A Hesscairn Playbook for Conceptual Understanding and Expertise

Use and acknowledgements. The AAA+ or ‘Triple A Plus’ model was developed by Stuart MacAlpine.

Acknowledgements

Many important conversations contributed to the thinking that coalesced into this model of learning. Early conversations with a reflection group on East Campus supported the development of the first AAA model of reflection, with the middle A being ‘Analysis’. Natalie Abad Merrit was particularly influential here. Reading about mediated learning by Feuerstein was very influential to my thinking, and related to this was exposure to the sources of cognitive coaching which I explored as I worked with Gavin Grift. Conversations with Carla Marschall helped my understanding of concept based learning models based on Lynn Erickson’s thinking. A workshop with Lynn Erickson, gave me space to realise that her model was strong, but was made of fragments of a larger model and had one or two misconceptions inbuilt. It was a sudden realisation in Harlaam that there was a simpler and more comprehensive model for what she was talking about in the AAA model that was the epiphany. After reading through the literature of expertise, particularly Andres Erickson’s Handbook of Professional Expertise, the Dreyfus and Dreyfus model and books like ‘Cognition in the wild’ after recommendations from Dylan Wiliam I began to realise that the missing piece was an acknowledgement of the qualitative difference between conscious competence as we form mental schema and the unconscious competence of expertise. The final refinements came from reading McGilchrist’s The Master and His Emissary, less on the physiological claims, but the recognition that interest in Gestalt ‘wholes’ is not the same as specific criterion focused attention. Many people at Sky School, UWCSEA and elsewhere contributed towards reading drafts, correcting and suggesting improvements. There work is all reflected throughout these pages.

How the AAA+ Model frames concept based learning.

The AAA+ model is a sense making framework, or description, of how to teach for understanding effectively.

In order to construct new learning, we need to be thinking about something (awareness). When we notice patterns and relationships we abstract them from the context in which we have found them, and consider if there is a generalisation or principle at work (abstraction). To test our ideas out, we apply our generalisation to a new context to see if it works there too, or if we need to adjust it in someway (abstraction). And finally once we know the 'rules' of a certain domain we generally start to develop expertise by high volumes of practice that supports us developing tacit or intuitive knowledge that allows us to make rapid decisions about when and how to apply our understanding.

When using triple-A + learning, the educator has four simple questions to ask themselves:

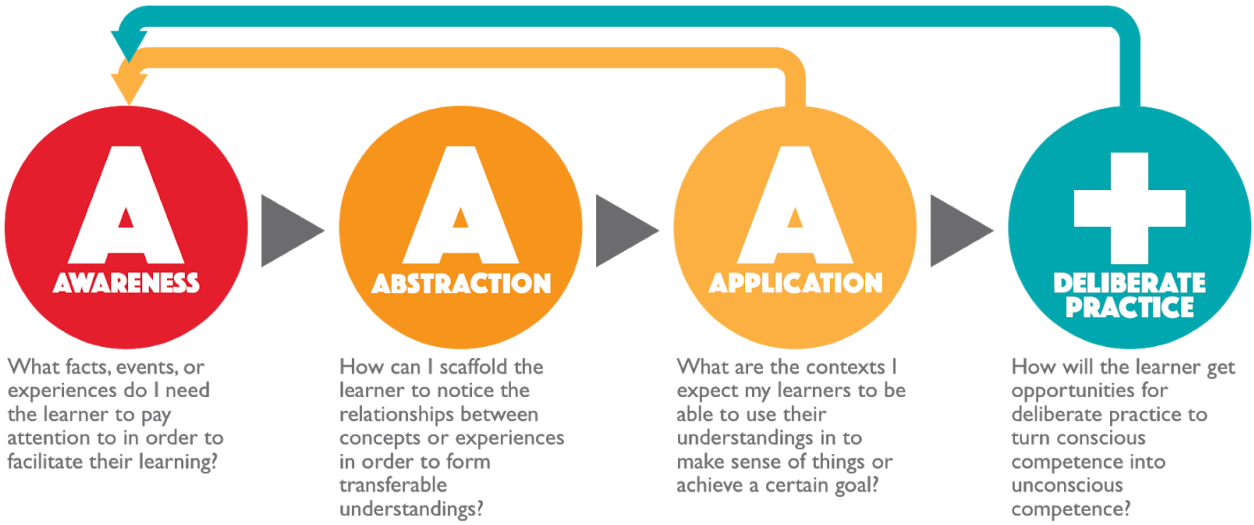
Awareness: what facts, events, or experiences do I need the learner to pay attention to in order to enable their learning?

Abstraction: how can I scaffold the learner to notice the relationships between concepts or experiences in order to form transferable understandings?

Application: what are the contexts I expect my learners to be able to use their understandings in to make sense of things or achieve a certain goal?

Deliberate Practice: how will the learner get opportunities for deliberate practice to turn conscious competence into unconscious competence?

These questions can guide educators in supporting learners to construct and use powerful understandings about the world around them.



What happens if we miss stages out?

We are all aware that sometimes we do not get all the learning experiences we need in order to fully understand and become expert in a given area. Below is a summary chart to show common outcomes when specific stages of the AAA+ cycle are skipped.

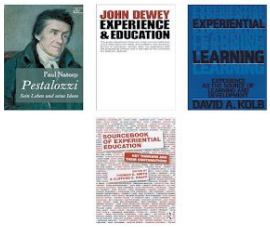
AWARENESS	ABSTRACTION	APPLICATION	DELIBERATE PRACTICE	OUTCOME
✗	✓	✓	✓	Superficial verbal learning of ideas and rules.
✗	✗	✓	✓	Skill drill and kill.
✓	✓	✗	✗	Naive learning without application
✓	✓	✓	✗	Understanding without expertise.
✓	✗	✗	✗	Rote learning.
✓	✓	✓	✓	Rich learning of skill, knowledge and understanding leading to expertise and enhancing thinking skills.

The model itself is informed by a great deal of reading and research. A selected visual bibliography follows for those who would like to explore the origins of the model further.

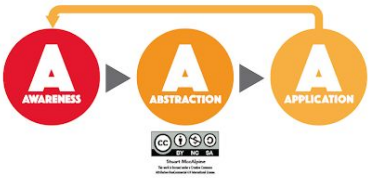
Asking Not Telling

which is the basis of constructivism

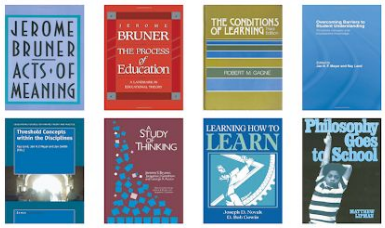
and experiential education



requires scaffolding thinking



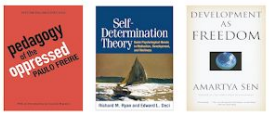
and thinking in concepts is more effective than thinking in topics



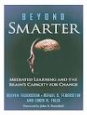
and knowledge and skill are different

and for understanding require a pedagogy based on

building agency and wellbeing

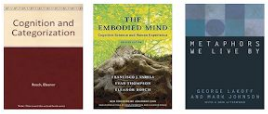


creating 'mediated learning'

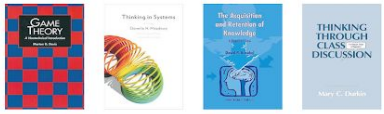


which led to cognitive coaching

Awareness



Abstraction & Application



Deliberate Practice

A AWARENESS A ABSTRACTION A APPLICATION + DELIBERATE PRACTICE

Awareness

Before we can think or learn we need to have something to think about. Our perception of the world around us is both selective and directed - so supporting learners to focus on important aspects of a situation is enormously important to support their learning.

A key part of learning is noticing what is most relevant or meaningful to the learning we are about to do.

Unfocused awareness of everything is just as bad as overly concentrating on one specific variable and ignoring contexts which are important (like William Blake's Newton below).

Novice learners often do not know where to focus their attention or which aspects of their experience will be significant for understanding and which are trivial. The tools in this section of the text are designed to help focus attention on what will be significant.

In fact we know that brain plasticity means our ability to perceive the world is actually shaped by the kinds of stimulus made available to us (an example of this is our ability to distinguish sounds in spoken language, see The Scientist in the Crib by Alison Gopnik).

Tools to support Awareness

Pointing

As humans we follow the attention of those we seek to learn from. Children learn to follow their parents' eyes, and often when frightened will look at their parents' eyes to see where they are looking to identify sources of danger.

The simplest teaching action is simply to point. In Triple A + learning this is the simplest intentional act to support learning by pointing at what we want learners to notice, because we know that a specific thing is essential for learning. Often we'll highlight a particular part of a system, or a specific attribute. We use colours, highlights or even things like adding tracking stain to an air or water flow so we can see its movements in a wind tunnel or water course.

This is the simplest and most fundamental form of awareness and accounts for all those pointy sticks in teachers' hands in old pictures.

Framing

Sometimes just putting an object on display or in a frame means we pay attention to it in new and intense ways. Having frames and displays in classrooms is a way to achieve this when the objects are important in the awareness stage.
Equally have video footage on loop as a provocation works effectively and is seen in Reggio Emilia schools often.

Factual Questions

Asking a factual question is a very straightforward way to draw attention to significant aspects of an external environment which we know are important for learning..
Many people regard questions as being about finding answers. In the awareness stage, it's possible to view questions as simply being a way to manage attention to the outside world.
An important distinction about these factual questions are that they are asking the learner either to:

- Notice something in the world the learner might not be aware of. For example asking "What shape are these finches beaks and what do they eat?"

- Recall something that the learner may not be accessing but is relevant to the learning at hand. For example, asking a history student "If these were the conditions for the Russian Revolution, what conditions existed prior to the French Revolution which are the same?"

A factual question in this context would not include simply requesting memory recall to see if someone knows a specific fact. Simply asking "what date was the Battle of Hastings?" to test knowledge is not part of this intentional learning sequence.

Perception Tools

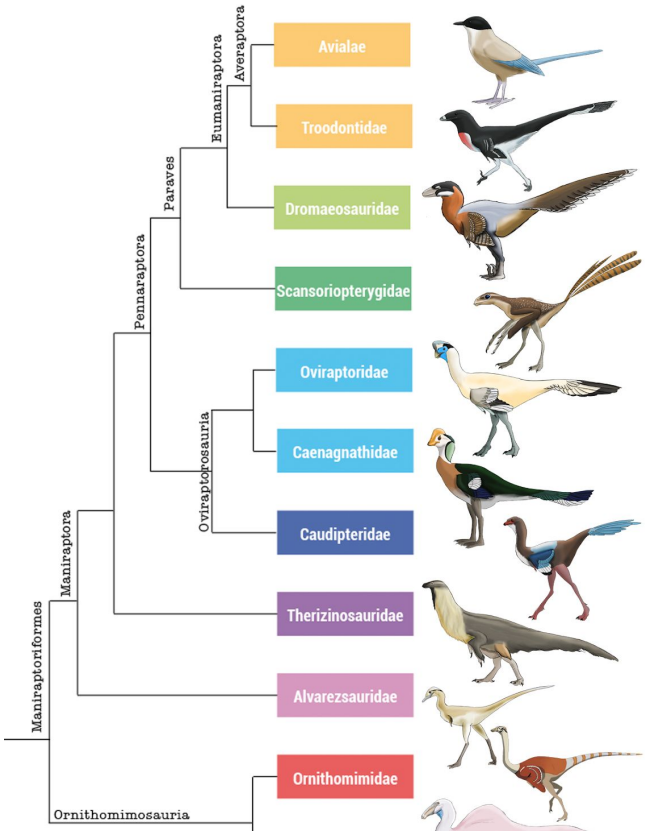
Another set of awareness tools that is so obvious that it often overlooked as significant, is the set of any tool which extends our perception of the world around us. From the microscope to the telescope, from the seismometer to the oscilloscope, any tool which allows us to extend the range of what we can perceive can be regarded as a tool for awareness.

Awareness of Differences of Kind

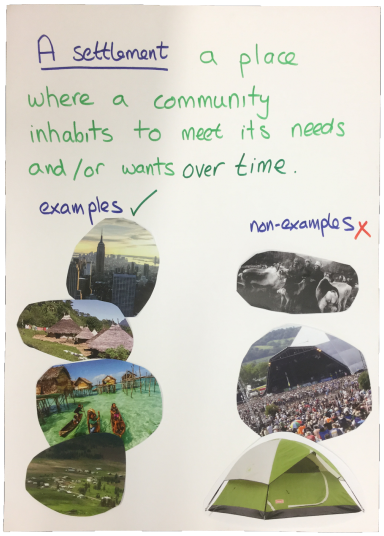
When we are aware of the world we represent it in our senses and in thought. This section explores how we represent and become aware of the world through concepts and what tools we can use to support this explicitly for students.

One of the most powerful ways we become aware of something is by naming it: it is perhaps illustrative that in the biblical story of Eden the first human act was to name what they saw.

With the possible exception of proper nouns, most words represent an awareness of a group of phenomena that share some attributes. We can call these concepts.
When we want learners to become aware, we often want them to become aware of a concept label for a group of phenomena. As Piaget knew so well, this process involves assimilation of examples into groupings, and accommodation when we question and reform these groups to account for new experiences.



Concept Acquisition



Each discipline organises awareness of phenomena (how things are organised -facts- how things are done -processes and skills).
When we say we want students to understand a concept, what we mean is they understand which phenomena fit into the concept set and what the implications are of being a member that set.

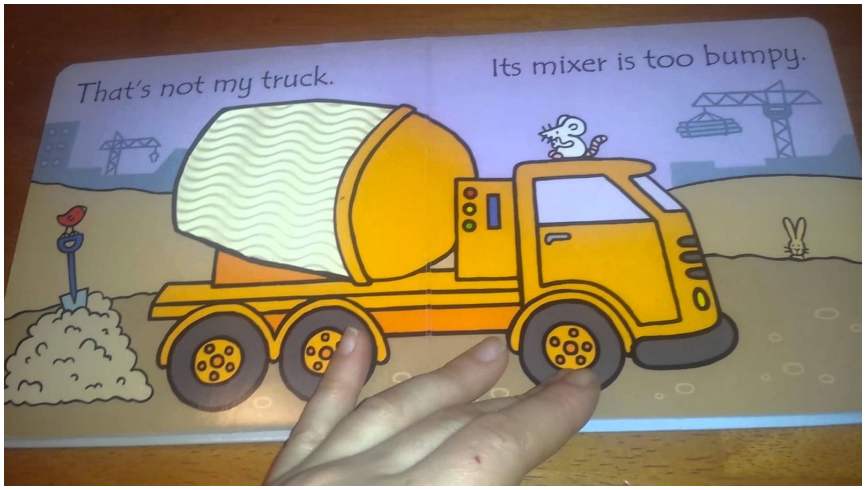
For example, if I am a regular polygon, then I will have the attributes of being a two-dimensional shape, with a number of sides greater than two, with regular interior and exterior angles, and all my sides will be the same length. Likewise if I am significant historical event, I will involve lasting change for a large number of people, have both historical causes and consequences or be powerfully illustrative of such an event.

There a number of tools and strategies we commonly use to support students constructing an understanding of a concept.

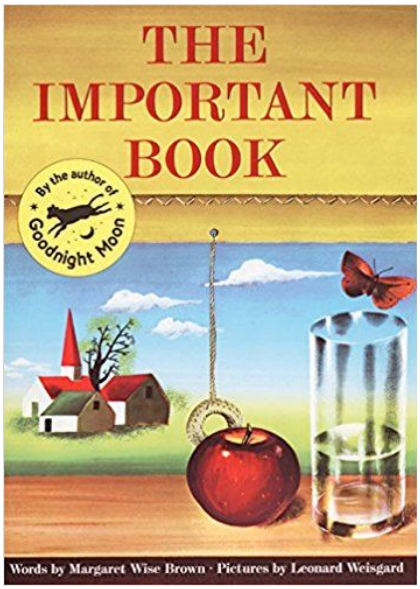
The most basic approach is that used by Robert Gagne where he says that to understand a concept we need a definition, examples and non-examples.
Lynn Erickson uses the phrase macro-concepts for concepts (like systems, or parts) which are used in many disciplines, and micro-concepts (like photosynthesis, gearing or dramatic irony) which are used in specific disciplines. Although these have different scope, the processes and strategies that support learners is grappling with concepts is the same regardless of the 'scale' of the concept.

Naming and noticing attributes

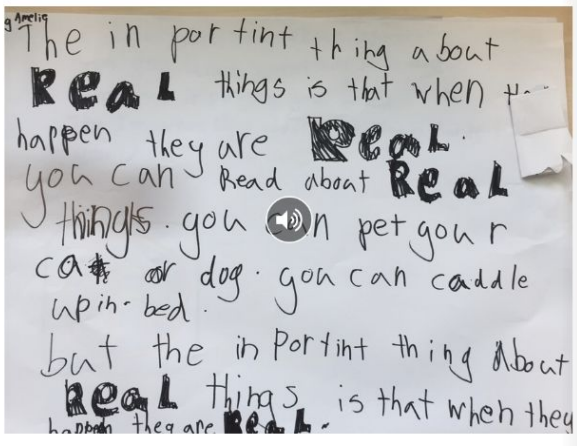
The simplest kind of understanding of a concept is an understanding of it attributes. These attributes can be anything in the range of physical features or behaviours. We see this a great deal in early childhood learning.

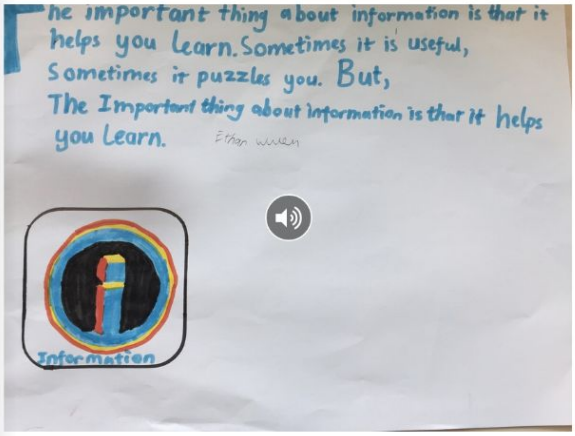


But we also see this with much more complex concepts, for example, “what are some of the features of poetry that we find less of in prose?”



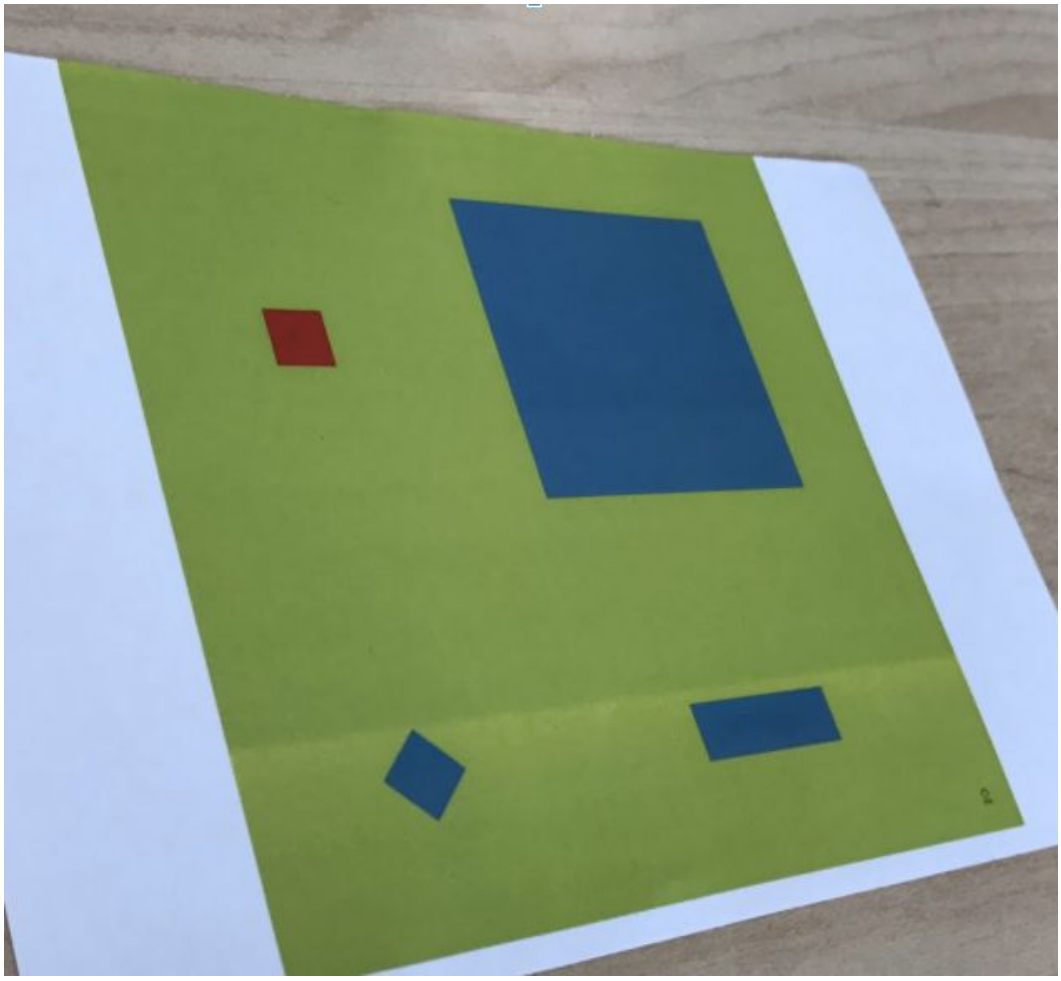
Another way of doing this is using ‘The Important Book” which states ‘The most important thing about X... is....’ and asking students to construct a sentence for a variety of concepts. Some examples are below.





Odd one out

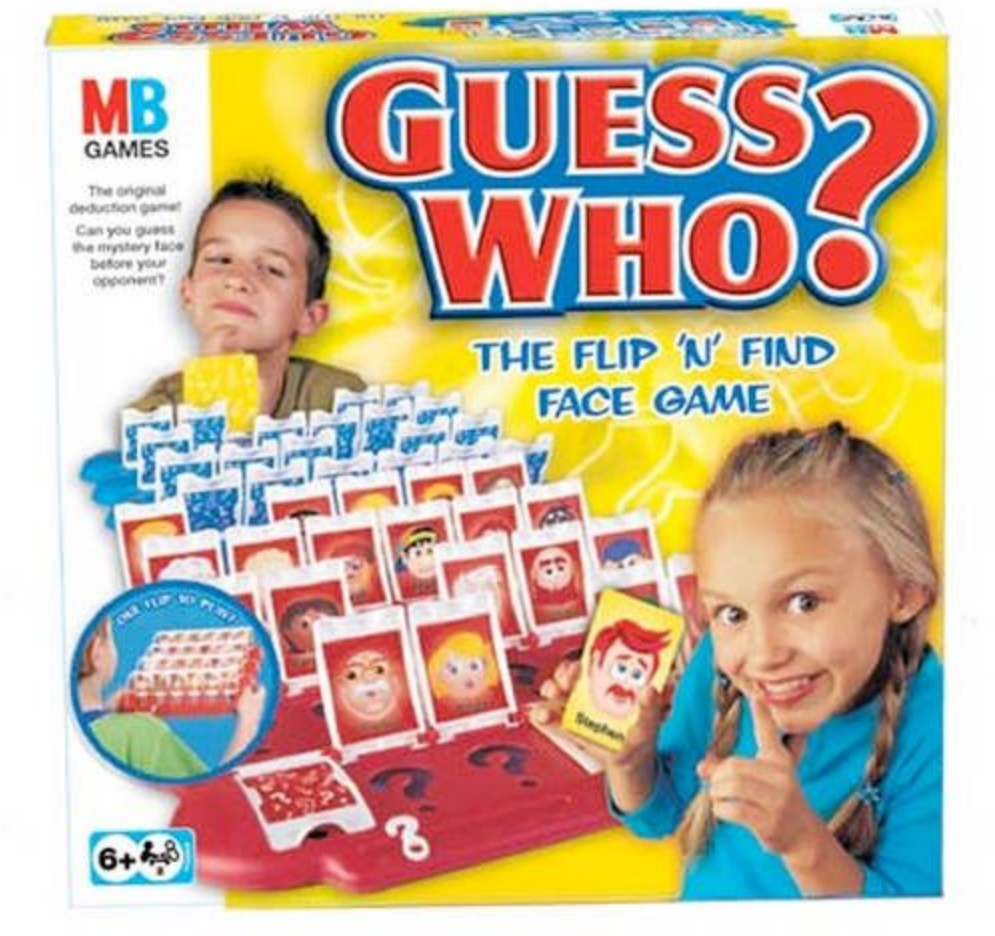
Without an explicit understanding of a concept we can still often find the odd one out. This is a significant part of IQ testing, as it is such an effective way of establishing if someone is capable of recognising or forming sets based on shared attributes.
The example below is fascinating because there are many right answers and some misconception traps. You simply ask children to spot the odd one out and justify their answer.



#WODB

Attribute Games

Games like 20 questions, or Guess Who? rely solely on attributes rather than definitions to identify and distinguish examples of concepts, they are great fun to adapt in the classroom.



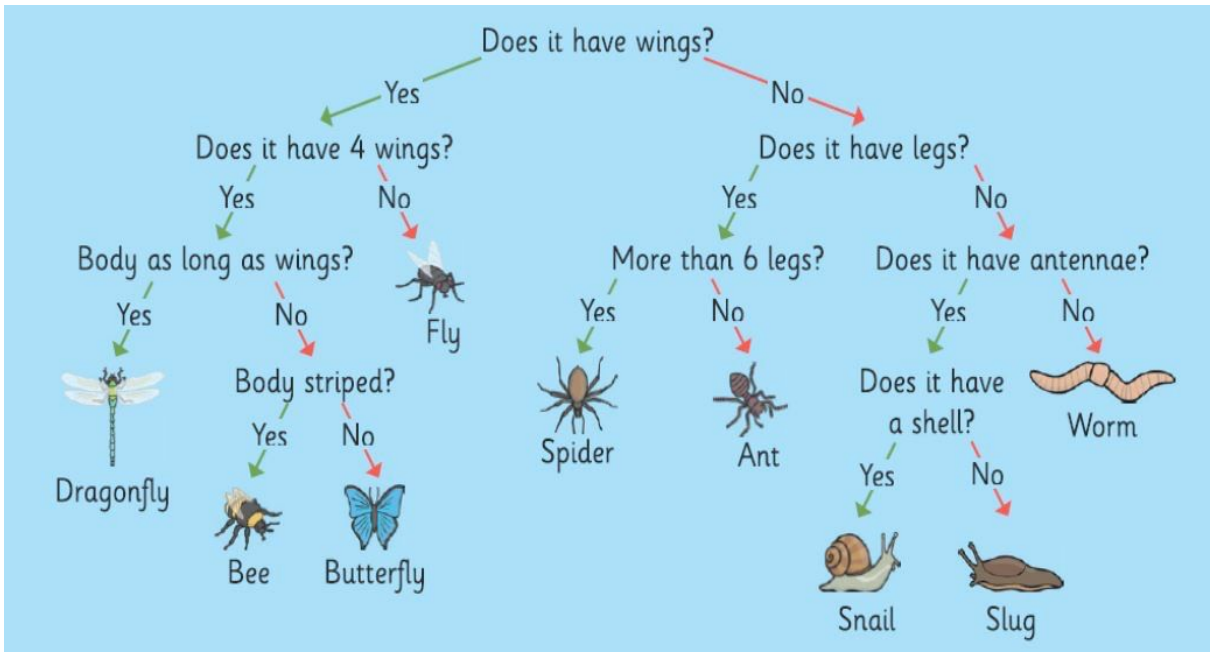
Sensory Denial and Focus

A common strategy for awareness of attributes is to deny some of the senses to heighten another. All horror writers know this: deny sight and the sense of hearing becomes acute.

A way to support awareness of attributes is to for example place objects in a feely bag, so that students become highly sensitised to touch, focusing on shape and texture. Numicon for example uses this to get children to feel the number-shapes to support number sense. But you could do this with any object that fits in a bag, or fits in a room with the light out!

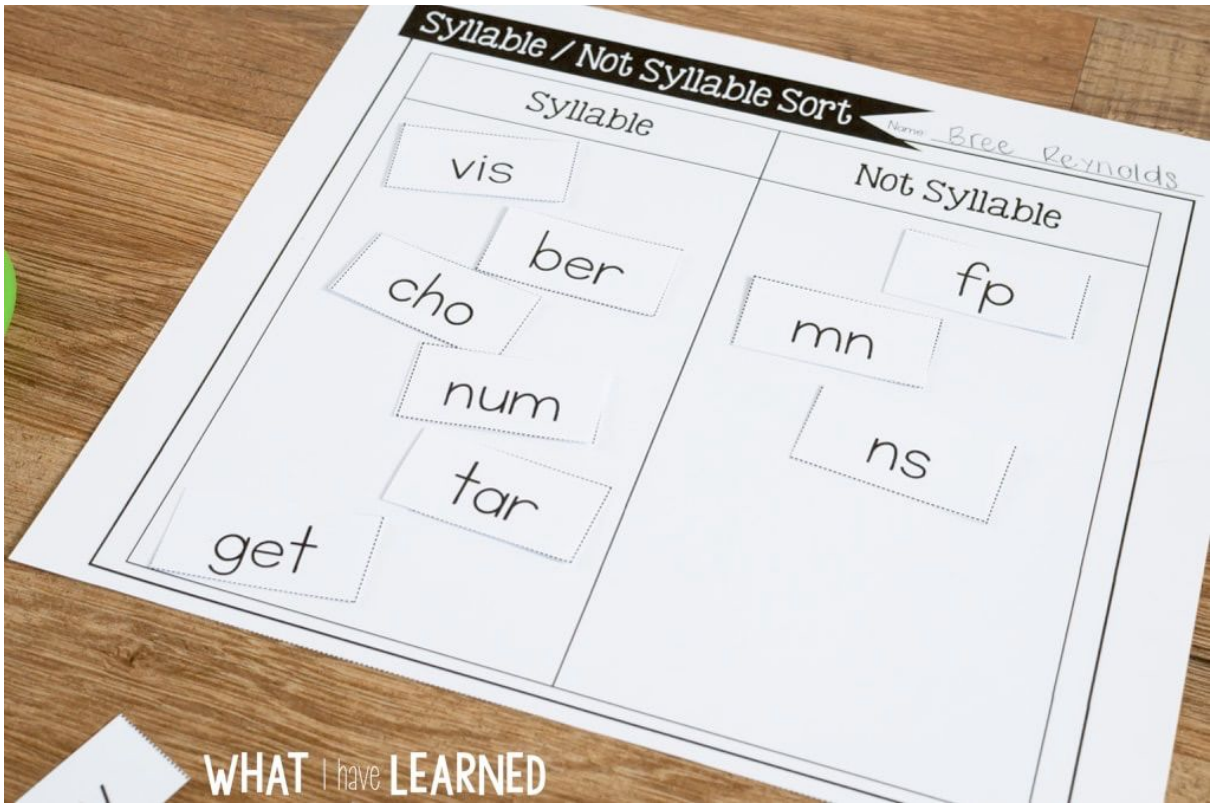
Classification Key

Another attribute based strategy to support awareness of concepts is to to ask students to develop or to give them classification keys. Asking students to construct their own, can be a highly effective way of constructing and expressing understanding and awareness.



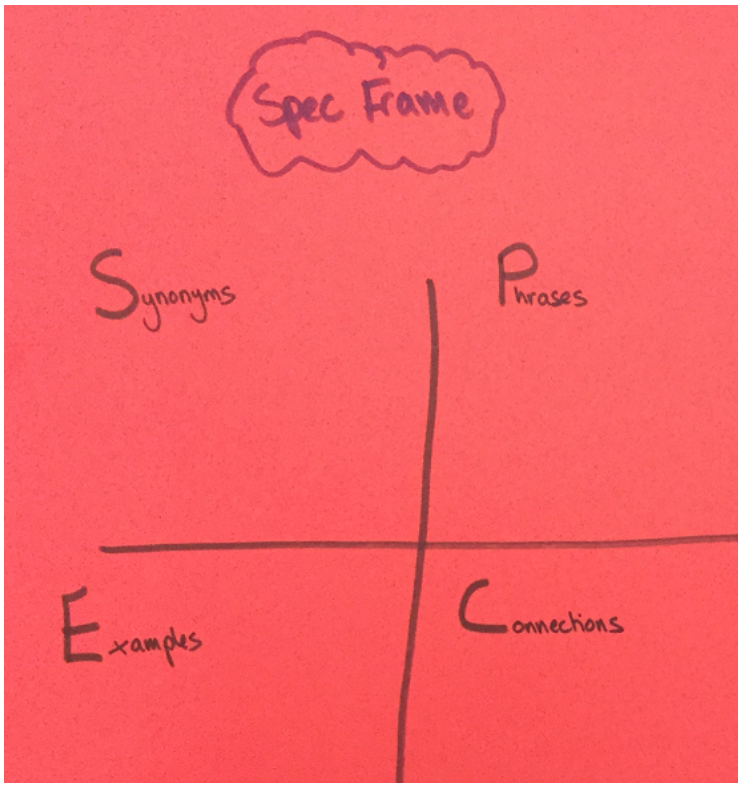
Open sort

Open sorting of examples and non-examples of a concept is an effective way to create an awareness of the attributes of the concept. These can range from simple “in or out” games, like “which of these animals goes in the hula-hoop and which go outside the hula-hoop?”, all the way to very verbal exercises like playing a version of the television show Room 101, where contestants have to justify why a particular object should go into room 101, which in this case would mean that the object in question was an example of the concept.



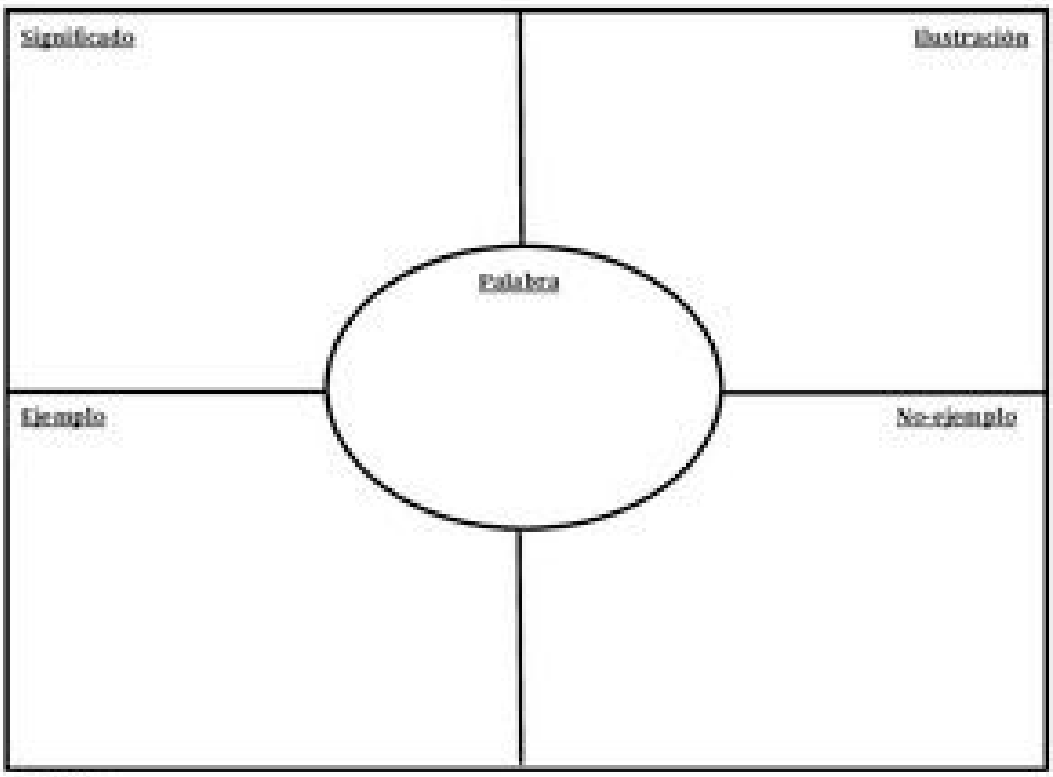
Definitions

Verbal definitions are a powerful way of identifying a concept. These can range from conventional Dictionary definitions, to students constructing their own definitions and then combining these to look for commonalities and outliers.
Philosophy for children uses the SPEC framework to invite children to construct their own understanding the definition of concept, and it can be very useful in the classroom. Children are asked for Synonyms, Phrases the concept label is used in, Examples of how it is used and Connections to other concepts



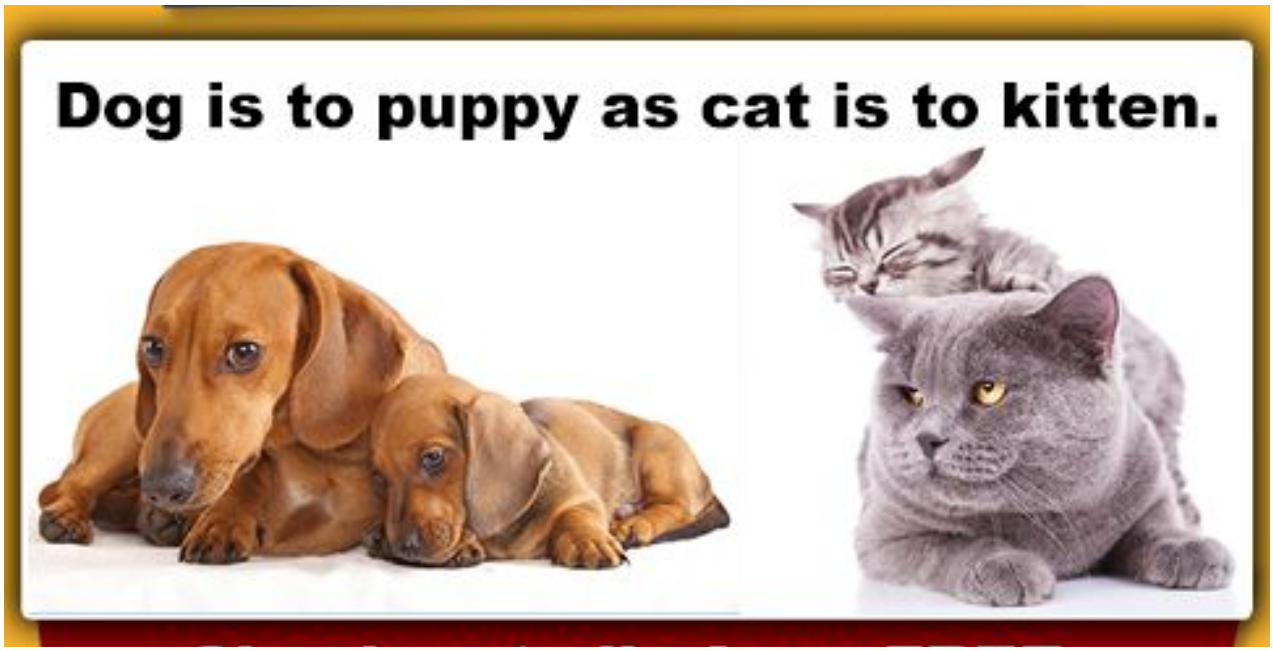
Frayer model

The Frayer model is one of the simplest and most effective ways of framing a concept. It works best with concepts which are not too fuzzy - you will struggle to write one for poetry, but for any sort of classification system concept they will work incredibly well.



Analogies

Analogies are about identifying relationships. We can help students become aware of the attributes of a concept by asking them to form analogies for this relationship. So for example if we asked “wheels are to a car as what is to an aeroplane?” We will get some very good discussion about forces and locomotion, and make students much more aware of the different ways that force is exerted.

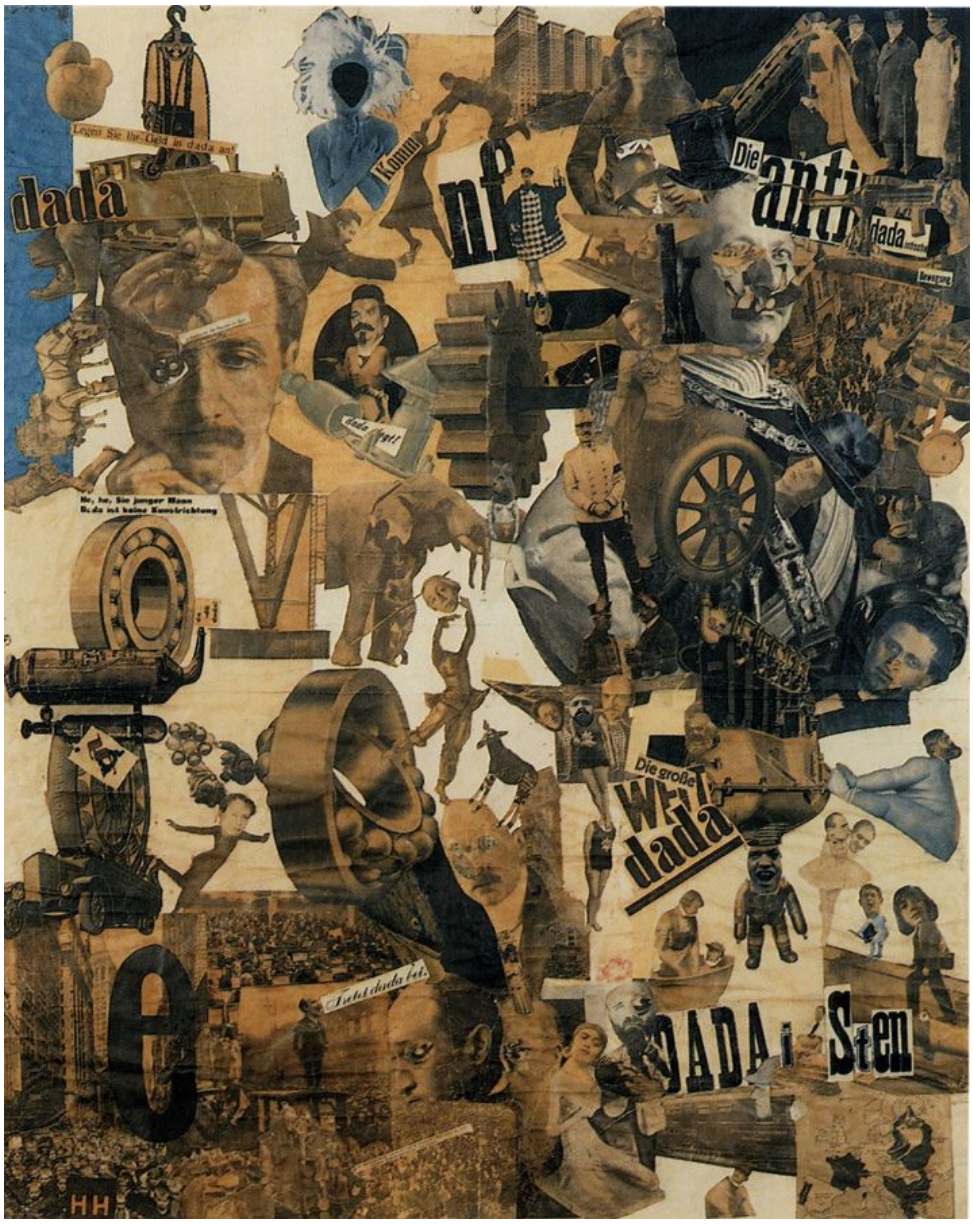


Translation and back translation

A fun exercise is to explore the way that different languages use concept labels the similar but subtly different concepts. Translating a words from one language to another and back again can often reveal some of the ways that we use that particular concept label. For example two students in my class recently mentioned that if you translate healthy into Hindi, you're quite likely to hit upon words associated with overweight, where healthy is being used as a euphemism. When this is translated back into English you perhaps get a word like chubby, rather than your original word healthy. Likewise if you translate friendly into Italian you might get *sympatico*, but when you translate this back you might get *sympathetic* or *cordial*. Rather like the 100 languages of children, translations between languages allow us to explore concept labels more richly

Collage

Collages of visual images, like this famous image from Hannah Hoch are another way to represent a concept. Given that they are quite diverse and relatively unmediated, they are a quite imprecise way of support concept acquisition, but for certain concepts they can be a useful tool to support or construct understanding. They are like a Frayer model with no dividing lines or definitions.



Awareness of Differences of Degree

Introduction to Differences of Degree

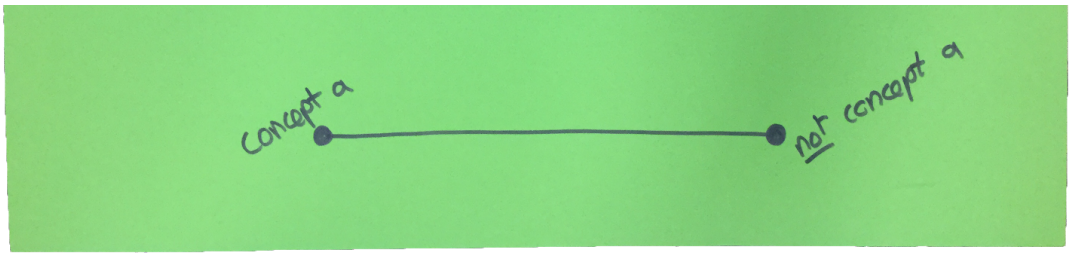
There is a famous paradox in philosophy called the Sorities paradox. Everyone knows what a heap of sand is, but if you ask someone “can a heap of sand be defined to a precise number of grains of sand?” they would say “no”.
Then you show them a single grain of sand and ask “is this a heap of sand?” and they will of course say “no”.
Now you add one grain of sand at a time and after everyone, ask “is this a heap of Sand?”
At some point they have to say “yes” as otherwise they will be saying that a large heap of sand is not a heap. Yet any point that you choose to say “yes” seems absurd - as surely one grain of sand cannot transform ‘some sand’ into a ‘heap of sand’.
The Sorites paradox emerges from the fact that human beings think in terms of discrete categories and continua at the same time. And these ways of thinking compliment each other but also produce very different results. A bit like thinking of light as both a particle and wave.
This problem of discrete and continuous thinking is evident in how Philosophers have tried to describe how we form ideas or recognise objects. For Aristotle the concept could be defined by necessary and sufficient conditions. So for example, if I’m a two-dimensional shape whose angles add up to the same amount of degrees as a straight line, with three straight edges which are joined at three apexes, then I must be a triangle. For Plato this was a more difficult question, because if one were to look for necessary attributes for a table, one would struggle to find a definitive list. Not all tables have four legs, in fact the table doesn’t even need to have legs if it is a solid block of wood, and not all tables are flat... So Plato decided that we must hold an archetypal table in our head and we must be tacitly comparing the various tables we see to that ideal.
On one hand this sounds like an absurd imaginary world, but on the other, we know for example that wine sommeliers use exactly this technique: they’re encouraged to construct in their head an ideal Bordeaux (which does not exist, but is a kind of ideal average) and use that to compare with the Bordeaux that they taste in order to give themselves a reference point to be able to taste blind. Perhaps the idea is not absurd at all.

Another way that philosophers have understood concepts is as continua rather than discrete sets. For example, the theory of family resemblances. Wittgenstein proposed that just as we might recognise members of the same family despite them having a wide variety features with no essential necessary features, so when we look at the large collection of tables we are aware that the overlapping continua of criteria is what allows us to group these items as belonging to that specific concept. Some natural kinds of concepts such as flowers probably fall into this category for most of us: we can recognise that the bougainvillea flower, the cactus flower and the courgette flower belong to the same family of objects despite the huge differences without needing to biologically dissect them to establish their purpose.

There are times when it is more helpful to explore concepts as being a matter of degree, rather than kind. In these instances we can use a different set of tools and strategies to help learners engage with the concept and the cognitive dissonance that comes with the difficulties of setting boundaries around a concept that is not precisely defined.
This idea is called concept stretching in philosophy for children. It is also part of what is Jean Piaget calls accommodation, when we challenge existing mental schema by considering new examples that don't fit existing patterns perfectly. Whilst Piaget thought that this happened intuitively, we now know that this is something we can consciously do in the classroom. And in fact studies of philosophy for children suggest that this significantly improves cognitive functioning.

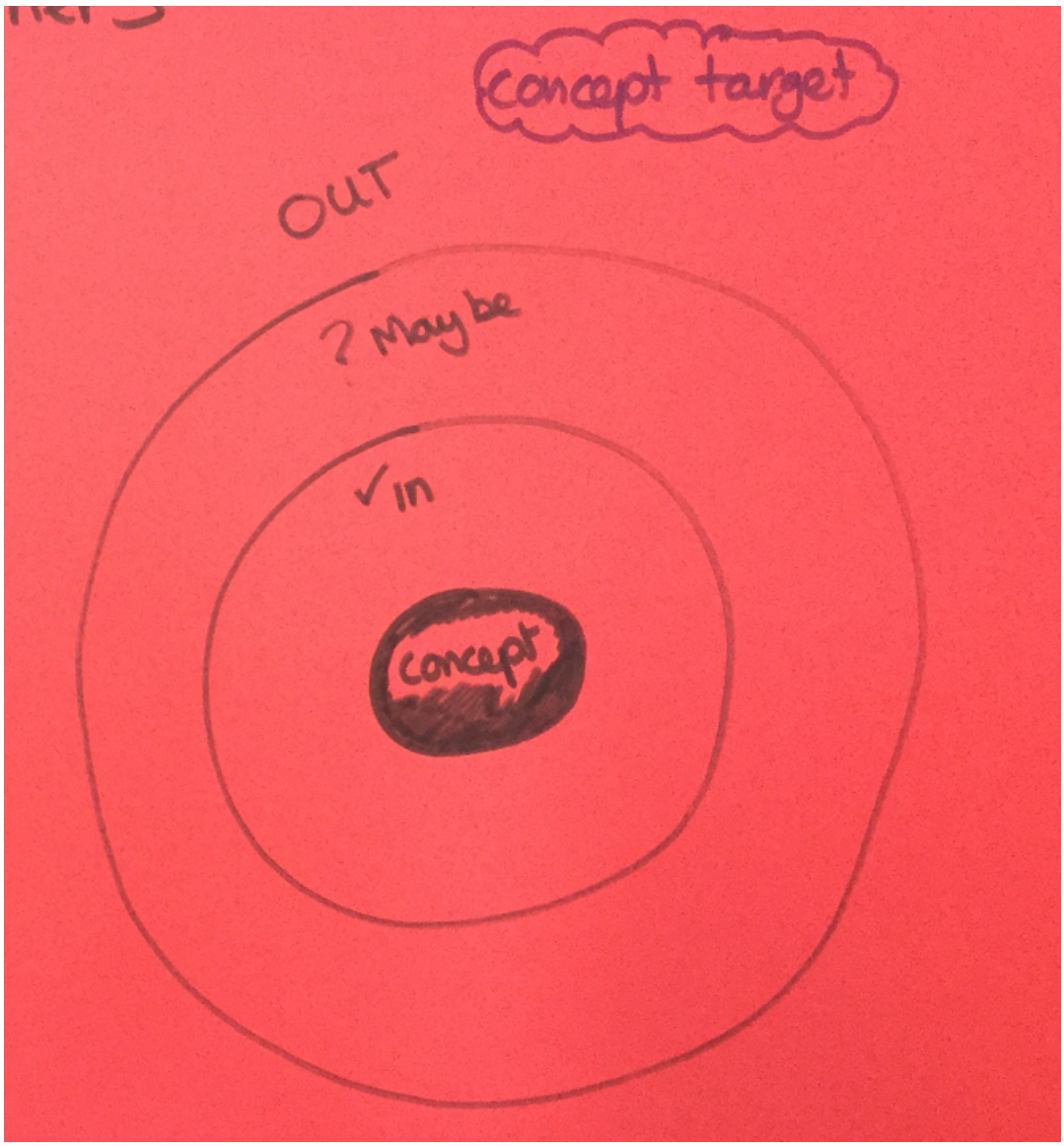
Concept lines

A simple way to explore the attributes of a concept, when the concept is a matter of degree rather than kind, is to place examples of the concept along a line, one end of which represents an absolutely certain example of the concept and the other end of the line represents a very weak example of the concept.
You can do this in many ways, from getting children to hold examples of the concept and stand along a line in the classroom, to placing post-it notes along the line, or moving icons in an app like padlet.



Concept target

Concept targets work in exactly the same way as concept lines, except you place examples of the concept closer to the centre of the circle the more strongly you feel that they are an example of the concept, and further out if you are not sure if they're an example of the concept, and outside the circle if they are a non-example of the concept.

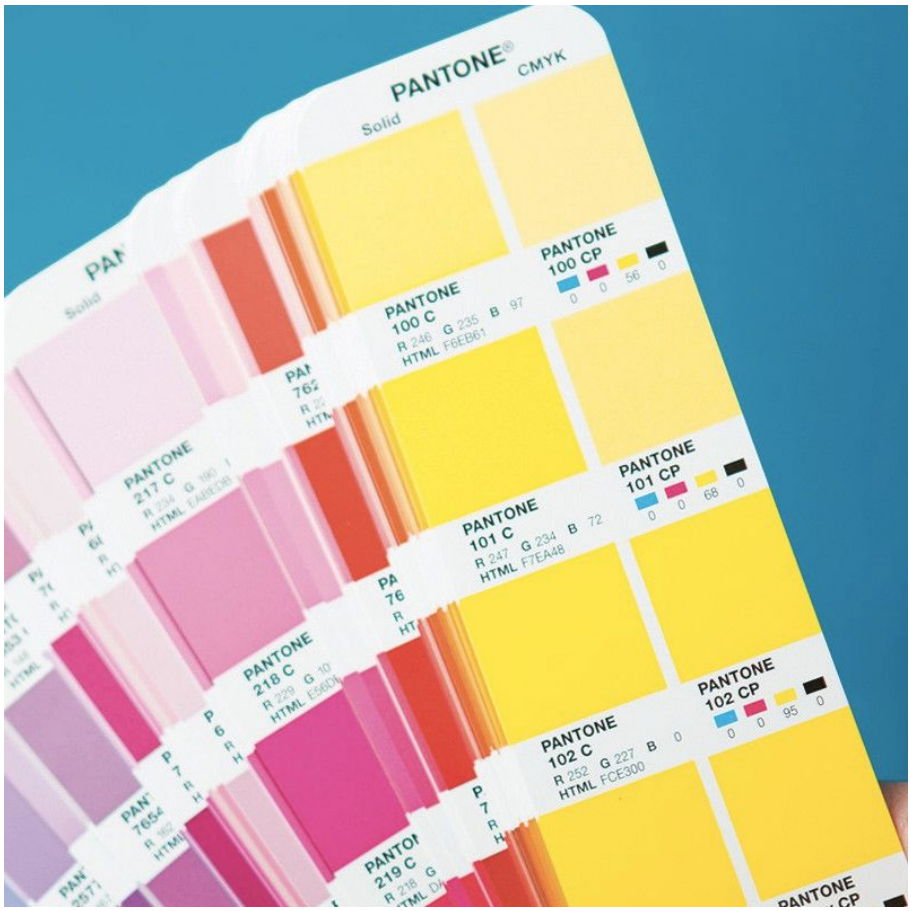


Cards

Another way of exploring differences of degree is to simply ask students to sort cards in order of most to least intensely representing a concept. You could have for example 10 different cards with a picture of historical revolutions and ask students to rank them in terms of the most to least significant. Students would then have to justify their opinion with reference to the concept of significance.

Palettes

Palettes like Pantone colour bridges are a lovely graphic way of representing differences in intensity. The idea of the colour bridge is that the colours are identical hues but different tones. They can be used as a concept line if you ask students to use the darkest hue to label the most intense example of the concept, and the lightest hue to label the least intense example of the concept. So for example the French Revolution might be the darkest hue and the English glorious Revolution of 1688 might



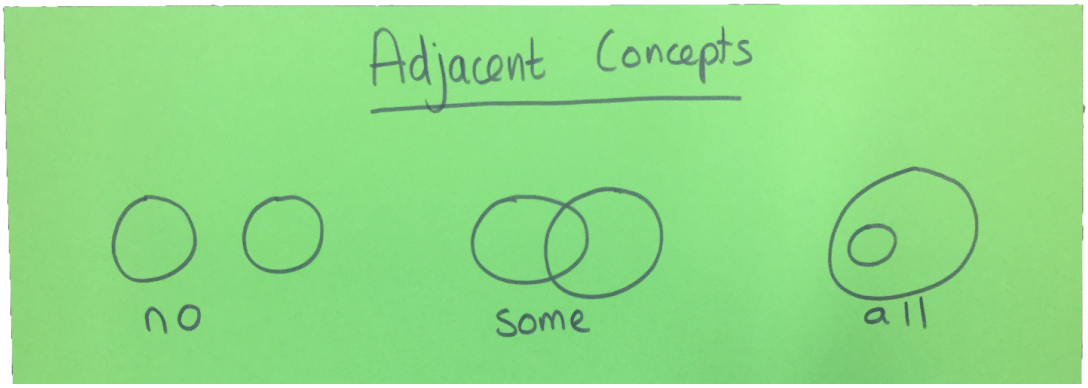
be the lightest hue.

Adjacent Concepts

Another set of strategies for exploring degrees a difference or concept stretching comes from the fact that all words exist within a semantic field of meaning and sometimes it's hard to see exactly where that field ends. Sometimes the most effective way of doing this is to jar it against another word and see whether this helps us clarify the boundaries.

An example of this is the classic 'friends' and 'acquaintances'. We get a clear understanding of each by asking, are all friends acquaintances, are some friends acquaintances or are none?

This is typically represented using the following Venn diagram. And you can describe the different diagrams as binoculars, butterfly or fried egg.



The other way is to put two concepts on a line with one of the concepts at each end and then present case studies and each time ask where on the line you would put them. A further activity would then be to say "put a line when someone stops being a friend and start becoming an acquaintance" or the other way round.

Languages and trans-mediation

The preceding sections on concepts all made an assumption that the symbolic language we are choosing to represent concepts in is verbal and all the cases we looked at happened to be English. We know that any language used to represent a concept, shapes how we become aware of the attributes of that concept. We know that a painting of a horse captures different attributes and aspects of horse than does a vet's medical report. Guernica presents a different understanding of the Spanish Civil War than does Ernest Hemingway's account of it.

So if we want a full understanding of a particular concept, one of the filters we can consider is to asks learners to construct representations of that concept in different forms. Reggio Emilia early childhood education has this at its core. Children represent ideas like wind or community, through clay sculpture, dance, music, shadow play etc. Some of the more famous visible thinking routines, such as representing a concept through colour, symbol and image, are in fact just a variation of the idea of trans-mediation. It is a powerful strategy for building awareness through a number of perceptual filters and symbolic languages.

This strategy of trans-mediation may sound quite abstract, but in fact most teachers use this without thinking about it. Every time we use manipulatives, pictograms, maps etc we're trans-mediating conceptual understanding in order to support awareness.

Awareness of Skills

Introduction to Awareness of Skills

The distinction between knowledge and skill is at once ambiguous and deeply profound. Leading cognitive scientist Herbert Simon explores this in the seminal text of artificial intelligence “Sciences of the Artificial” pointing out that all learning is stored as either data or process, with both of these organised in hierarchical structures that he calls “boxes within boxes”.

If we want students to become aware of skills, all of the preceding strategies for knowledge will work for describing skills. For example, becoming aware of the concept of an effective zone defence in an invasion game.

Given that we want students to become aware of a process that happens over time we may also choose some slightly different strategies to supplement awareness. Because skills are actions, awareness of skills has two parts. Firstly understanding the steps and stages involved in the skill. Secondly understanding when and how to use the skill (we will say more about this in the abstraction phase). The following examples explore ways to build awareness of a skill.

It is worth noting as we begin this section, that Lois Lanning provides an extremely useful taxonomy of levels of skill, starting with ‘skills’, which can be combined in a ‘strategy’ which has more than one action as an option, which can be strung together in a ‘process’. Processes, like the design process or writing process, are a meta-sequence that is designed to produce a particular outcome. We will use that vocabulary as it is so useful. The categories really just name the scale and complexity of a sequence of actions, but there is actually no distinction in kind between these.

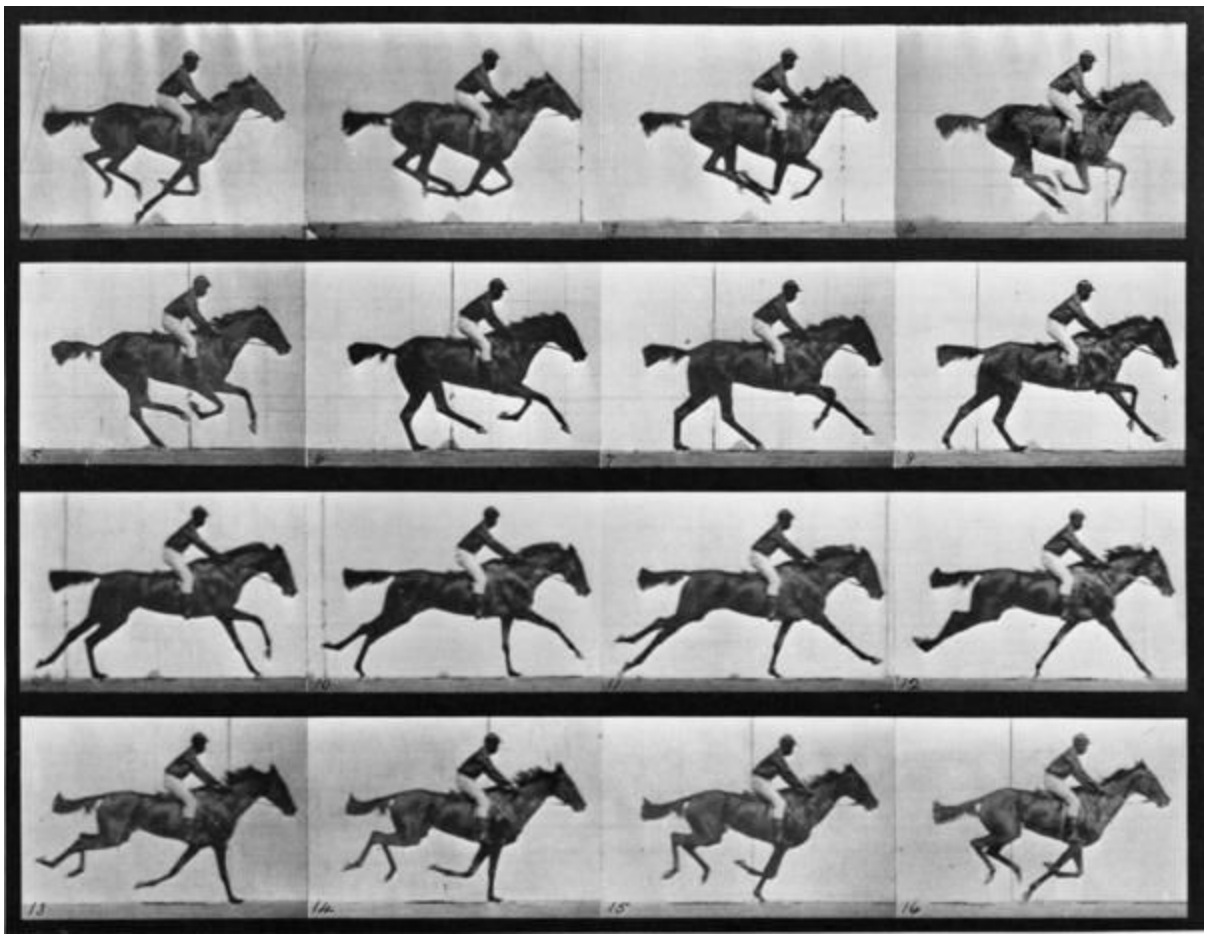
Modelling

Human beings appear to be hardwired to copy and imitate those around us. A fundamental part are becoming aware of a skill is having it modelled for us. Many traditional skills pedagogies, such as readers writers workshop start with exactly this. Intriguingly this behaviour is not limited to humans, and it is well known that wild orangutan when they overlap with human settlements, will copy human behaviours they see even if they don't know what they are for.

Apprenticeships are an extreme of this approach to awareness of skills

Parts and Sequence Strategies

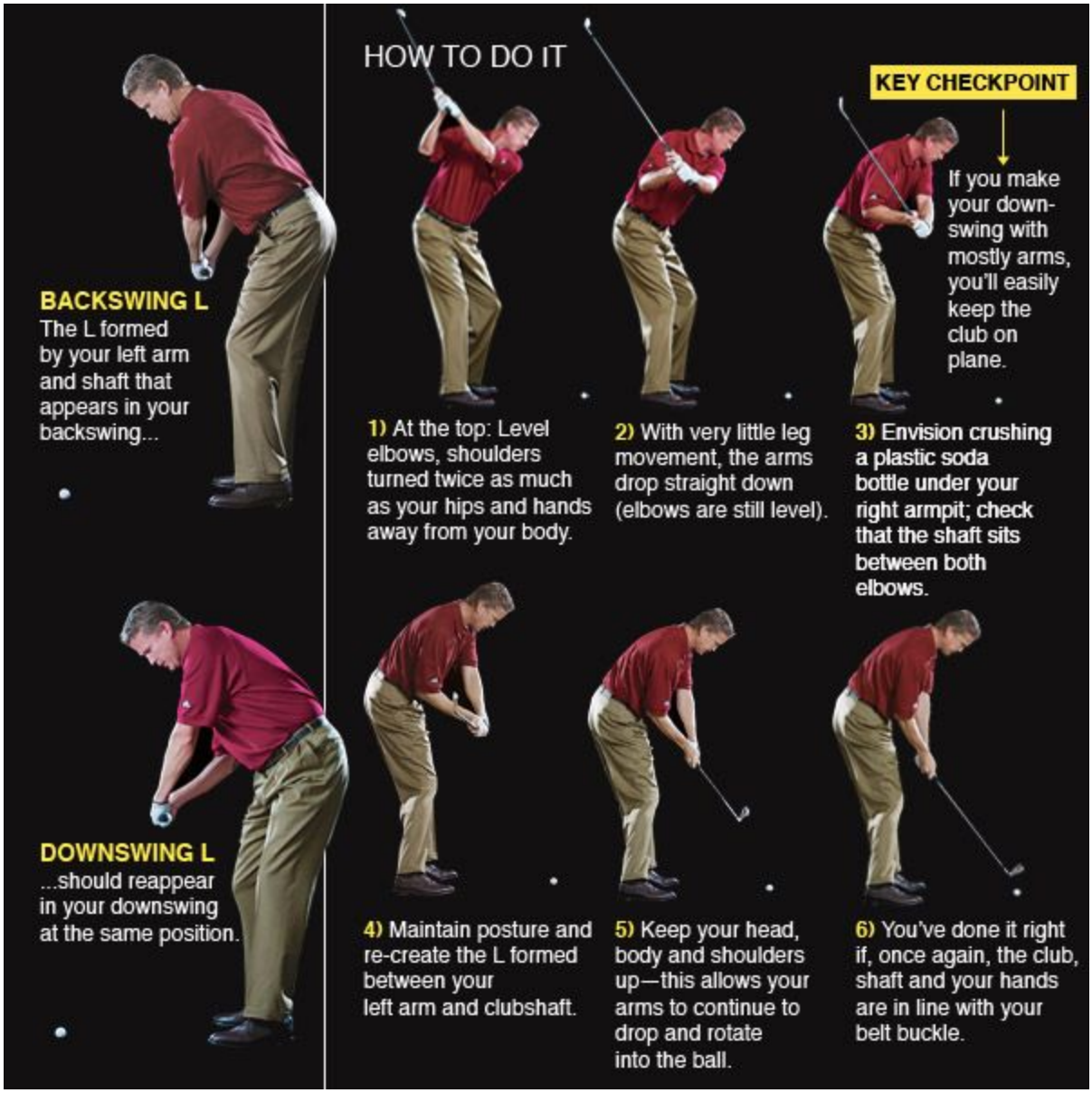
A distinguishing attribute of skills is that they take place over time, unlike conceptual awareness of facts, which represent an essentially static relationship.
Some of the earliest attempts to understand skills consisted in multistep instructions or sequences of images, like the famous image of a horse galloping below.



Parts and Sequence Strategies

Multi-step diagrams

Multistep diagrams or multistep instructions are one of the most direct and straightforward ways of building awareness of what constitutes a specific skill or action



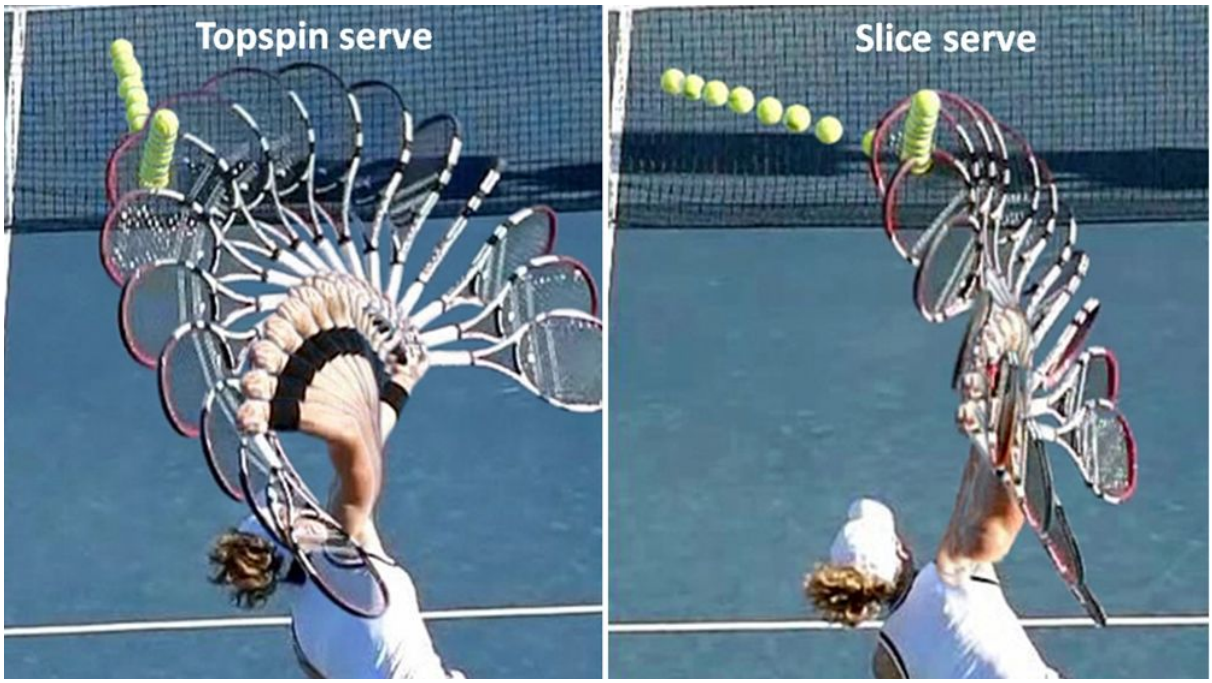
Strobe Lights

Strobe lights isolate moments of time within a sequence, such as the performance of a skill or a movement of an object, and we can become aware of actions or movements over time in a way that is impossible without them. They could be used for looking at a

dancer’s movement, or as in the picture below noticing the harmonic frequencies that mean guitar strings move together when one is heavily plucked.

High Speed Camera

High speed cameras have a similar effect to strobe lights and let us be aware of sequences we simply could not appreciate without this aid.



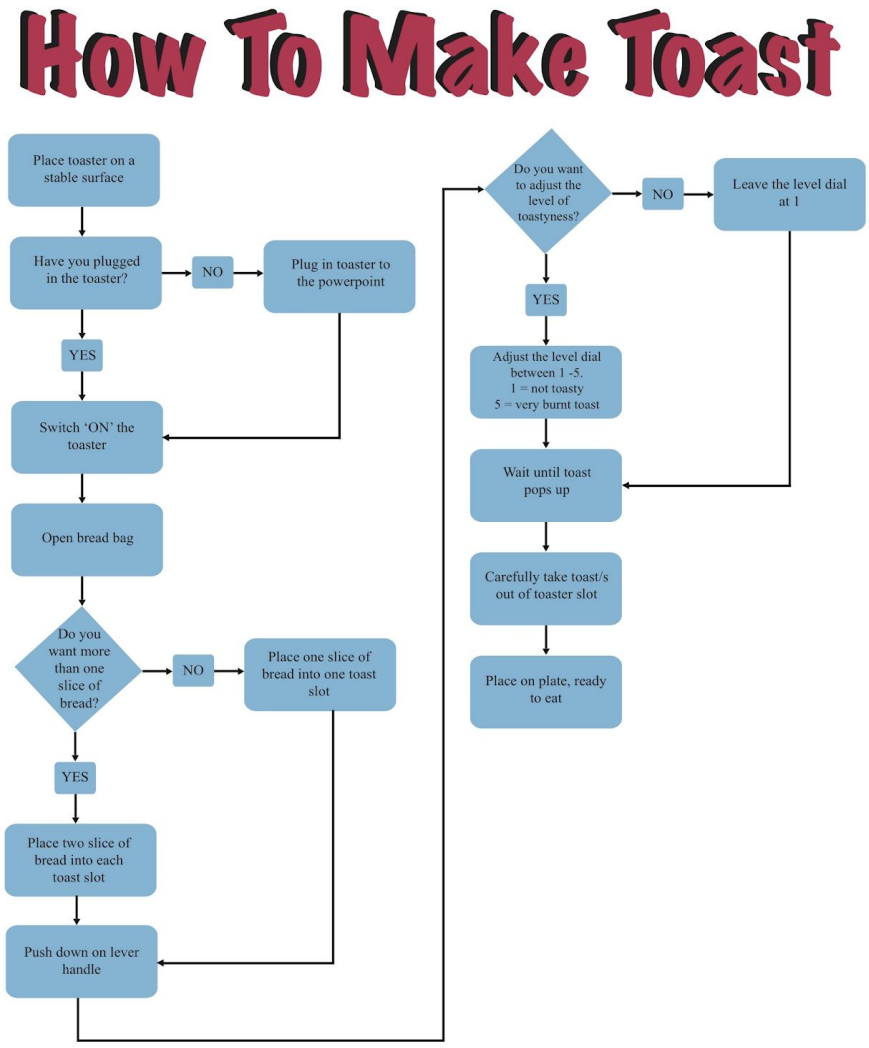
Recipes

Asking students to create recipes for a particular skill is an effective strategy for being aware of skills and processes. This includes naming: the essential preconditions and components (ingredients); the different steps in the action (preparation); and when and how to use it (serves: x).

This recipe task is often used more abstractly for things like “what is the recipe for freedom or happiness?”, for which it certainly can work, but it works extremely effectively for skills, for example, the recipe for a perfect tennis serve or a speech.

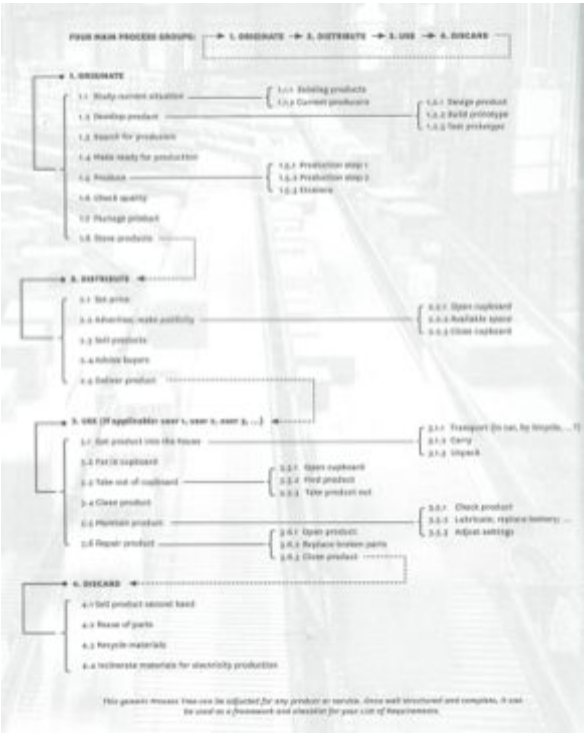
Flow diagrams

Even the simplest and most discrete skills are multistep. For example throwing a ball consists in many different muscle movements and weight shifts, although we see it as a single, discrete action. To become aware of skills, flow diagrams can be extremely effective.



Process tree

A very similar way to support students learning processes of skills is a Process Tree, such as this one from the Delft Design School.



Visual Strategies

As we have already suggested one important attribute of skills is that they take place over time. Anything that allows us to capture discrete moments within the sequence of a skill, or to slow down or speed up time can allow us to become much more aware of the subroutines and steps of a skill.

Mirrors

The simplest of all is the dance studio with a mirror. We can uses mirrors to help students become aware of how they are performing skills.

Video

From golfers, to swimmers to sculptors, video footage can be used and annotated to help learners become acutely aware of how they are performing skills.

Drone footage

Cheap availability of aerial photography means that for practising strategies and tactics we can become fully aware of team movements and responses by filming from above and reviewing this afterwards

Marks and measurement

A very widespread strategy for skill awareness and acquisition is the placement of markers or measurements that allow us to become aware of how we are doing or how a skill is being performed. This can be as simple as race times, or skateboarders slapping stickers on ramps at the peak of their run to record and represent their movement. With video footage it is even easier to add markers, lines and measurements.

Guided practice and stabilisers

Another common aspect of skills awareness and acquisition is the modification and guidance of practice. In pedagogy is like “teaching games for understanding” skills related to specific games are simplified and modified to reduce the amount of variables involved so that students can learn the skill in an authentic context of gameplay but not being overwhelmed by a huge number of variables.

Awareness Through Filters of Perception

Awareness Through Perceptual filters

In “Conceptual blockbusting” by James L. Adams he points out that spotting conceptual relationships is often difficult because we choose the wrong way to imagine them in our heads. His observation would apply to any time a teacher wanted a student to form a generalisation by reviewing case studies or factual information to build awareness.
James L. Adams gives a good example:
A monk starts at exactly dawn from a gate at the bottom of a mountain and walks to the top arriving at exactly dusk. The next day starting at dawn, the monk starts at the top and walks down the mountain arriving again at the gate at exactly dusk. Prove that there is a place on the path that the monk was at exactly the same time both days.
Try to solve it before reading on!
Adams points out that if you tried to do it logically using words, you probably really struggled. If you abstracted that language to maths you might have managed to do it thinking in terms of time-displacement graphs and lines crossing. If you tried to solve it visually, and imagined the monk as two people, walking both up and down, you’d have instantly seen them pass each other at a given time, and solved it.
Cognitive coaching and Neurolinguistic Programming both point out that on the whole we only use ‘seeing, hearing, or feeling’ as ways to represent experiences to ourselves. Using language might include a wide range of symbolic languages too… but the point is that directing students how to use these three major filters can have powerful effects on how quickly and confidently students grasp ideas.

Awareness through Reflection

When we reflect, we do something quite unique. The Awareness stage does not involve ‘new’ experiences from the outside environment. It involves being fully aware of and reorganising existing experiences held internally in memory.
Tools which spot-light prior experiences are vital so we get a fuller picture of our experience.

Footprints

Students identify a particular learning moment or event. Invite students to draw footprints (or stepping stones) and write five chronological events or learnings that led them to that moment or event. This is a good “making thinking visible” strategy for awareness.

Descriptive, Personal, Reflective

Ask students to write a description of an event they were involved in using an objective and third person voice.
Then ask students to rewrite the event in first person including their feelings and perspectives
Finally ask them to write about what impact that experience has had on them.

Five Whys

In pairs: one student makes a statement about an experience of event.
The other student asks why, waits until the other student has finished their response, then asks why again... and repeats until they have asked why five times.

Four Corners

Name 4 corners or the classroom Self; Others; Community; Society and the World
Ask students to think about a recent experience, then go to the corner that you connect with the experience. The corners represent the focus of your connection and the main learning you may have had.
In the corner discuss the experiences you have had.
SELF- thoughts, ideas, values, feelings, strengths, ethics, opinions, values, actions, hope
OTHERS- peers, people, meet/interact
COMMUNITY- places to interact, noticing concerns, successes, trends, ideas, culture, value
SOCIETY and the WORLD- big picture, insights and understanding.

Walk and talk

Take a group walk, with students talking and walking with a partner.

Quotes

Ask students to bring in a quote that is reflective of a recent experience. Randomly select several and place them on the wall. Students gather around the quote that most represents their thoughts or feelings regarding an experience. This can also be done with song lyrics or melodies.

Silent Drawing

Spread out large sheets of paper. Ask students to enter the room and ask for silence. Students consider a common group experience or simply what has been occurring and draw, in silence. This typically lasts 3–5 minutes. Then ask the students to add two

words. Based on the words, students can select three words from anywhere on the paper and use these to write a short poem or haiku.

Cartoon or Meme

Ask students to create a meme or cartoon to represent a learning event or moment. Next share and explain it to a partner or group.

Capturing the moment

Ask learners to bring a photograph that captures, without any additional words, something meaningful in an experience: a photo that says it all. Share without commentary from the photographer with the group.

Using a scale

Invent a scale, (e.g. one to ten) for a particular feature of an experience like 'how important was this experience?', 'how bad was this experience?', 'how much learning was there'. Invite students to pick a level on the scale and explain.

Using a graph

Invent a graph to show feelings over time, or learning over time, or intensity of engagement (awareness). Support students in identifying why it was at this level (analysis) and then what they might do to make it more as they wish (application)

Compare accounts

Ask two students who shared an experience. Record it in first person, including their feelings and thoughts. Then invite them to read and compare each other's accounts.

Act it out

Ask students to act out a scene from their experience and explain why it is important.
Pick an object
Either from a group of objects curated by the facilitator, or brought in by students for this purpose, students choose an object that represents their experiences and explain why it does (awareness).

Writing a letter you will not send

Invite students to write a letter to a real or imaginary person who is connected to their experiences - this could be cathartic or clarifying for students.

Currere

This is a technique from Pinar. The task is to write briefly about an event and how it relates to your past in one paragraph, your present in another, and your future.

Path not taken

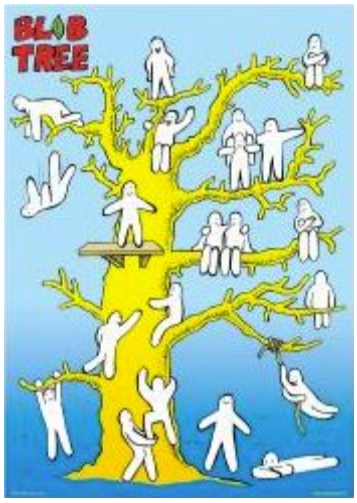
Invite students to write about something they did not choose to do, and explore what that might have felt like, or lead to, in comparison to what they did choose to do.

Doodle

Ask students to draw doodles that reflect their experience, thinking and ideas. Then ask them to share with a partner and explain what they see in their doodle. For example you could ask them to draw their experience as a tree, or if it was a maze, or a vehicle etc.

Blob Image

Use a blob image, like the blob tree image and ask students to identify who they are in the tree and why.



Road Map

Ask students to draw a road map, with road signs, of their current situation.

What if?

Ask students in pairs to ask each other 'what if' questions about their current situation.

Me, My relationships, my community, our world

Ask students to think about the significance of an experience through these concentric circles of influence.

Create Metaphors and Similes

Ask students to create similes or metaphors for a learning moment. "This event is a boulder rolling down hill" and then share why they chose that metaphor.

Choose Metaphors and Similes

Present students with some images. Ask students to choose one as a similes or metaphors for a learning moment and explain why.
Below is one often used to choose one to represent feelings about an event

Awareness Through Mindfulness

In conventional concept-based teaching and learning, the awareness stage is usually under-represented as being about facts and case studies. In areas where personal engagement with learning or where social emotional learning is the focus, awareness needs to include a wider range of perceptions. For example, if our goal is to develop strategies to deal with a wide range of emotions in our personal social & emotional education learning program, then effective awareness could include how these emotions enter us, what they feel like physically and emotionally, and the thoughts that arise when we are feeling them. Mindfulness is an effective way to achieve this. Some definitions of mindfulness are:

- Knowing what you are experiencing while you are experiencing it. (Guy Armstrong)
- Mindfulness means paying attention in a particular way, on purpose, in the present moment, and non-judgmentally, In the service of self understanding and wisdom. (Jon Kabat-Zinn)
- A clear, non-judgemental awareness of your inner and outer world. (Rick Hanson)
- Mindfulness is secular, present moment awareness, a way of being, which involves noticing the movements of the mind (thoughts and emotions) and has the goal of greater awareness and acceptance.

Mindfulness is not religious and spiritual, nor transcending the present moment, nor following prescribed practices and forms, clearing the mind, enlightenment nor supposed to be relaxing.

The major realms of awareness in mindfulness are represented in this graphic.

There are many forms of Mindful Practice that may well be required in the awareness stage of learning. These are potentially for many different kinds of learning, from dispositional to conceptual. Mindfulness might support a connection to nature in Outdoor Education, emotional self regulation in PSE or an awareness of sound during a unit in Physics. But the tools are generic and shared.

These include

- Everyday Mindfulness (stepping out of autopilot)
- Bringing awareness to daily routines
- Using techniques to bring awareness to thoughts, emotions and body sensations throughout the day
- Sensations of movement (e.g. walking)
- Eating (taste and texture of food/movements of the jaw, tongue, etc.)
- Environment (bringing the senses to the surroundings)
- Routine Tasks (teeth brushing, showering, getting dressed, etc.)
- Three step breathing space
- Formal Mindful Meditation Practice
- Setting aside time for the 'mental gym' by choosing an area to focus on (e.g. breath) allowing the training of attention
- Awareness of body and breath meditation
- Awareness of thoughts meditation
- Awareness of emotions meditation
- Body Scan
- Compassion meditation
- Open Awareness (directing the mind to whatever predominates it e.g. how it is manifesting in the body and bringing acceptance) e.g. pain and noticing where the mind goes; tightness in chest associated with anger; lump in throat associated with sadness
- Retreat Practice

- Cultivating Mindfulness through extended periods of practice

It would be expected that leading mindfulness in classrooms would involve experience and a strong personal practice. With this in place it is possible to use mindfulness as a powerful tool for awareness to facilitate learning, especially in the dispositional personal, social & emotional sphere. It is also possible to use this kind of mindfulness as awareness for academic learning. You might make students aware of the way they think about, feel and experience a particular concept. An example of this is a Physics teacher on East campus UWCSEA who invites students to be mindful of light and electromagnetic waves: how light hits their skin creating warmth and travels through them.

Portfolios and Records over time

Portfolios and blogs are widely used to record impressions which can become the material for the first stage of learning: we can become aware of patterns, regularities and groupings that our frail memory would struggle to support or recall on its own.

Gestalt Theory and The implicit ‘Thingness’ of Things

A definition of a horse

‘Bitzer,’ said Thomas Gradgrind. ‘Your definition of a horse.
’‘Quadruped. Graminivorous. Forty teeth, namely twenty-four grinders, four eye-teeth, and twelve incisive. Sheds coat in the spring; in marshy countries, sheds hoofs, too. Hoofs hard, but requiring to be shod with iron. Age known by marks in mouth.’ Thus (and much more) Bitzer.
‘Now girl number twenty,’ said Mr. Gradgrind. ‘You know what a horse is.’
Despite Blitzer’s excellent categorical knowledge in Dickens’ satire Hard Times, it seems that he has failed to capture the essence of ‘horsiness’, and even less likely that Girl Number Twenty ‘knows’, in any meaningful sense, what a horse is.
Three time fellow of All Souls College Oxford, Psychiatrist and John Hopkins neurological researcher, Iain McGilchrist, in ‘The Master and his Emissary’ points out that the brain can be seen to process information in two complementary ways. (He has an excellent video)
On the one hand there are identifiable areas of the brain which specialise in category formation (such as we have largely been focusing on), on the other, there are complementary processes that focus on our sense of the gestalt whole. Both processes are necessary for our experience of the world to be rich and profound, but the kind of processing that focuses on the ‘quiddity’ or ‘thingness’ of unique, individual things (like people, metaphorical meaning or art works) cannot be reduced to simple rules or explicit meaning.

If someone were to look at David by Michelangelo and ask: “So, what is it about? What is the generalisation I should form?” then we would assume they had rather missed the point. That is not to say that in studying Art students should not form generalisations, nor that there are not understandings about this piece that are transferable related to mimesis, or the human form, or sculpture, or simulacra, but ... all of these fall far short of the quiddity or ‘thingness’ of the work of art.

Likewise with Literature. Although we can make generalisations about the way we can read and write texts, and we can certainly interpret texts using generalised conceptual knowledge, the interpretation falls far short of the work itself.
So if we look at a poem from Yeats, ‘He wishes for the clothes of heaven’

Had I the heavens’ embroidered cloths,
Enwrought with golden and silver light,
The blue and the dim and the dark cloths
Of night and light and the half light,
I would spread the cloths under your feet:
But I, being poor, have only my dreams;
I have spread my dreams under your feet;
Tread softly because you tread on my dreams.

You can explain it in many ways using references to Yeats’ theory of gyres, the intertextuality with other of Yeats poems, by contrasting this with the aggressive poetry of Leda and the Swan, explore the relationship between the voice of the poem and of the poet, pick up references to Courtly Love, but ultimately that is like explaining why a joke is funny. The quiddity of the poem stands above and beyond explicit explanation. What this means is that sometimes awareness of things as they are, rather than the abstraction of them via categorical thinking is very important.

In Hamlet, Claudius’ statement about Hamlet’s grief for his dead father illustrates the point very well.

'Tis sweet and commendable in your nature, Hamlet,

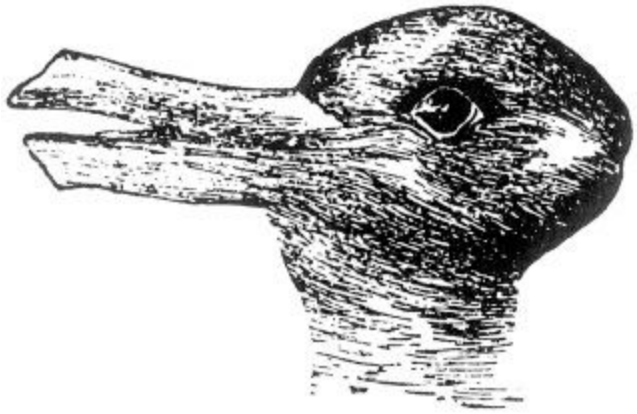
To give these mourning duties to your father;
But you must know, your father lost a father;
That father lost, lost his, and the survivor bound
In filial obligation for some term
To do obsequious sorrow. But to persever
In obstinate condolement is a course
Of impious stubbornness. 'Tis unmanly grief;
It shows a will most incorrect to heaven,
A heart unfortified, a mind impatient,
An understanding simple and unschool'd;
For what we know must be, and is as common
As any the most vulgar thing to sense,
Why should we in our peevish opposition
Take it to heart? Fie! 'tis a fault to heaven,
A fault against the dead, a fault to nature,
To reason most absurd, whose common theme
Is death of fathers, and who still hath cried,
From the first corse till he that died to-day,
'This must be so.'

According to Claudius and categorical thinking, one of the attributes of fathers is that they eventually die, so Hamlet should not grieve excessively or be surprised at his death. According to reason this is the truth. But Hamlet's father was a person whom Hamlet was deeply attached to, not just an illustrative example of the concept of fatherhood. The quiddity and individuality, indeed the meaning of human life, does not just give itself over to abstractions.

The Gestalt

The phrase ‘the sum of the whole is greater than the parts’ or the idea of emergent properties of systems are both indications that at times we cannot access the meaning of the whole by a division and identification of parts.
The gestalt image of Dalmatian is a classic. Either you perceive the ‘whole’ or you perceive nothing. But you cannot get to the whole by simply examining the parts.

Likewise with the Duck/Rabbit image, you cannot see both simultaneously.



This is a reminder of the way that the brain perceives ‘wholes’ is not the same as the way it breaks down and categorises parts. To understand a ‘rabbit’ might include categorical thinking about attributes, but to recognise one is often quite a different process.

The implications of this are that categorical awareness of attributes and classifications must be complemented by time to appreciate the ‘quiddity’ of things. Our awe and wonder at the world is complementary to, not replaced by our categorical knowledge.

Explaining Metaphors and Analogies (and why not to do it too much)

Ian McGilchrist in The Master and his Emissary, writes that when we use metaphor: “words are used so as to activate a broad net of connotations, which though present to us, they remain implicit, so that the meanings are appreciated as a whole, at once, to the whole of our being, conscious and unconscious, rather than being subject to the isolating effect of sequential, narrow-beam attention. As long as they remain implicit, they cannot be hijacked by the conscious mind and turned into just another series of words, a paraphrase. If this should happen the power is lost, much like a joke that has to be explained”

He goes on:
“when the metaphor is paraphrased or replaced, whatever had been extra lingual, unconscious, and therefore potentially new and alive in the collision of these two entities get reconstructed, this time in terms only of what is familiar. The point of metaphor is to bring together the whole of one thing with the whole of another, so that each is looked at in a different light. And it works both ways, as the coming together of one thing with another always must. You can’t pin one down so that it doesn’t move, whilst the other is drawn towards it: they must draw towards each other. As Max Black says:” if to call a man Wolf is to put him in a special light we must not forget that the metaphor makes the wolf seem much more human than he would otherwise.”

Asking students to choose or construct metaphors or indeed to respond to them, in order to understand a concept or a ‘thing’ is a highly creative and rich way of thinking about ‘wholes’.

Awareness of Reasoning

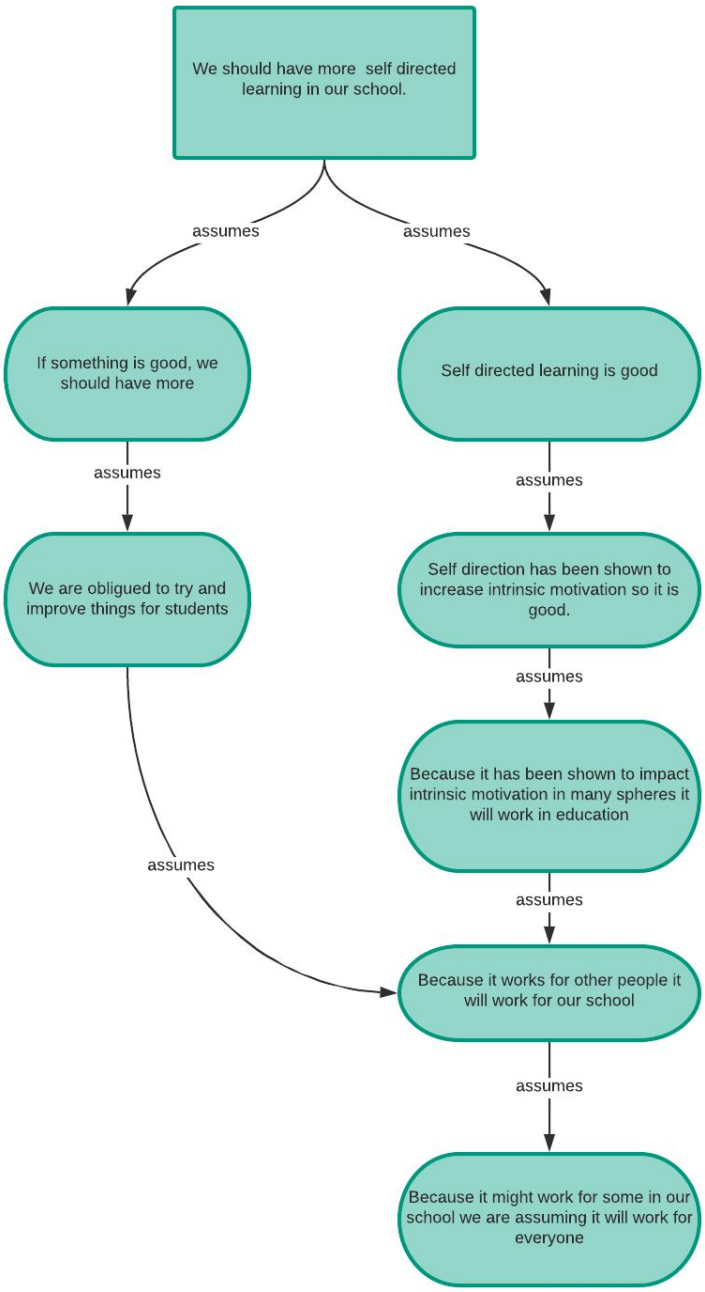
Identifying Assumptions, Axioms and Premises

Assumptions questions are quite simply asking students what assumptions are made by someone who makes a specific claim. So a simple example would be, if someone were to say that all three sided shapes with straight lines and three apexes, have interior angles that add up to to 180°, what assumptions are they making?

The answer here is that the assumptions would be that this shape is on a two-dimensional plane and we are using a 360° model of a circle, rather than, say, radians.

Back mapping premises

Likewise we can back map premises to become more aware of how a particular argument might be working.



The point is that this allows us to become aware of the assumptions and premises that might be informing particular statements.

Introduction to Awareness of Reasoning

A great deal of the time in the awareness phase, we want students to notice observable phenomena in the world so that they can abstract categories and rules, and form knowledge inductively. In all disciplines there are times when what is most important is to notice axioms and assumptions that are being used because in the abstraction phase we want students to make deductive inferences.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ABSTRACTION

Abstraction of Conceptual Relationships

In learning, our goal is never to just notice and categorise things in the world. Our goal is to understand the interconnections and relationships between the various types of phenomena we are aware of. This is generally what we call “understanding” (although that word can also apply to things like intuition or sensibility). As we explored in the introduction in chapter 1, the most significant way we can help learners to understand the world is by supporting the construction of generalisations.

It has been recognised since Piaget that this is the essence of all meaningful learning that moves beyond the episodic or rote. Within an international or refugee context, these generalisations should be transferable and make sense of illustrative content from a wide range of times, cultures, contexts and situations. For example, if we learn about a historical event from one nation’s history, we ensure that this factual content is used to support students understanding how historians determine historical significance. This understanding can then be applied to historical events from any country’s history. Likewise if we are learning how to solve simultaneous equations by using a specific algorithm, we want students to be forming transferable understandings about how mathematicians can use substitution to reduce variables as a problem solving strategy, and then in turn how substitution can be used in non-mathematical settings too. The advantage of this approach is that this kind of evidence-based inferential thinking is that it is essential in the development of critical thinking in a wider sense.

When we notice patterns and relationships in order to form generalisations we are abstracting understanding from specific examples. Ian Gilchrist states that abstraction

“is the process of wresting things from their context” and provides “the foundations of ... intellectual power.”

This kind of thinking is only possible after the awareness stage. The common misconception is that we should start with the big idea of how things connect. In fact, we should start with a deep and profound awareness of the things we are trying to understand and then invite students to make inferences.

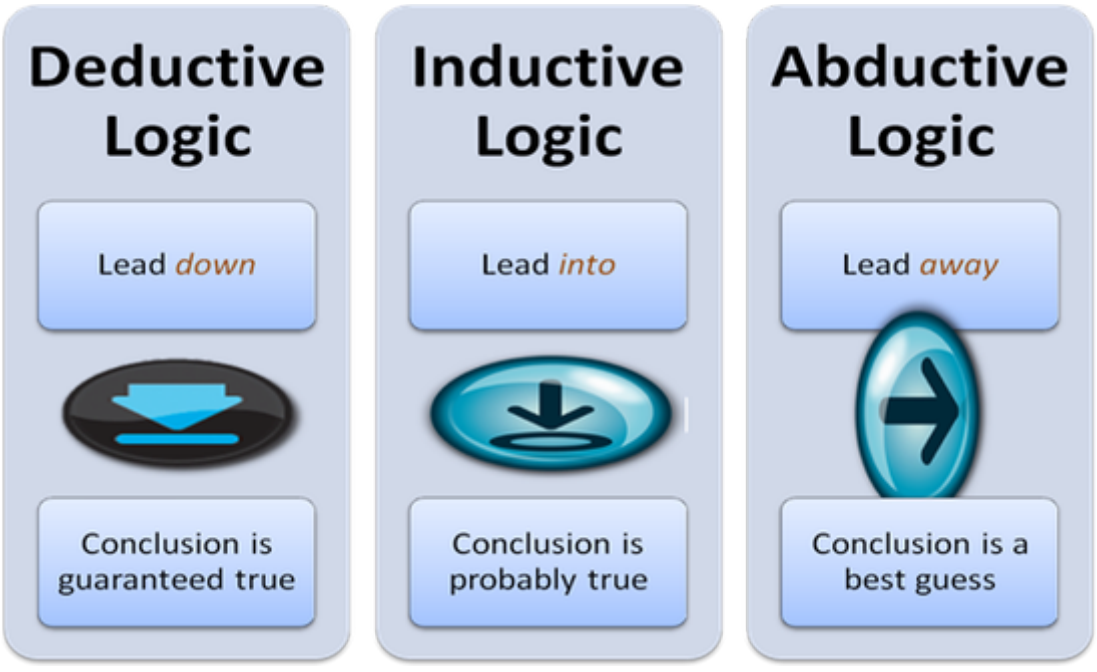
There are, therefore, two approaches to helping students understand the relationship between concepts. One is to simply tell them, and then have students to test out whether the idea works. We often see this in skill based areas. For example, in PE we might tell students that creating space increases opportunities to score in invasion games, and then have them try out some strategies. Or in Maths, substitution might be presented as an effective strategy for reducing number variables in algebra. We would then give students problems in which they have to try this.

The danger of this style of ‘advance organiser’ learning, is that students learn the understanding verbally, but have no real mental schema. By skipping the awareness stage, we feed students ideas to parrot and their challenge is to accept them on trust and use them blindly. It is inevitable, especially in high school, that not all conceptual understandings can be constructed from awareness to abstraction by students. But we should be giving students plenty of meaningful experiences of this in high-value areas. The benefits of students forming their own generalisations have been shown to be: stronger retention of learning; greater ability to transfer learning to new contexts; and the development of metacognitive skills that allow students to be self-managing, self-monitoring and self-adapting.

The separation between those who prefer to see conceptual understandings are ‘passed on’ rather than ‘made again’ may well come down to which educational belief system dominates our thinking. (Cognitive Coaching Guide). For academic rationalists there will be a strong draw towards telling and sharing wisdom in the form of advanced organisers and exemplars. For Self-actualisers and constructivists the draw will be

towards sharing understanding by making it again and thereby simultaneously building the thinking habits which will allow new thoughts and individual understandings to be build. Triple A Plus is in the constructivist tradition of Dewey, Hahn, Piaget, etc.
The essential part of the Triple A plus model is that students should be making inferences based on the scaffolded awareness that the teacher has facilitated.
In concept based curriculum and instruction this is about students making connections between two or more concepts to form a conceptual understanding.

There are three kinds of inference students can make: inductive inferences where they generalise a rule from instances; deductive inferences where they extrapolate necessary conclusions or truths from a set of simpler axioms; abductive inferences where they offer the simplest and most broadly acceptable explanation for a set of phenomena.



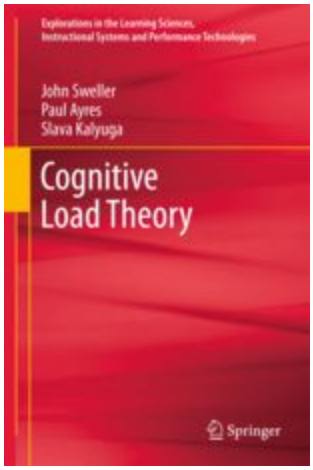
Of these strategies inductive strategies dominate the humanities and the empirical sciences because they are based on the attempt to explain physical phenomena or events and establish causality. Mathematics constructs knowledge from axioms, so is

dominated by deductive inferences, although students often first become aware of patterns inductively. Disciplines based on interpretation, like Literature, or Art History, Philology use abduction.

In the skills based areas we will find an increase in deduction: for example we might hear a teacher in an invasion game asking “what will happen if you pass the ball over there?” expecting students to be able to make deductions based on the motivation and abilities of the players around them.

It is worth understanding as a side note that the Lynn Ericsson school of concept based teaching and learning makes quite a significant misconception in calling all concept based teaching “inductive”, when in fact it it is all three kinds of inference. She then compounds the error by describing the pedagogy of telling students the understanding and asking them to use it, as “deductive”. This leads to a great deal of confusion. The simple truth is that the opposite of constructivist teaching in which students construct their own understandings in the abstraction phase inferentially (using induction, abduction and deduction) is telling students the understanding before students have a chance to think for themselves. Some models of conceptual learning do advocate this approach, such as David Ausubel, who suggests using an “advance organiser”, which might be, for example, a complete concept map of what is going to be learned before students have had a chance to think or experience anything themselves. The dangers of this are well documented - verbal, superficial learning of ‘understanding’ leading to weak critical thinking, application and transfer.

The heart of the abstraction phase is seeing patterns and causality. The major block to this for humans, once we are aware, is simply our brain’s ability to cope with the volume of information in order to identify the pattern that we’re looking right at. There are many tools and strategies we can use to support students being able to lower the cognitive load in order to be able to construct an understanding about the relationship between two or more concepts.



Conceptual Questions

Over the course of this chapter there are many strategies to represent conceptual relationships in order that learners can form conceptual understandings. In order to help learners make their understandings explicit and subject to reflection, it is important to ask learners to verbalise (or otherwise represent) their understanding.

The simplest way to do this is to ask a Conceptual Question.

A conceptual question asks students to identify the relationship between two or more concepts.

The simplest way of asking a conceptual question is quite straight forwardly to ask directly what the relationship is between two coordinate concepts, and require that students use inference (induction, deduction or abduction) to answer it based on the awareness-stage.

How does imagery suggest character in novels?

Of course this question will fall flat on its face if you have skipped a carefully curated awareness stage or if you fail to provide structures for working memory (see later in this section).

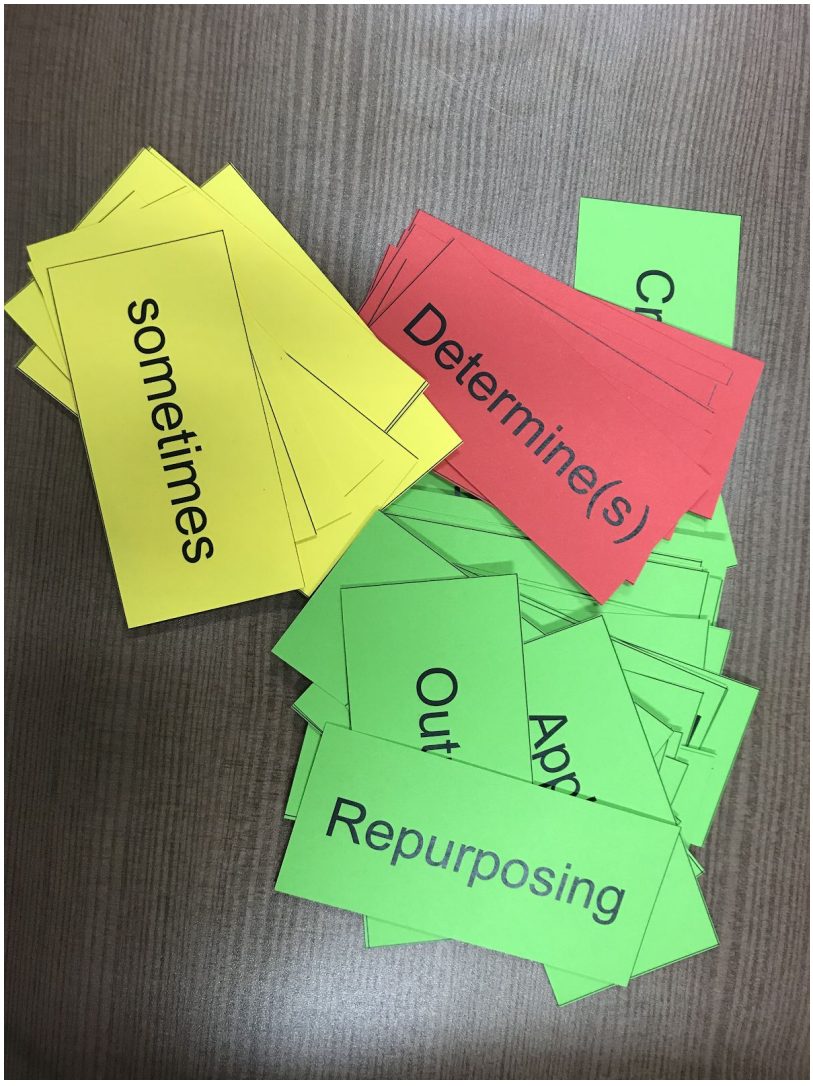
It is important to distinguish questions about a relationship between two coordinate concepts from questions that are about a single concept. For example “What elements does a community require?” is a question about the single concept of community and its attributes (awareness stage) rather than really about two concepts.

When we ask conceptual questions we invite students to make connections between two concepts to form a generalisation that may be qualified (often, can, may) or not.

Lynn Erickson calls unqualified generalisations ‘principles’ which is a useful taxonomy for us to use.

Card Sort and Connect

An extremely simple strategy to helping students name the relationship between two or more concepts is simply to give them the name of potentially relevant concepts on cards, with verbs and qualifiers on a differently coloured cards, and ask them to construct sentences they think are true based on their awareness.



Verb lists by type of relationship

Obviously there are many different kinds of conceptual relationships that can exist between two concepts. Giving students lists of verbs and asking them which verb might apply to the relationship they are looking at, can be an effective way of scaffolding understanding. Most list of verbs that appear in books, such as from Lynn Erickson, aren't sorted into typologies of relationship, and this is actually very unhelpful. Below you'll find an illustrative list of verbs sorted by type of relationship.

Concept Definition (Lynn Erickson points out these relationships are not really a conceptual understanding, but they do often appear in concept maps)

- has
- is

Vague and indeterminate (Lynn Erickson points out these relationships are so vague that they don't really mean anything apart from 'there is a relationship of some sort, but they do often appear in concept maps and sometime conceptual questions)

influence

- affects

Correlation and Proportional

- correlate
- correspond
- are proportional

Direct cause

- creates
- accomplishes
- define
- determine
- Makes

Necessary or sufficient

- allow
- require
- necessitate

Partial or relative significance

- assist
- share
- help
- Catalytic
- accelerate
- multiply
- increases

Inhibitive

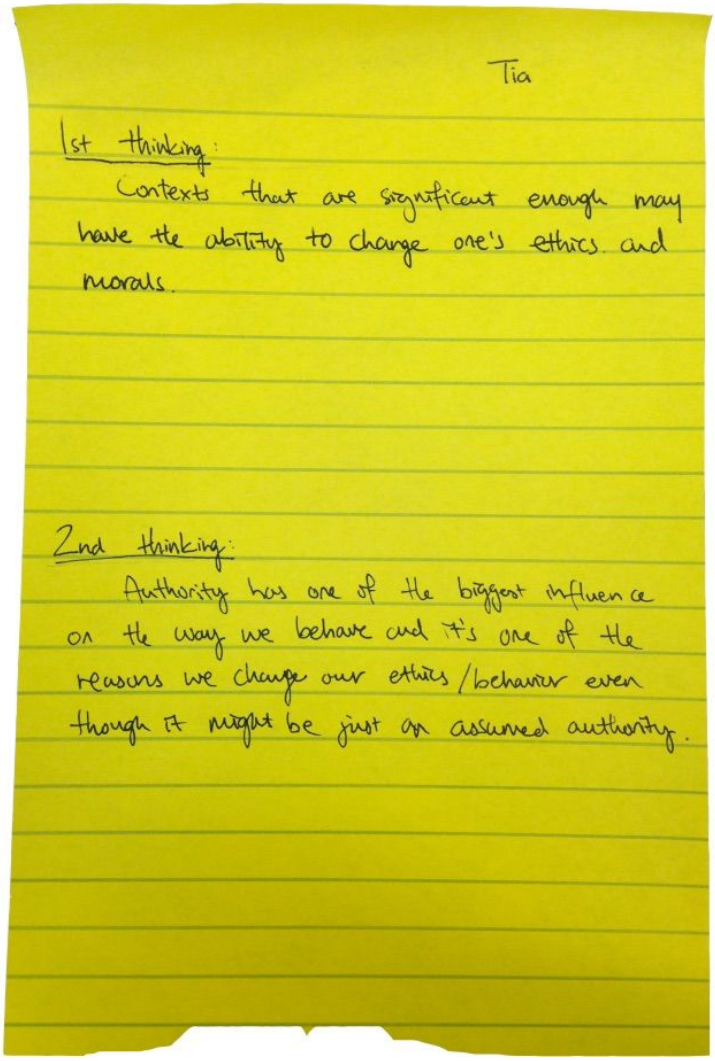
- prevent
- deter
- block

Representations

- represent
- illustrate
- demonstrate
- display
- manifest
- record

Retrieval Charts

Retrieval charts are a simple and straightforward way to help students form generalisations. Simply record attributes of case studies in the chart, and then invite students to spot what is true across the different case studies. These can start with quite functional observations and then be abstracted into a hypothesis or generalisation about the world, which can then be explored in further case studies.
Here students are constructing a retrieval chart whilst watching at TED talk about human rights abuses.



And is one of the generalisations they refined.

Breaking down relationship into steps

We often form of generalisations with a single verb as if that represents all the complexity of the relationship. A strategy that I really like, that I first saw from Adam Steele, is the chain of reasoning. So if students assert that reduced prices for agricultural crops in South America led to increased drug production and crime in North America, then inviting them to spell out each step of that causal relationship in a chain.

A variation of this activity from Adam is to use cogs instead of chain links and make the size of the cog equivalent to the significance of the step.

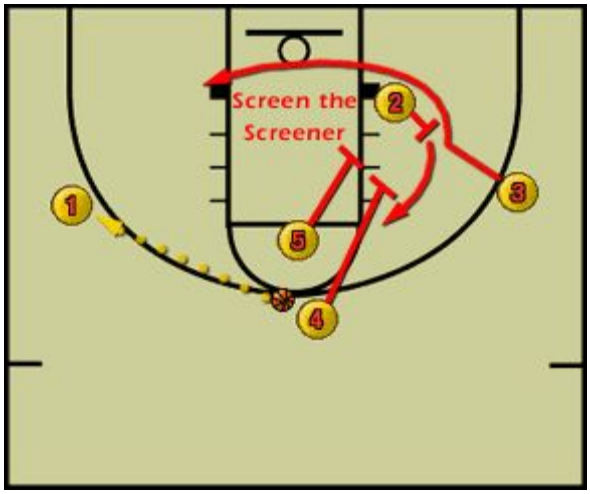
Hypothesis testing and recording

Hypothesis testing and recording is crucial part of generalisation formation. Any form of experimental cycle in which students look for evidence that the generalisation is true and case studies or examples where it does not apply would fall into this category. Again any simple retrieval chart that records “yes, it worked” and what were the significant variables, or “no, it didn’t work” and what were the significant variables, will support students in forming reliable generalisations.

Abstraction of Conceptual Understandings of Skills

Skills generalisations

Generalisations based on skills tend to focus on why, how, when, and in which contexts specific skills are powerful or effective.
Giving students the chance to record multiple examples of the skill being used and analyse when or how it's effective is a crucial crucial first step to forming a generalisation about how they might use that skill or help others use that skill.
Again, simple retrieval charts can be used, but it is likely that they might include video evidence or annotations. A key feature of these retrieval charts will be recording conditions and outcomes.



May, Can, Does

When thinking about skills we may ask students questions about how they would qualify their generalisation.

A useful typology for these is that a skill may end up with a particular outcome; can end up with a particular outcome or does end up particular outcome. This graduates the levels of certainty with which a particular outcome may be achieved. So prototyping can improve product design, does allow engineers to explore performance, and may support creative thinking.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ABSTRACTION

Abstraction of Systems

Complexity and Systems Tools

There are many situations when relationships we want students to make generalisations or abstractions about are not simple or complicated, but rather complex. This means that the relationships between variables are affected by interrrelationsships, unpredictability or emergent behaviours. This means exact predictions are hard to make, or in some cases impossible - but we can still map or seek to understand system behaviours. In a complex and interrelated world, competency with complexity is becoming increasingly important.

To understand these relationships we would normally use complexity tools.

Types of Complexity Tools

Models for complexity can be defined by their purpose: to uncover perspectives, understand systems, explore emergent behaviour, or plan for action.

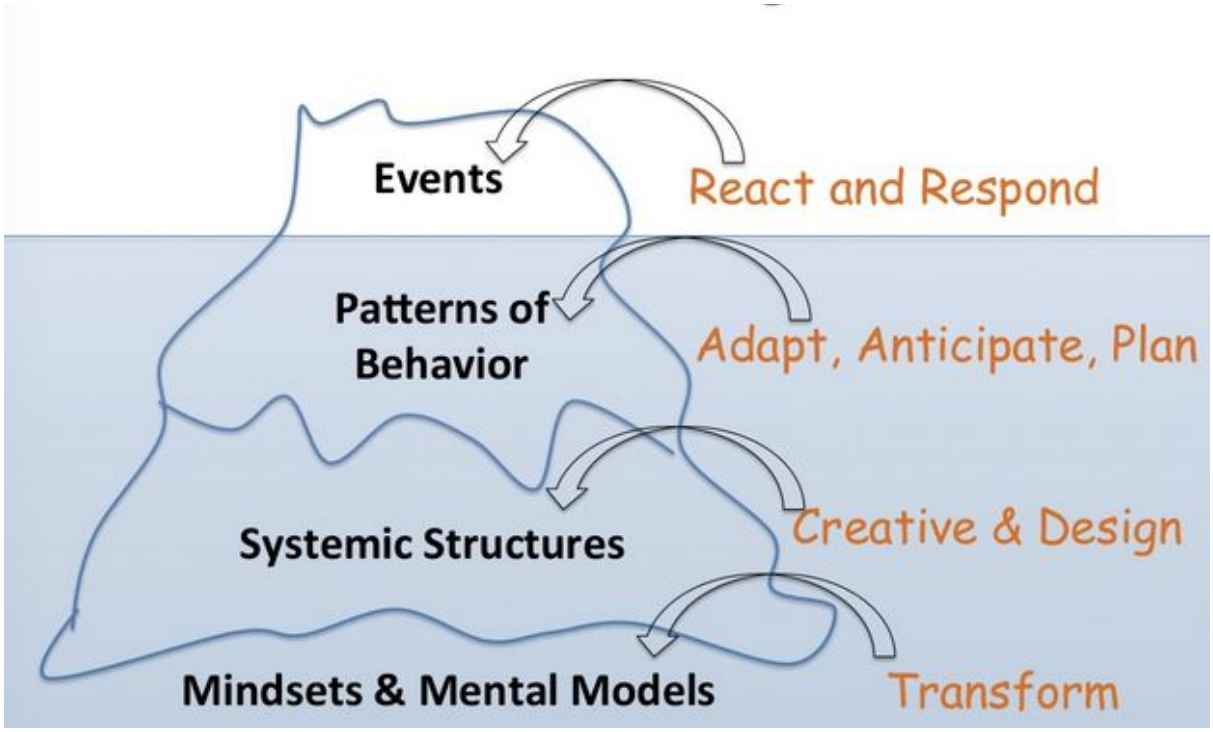
Perspective Models

The Five Ps

Useful for Introducing Concept of Sustainable Development and thus a starting point for understanding our mission and how any of our work is connected to it. A framework to start to make links between 5 pledges of the 2015 Agenda for Sustainable Development. Benefits from deeper reading of pledges in Agenda for full understanding and to understand relationships and hierarchy as this not shown in image.

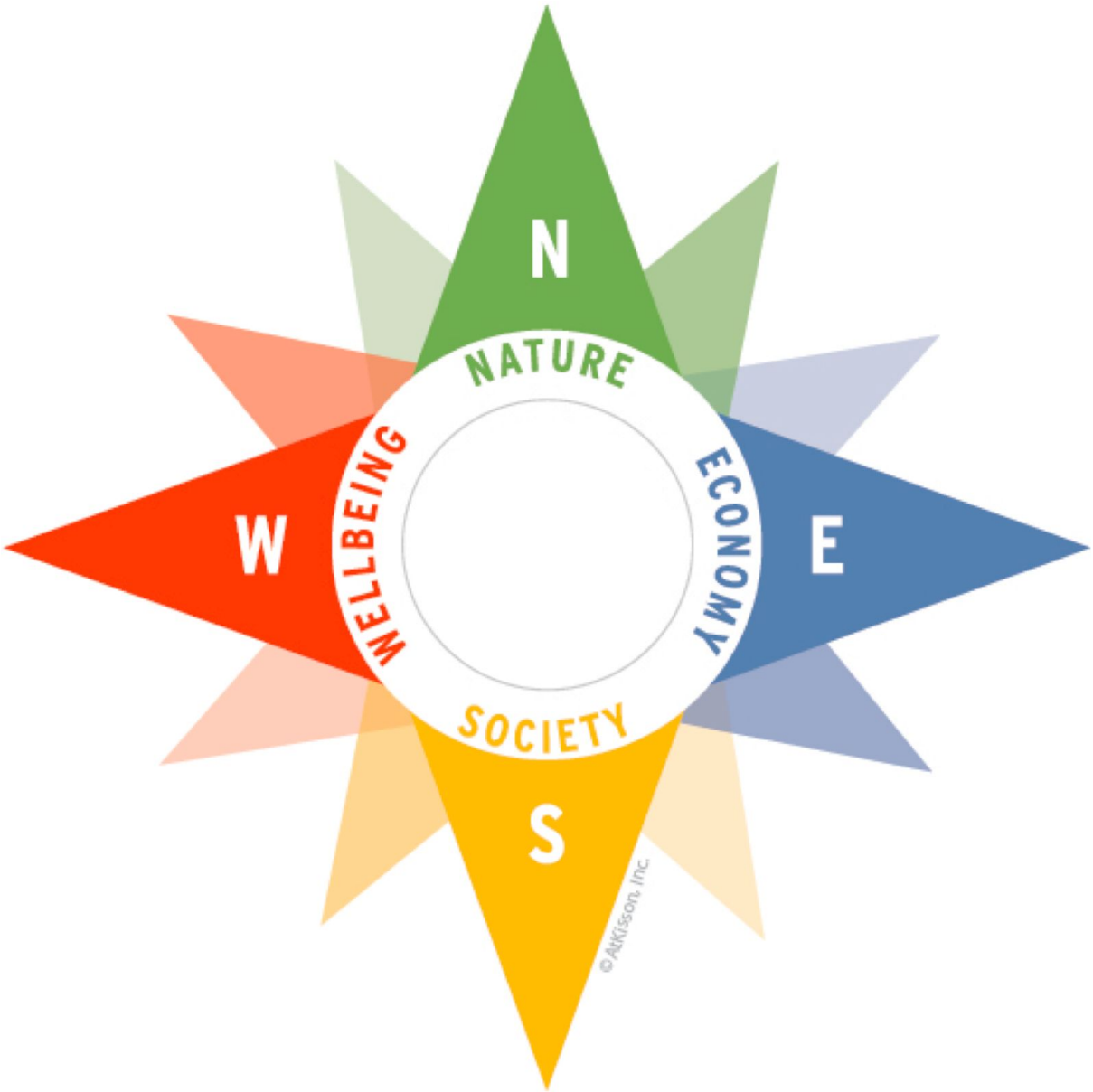
The Iceberg

Use for a deeper understanding of an issue for more effective action. To avoid ‘blame’ for behaviour. Great for quick analysis or can integrate other models (e.g Systems Map, BOTGs) for full investigation.



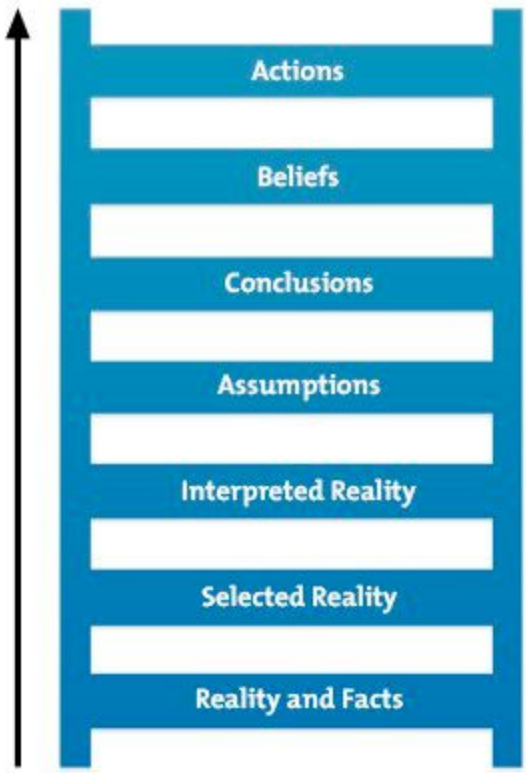
The Sustainability Compass

Good for quick, broad or deep analysis of sustainability and interconnections. The problem of categorisation leads to understanding of the connections *(doesn't this really fit here?)*
Worth emphasising in discussion the link to our definition of Sustainable Development (*Wellbeing for all within the means of Nature)* – The economic and social realms are intermediate means and ends towards the ultimate end of wellbeing not goals in their own right. Nature is the ultimate means – everything depends on this.



Ladder of Inference

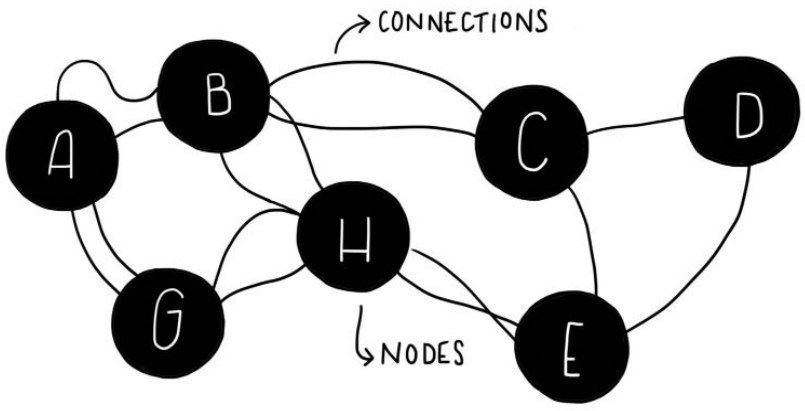
Good for questioning assumptions and biases in decision-making, debates, reviewing decisions. Need to stress backward links between rungs e.g: Beliefs affecting Interpretations.



System Mapping & Dynamics

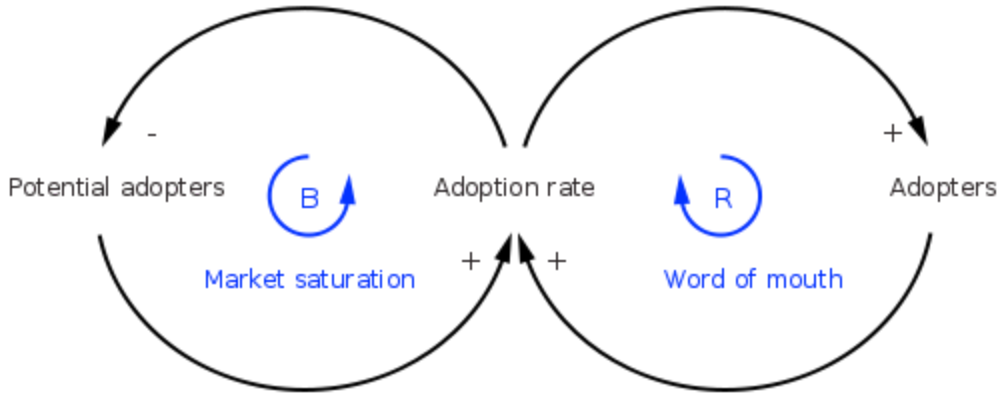
System Maps

Essential for getting the big picture of an issue as a starting point. Defining boundaries, gaining perspectives. Seeing connections.
Be aware of the fallacy of representative agent - the situation is always more complex - and also where boundaries lie. Be explicit that we chose these and no completely closed systems really exist.



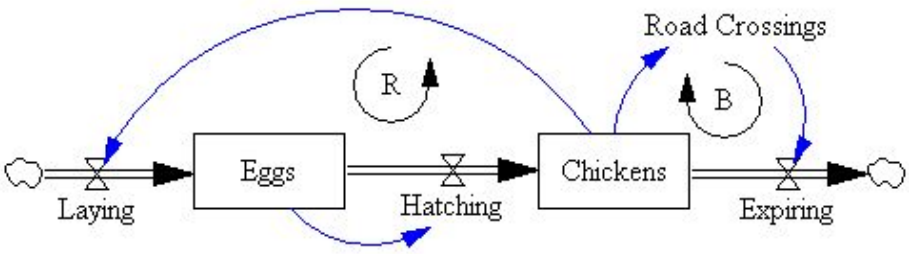
Causal Flow Chart

For a deeper understanding of drivers of system/ behaviour over time. Identifying virtuous and vicious circles.
Good to run simulations if using Loopy.
Be aware that size of effects might not be shown in simple versions and again highlight prescribed choice of boundary.



Stock Flow Diagram

Looking for leverage and drivers in a system.
Be aware that size of effects might not be shown in simple versions and again highlight prescribed choice of boundary.



String Game

A physical Systems Mapping - For understanding connections /leverage within a system in a physical way.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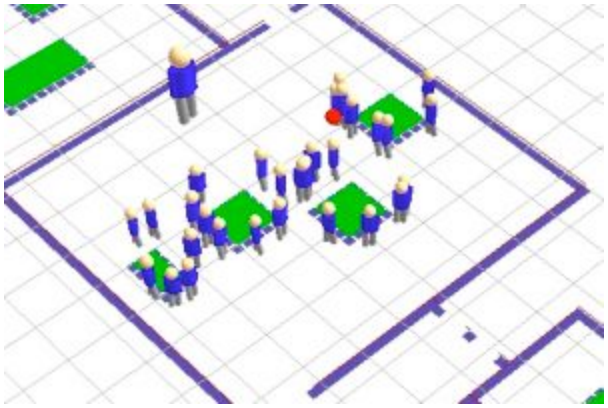
ABSTRACTION

Simulations & Emergent Behaviour

Agent Based Modelling

Good for showing emergent patterns from simple rules arising from complexity within physical and human sciences. For testing scenarios (e.g: *What if we raised taxes?)*
Useful application of simple coding skills.
Building realism into models takes time.



Process Models

Pyramid Model

Planning long term action. Encourages careful, multi-stakeholder plans. Full versions will need lots of time and use of other models to inform.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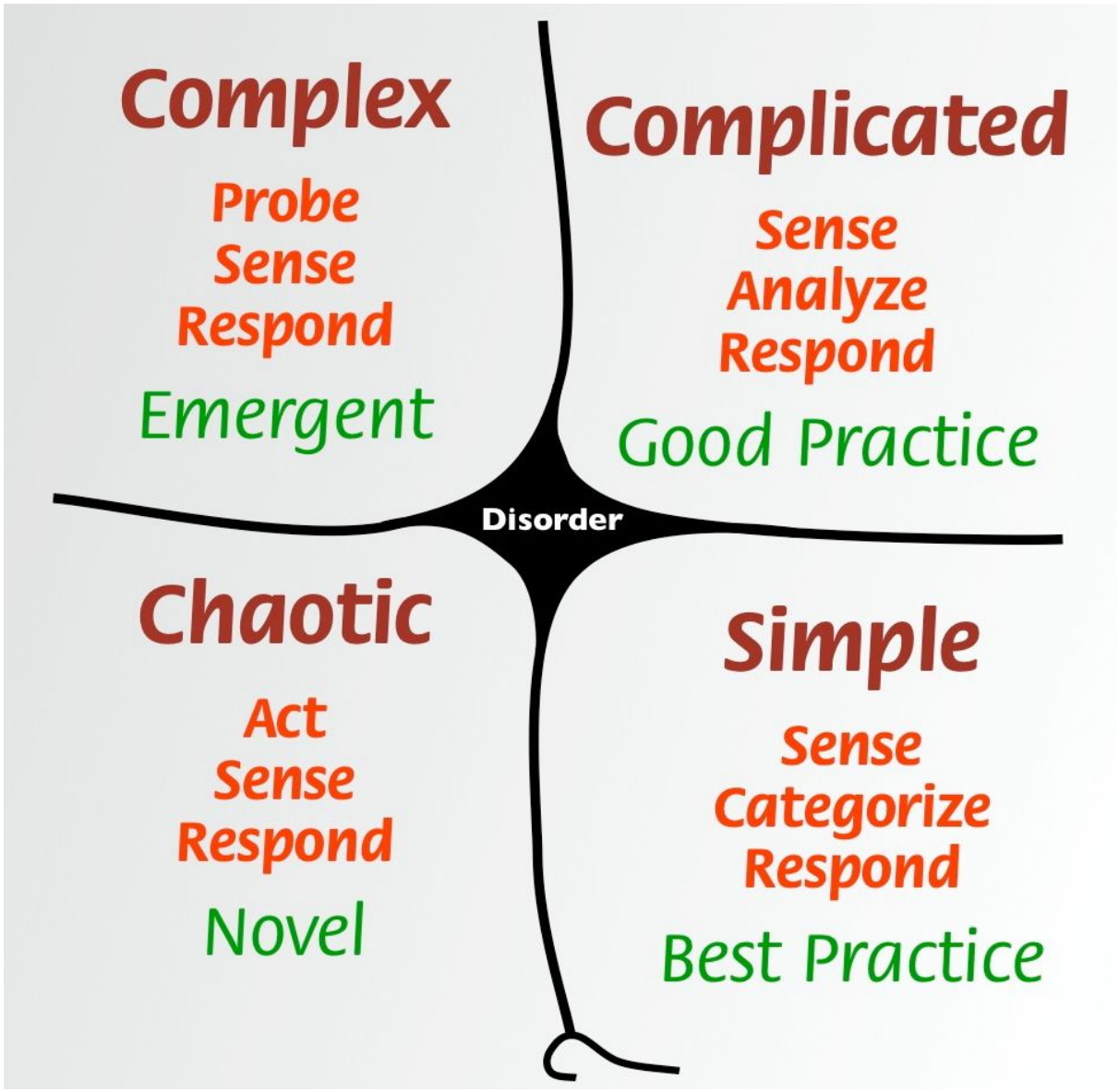
ABSTRACTION

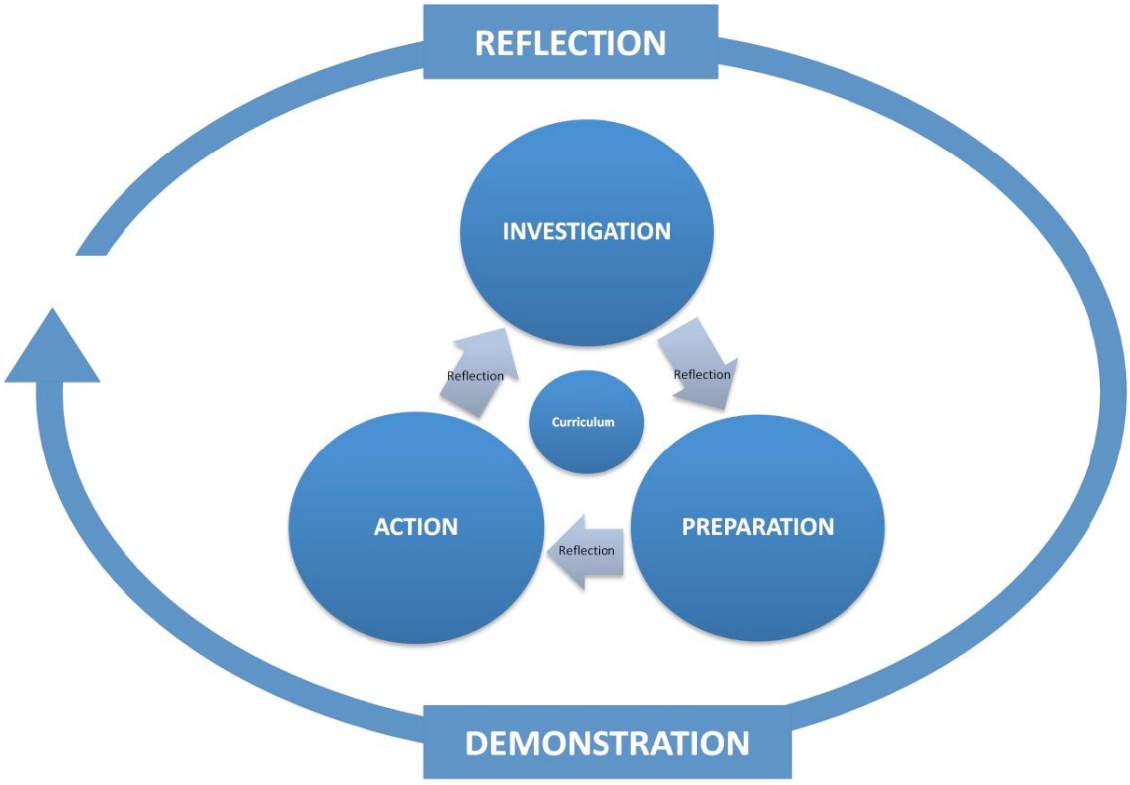
Cynefin Framework

For sensing the nature of the problem and the decision-making process.



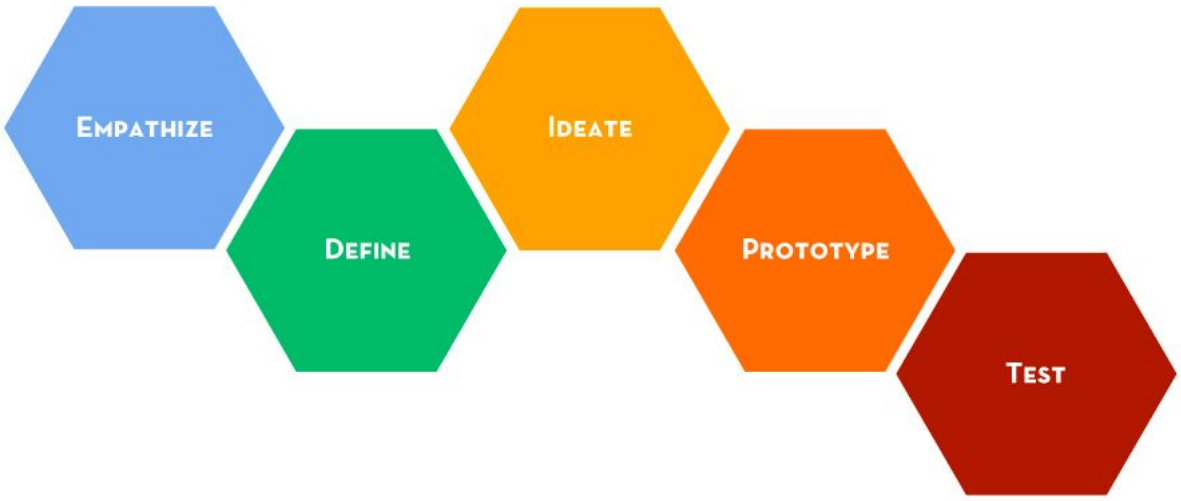
CBK Service Learning Model

The standard model for Service Learning to ensure continuous improvement in action and deeper learning.



Design Thinking Cycle

Problem-solving / For planning a solution (not necessarily involving product). Best practice incorporates complexity understanding (e.g there is never a ‘right’ solution).
Iteration is crucial which needs to be planned for.



Questioning for complexity

As well as the use of models a planned, habitual metacognitive approach is essential to understand complex systems. Encouraging the right questions will help before, during and after study.

Purpose of Questions	Typical Questions	Example Questions in UWCSEA Context
Determine where the boundaries of our system might be	How wide should we map this system? What scale is most relevant?	*Do we include the effect on local businesses partners of our purchasing policies?* *Do we need to look at the entire Drainage Basin when studying this river?*
Determine the importance of outliers in a pattern	Are anomalies more revealing than patterns?	*What can the I.B students who get plenty of sleep and experience low stress tell us?* *Do richer countries with lower ecological footprints point a path to Sustainable Development?*
Determine the relevance of the context and conditions in our study	Are these patterns the same every day?	*Would litter patterns change on rainy days?* *Are all revolutions the result of oppression?*
Determine whether a complexity or reductionist approach is most suitable	Is this really a complex problem or just complicated?	*How do we reduce food waste on campus?* *How do we adjust the school day for efficiency?*
Determine how organised or random patterns are in system	Why does this system behave this way?	*Is gender prejudice in our school mainly a result of sporadic behaviours or systemic issues?* *Are there hotspots of Biodiversity in Singapore (Extended Essay)*

Determine the intended goals of the System	Is resilience in the system really beneficial here?	*Is our GC partnership helping to reinforce existing problems rather than making change?* *Should taxes be used to deter unhealthy behaviour or raise revenue?*
Determine the role of collective / individual / planned action in shaping patterns	Who were the key agents in the evolution of this system?	*Is the role of the lone inventor / Great Man overplayed in our History Unit?* *Has Turnitin reduced prevalence of plagiarism on campus ?*

Stewardship thinking frames

Abstraction Based on Abduction

Criteria for Abductive Inferences

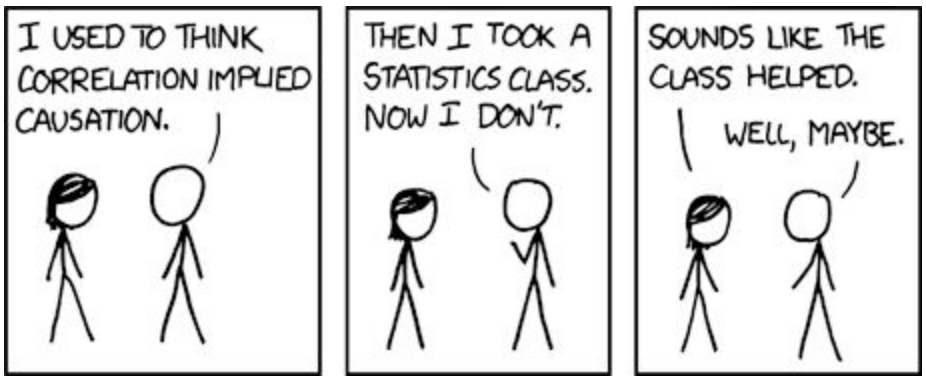
In some areas that rely on interpretation, abductive inferences are the most significant. When students construct an interpretation of a literary or artistic text some of the most important questions are:
Is there a simpler explanation with less variables? (If there is, use it)
How does this rely on implicit theories and assumptions and how valid are these to apply here?
How might others read or understand this?
How much of the text does your interpretation explain?
Are there any pieces of textual evidence that would contradict your interpretation?
If your interpretation were correct, what other inferences could you make and are all these supported by evidence?

Abstraction Based on Deduction

Deductive inferences are about what must follow from the premises or axioms. Mathematical proofs are based on deduction and so often we might be asking students, “given these axioms and this visual representation of them, what are some of the things that must essentially followed from this?”
This gives students the opportunity to identify a range of inferences and establish which ones are significant for the learning at hand.

Causal Inferences and fallacies

Causal inferences are often buried within a complex series of interrelationships. At the simplest they usually boil down to something like this:
If A then B, if B then C. Therefore if A then C.
Flow diagrams or similar can often support students thinking about what must happen if certain choices are made.
We can then ask questions about what would happen if… and students should be able to infer relationships and outcomes.



As the graphic implies, there were many pitfalls to assuming causality. A powerful exercise in supporting students thinking can be to introduce them to common argumentative fallacies

Logic - truth tables

There is a huge branch of knowledge associated with deductive logic which won't yet be covered here. Some of the tools which are most useful are logic tables that allow you to identify what must be true and given a set of axioms, what might to be true and what can't be true.

Giving students a range of premises and factors and asking them to categorise outcomes into these categories can be a powerful way to build understanding.

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

What happens if...what would have happened if...

Speculative questions about what would or might have happened if certain event did or did not occur are effective when we're in a realm in which deduction is possible. In human sciences of these speculative questions tend to be fatuous as we can never really know what would have happened if we don't know what did happen. For example asking what would have happened if Hitler had won World War II is an almost pointless speculation, as we have few grounds upon which to make solid predictions.
However in areas such as mathematics, these are very important questions. For example asking what happens if I change a variable or I reverse a procedure is a very meaningful question. In science these questions will lead to predictions.
Therefore using speculative questions can be an effective way to support learning if we feel students are in a position in which deduction can be meaningfully undertaken.
When we are physically manipulating objects or in physical education, where the behaviour of opponents or objects are relatively predictable, asking speculative questions can again be powerful to help students think through what they're about to do

Scaffolding Students' Generalisations

During this chapter we have introduced the idea of asking conceptual questions, and then illustrated many structures all visual thinking tools that can support lowering working memory in order for students to be able to form understandings about relationships between concepts.

There are many ways that students can show understanding of a conceptual relationship. In areas like physical education or language acquisition which are heavily skills based, we can often be satisfied with students showing through performance they understand the conceptual understanding of the learning has been focused on. Or perhaps we might be satisfied that by correctly choosing analogies or metaphors for the relationships between concepts they are providing evidence of understanding.

However, by asking students to explicitly verbalise that understanding of the relationship between concepts, we allow them to share, refine and improve the specificity and accuracy of their conceptual understandings. This section is about helping students to express and refined their understandings verbally.

Scenario for the scaffolding techniques which follow

Let's imagine we are teaching students about diction and literary technique in a poetry unit. In this unit we are using a "readers workshop" model where students explore ideas

in poems from an anthology or their own reading exploring ideas from a mini lesson and then sharing their findings.

Let's assume the conceptual understanding is the one below:
Writers can use literary techniques to suggest connotative and implicit meaning.

And let's also assume that we have asked the conceptual question:
How do poets use literary techniques to add to the meaning of their poems?

Our final assumption is that we have asked students to go away and use a retrieval chart like the one following to gather some examples of how literary techniques are being used in the various poems they are exploring.

(Please note that these techniques will effectively work for any subject area, and I could've given the example of a Science experiment or strategies within invasion games.)

Poem Literary Technique Retrieval Chart:

Poem Case Study	Literary Technique	Implied meanings	Relationship to main theme of poem

Conceptual Question: How do poets use literary techniques to add to the meaning of their poems?

Examples of scaffolds or supports to answer the conceptual question

Post It Note

Just ask students to write their thinking on a postit note as an exit ticket.

You can then gather examples together and see patterns in the class' understanding.

Starters and Clozes

By definition the simplest strategies to support students forming generalisations is to provide them with either a sentence starter or cloze.

For the example here we might use:

- Poets use literary techniques to.....

Or perhaps even cloze sentence

- Poets use literary techniques to.... meaning in their texts.

Note that students generalisations should be in their own language, and that although the generalisation you are teaching towards is important it is not the only way that understanding can or should be expressed. An exception to this might be in areas where a precise relationship such as in science or maths is an essential outcome of the learning. In these cases, these can be shared with the students to compare to their own generalisations once they have had a chance to do their own thinking.

First thinking, Last Thinking

A powerful exercise can be at the beginning of the lesson to ask students to write down what they expect to find, as their first thinking, and then ask them having completed the retrieval chart to write down their second thinking.
This is very similar to the visible thinking routine of “I used to think, now I think”.

So a students first thinking might read:
Poets use literary language to make their meaning more interesting.
And their second thinking might read:
Poets can use literary techniques in order to suggest subtext or hidden meaning in addition to what the poem says explicitly.

Scaffolding up student generalisations

Lynn Erickson and Lois Lanning have done a lot of work on effective questions that help students improve the quality of their generalisations.

Let’s take the last example:

> *Poets use literary language to make their meaning more interesting.*

Step One: use a checklist
Generalisations should be:

- True, which also means qualified where necessary (may, can, often etc.)
- Written in third person (people can…)
- No proper nouns.
- Descriptive rather than normative. What Erickson calls ‘value free’. So they should not say ‘should’ or ‘ought’.
- Active voice, not passive where possible (as the passive voice speaks of the effects of action, not the agent responsible for the action itself)
- Use verbs that as clearly as possible describe the relationship. Avoid ‘has’ and ‘is’ as these are about concept formation not relationships between concepts, and avoid very vague relationships like ‘affect’ or ‘influence’.

In this case the generalisation just falls foul of the first; by suggesting this is always the case, the generalisation is not true.
We can remedy this by:

Poets can use literary language to make their meaning more interesting.

Step Two: ask how or why?
Students and indeed everybody's, first of generalisations can often be quite low-level and and vague.

To remedy this we can simply ask students: **How? Why?**

Question: **How** can poets use literary language to make that meaning more interesting?

Answer: Poets can use literary techniques in order to suggest subtext or hidden meaning in addition to what the poem says explicitly.

This allows students to reach a greater specificity of thinking and often involves concepts which are implicit but not explicit in their first thinking. This is what Lynn Erickson and Lois Lanning call a level two generalisation.

Step Three: so what?
We are often happy with level two generalisations, but to see this generalisation in a greater context we can additionally ask "So what?". This challenges students to suggest reasons why this understanding is important in relation to other things that they understand about the discipline or the world.

Question: So What?

Answer: poets can explore connotative meaning to suggest that the physical world is numinous or pregnant with meaning that transcends the literal.

This generalisation is what Lynn Erickson calls a level three generalisation. She suggests they are most useful for extending and challenging students, and that we normally teach to the level two. I think this depends a great deal upon context and discipline.

Checking Subordinate Concepts

If we take the example generalisation we have formed:

Poets can use literary techniques in order to suggest subtext or hidden meaning in addition to what the poem says explicitly.

And we know that each concept nests smaller concepts, and within those examples, we can explore and check our generalisation in a subordinate concepts and case studies table such as the one below.

As students to draw lines between any of the Poets or Techniques and evaluate is the generalisation true here or not?

<table>
<tr><td colspan="3">Writers</td><td rowspan="4">Use</td><td colspan="4">Literary techniques</td><td rowspan="4">to imply hidden meanings.</td></tr>
<tr><td colspan="3">Poets</td><td colspan="4">Metaphorical language</td></tr>
<tr><td>European Poets</td><td colspan="2">British Poets</td><td>Metaphor</td><td>Synecdoche</td><td>Personification</td><td>Objective Correlative</td></tr>
<tr><td>Metaphysical Poets</td><td>Elizabethan Poets</td><td>Early Modern Poets</td><td colspan="4">Metaphysical Conceits</td></tr>
</table>

Substituting our way to conceptual generalisations: Proper Nouns to Common Nouns and Concepts

Students might initially be much more confident writing a generalisation about the specific case study there looking at before considering the broader concepts that the case study illustrates.
A simple way to support this is ask students write a generalisation that is true for the case study such as:

John Donne can use metaphysical conceits to suggest erotic desires.

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We can then help students scaffold this up identifying the proper nouns and to each one asking what it is an example of and seeing if the sentence still works.

Prompt:
John Donne **- can use -** metaphysical conceits **- to suggest -** erotic desires

Is an example of?

Metaphysical Poets **- can use -** conceit **- to suggest -** hidden thoughts. ✓

Is an example of?

Early Modern Poets **- can use -** metaphor **- to suggest -** subtext ✓

Is an example of?

Poets **- can use -** literary features **- to suggest -**Implicit meaning ✓

We can see how at each row, the supraordinate concept is substituted for the subordinate concept, and the sentence is sense checked. This allows us to go from the concrete to the conceptual within the framework of the senten

Application

Transfer and Redundancy

Educators talk a lot about transfer, which means when students apply conceptual relationships that have been learnt in one context to new group of examples or set of relationships. So for example if I understand the conceptual relationship of being inversely proportional to distance and proportional to size in the context of interplanetary gravitation, some economists use the same set of conceptual relationships to describe the expected volume of trade between countries. It is often proportional to the size of their economies and inversely proportional to the distance between them. Notice that in economics this is a qualified relationship ('often') whereas for interplanetary gravitation it is a determined relationship.

The transfer of skills again is an expected outcome of concept based skills learning. So for example if you learn that breaking the advantage line in football creates opportunities for scoring, you understand that the same thing applies to rugby without having to learn again from scratch.

Transfer makes this sound like quite an abstract process - and perhaps a more useful word is the word that database and information specialists use, which is redundancy. If I can use the same routine twice or the same piece of information twice, I should not need to record it twice, but rather record it once and then remember where to use it. The same thing applies here.

Sometimes the situations for transfer are extremely similar, and this is what David Perkins calls near transfer. An example of this might be that once I've learned to ride a bicycle, then riding a tricycle, or even a unicycle reuses lots of skills I already learnt and I only need to make small adaptations in order to reuse what I have already learnt.

High Context and Low Context understandings

We could classify understanding according to the extent to which the relationship described is determined by context. This same classification would tell us how easy it is to transfer this understanding to new case studies or examples. Mathematical understandings for example will be extremely low context. The properties of a circle and the relationship between interior angles of regular polygons to each other, vary extremely little over contexts. In many process based subjects like the arts, process understandings transfer very well across different media and contexts. In areas such as the human sciences, there is less certainty of transfer and at the extreme end of this will be disciplines like History in which there are extremely few or no universally true statements about the way things are or have to be. In the case of History what is transferable are methodological understandings (like Historian's divide causes into short term, long term and trigger in order to understand events) rather than content understandings.

Asking students explicitly "what kind of case studies will your understanding apply to and where will you have to be careful about not overgeneralising?" is an important part of building students' ability to apply their understanding.

New Case Studies or Problems

The simplest form of transfer, which are all teachers are familiar with, is simply to present new case studies and ask students to what extent their existing understandings make sense of the case study and where do they breakdown or fail to provide explanations. We all as teachers know that this is normally carefully scaffolded from a transferring single understanding in a familiar context to transferring and identifying multiple points of transfer in more complex contexts.

There are many questions that we can ask to support learners in transferring a conceptual understanding from one context to new context.

- What are some other similarities in this case study two case studies you have generalised about previously?
- Which elements of this case study have a equivalents in the prior case study?
- Which relationships between elements in this case study function in the same way as the previous case studies you have generalised about?
- What is exceptional, local or specific to this case study?
- Which relationships in this new case study do your prior generalisations describe?
- On the basis of the similarities between this case study and your generalisation, what inferences are you able to make?
- Where you are problem-solving, which strategies and sequences are likely to be effective in this context given your prior generalisations?

Metaphor and Analogy

Interestingly the word metaphor literally means transfer, and can be seen on removal lorries in Greece. When we realise that one thing we're looking at in fact has the same properties or relationships as something we already, know we frequently jump straight to a metaphor. So for example, swinging a yo-yo around your head you may suddenly realise that the string is acting a bit like gravity and say "my gosh this is just like a planet's rotation". The metaphor allows us to express the application of understandings we have already gained in a different domain.

Analogies are even more extensive versions of this. And we always have to be careful with analogies that they are in fact valid. So for example, people in the middle ages regularly used the analogy of the body politic. Claiming that the natural organisation of society was like body, with the king as the head, the army as the hands, the common people as the muscles and bulk and perhaps the church as the heart. So they took the

interrelationships understood in the body, and applied this do something that they were struggling to understand which was social organisation. Of course analogies can create false assumptions as much as they can illuminate the nature of relationships.

Asking students to form analogies between existing knowledge and new contexts is an excellent way of stretching and applying their understandings.

Asking students to examine the validity of this is also extremely important.

So for example, you could ask students “to what extent is the metaphor of a chain of command helpful or unhelpful in understanding military leadership?”

Experiential and Service Learning

Any complex embedded task or experience such as those which are a part of experiential service learning by virtue of the diversity of its components and contexts will require an enormous amount of prior understandings to be deployed. Explicitly scaffolding these experiences in order to require transfer of existing understandings to new contexts is an important part of the application phase of learning.

There are four types of Service Learning Action we might consider as sites of transfer:

- Direct Action
- Indirect Action
- Advocacy
- Research

Problem and Project Based Learning

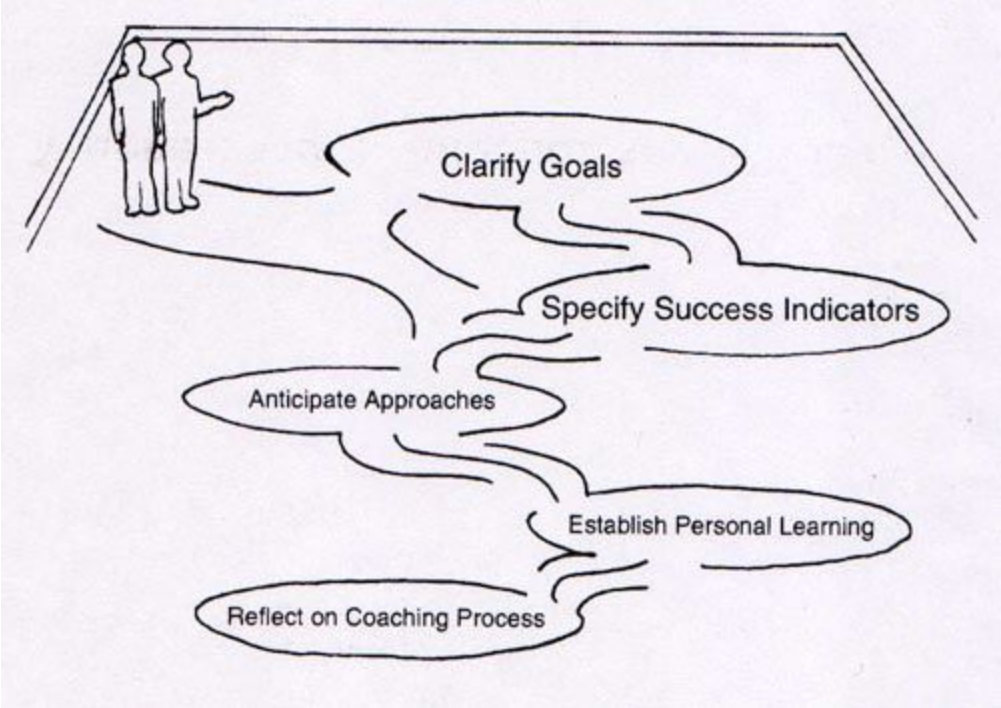
Problem based or project -based learning is often used as a methodology for teaching in which praxis proceeds theory. There are certain contexts in which this is possible and perhaps even beneficial, but it is much better used as a strategy for application of learning.
Creating rich, engaging and authentic problems for learners to work upon allows them to experience the joy and moral satisfaction of having an impact on the world whilst also providing rich opportunities for learners to transfer their understandings to new contexts.

Break Out Boxes

A variation of problem based learning is the short, intense ,curated experience of a breakout box. Again teachers can create authentic tasks to require students to deploy understanding to solve problems in order to breakout. This is better used as a strategy to transfer learning than a strategy to learn new knowledge, skills and understanding.

Planning Conversations

Transfer of learning to new contexts may be as simple as a planning conversation in which students reflect upon the learning and identify places where they can apply that learning in new contexts.



+ Deliberate Practice

We've all had the experience of thinking that we know the rules of a game and then being thrashed by an expert. An important part of learning is deliberate practice in which we learn expertise in the form of tacit knowledge and heuristics about when and how use what we have learnt. When we do this, we change conscious-competence into unconscious-competence.

Deliberate Practice

Levels of Competence

We can think of all learning engaging at different levels of competence.

- There is **unconscious incompetence,** when I do not even realise that I am not very good at doing or understanding something.
- At the stage of **conscious incompetence** I become aware that my current skill or knowledge level is not adequate, but I have net yet learnt what I need.
- At the stage of **conscious competence** I have learned the rules and done some practice and with conscious effort I can use my learning.
- At the stage of expertise I cease to need to pay conscious effort to making choices in the moment, and develop **unconscious competence.**

Many curriculum frameworks, especially concept based ones, stop at the level of conscious competence. But this is problematic for a number of reasons.

Both understanding but more strongly skills require high levels of volume and stamina in order to move to unconscious competence where we can rapidly and intuitively adapt our use of learning to match. This is what we call expertise.

At the stage of unconscious competence I can rapidly transfer and adapt what I have learned to contexts and situations, often without having to consciously plan steps. We can also call ourselves experts at this stage.

Dreyfus and Dreyfus' (1986) description of expertise, defined it as consisting in learning 'a prioritising procedure' for decision making when 'the number of recognisable elements which an individual sees in a concrete situation becomes overwhelming' and when the simple rules ... 'quickly become a barrier to the learning process and must be put aside in order for the novice to advance.' (Dreyfus, Dreyfus 1986).

Their work inspired Andres Ericsson whose work on 10,000 of deliberate practice has become famous.

Herbert Simon in "Sciences of the artificial" makes an extremely similar point, when he points out that all neatly arranged hierarchical knowledge, such as that which might be gained through traditional concept base teaching-learning, ignores nuances of context and cross-links between concepts which become important when you start thinking about the idea of expertise in practice. This is not rote repetition, but rather high volumes of contextualised and intentional practice with feedback. Research in the field from military aviators to chess players backs up his theory that the move from conscious competence based on explicit learning, to unconscious competence a based on high volumes of contextualised practice, is enormously significant.

The kind of expertise that develops with practice is also often called tacit knowledge because it relies on heuristics and subroutines that even the learner is not entirely consciously aware of.

A classic example of this comes from Hutchins's Cognition in the Wild. Hutchins uses the example of the Micronesian navigators' ability to judge large distances on the open sea by an estimation of 'a day's sail' adjusted to conditions such as tide, wind, the boat's performance and weight as a 'judgement [which is] is probably the sort of skill that no practitioner can describe in detail' (Hutchins) It is a tacit, deeply internalised ability to apply knowledge to context.

If we want learners to be expert writers, artists, thinkers, collaborators, change agents we need to teach them a lot more than the rules. We need to go through the stages of awareness, abstraction and application and then move them into the realm of deliberate practice.

Conditions for high volumes of practice.

The difficulty for any educator is that deliberate practice, while worlds away from the idea of rote repetition, can unfortunately turn into this without the right conditions in place. Readers and writers workshop is one of the rare pedagogies that clearly create conditions for deliberate practice. It is interesting to explore the conditions they think are essential.

- Learners must have freedom to choose what to work on
- Learners must work on something that is real and has a real audience and purpose in the world
- Learners must be given sufficient time to practice
- Feedback should come from authentic audiences and should be tailored and personalised to their aims not standardised
- There should be high levels of trust and cooperation in the learning environment

- The learning environment should be flexible to allow students to work how and where they need as they practice
- Learners should be able to share successes frequently and easily and to share frustrations and challenges
- Self-monitoring of learning should be at the core of assessment practice
- One-on-one mentoring and reflective conversations should support the learner in setting goals
- Learning should be made visible and recorded in the form of post-its or observations

All of these conditions one might well apply to what it means to be great scientist, a great designer or a great change agent. Whilst the Triple-A is essential in setting learners up for success, these are necessary but not sufficient conditions for expertise. The plus deliberate practice is an essential part of student learning if we really want to create independent, passionate and expert learners.

Gamification

Gamification is often used as a strategy for initial learning, but is much better deployed as a strategy for deliberate practice. Although advances in this area are limited, simulations and gamification that give learners a chance to experience volume and stamina are very important. Just as trainee pilots will spend a great deal of in flight simulators, so we should be able to create gamified environments in which learners can develop expertise and physiques.

Appendices

Examples of AAA+ learning sequences

- In **Art** I might become aware of different kinds of shading and texture. I am also aware of the creation of a sense of depth in different drawings and sketches I learn about. I form a generalisation that artists can use shading and texture to create the illusion of depth in art. I feel quite confident about this, but my Art teacher challenges me to apply this understanding to relief sculpture and see what is different or similar. I adjust my understanding to include the use of shadow and perspective. (application) I then want to get really good at doing this in my own work, so I practice and use mentor texts and get feedback to really hone my skills.

- In Science
- In PE
- In Infants School UOS
- In PSE
- In Language and Literature

Although learners and educators can loop back at any stage, the fundamental point is that awareness should come before abstraction, abstraction before application and deliberate practice should follow, not precede this learning.

Assessing Conceptual Understanding

Assessing conceptual understanding is not as important as the journey towards conceptual understanding.

All the tasks below assume that students had the opportunity to construct their own understandings rather than just learn verbal definitions.

This should be a ‘map of a well-known territory’ for all teachers, the model just simplifies and arranges what teachers already know about learning to explicitly allow for conceptual growth.

Stage of Learning	Task	Example prompts
 Awareness	Identify and name examples of the attributes of the concept	e.g. What attributes must something have to be considered living?
	Identify examples and non-examples of the concept	e.g. sort these shapes into regular and irregular polygons; or ‘find the odd one out’
	Identify the concept if given examples, non-examples or definition	e.g. what concept label would you give to these images of living things? Which is the odd one out?
	If given concept, can differentiate critical and variable attributes	e.g. when writing a Sonata, what choices does a composer have, and what constraints are assumed?
	Can name supraordinate and subordinate concepts	e.g. metaphor is an example of which other concepts?
 Abstraction	**Differentiate coordinate concepts**	What is the difference between reproduction and cell division?
	Name concepts which are related to the concept	Create a mind map (not a concept map) showing connections between the idea of Epic Theatre and other related concepts
	Identify misconceptions (erroneous or non-existent relationships between concepts)	Hinge questions
	Choose an appropriate verb to define the relationship between two or more concepts	Create and label a concept map correctly when given concepts on cards

	Choose an appropriate verb to define the relationship between two or more concepts and select an appropriate qualifier	Use sentence stems and qualifier cards to construct valid sentences about concepts being explored and explain use of the qualifiers
Application	**Solve a problem using the conceptual relationship**	**E.g Infer the value of a variable or condition (concept) given other conditions. E.g. 'Explain how reliable we might judge this historical source is given what you know about the context of its production and the concept of ideology' or 'What are the possible masses of objects A and B, given their interaction in the diagramme?'**
	Respond to a scenario using the conceptual understanding	If pressure is increasing but temperature is not going up, what else might be happening?
	Explain an outcome using the conceptual understanding	Why did literacy increase in Cuba even though GDP was not growing?
	Describe in different contexts or situations for which the CU can be applied using the terms Always, sometimes, never…	When does quantitative easing encourage economic growth?
	Explain which coordinate, subordinate or supraordinate concepts the relationship is also true for.	If for a downhill soap box derby racer, mass, counterbalanced by rising friction and drag, can be used to increase acceleration and terminal velocity, which other kinds of vehicles or movement is this true or not true for and under what conditions?
+ Deliberate Practice	**Assessment of deliberate practice is an assessment of expertise, so would involve both performance and expert contextualised analysis. They are by definition 'holistic' or 'synoptic'. The judgement involved in assessment is also qualitative primarily although might involve quantitative aspects like speed or accuracy.**	Complex debugging and analysis of a practical solution to a problem. Composite and contextualised performance. Completion of a process in context (writing process, design process, artistic process etc.)

Bibliography

Dorothy A. Frayer - 'Working Paper No.16 A Schema for Testing Level of Conceptual Mastery' , Wisconsin Research and Development Centre for Cognitive Learning, Uni of Wisconsin, April 1969

David N. Perkins - 'Transfer of Learning' International Encyclopedia for Education, Second Edition, Oxford 1992

Concept maps and Vee Diagrams

When we are exploring multiple relationships between concepts that we have become aware of, we can use slightly more elaborate tools to map these relationships. A staple is the concept map, designed along with the guidelines from Novak.

More information can be found on the concept blog here at https://uwcseaconcepts.wordpress.com

When we are particularly interested in how to build conceptual understanding through the methodologies of a particular discipline, then Gowin's V diagrams are extremely useful.