KNOWLEDGE: WHAT IS IT AND HOW IS IT ACQUIRED?

Working Towards Task #2

The information is these slides is based on Hattie, J. and Yates, G. 2014. *Visible Learning and the Science of How We Learn*. Routledge: London, chapters 13-14.

TASK: PLANNING

Pre-service teachers are to produce a unit plan that satisfies accredit item work program requirements for their teaching area specialisation. Included in the unit plan will be a sequence of lessons that contribute to the unit, a piece of assessment and a suitable guide to making judgments. Pre-service treachery will need to include reflections on how the unit satisfies culturally sensitive approaches for the implementation of literacy, numeracy and digital literacies demands, and indicate where these will occur.

WHERE TO START?

We need to understand the nature of knowledge and how it is acquired

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'What you already know determines what you can learn and how you can think. Learning proceeds quietly and efficiently when what is new is built upon what is already secured.' (Hattie & Yates, 2014, p. 126)

WHERE TO START?

Types of Knowledge (after Hattie & Yates, 2014, p. 127)

Type of Knowledge	Description
Sensory Recognition	Declarative knowledge
Strings	Declarative knowledge
Ideas	Declarative knowledge
Schemata	Declarative knowledge
Mental models	Declarative knowledge
Procedural knowledge	Procedural Knowledge

TABLE 14.1 Types of knowledge

KNOWLEDGE TYPE	RELATED TERMS	FUNCTIONS	EXAMPLES
Sensory recognition	Visual memory Tactile judgement Auditory discrimination	You use sensory inputs with precision and expertise in making sensitive judgements.	Knowing basic shapes, patterns, and substances. Able to judge distances. Knowing when the dough mix is the right consistency.
Strings	Serial ordering Sequences Chains Simple associations	You can access short manageable bursts of information without any specific need for elaboration.	Telephone numbers. Lines of poetry. Multiplication tables.
Ideas	Propositions Subject and predicate Object properties Facts	This allows units of information to be stored as relationships between discreet entities.	Glass is made from sand. Mary is married to Frederick with two children. The major population centre in West Australia is the beautiful city of Perth.
Schemata	Concepts Abstractions Script The big picture	Ideas are not isolated but are grouped into a higher level of organisation providing scaffolding and structure.	All countries will have a capitol, exports, money, and so on. Anything used to move things is a *vehicle*, for instance a cup is vehicle, and so is a legal contract.
Mental models	Problem solving Hypothetical thinking	Ideas and schema are used to simulate different possible versions of reality.	*What would happen if the poles melted?* *Suppose the cell membrane failed to block the attack?*
Procedural knowledge	Actual skills Task analysis If–then contingencies Automaticity Conditional knowledge	When a situation develops, you produce the right sequence of responses, at the right level of intensity and correct timings, in achieving a goal in real life, in real time.	Knowing how to skim read. Calculating the area of a block of land. Fixing flat tyre on your VW. Knowing how to act professionally when assailed by a rude parent.

Types of Knowledge (after Hattie & Yates, 2014, p. 127)

SENSORY RECOGNITION KNOWLEDGE

Mastering Sensitive discriminations

- How our mind relates toward information within our immediate sensory experience
- Uses visual memory, tactile judgement and auditory discrimination, for example
- Eg. The difference between a

SENSORY RECOGNITION KNOWLEDGE

Mastering Sensitive discriminations

- How our mind relates toward information within our immediate sensory experience
- Uses visual memory, tactile judgement and auditory discrimination, for example
  - 'Watch out for the white bird with large speckled head!'
  - Visual information with personal meaning such as faces of people we know
  - Identifying sounds with great sensitivity such as the sound a computer makes when turned on
- Experience allows us to use sensory recognition to make fine grained judgments eg. The flight of a ball or when a roast is cooked

SENSORY RECOGNITION KNOWLEDGE

Mastering Sensitive discriminations

Cristiano Ronaldo:

https://m.youtube.com/watch?v=aoScYO2osb0

SENSORY RECOGNITION KNOWLEDGE

Mastering Sensitive discriminations: **Application**

- Being able to match gradations of sensory input with outcomes and recognize the nature of available feedback
  - Attention to fine grain details is important
  - Learning is typically non-verbal in the first instance
  - Appropriate vocabulary can then be developed
  - Initial learning is fast but difficulties in conveying discriminations can occur
    - Eg. A chef shouting 'Mix the batter to the right consistency!' may be unhelpful
- Is the reason why feedback from teachers may not be received, understood or acted upon by the learner

STRINGS

How we handle simple associations

- Often known as serial orderings some but also as associations
- We often acquire 100s in our lifetime:
  - A B C D _____
  - We all live in a yellow _____
  - He took it hook, line and _____
  - To be or not _____
  - Supercalifragilistic _____
  - Your telephone number is _____

STRINGS

How we handle simple associations: **Application**

- This is not 'rote learning'; instead, 'rote learning' may actually refer to the acquisition of serial orderings
- It is a sequence easily rehearsed over a brief time frame
- They are acquired through deliberate focus and repetition
- Use the well-known ***look-say-cover-write-check*** method often used to teach spelling in early years

IDEAS

Knowledge as Propositions

- Ideas describe the next level of complexity
- They are propositions about things and commonly link one entity with other properties
- For example:

  The major population centre in West Australia is the beautiful city of Perth

- Five separate ideas

IDEAS

Knowledge as Propositions

- Ideas describe the next level of complexity
- They are propositions about things and commonly link one entity with other properties
- For example:

The major population centre in West Australia is the beautiful city of Perth

WA must have several towns

Perth is a city

Perth has more people than any other place in WA

Perth is probably the capital city

Perth is pleasant

IDEAS

Knowledge as Propositions

- Notion of idea implies linkages at the level of conceptual meanings rather than simple strings
- New words are tied to previous vocabulary and allow a refinement of ideas as their properties are added into your mental network
- People process information at the level of ideas when using their own language and meaning takes precedence, for example:

WA must have several towns

Perth is a city

Perth has more people than any other place in WA

Perth is probably the capital city

Perth is pleasant

The largest city in WA is Perth, which is a lovely city

IDEAS

Knowledge as Propositions

- You only realize there is a difference when you compare the two sentences:

The major population centre in West Australia is the beautiful city of Perth

WA must have several towns

Perth is a city

Perth has more people than any other place in WA

Perth is probably the capital city

Perth is pleasant

The largest city in WA is Perth, which is a lovely city

IDEAS

Knowledge as Propositions: **Application**

- Ideas are acquired through exposure to factual information
- Verbal or written – doesn't matter provided attention limits not exceeded (15-20 mins max)
- Limits on how much can be assimilated
- New ideas are meaningful once related to prior knowledge that leads to elaboration

Best Way: ask 'Why is this fact true?'

- This will make links explicit and avoid creating 'islands of knowledge'

SCHEMATA

Knowledge becomes organised

- The basic units though which structure and organise our knowledge
- Deeper meaning occurs and the 'overall big picture' emerges
- Provides the frames to make sense out of ideas and facts that would otherwise be 'islands of knowledge'
  - For example: schema for 'country'
    - Wellington is a capital of NZ and can be added to other knowledge such as

SCHEMATA

Knowledge becomes organised: **Application**

SCHEMATA

Knowledge becomes organised: **Application**

- Not easily acquired as the level of organisation is complex
- Concepts or ideas are learned readily (after 3-4 exposures) schema can take many years
- Schema refinement generally begins once a realisation that existing ways of organising knowledge is inadequate
- Based on Piaget's notion of disequilibrium and that we make subtle adjustments to accommodate incongruent data

MENTAL MODELS

Putting Schemata to work

- Are something you can run entirely in your head and enable you to simulate reality
- Enables you to engage in problem solving calling on all available schemata
- Eg. Solving a problem on your home computer
- Allows 'if-then' thinking to be given free reign
- Although mental models allow hypothetical thinking, the outcomes are tied to reality and dependent on:
    a. The availability of accurate knowledge
    b. The ease such knowledge can be stored and handled in working memory

MENTAL MODELS

Putting Schemata to work: **Application**

- The conditions we acquire mental models are poorly understood
- Known to involve:
  a. exposure to individuals who display abstract thinking
  b. experiences of challenge
- Expertise developed over time allows the ability to construct mental models with ease
- Examples:
  a. the construction of the idea of 'evolution' in the school curriculum
  b. the development of lesson and unit plans for ITE students

PROCEDURAL KNOWLEDGE

Learning Actions

- Implies a sequence of sub goals

Example:

- Do you know how to change a tyre? How many of you have actually done it?
- A task is broken down into a series of 'if-then' contingencies

PROCEDURAL KNOWLEDGE

Learning Actions: **Application**

- Relevant to cognitive function as well as well as physical or motor activity

Example:

- Knowing how to read and comprehend text requires certain procedural skills for certain genres and certain outcomes to assist in knowing when
  a. To read quickly
  b. To read text again
  c. To read strategically (such as for a research assignment)
- Enhanced by following worked examples

PROCEDURAL KNOWLEDGE

Learning Actions: **Application**

- Enhanced by following worked examples
- Recognise that procedural learning is:
  a. Slow
  b. Requires much feedback and extended practice
- Once mastered becomes the basis for action and expertise through behavioural chaining and automaticity
- To avoid overload, backward training is essential for teaching difficult skills

BRINGING TOGETHER

- This analysis of knowledge is based on cognitive psychology
- Different to curriculum-based knowledge structures such as Bloom's Taxonomy

knowledge → comprehension → application → analysis → synthesis → evaluation (1956)

Or remember → understand → apply → analyze → evaluate → create in revised model (2000)

[refer to Krathwohl (2002) for details: http://www.unco.edu/cetl/sir/stating_outcome/documents/Krathwohl.pdf]

- Mental process underpinning learning (according to cognitive psychology) do not align with such processes
- John Biggs and Kevin Collis propose the SOLO (Structure of Observed Learning Outcomes) model instead:

Four Levels:

1. One Idea
2. Many Ideas
3. Relate the Ideas
4. Extend the Ideas

Surface learning

Deeper learning

BRINGING TOGETHER: DISCUSSION QUESTIONS

1. Deciding when the dough mix is just at the right consistency is knowledge requiring sensory recognition. Can you think of any other examples in your life where you have learnt to make sensitive assessments based directly on gradations in sensory information? How can we teach these sensory discriminations?
2. One reality of this modern world is the need to learn multiple strings of information such as your visa number, passwords, or ID numbers. Can you recall any situation where failure to recall a string has occasioned disaster in your life? What are some good ways to commit such strings to memory?
3. In terms of your mental organisation, Perth's standing as a beautiful city is not an information string. Instead, it is a proposition or an idea. What is the difference between a string and an idea?
4. Schemata are more abstract things than ideas. Ideas can be taught quite directly (as facts to acquire). Schemata can be taught, yes, but just why is such resultant learning so much more difficult to achieve?
5. Problem solving results from people becoming able to run strong mental problems in their heads. This view says that problems are solved by activating the right knowledge, at the right time, in the right place. How does this mental model view contrast with the view that solving problems depends upon one's divergent thinking or creativity?

based on Hattie, J. and Yates, G. 2014. *Visible Learning and the Science of How We Learn*. Routledge: London, pp. 134-5)

BRINGING TOGETHER: DISCUSSION QUESTIONS

6. Hattie and Yates (2014) describe the development of the mental model of evolution in education curriculum as:

   '…*evolution* itself is subject to progressive refinements as a student moves through the school years. At the outset, it is possible to appreciate evolution as a simple uncluttered fact, learnt in one class at one moment in time. But with more and more knowledge entering the mind, this term takes on the properties of a concept that can be applied across different contexts. It takes three examples of the idea being seen in different contexts for the mind to begin treating evolution as a concept. Later, it will become an overarching schema used to organise a huge body of information. By the end of high school, evolution has developed to the level of a highly functional theory of living systems that provides the mind with a mental model it can employ to solve highly complex problems.' (Hattie & Yates, 2014, p. 131)

   Explain how the notion of 'evolution' could be acquired initially as an idea, but later as a schema used to organise coherent knowledge, and finally as a fully developed mental model able to be 'run' in the head. Are there any other examples you can think of in your teaching area where simple ideas are progressively built on over many years, to create deeply elaborated models of functioning?

7. One interesting finding is that although verbal cueing helps a person recall which procedure to use, in fact verbal instruction, within itself, does not help procedural learning (and may interfere) if that is true, then how does a person actually achieve secure procedural learning? Just what has to take place, and what helps the process?

8. Is it fair to say that knowledge is acquired, which leads to comprehension, then application, and analysis? What is wrong with such logical sequences?

based on Hattie, J. and Yates, G. 2014. *Visible Learning and the Science of How We Learn*. Routledge: London, pp. 134-5)

HOW IS KNOWLEDGE ACQUIRED?

WE KNOW A LOT ABOUT LEARNING

- Over the past century, we have learned a lot about the learning process
- We can summarize these findings into three groups:
  1. Six principles of acquisition
  2. Six principles of memory retention; and
  3. Five aspects of handling information overload

In order to retain this information, we utilize three types of memory:

1. Iconic or sensory store,
2. The working memory
3. The long-term memory

6 PRINCIPLES OF ACQUISITION

1. Learning requires time, effort and motivation
2. Concentration spans are short
3. Distributed practice is more effective than massed practice or cramming
4. Prior knowledge effects are powerful
5. Your mind responds well to multimedia input
6. To learn, your mind has to be active

6 PRINCIPLES OF MEMORY RETENTION

1. To recognize is easy: to recall is hard
2. Information given first and information given last is often recalled more easily
3. Over time, there are different rates of forgetting
4. Memory is a highly constructive process
5. The principle of savings: what is forgotten can still help
6. Your memory is subject to interference

5 ASPECTS OF HANDLING INFORMATION OVERLOAD

1. From the learner's perspective, learning is not always a pleasant experience
2. Learning places great stress on mental resource
3. For all learners, it is crucial to develop coping strategies
4. Sources of overload can be identified
5. We are all subject to overload

MULTI-STORE THEORY OF MEMORY

- Iconic memory, aka sensory memory or ultra-short-term memory
- Short-term or working memory
- Long-term memory

DEVELOPING EFFICIENT LEARNING STRATEGIES

Practice **CRIME**

- **C**HUNKING
- **R**EHEARSAL
- **I**MAGERY
- **M**NEMONICS
- **E**LABORATION

BRINGING TOGETHER: DISCUSSION QUESTIONS

1. If we want people to focus intensively, with relatively low levels of mind wandering, learning experiences might profitably last for just how long?
2. Effects due to prior knowledge are often shown to be stronger than the effects of IQ. Can you recall any experiences with students that appear consistent with this finding? What happens when you have a student who arrives with high levels of knowledge about a topic?
3. Do some students learn better than others from images or from listening?
4. If the mind has to be active in learning, how come we learn by just observing others?
5. What types of learning are retained easily? What things are quickly forgotten?
6. The principle of savings means we often can learn things remarkable quickly. But is actually occurring?
7. One factor implicated in overload is our natural over confidence. This has nothing to do with self-esteem as such, but reflects a type of error people are prone to make. What experiences enable this error to be reduced?
8. Explain why learning is not always a pleasant experience.
9. What are the six causes of overload?
10. Describe strategies students are likely to use in learning situations? What is CRIME?

based on Hattie, J. and Yates, G. 2014. *Visible Learning and the Science of How We Learn*. Routledge: London, pp. 125)

Understand
acting like a Dictionary understanding words, concepts, cause-effect and 'reasons for'

Strategy 13
CONCEPT MAPS

Background

Most sensory information is received through the eyes, so concept maps are a highly effective tool for presenting information. Since concept maps require students to synthesise information, they are the ideal vehicle for students to construct their own learning.

Process

Concept maps make explicit the links between cells on a map and explain the connection between ideas. They should not be confused with other types of visual maps such as spider webs, flow diagrams or bubble maps.

Sample

Topic: Water and the Human Body

Step 1: Name Idea 1	Step 2: Build Connections 2	Step 3: Explain Connections 3	Step 4: Extension 4
Enter the idea in the top cell of the concept map.	Build connections outwards from the topic.	Explain the connections between each linked cell/idea.	The Concept Map can keep 'growing' as the class synthesises the information they gathered.

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Observation

Students do not intuitively work well with concept maps, but once they are familiar with the skill it is surprising how effective their work can be. Concept maps are an excellent tool for reviewing information and can readily reveal any misunderstandings about the topic.

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