
3. imagine you were living at Lake Mungo 40,000 years ago. What would it have been like? What would you see/hear/ do?
4. what challenges do you think the people at Lake Mungo needed to deal with? What problems might they have needed to solve? What things did they need to do to live there?
5. what questions might you be able to answer at the end of learning it?

Skeleton of a woman who has lived there about 40,000 years ago. One is called Mungo Woman, or Mungo Lady.

We are going to learn about some of the things Professor Bowler and his colleagues discovered about the people who lived around Lake Mungo about 40,000 years ago and how they lived. We will also look at how Professor Bowler did his explorations and what they told him about how people lived there then.



# How to interpret students' outcomes on the pre-topic assessment

Our goal is to identify how many plausible responses each student gives to each item and to categorize each response in terms of whether it is

1. Literal, that is, provided in the information you give to the students – 1 mark
2. Near inferential, that is, extends from the context that is given but doesn't infer that the context could be different– 2 marks
3. Far transfer, that is, recognizes that the context could be different-3 marks

The total number of responses for each student tells you how rich or broad a student's knowledge on entry to the teaching.

We assess the extent of inference in the student's response because we defined a gifted learning capacity in terms of how well the student could teach themselves new ideas by inferring.

Question	Type of giftedness
What things do you think you might you learn?	All types
What words might be said ?	Verbal
Imagine you were.....	Nonverbal
What challenges do you think ...? What problems might they need to solve?	practical
What questions might you be able to answer	All types



Once you have assessed each student's response/s to each question, you then convert the raw score to a z-score. This tells you how many standard deviations above or below the average each score is.

# An example of each student's response to Question 1

















Name :	1. What things do you think you might learn? Write down as many things as you can	
P	How to identify an old community like lakes, house, people	2
W	How they live and what they eat 12	3
A	How hot was it and what food was there	2
T	History	1
F	How many layers there was	2
E	History of lake mungo	1
Al	About Dr Jim bowler	1
An	I think I'll learn more about how the lakes and how they might of dried up. 1+2	3
X	About the history of Australia and a bigger dive into climate change. Also about the mungo people and mungo lady. 1+3+1+1	6
Es	I think we will learn about how life was 40,000 years ago	1
Li	How long to It took them to find Mungo Lady	1
Ja	I think we would learn about the history about mango lake and also what Dr Jim Bowler does in his life and what he finds what he does it, we would maybe learn about the mango woman.	4
Ar	How long it took for the layers to cover the water and how the mungo ladyb. 3+1	3
Sk	I think we might Learn about Dr Jim bowler. We also might learn about the setting and the people that used to live there and how they lived.	4
Ei	I might learn about how the lakes were carved. I would also learn about what tools where used and how you would live. 3+1+1	5
SA	Gold	0

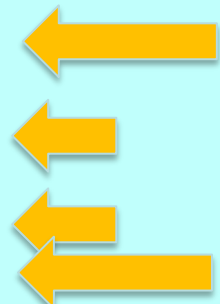
# Interpreting students' existing knowledge scores

I changed each student's score on each task to a 'standard deviation' score. This showed me how many SDs each student was from the mean.

SD scores in 1-2   
SD scores above 2. 

You can see which students entered the teaching advanced knowledge and thinking .

	Tasks				
	1 learn?	2 words?	3 visualise?	4 problems	5 questions
P	-0.0	1.6 	0.0	-0.7	0.05
W	0.6	-0.1	-1.4	-0.3	-1
A	-0.1	-0.7	-0.2	0.12	0.1
T	-0.7	-1.3	-0.9	1.0	0.5
F	-0.1	-0.7	0.2	0.6	0.0
E	-0.7	-0.1	0.0	0.6	0.0
Al	-0.7	-1.3	-1.1	-1.2	-1
An	0.6	1.0	-0.9	-1.1	0.1
X	2.5 	0.4	0.9	1.5 	3.7 
Es	-0.7	0.4	0.9	1.5 	0.1
Li	-0.7	1.0 	-0.5	-0.3	0.0
Ja	1.2 	1.6 	-1.2	-1.2	-0.5
Ar	0.6	-1.9	-0.9	-1.2	-1
Sk	1.2 	0.4	1.4 	1.5 	0.1
An	-0.7	-0.1	2.4 	1.5 	1.1 
Li	-0.7	1.0 	-0.9	-0.3	-0.5
Ei	1.9 	0.4	-1	-1.6	-0.5
SA	-1.4	-1.3	-0.9	-0.7	-1
T	-0.7	0.4	0.9	-0.3	-0.5



# Your turn 8 : Analysis of the content

## **Mentimeter Slide 13 (Open-ended)**

How could you use differentiation at the 'getting knowledge ready' phase to identify instances of gifted learning?

## **Mentimeter Slide 14 (Open-ended)**

How could the work that you do at this phase contribute to your teaching?

## **Mentimeter Slide 14 (Open-ended)**

How can you use this procedure in your teaching in the future?



# How to differentiate phase 2 teaching.

Goal of phase 2 teaching: gifted students learn /form their own personal interpretations of the teaching information

What thinking might help you learn this topic ?

infer patterns, relationships or rules such as possible causal or consequential links

transfer and apply their knowledge across content area boundaries

infer a big ideas understanding that links two or more patterns, rules or general propositions at once.

suggest a personal, intuitive 'semantic theory' understanding of a topic

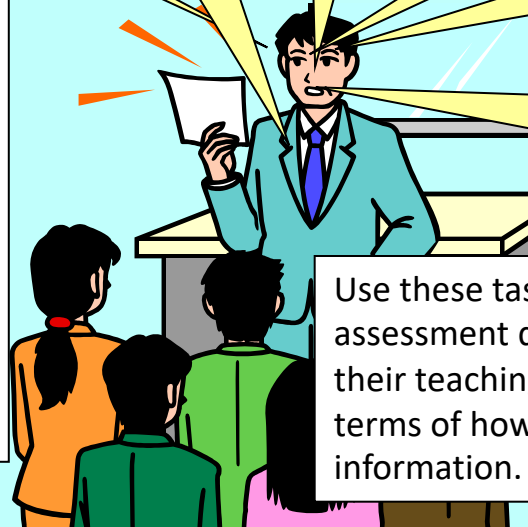
talk about a big idea understanding and possibilities

Use tasks that ask students to interpret information using

- high-level inferential thinking,
- ability to make far transfer and analogy,
- ability to infer a topic and broad-based links,
- prioritize and re-organize ideas.

Gifted students may ask clarifying questions based on their high-level thinking and that differ from those asked by the peers.

Use these tasks to make effective formative assessment decisions in the classroom to differentiate their teaching. Categorize students' responses in terms of how they interpreted and responded to the information.



# Differentiate phase 2 teaching: Planning guide

Types of cues you can use to differentiate your teaching. You can ask them to:	Examples from the two pages
<p>unpack or identify what they don't know or understand about a topic they are learning.</p> <p>Give a challenge that motivates their engagement and thinking, for example, information that seems to be unclear or contradictory.</p>	<p><i>How might the oxygen get from the air pockets in your lungs into your blood?</i></p> <p><i>How do you think the bones in each finger are joined together so that they can still move?</i></p>
<p>infer possible causes or consequences and extend or interpolate patterns, relationships or rules. Patterns can be verbal, quantitative, nonverbal, spatial or actions</p> <p>They can imagine or visualize the content in specific contexts and imagine key aspects and elements changing. They predict the outcomes of the changes.</p>	<ul style="list-style-type: none"> <li>• <i>Why do you think the joints in the finger bones are curved? Why do you think the thumb bones are separate from the finger bones?</i></li> <li>• <i>Imagine air in an air pocket in your lung. How might it get into your blood? What does it need to do? Where might the air and the blood meet?</i></li> <li>• <i>Imagine how an air pocket might change when you breathe in and breathe out?</i></li> </ul>
<p>identify trends by comparing and linking two patterns, apply an idea in another context. <i>How did the patterns affect .... ? What might happen if..? , If this happens, then..., but because of.. I would.... How / why did the trend affect/change the direction of the pattern?</i></p>	<ul style="list-style-type: none"> <li>• <i>What does having the joints in our fingers and thumb allow us to do? If we had only one bone in our fingers, how could each finger move?</i></li> <li>• <i>Move your thumb. How does it move differently from the fingers? How can you tell it has only two bones?</i></li> </ul>
<p>transfer and apply their knowledge across topics, make unusual and 'far transfer' links, reason by analogy or look for similarities between otherwise unrelated ideas.</p> <p>Ask open-ended questions for creative thinking, flexibility, originality and novel outcomes. Ask 'what if...?' questions that require them to think about multiple possibilities at once and form plausible ideas.</p>	<p><i>How many bones do you think are in each of your toes? How did you decide this?</i></p> <p><i>Suppose you were to design a 'robot' hand. How would the number of joints in each of its 'fingers' affect what it could do?</i></p> <p><i>How might an air pocket be similar to a bicycle tube?</i></p>

# Differentiate phase 2 teaching.

Types of cues you could use to differentiate your teaching. You can ask them to:	Examples for the two pages
analyze or evaluate their understanding, ideas such as solutions in terms of their consequences and implications. Ask 'What if... ?' questions.	<i>How could you tell which pawed animals in a zoo might have two or more bones in each digit? What if the base of the thumb bone was closer to the base for the finger bones? How well could your thumb move? Do you think the bones in your big toes are more like the bones in your thumb or the bones in your fingers? What could happen to a person's lungs so that they have difficulty breathing?</i>
Synthesize a 'big ideas' understanding that combines two or more patterns or rules. Students 'think above' the individual ideas to form a possible main idea.	<i>How would our lives be different if we had fewer bones in each hand? How has the development of the human hand helped people in history?</i>
suggest a personal, intuitive theory understanding of a topic. <i>Put all these ideas into a possible explanation.</i> Students share their intuitive or 'yet to be tested' ideas and beliefs about a topic they are learning.	<ul style="list-style-type: none"> <li>• <i>What/ how/why /might human hands have changed over history?</i></li> <li>• <i>How can you use your new knowledge in creative, novel ways? How might our hands change in the future as we use them differently?</i></li> <li>• <i>How might our hands change in structure if we use them differently?</i></li> <li>• <i>How could medical discoveries help us use our hands differently.</i></li> </ul>
identify what doesn't change in a topic they learn and why Ideas that don't change include the conventions that define the topic and how concepts are defined, for example, the meanings of words.	<i>What did you already know about Body Facts? How did you use what you knew?</i>
suggest how a particular idea may have been researched or investigated to establish a cause and effect or to draw a conclusion.	<i>How do you think people obtained the information in Body Facts about the hand and the lungs?</i>

# Differentiate phase 2 teaching.

What do you see in this picture ?

Why do you think the joints in the finger bones are curved? Why do you think the thumb bones are separate from the finger bones? .

Read this section. Say it in your own words.

What are muscles /blood vessels/ cells

What does the writer want to tell us here about the cells in our body?



Inside your hand are 27 bones. Each finger has three bones, but your thumb has only two. The

Read this section. What does it tell us ?

Move your thumb. How does it move differently from the fingers? How can you tell it has only two bones?

How many bones do you think are in each of your toes? How did you decide this?

## ***What's inside me?***

Inside your body are

- 206 bones,
- more than 600 muscles,
- 96 000 km of blood vessels and
- 50 000 million cells.

✦ You have more cells in your body than there are people on the Earth.  
✦ Your blood vessels are long enough to circle the Earth twice.

## **Baby bones**

When you were born, you had 100 more bones than you have now.

Most of these extra bones disappear as you grow bigger.

What might this section tell us ?

What do you think is a blood vessel?

What does this tell us about the blood vessels?

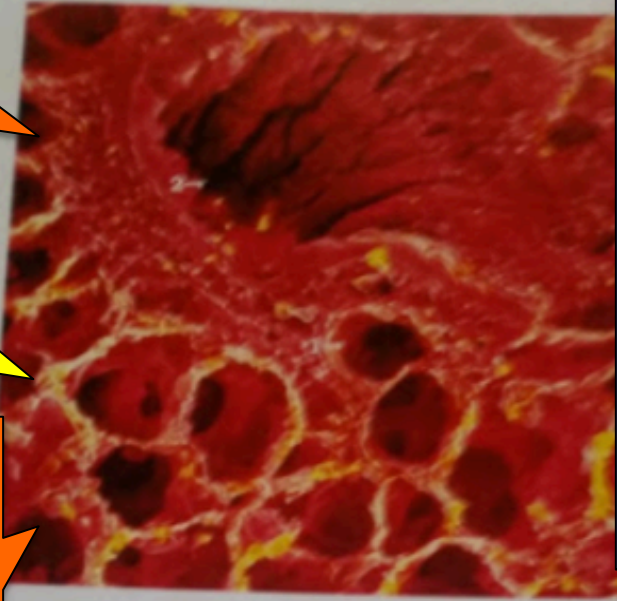
What questions can you answer now?

What do you see in this picture? What might these things be?

Read the text? Say in your own words what is happening.

If this is a picture of something in your body, what do you think it shows?

Imagine air in an air pocket in your lung. How might it get into your blood? What does it need to do? Where might the air and the blood meet? How might the blood pick up the oxygen?



Your lungs have millions of air pockets called alveoli. The blood vessels called capillaries form a net around each pocket. Fresh air is carried to them by small tubes called bronchioles.

What are some body facts here? What are some things you have in your body?

What could happen to a person's lungs so that they have difficulty breathing?

### *Why must I breathe?*

Every time you breathe in, your lungs fill with air. One-fifth of the air is oxygen. Millions of air pockets in your lungs pass the oxygen into your blood ...

### **How big are my lungs?**

Your lungs hold enough air to fill about eight milk bottles (4.5 L). Each lung is folded into a small space chest. ... your lungs cover a tennis court.

What questions can you answer now?

What type of text do you think this could be?



# How to differentiate Hieroglyphics

	Ways of thinking	Level of inference
	Interpret, store teaching information	How does hieroglyphics differ from contemporary written languages as a system for communicating? What types of ideas are/ aren't easily communicated using them? What can we learn about the people who developed / used them?
Patterned understanding	Infer patterns in the ideas	Describe and explain Narmer's Palette and the Rosetta stone. Describe the characters of Egyptian writing. Explain the origin of each.
	Infer possible trends	Why is the word 'alphabet' in inverted commas? (para 1) Why was the hieroglyphic alphabet much larger than ours? What patterns exist in the use of symbols on Narmer's Palette and the Rosetta stone? How was each used for communication? How is Narmer's Palette like a poster?
	Generate possibilities	Why do you think picture writing was gradually replaced with writing that had symbols for sounds and syllables? (para 1) How would learning picture symbols be different from learning symbols for sounds? What would be harder to learn? What does each type of symbol require the reader to learn? What might have caused the written Egyptian communication forms to develop in this way?
Big ideas understanding	Synthesize generalities, rules	Why do you think writing was used on religious statues, tombs and temple walls? Why were written messages used in these situations? What might the messages have said? Why do you think the Egyptian written languages used symbols both for sounds and for syllables? What are the differences between them? `Were the <i>sacred carvings and hieroglyphics</i> part of a trend or did they set one?
	infer ethical issues	Did rules apply to hieroglyphics or were they set as a result of the development and use of an artistic code of writing?
	Infer, synthesize big ideas	In what ways were written messages used for the public good and to foster human freedom vs subjugation and restrictions. How can a culture respect humanity through its writing ?

# To plan for higher levels of thinking : Roald Dahl's Boy

Ways of thinking	Level of inference	
Infer patterns in the ideas	<ul style="list-style-type: none"> <li>infer specific ideas not included in the topic, generalize and summarize key ideas. Identify what they share.</li> <li>infer patterns or general ideas; predict, decontextualize understanding across contexts, elaborate, extend and abstract the pattern to form new concepts or relationships.</li> <li>question, speculate about the patterns, generate possibilities; <i>How did the patterns effect / contribute to .... ?</i></li> </ul>	<p>Roald Dahl says: To us it was what a bar is to a drunk or a church is to a Bishop. Why do you think he says this? The next sentence begins with But. Why do you think Roald Dahl used but in this case?</p> <p>How does Roald Dahl let us know that the sweet shop was really important to the boys?</p> <p>Why do you think Roald Dahl thought the licorice bootlaces were the best value in the shop?</p>
Identify / infer possible trends	<ul style="list-style-type: none"> <li>link two or more patterns into a possible causal or consequential trends. <i>How / why did the trend affect/change the direction of the pattern ?</i></li> <li>analyze the new ideas from multiple perspectives.</li> </ul>	<p>Why do you think Roald Dahl describes Mrs Pratchett in the way that he does?</p> <p>What does Thwaites' story about licorice tell you about the boys? Why do you think Roald Dahl included these descriptions in the chapter?</p> <p>What image did you make of the boys as they passed the sweet shop? What feelings do you think they had? What do the boys' actions tell us about how they felt ? What might they have been saying to themselves?</p>

# To plan for higher levels of thinking : Roald Dahl's Boy

Ways of thinking	Level of inference	
Generate possibilities	<ul style="list-style-type: none"> <li>explore, analyze, reflect on the ideas from multiple perspectives, make far transfer links and use analogies, look for possibilities and options: <i>What might happen if ..?</i></li> <li>monitor, manage and use their knowledge efficiently and change direction or re-question what they know.</li> </ul>	<p>Why do you think Roald Dahl described his favourite sweets in such detail?</p> <p>How does the author use language to tell us how the boys felt?</p>
Identify generalities, rules	<ul style="list-style-type: none"> <li>infer, synthesize rules or general propositions, into big ideas by abstracting or generalizing to form rules, formulae and principles, identify their boundaries.</li> <li>re-organize and re-prioritize aspects of their knowledge</li> </ul>	What do we know about Roald Dahl from this chapter?
infer ethical issues	<ul style="list-style-type: none"> <li>link moral / ethical issues with the rules or general propositions : <i>What / how/why should/might ....?</i></li> </ul>	would the boys' ethics and morals clash with those of Mrs Pratchett ?
Identify / infer big ideas	<ul style="list-style-type: none"> <li>infer how the 'big ideas' could be used to solve problems and generate creative outcomes, use 'big ideas' fluently and automatically to solve problems and make decisions, <i>"If this happens, then.., but because of .. I would...."</i></li> <li>infer and investigate broader possibilities and options</li> </ul>	What do you think is the purpose of this chapter in Boy? How does it fit with the rest of the text? It provides a context and tells you more about the protagonists



# Intuitive theories about Rearranging formulae

What do you imagine when you hear  $A=lw$  or  $C=2\pi r$ ?

What image can you make formula like  $A=lw$  or  $A=\pi r^2$ ? What image do you make of  $A$  or  $l$  in  $A=lw$

What do formulae like  $A=lw$  or  $C=2\pi r$  have in common?

In maths we often use letters. What special message does a formula give you? How is it different from other messages such as  $A=4$ ?

How can we have different formulae with  $A$  such as  $A=lw$  and  $A=\pi r^2$

What does a formula tell you to do?

## Rearranging formulas

A **formula** is an **equation** showing the relationship between two or more variables and unknowns. It is written with one variable on the left-hand side of the equation and the other variables on the right hand side. The variable on the left-hand side is called the **subject** of the formula.

When the variable required is not the subject of the formula, we need to rearrange the equation. The formula for finding the velocity,  $v$ , of an object after accelerating over a distance  $d$  is  $v^2 = u^2 + 2ad$ . We can rearrange this to make  $u$ ,  $a$  or  $d$  the subject; that is, we can write the formula to the form  $u = \dots$ ,  $a = \dots$  or  $d = \dots$ .

We need to use the correct order of operations to rearrange the formula correctly.

### Worked Example 13

The formula for finding the velocity,  $v$ , of an object after accelerating over a distance  $d$  is  $v^2 = u^2 + 2ad$ .

- (a) Rearrange the formula to make  $a$  the subject.  
(b) Find  $a$  when  $v = 5$ ,  $u = 1$  and  $d = 2$ .

**Working**

Identify the first operation that needs to be performed on the equation and perform that operation. (Subtract  $u^2$  from both sides.)

Identify the first operation that needs to be performed on the equation and perform that operation. (Divide both sides by  $2d$ .)

Rewrite the formula with  $a$  as the subject. By convention, the subject is written on the left-hand side of the equals sign.

- (b) 1 Substitute the known values into the rearranged formula.

- 2 Simplify to find the value of  $a$ .

**Working**

$$\begin{aligned} (a) \quad v^2 &= u^2 + 2ad \\ v^2 - u^2 &= u^2 + 2ad - u^2 \\ v^2 - u^2 &= 2ad \end{aligned}$$

$$\frac{v^2 - u^2}{2d} = \frac{2ad}{2d}$$

$$\frac{v^2 - u^2}{2d} = a$$

$$a = \frac{v^2 - u^2}{2d}$$

$$(b) \quad a = \frac{v^2 - u^2}{2d}$$

$$a = \frac{5^2 - 1^2}{2 \times 2}$$

$$a = \frac{25 - 1}{4}$$

$$a = \frac{24}{4}$$

$$a = 6$$

What do you think 'arranging a formula' means?

How do we 'arrange a formula'? What tells us how to do it?

What are some other things you could re-arrange? What do you do when you re-arrange your bedroom or the food on a table?

How might  $C=2\pi r$  look if it were re-arranged?

Could you say the idea in  $A=lw$  or  $C=2\pi r$  in other ways?

What might re-arranging a formula mean?

Why might some-one need to re-arrange a formula?



## 3.4 Rearranging formulas

### Navigator

Answers  
page 609

Q1, Q2 Column 1, Q3 Column 1,  
Q4, Q5, Q6, Q9, Q10, Q13

Q1, Q2 Column 2, Q3 Column 2,  
Q4, Q5, Q6, Q7, Q9, Q10, Q11,  
Q13

Q1, Q2 Column 3, Q3 Column 3,  
Q4, Q5, Q6, Q7, Q8, Q9, Q10,  
Q11, Q12, Q13

Equipment required: calculator for Questions 5, 6 and 7

### Fluency

WE13

- 1 (a) (i) Rearrange the formula to make  $k$  the subject if  $P = mk$ .  
(ii) Find  $k$  when  $P = 32$  and  $m = -4$ .  
(b) (i) Rearrange the formula to make  $b$  the subject if  $y = mx + b$ .  
(ii) Find  $b$  when  $y = 9$ ,  $m = 5$  and  $x = 2$ .  
(c) (i) Rearrange the formula to make  $h$  the subject if  $C = ah - g$ .  
(ii) Find  $h$  when  $C = 19$ ,  $a = -24$  and  $g = -7$ .  
(d) (i) Rearrange the formula to make  $x$  the subject if  $a = mx + c$ .  
(ii) Find  $x$  when  $a = -21$ ,  $m = 4$  and  $c = 3$ .  
(e) (i) Rearrange the formula to make  $p$  the subject if  $k = \frac{mp-2}{n}$ .  
(ii) Find  $p$  when  $k = 42$ ,  $m = -4$  and  $n = 5$ .  
(f) (i) Rearrange the formula to make  $w$  the subject if  $u = \frac{w}{v} - xy$ .  
(ii) Find  $w$  when  $u = 6$ ,  $x = -3$ ,  $y = 7$  and  $v = -2$ .

WE14

- 2 Rearrange the formula in each of the following to make the variable in brackets the subject of the formula. (Assume all variables are positive.)

$$\begin{array}{lll} \text{(a)} V = \pi r^2 h & (r) & \text{(b)} E = \frac{1}{2}mv^2 & (v) & \text{(c)} F = \frac{dh^2}{k} & (h) \\ \text{(d)} k = 7\sqrt{\frac{m}{n}} & (m) & \text{(e)} d = 2\sqrt{\frac{b}{c}} & (b) & \text{(f)} m = x\sqrt{\frac{y}{z}} & (y) \end{array}$$

- 3 Rearrange each of the following to make  $x$  the subject.

$$\begin{array}{lll} \text{(a)} x + y = z & \text{(b)} x - 3a = 2b & \text{(c)} kx - m = n \\ \text{(d)} dx + c = f & \text{(e)} rt - x = p & \text{(f)} vy - x = -w \\ \text{(g)} \frac{2x+y}{p} = k & \text{(h)} \frac{t+rx}{w} = m & \text{(i)} \frac{mp+px}{m} = n \\ \text{(j)} cdx + e = gh & \text{(k)} axp - k = mn & \text{(l)} s - tux = vw \\ \text{(m)} b + \frac{xd}{y} = f & \text{(n)} \frac{mx}{n} + kp = t & \text{(o)} ab - \frac{dx}{c} - f = o \end{array}$$

- 4 The formula for finding the velocity,  $v$ , of a moving object is  $v^2 = u^2 + 2as$ . A correct rearrangement of the formula would be:

$$\begin{array}{ll} \text{A} & u^2 = v^2 + \frac{2as}{2} & \text{B} & s = \frac{v^2 - u^2}{2a} \\ \text{C} & a = \frac{2s}{v^2 - u^2} & \text{D} & a = \frac{u^2 - v^2}{2s} \end{array}$$



### Understanding

- 5 The formula for finding the velocity,  $v$  m/s of an object starting with a velocity of  $u$  m/s and undergoing a constant acceleration of  $a$  m/s<sup>2</sup> over time  $t$  s is  $v = u + at$ .

(a) Rearrange the formula to make  $t$  the subject.

(b) Find the value of  $t$  when:

(i)  $a = 14$  m/s<sup>2</sup>,  $u = 20$  m/s and  $v = 76$  m/s

(ii)  $a = 2.4$  m/s<sup>2</sup>,  $u = 5.7$  m/s and  $v = 12.9$  m/s

- 6 The circumference ( $C$ ) of a circle is related to the radius ( $r$ ) by the formula  $C = 2\pi r$ . Use the calculator value for  $\pi$  and give your answer correct to two decimal places.

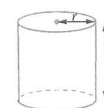
(a) Rearrange the formula to make  $r$  the subject.

(b) Find the value of  $r$  when:

(i)  $C = 628$

(ii)  $C = 16.4$

- 7 The formula for the volume ( $V$ ) of a cylinder is  $V = \pi r^2 h$ . Rearrange the formula to find  $h$  when  $r = 5$  and  $V = 157$ . Use the calculator value for  $\pi$  and give your answer correct to two decimal places.



- 8 The perimeter of a rectangle is given by  $P = 2(l + w)$ , where  $l$  and  $w$  represent the length and width of the rectangle, respectively.

Rearrange the formula to make  $w$  the subject. Find the width of the rectangle if the length is 23 m and the perimeter is 84 m.

### Reasoning

- 9 The kinetic energy ( $E$ ) of an object, in joules, is found using the formula  $E = \frac{1}{2}mv^2$ , where  $m$  is the mass in kg and  $v$  is the velocity of the object in m/s.

(a) Determine  $E$  when  $m = 2$  kg and  $v = 1.2$  m/s.

(b) Determine  $m$  when  $E = 162$  joules and  $v = 9$  m/s.

(c) Determine  $v$  when  $E = 1.96 \times 10^6$  joules and  $m = 8$  kg.

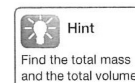
(d) Explain why there are two answers for part (c) and what each answer means.

- 10 The density ( $D$ ) of a substance is related to its mass ( $M$ ) and its volume ( $V$ ) by the formula

$$D = \frac{M}{V}$$

(a) Find the difference in the mass of two objects made of the same material with a density of 7 g/cm<sup>3</sup> if one has a volume of 12 cm<sup>3</sup> and the other has a volume of 15 cm<sup>3</sup>.

(b) A flotation device is to be made of a material on the outside with a density of 1.8 g/cm<sup>3</sup> and a mass of 2.4 kg. It is filled inside with a material of density 0.9 g/cm<sup>3</sup> and a mass of 7.8 kg. Will the device float on sea water given that the density of sea water is 1.025 g/cm<sup>3</sup>?



What do all maths formulae have ?

What are some other words for re-arrange a formula ?

Would the rules for re-arranging formula apply to formulae in other subjects such as in health and phys ed or science ?

3.4

11 The area of a trapezium is given by the formula  $A = \frac{(a+b)h}{2}$ .

- (a) Rearrange the formula to make  $b$  the subject.
- (b) Use this rearranged formula to find the value of  $b$  if  $a = 9$ ,  $h = 6$  and  $A = 66$ .
- (c) We could substitute these values for  $a$ ,  $h$  and  $A$  into the original formula and solve the equation  $66 = \frac{(9+b) \times 6}{2}$  to find the value of  $b$ . Explain why would we rearrange the formula to find the value of  $b$ .

12 Consider this formula:

$$S = \frac{n}{2}[2a + (n-1)d]$$

Expand all the brackets in this expression and use this form to explain why it is difficult to make  $n$  the subject.

**Open-ended**

13 Ruth has been rearranging the formula for the area of a trapezium:

$A = \frac{(a+b)h}{2}$ . She has produced the following working while trying to make  $a$  the subject. Where has she made a mistake? Now rearrange the formula to make  $b$  the subject.

$$A = \frac{h(a+b)}{2}$$

$$2A = h(a+b)$$

$$\frac{2A}{h} = a+b$$

$$a = b - \frac{2A}{h}$$

What are principles for re-arranging a formula? What would you want year seven students to know about rearranging any maths formula?

## Outside the Square Puzzle

**In the prime of his life**

Theo found that the product of his dog's age, his mother's age and his own (all in years) is 8533. Theo is older than his dog. How old is Theo?



Are all formulae re-arrangeable? What makes some easier to rearrange than others? What would you tell yourself to do? ?

# To plan for higher levels of thinking: Rearranging formulae







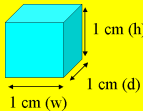

Ways of thinking	Level of inference	
Infer patterns in the ideas	<ul style="list-style-type: none"> <li>infer specific ideas not included in the topic, generalize and summarize key ideas.</li> <li>infer patterns or general ideas that contain the ideas, decontextualize, speculate about the patterns, generate possibilities; <i>How did the patterns effect/contribute to . ?</i></li> </ul>	<p>What do all maths formulae have?</p> <p>What are some other words for re-arrange a formula</p>
Identify / infer possible trends	<ul style="list-style-type: none"> <li>link two or more patterns into a possible causal or consequential trends. <i>How / why did the trend affect/change the direction of the pattern ?</i></li> <li>analyze the new ideas from multiple perspectives.</li> </ul>	Would the rules for re-arranging formula apply to formulae in other subjects such as in health and phys ed or science ?
Identify generalities, rules	<ul style="list-style-type: none"> <li>Infer, generalize ideas, synthesize rules or general propositions, identify boundaries and use analogies.</li> <li>synthesize the inferred patterns into big ideas by abstracting or generalizing to form rules, formulate and understand rules and principles</li> </ul>	What are principles for re-arranging a formula? What would you want Year Seven students to know about rearranging any maths formula?
Identify / infer big ideas 12/3/21	<ul style="list-style-type: none"> <li>infer how the 'big ideas' could be used to solve problems and generate creative outcomes.</li> <li>use 'big ideas' in topic fluently and automatically to solve problems and make decisions</li> <li>infer and investigate broader possibilities and options: <i>What might you do if .....</i></li> </ul>	<p>Are all formulae re-arrangeable?</p> <p>What makes some easier to rearrange than others? What would you tell yourself to do?</p>

# To plan for higher levels of thinking: Rearranging formulae

Ways of thinking	Level of inference	
Identify generalities, rules	<ul style="list-style-type: none"> <li>Infer, synthesize rules or general propositions, generalize ideas, identify their boundaries and use analogies.</li> <li>re-organize and re-prioritize aspects of their knowledge such as the main and subordinate ideas</li> <li>synthesize the inferred patterns into big ideas by abstracting or generalizing to form rules, formulate and understand rules and principles</li> </ul>	What are principles for re-arranging a formula? What would you want Year Seven students to know about rearranging any maths formula?
Identify / infer big ideas	<ul style="list-style-type: none"> <li>infer how the 'big ideas' could be used to solve problems and generate creative outcomes. Plan how they will use their new knowledge in creative, novel ways, use creative imagery thinking and analogy to generate creative knowledge and think in open-ended creative ways, use in problem solving</li> <li>use 'big ideas' in topic fluently and automatically to solve problems and make decisions, <i>"If this happens, then..., but because of .. I would...."</i></li> <li>infer and investigate broader possibilities and options: <i>What might you do if ..... Why wouldn't you .... ?</i> , ask <i>"What if..."</i> and <i>Where could you use this ?</i> types of questions.</li> </ul>	Are all formulae re-arrangeable? What makes some easier to rearrange than others? What would you tell yourself to do?



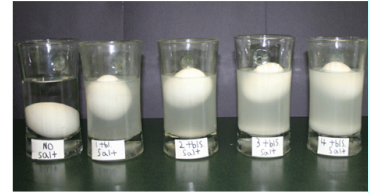



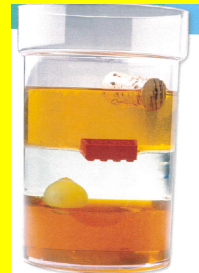

# Higher levels of thinking : Density

Ways of thinking	Level of inference									
Interpret, store teaching	<ul style="list-style-type: none"><li>identify ideas and links in the teaching information.</li><li>Think in ways cued or scaffolded explicitly by the teaching.</li></ul>	<p>What do you know about the physical properties of these three materials ?</p> <div></div> <p>What are different ways of describing them?</p>								
Infer patterns in the ideas	<ul style="list-style-type: none"><li>infer ideas not included in the topic, generalize and summarize the key ideas. Infer what they share across examples.</li><li>infer patterns or more general ideas; decontextualize understanding to form new concepts or relationships.</li><li>question, speculate about the patterns, form possibilities</li></ul>	<p>What is the pattern here? (work out mass/volume)</p> <div></div> <div><div>2.58 g</div><div>1.59 g</div><div>0.56 g</div></div> <div>Why do you think the brick weighs more ?</div>								
Identify / infer possible trends	<ul style="list-style-type: none"><li>link two or more patterns into a possible causal or consequential trends. <i>How / why did the trend affect/change the direction of the pattern ?</i></li><li>analyze the new ideas from multiple perspectives.</li></ul>	<div><div><div>1 cc</div><div>weighs</div><div>2.58 g</div></div><div><div>2 cc</div><div>weighs</div><div>?</div></div></div> <p>What is the pattern? What do we assume ?</p> <p>What are you doing to work out the density of the substance in each case? Work out a formula for what you do.</p> <div><div>Which substances are most /least dense ?</div><table><tr><td>bone</td><td>butter</td><td>copper</td><td>glass</td></tr><tr><td>brass</td><td>chalk</td><td>diamond</td><td>glue</td></tr></table></div>	bone	butter	copper	glass	brass	chalk	diamond	glue
bone	butter	copper	glass							
brass	chalk	diamond	glue							

12/3/21

35

# Higher levels of thinking : Density

Ways of thinking	Level of inference	
Generate possibilities	<ul style="list-style-type: none"> <li>explore, analyze, reflect on aspects of the new ideas from multiple perspectives, make far transfer links and use analogies, look for possibilities and options: <i>What might happen if ..?</i>, look for possible options: <i>"If this happens, then., but because of.. I would...."</i></li> </ul>	<p>How do you explain this ?</p> 
Identify generalities, rules	<ul style="list-style-type: none"> <li>infer and generalize the ideas, form rules or general propositions, make far transfer links, identify boundaries and use analogies.</li> <li>re-organize and re-prioritize aspects of their knowledge such as the main and subordinate ideas at once.</li> <li>synthesize the inferred patterns into big ideas</li> </ul>	<p>What happens to its density in each case ?</p>   
infer the 'big ideas	<ul style="list-style-type: none"> <li>infer how the 'big ideas' could be used to solve problems and generate creative outcomes. Plan how to use the new knowledge in creative, novel ways, use creative imagery thinking and analogy to generate creative knowledge and think in open-ended creative ways, use in problem solving</li> <li>use 'big ideas' in topic fluently and automatically to solve problems and make decisions</li> <li>infer and investigate broader possibilities and options: <i>What might you do if ..... Why wouldn't you .... ?</i>, ask <i>"What if..."</i> and <i>Where could you use this ?</i> types of questions.</li> </ul>	<p>How do you explain this ?</p>   <p>What do you know about density? How will global warming affect density?</p>



# Teaching provision for gifted students in regular classrooms.

Building an awareness of what each aspect of gifted learning would 'look like' in classroom practice.

Characteristic of topic learning	What would this look like in a classroom ?	How to modify teaching to accommodate it ?
show high understanding, takes the ideas apart rather than low level interpretation or application		
link ideas in lateral, broad unexpected ways		
keep track of several ideas at one, think in several directions		
think in larger jump, skipping steps in the thinking		
see novel connections between ideas quickly, infer		
solve problems in unusual or novel ways		
spontaneously ask complex questions about ideas		
use imagination or fantasy, show 'intellectual playfulness'.		
show focused, intense interest in a topic		
self – motivated to think and learn about the topic		
differ in how easily they spontaneously and selectively use these ways of making sense.		
monitor and direct their learning; plan how they will learn, monitor their learning, review progress		

# How to differentiate phase 3 teaching: the beginning of curriculum differentiation

Phase 3 teaching is when the gifted students collate, apply and investigate/evaluate their personal interpretations of the teaching information; their emerging intuitive theory about the teaching.

They draw together, infer, analyse, evaluate and synthesize the ideas they've formed in a range of ways. They link the new knowledge they've gained with what they already knew.

Invite gifted students to collate and explicate any intuitive theory they have made of the teaching information. Scaffold them to

- Unpack and organize their theory/ predictions
- Decide how they will investigate them further, what support for them would 'look like',
- trial and evaluate the theory, select, analyse and synthesize data
- modify, up-date and modify their theory
- share their tested theory with their class peers

Phase 3 teaching is when you implement curriculum differentiation. You generate more intellectually complex and demanding forms of the topic you are teaching and present them to the gifted students as open-ended problems and challenges to solve. This provides them with the opportunity to apply, investigate/ evaluate and extend their personal interpretations of the teaching information.

We examine this in more depth in the next session.

# Phase 3 teaching: example of differentiating the curriculum

This example shows how you would differentiate the curriculum to focus on a more intellectually complex understanding of a topic. The example here shows how you could generate a more complex understanding of density.

Type of inference	What do you think....	Why do you think....	When / where do you think....	How do you think....
Infer the nature of phenomenon	makes density?	different substances have different densities?	density is important to consider in everyday life?	density is displayed in everyday life?
Infer the nature of possible changes	causes the density of a substance to change?	objects are more likely to float when substances are dissolved in water?	the density of a substance changes?	density is affected by gravity, pressure, heat?
Infer cause and effect, read between the lines	will be the effect on density of travelling to other planet?	oil released from an oil tanker floats on the surface of sea?	density would be most likely to change as you change height or temperature: for a solid, liquid or gas?	how would density change as you go higher above the earth?
Infer consequence	would happen if the density of the air decreased?	sound would travel faster through denser air or liquid?	the density of substances may be affected by seasonal and climatic changes?	changes in the density of sea might affect how animals and plants live in it?
Infer the main idea and supporting details.	is the concept of density and what affects it?	the concept of density was developed? Why isn't it sufficient to talk about mass?	are the objects in the universe that have the greatest density?	global warming will affect the density of items in the world.

# How to differentiate phase 3 teaching.

Goal of phase 3 teaching: gifted students collate, apply and and investigate/evaluate their personal interpretations of the teaching information

Invite gifted students to collate and explicate any intuitive theory they have made of the teaching information. Scaffold them to

- Unpack and organize their theory/ predictions
- Decide how they will investigate them further, what support for them would 'look like',
- trial and evaluate the theory, select, analyse and synthesize data
- modify, up-date and modify their theory
- share their tested theory with their class peers

# Phase 3 differentiated teaching of science

You may decide to include additional attributes about which the students can infer. You can apply the inferential framework in Table 9 to any topic that is being taught in science.

Type of inference	What do you think....	Why do you think....	When / where do you think....	How do you think....
Infer the nature of phenomenon				
Infer the nature of possible changes				
Infer cause and effect, read between the lines				
Infer consequence				
Infer the main idea and supporting details.				

# Your turn 9 : Infer from the content

This session has presented one approach to differentiating the teaching for gifted students. It has the following features:

It is based on how gifted students interpret the teaching information. The approach to differentiation is based on how these students think, know and learn.

It describes how to differentiate at different phases of the teaching:

- Stimulating students' existing knowledge
- Interactive teaching to teach the new ideas
- Student consolidation and review

**Padlet 6** – <https://padlet.com/markeoliver/wp4o23zt0063tdy7>

Evaluate the approach in terms of ...

- How useful you think it is, whether you think it is do-able in the classroom
- How you could use it to plan teaching for gifted students and to implement differentiated teaching
- How you could use it to identify examples and incidents of gifted learning
- How it could help you understand how gifted students learn
- Its value for enhancing provision for gifted students in your school.