

Not All Content is Created Equal

Or All That Blossoms is Not from Bloom



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The type of information you are teaching dictates how it should be taught even within the cognitive domain.



Concepts



Principles

Recognize these, develop instructional examples, teach a lesson, assess student learning

Objectives:

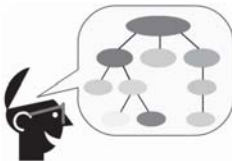
- Analyze content to recognize "concepts" and "principles" as defined in the context of course content.
- Compose objectives that communicate to students the expectation to apply and use "concepts" and "principles".
- Develop lessons to teach "concepts" and "principles" using the process described in the presentation.

Think about a hierarchy of learning across types of content (Merrill)

How the learning will be used		Type of content to be learned			
		FACTS	CONCEPTS	PRINCIPLES	PROCEDURES
REMEMBER	KNOW				
USE	APPLY		X	X	
FIND	ANALYZE		X	X	

Different types of content require different instructional techniques

Concepts



Concepts are categories or classes

- Categories or classes of:
 - Objects/things/entities
 - Qualities (think adjectives)
 - Processes/methodologies
 - States/conditions
- Members of those categories/classes
- Definable by their particular attributes which may include how it is used, its composition, how it appears, etc.
- May be concrete or abstract or imaginary

Concepts are categories or classes

- If a person understands a concept s/he can:
 - State the defining properties
 - Name/recognize/identify unfamiliar examples of the concept
 - Distinguish unfamiliar examples from unfamiliar non-examples of the concept

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How to recognize “concepts” in what you teach

- New words/terms you need to define
- Anytime you need to describe the qualities of something

Definable categories or classes

- Examples of concepts
 - Objects/things/entities = pipette, centrifuge, red blood cells, E. coli
 - Qualities = basophilic, anemic, Gram positive, icteric, A pos, diabetic, underfilled (blue top tube), certified
 - Processes/methodologies = centrifugation, inflammation, dialysis, spectrophotometry
 - States/conditions = diabetes, acute glomerulonephritis, pneumonia, positive agglutination result
- Non-examples (these are not concepts)
 - 37C is body temp
 - MCV= HCT X 10/RBC (without units of 10)
 - The depth of the counting area of an improved Neubauer hemacytometer is 0.1 mm
 - To make 3% cell suspension, fill a tube ½ full with saline....

How to recognize “concepts” in what you teach

- Statements/headings like:
 - “classification/classes/categories of [concept]”
 - “taxonomy/hierarchy of [concept]”
 - “organizational scheme of [concept]”
 - “different types of [concept] or X vs Y”
 - “The [concept]s”
 - “[concept] is used for...”
 - “[concept 1] is one example of [concept 2]”
 - “[concept] can be recognized/identified/diagnosed by these characteristics...”
 - “[concept] is composed of ...”
 - Anything that requires visual identification/recognition

	Concept	Principle	Neither
White blood cells			
Predicting relative migration of molecules of different MW on gel e'phoresis			
Alkaline vs acid			
Inferring genotype from phenotype			
Selective vs differential micro media			
The reagents of the Jaffe reaction			
Steps to set up a sed rate			
Distinguish primary and secondary literature examples			
The gas laws			
Recognize (interpret) a liver function panel consistent with hepatitis			
Interpret a liver function panel			

Choose how you will teach depending on your goals and available time

- Deductive: You give students the defining attributes followed by examples
- Inductive: You give students examples and they figure out the defining attributes

Choice consideration	Deductive	Inductive
Time	Less time	Need more time
Results	Long retention of concept	Learn how to learn

From Davis, pg. 225

How to teach “concepts” by deduction

1) Prepare a definition

- Incorporate the all DEFINING properties and attributes
 - Include, as appropriate, (non-exhaustive list)
 - Appearance
 - Composition
 - Uses
 - Relationship to other concepts (subordinate and superordinate)
 - Relationship among the attributes
- Include what is NOT among the defining attributes
- Be clear about the difference between defining attributes and variable attributes

How to teach “concepts” by deduction

2. Prepare the objective –

- Given unfamiliar [test results (specify), case information, etc], recognize examples of [concept 1] and distinguish from non-examples of [concept 1]
- Given unfamiliar [test results (specify), case information, etc], distinguish among the types of [superordinate concept].
- Given a hypothetical situation, recognize examples of [concept 1] and distinguish from non-examples of [concept 1]

Good verbs: identify, recognize, distinguish, differentiate, discriminate, classify, label

How to teach “concepts” by deduction

3) Prepare the instructional examples

- At least 2-3 classic examples that demonstrate all the defining features
- At least 2-3 classic non-examples that differ, ideally, on only one of the defining features each
- Use close examples when fine discrimination is needed

4) Prepare practice examples for students to study; include feedback

How to teach “concepts” by deduction

5) Conduct instruction

- Present the definition
- Present an example and explain how it fits the definition
- Present a non-example and show how it does not fit the definition
- Present an example and explain how it fits the definition
- Present a non-example and show how it does not fit the definition
- Restate the definition

How to teach “concepts” by deduction

6) Allow students opportunities to use the practice examples with feedback

How to assess “concept” learning

- Following the objective, provide examples and non-examples and ask them to:
 - Name/recognize/identify unfamiliar (perhaps hypothetical) examples of the concept
 - Distinguish unfamiliar examples from unfamiliar non-examples of the concept

	FACTS	CONCEPTS	PRINCIPLES	PROCEDURES
REMEMBER				
USE		X		
FIND		X Especially with induction		

Apply this process:

- To fundamental concepts they really, really need to know
- To concepts that you know are a problem for them or where fine discrimination is needed
- To broad (superordinate) concepts that will be most useful
- By double dipping on your examples; examples of one concept might be the non-examples of another and thus not quite so many total examples are needed

You have seen examples of how to teach concepts

Click by induction and the concept of “concepts” by deduction

Principles



A Principle expresses a relationship between variables

- The variables are usually concepts
- The relationship is often cause and effect
- Usually stated as:
 - If-then statements
 - Mathematical relationships
 - Scientific laws
 - Theories (which are usually a collection of principles)
 - And sometimes as rules
- If a person understands a principle s/he can:
 - Predict outcomes/consequences
 - Plan ahead to control variables and achieve desired outcomes
 - Infer cause when given outcomes
 - Explain the cause when an outcome is observed

Relationships/cause-effect

- Examples of principles
 - As pH drops, the oxygen-dissociation curve of Hb shifts to release oxygen from Hb
 - All other things being equal, if the angle of the spreader slide to the stationary slide is lowered, the blood film will be longer
 - $MCH = HGB \times 10 / RBC$ (no powers of 10)
 - If the agar is too thick, the K-B zones will be falsely small

Non-examples of principles

- Flame the loop, allow to cool, turn the plate 90°...
- Hepatitis
- Red blood cells are about 7µm in diameter
- Hemolyzed
- CSF rule of thumb – If low glucose & high protein, then bacterial meningitis

Though principles can be stated in if-then form, not all if-then statements are principles



Concepts masquerading as principles

Relationships/cause-effect

- Examples of principles
 - As pH drops, the oxygen-dissociation curve of Hb shifts to release oxygen from Hb
 - All other things being equal, if the angle of the spreader slide to the stationary slide is lowered, the blood film will be longer
 - $MCH = HGB \times 10 / RBC$ (no powers of 10)
 - If the agar is too thick, the K-B zones will be falsely small
 - $3 \times HGB = HCT$ (Rule of 3)

- Non-examples of principles
 - Flame the loop, allow to cool, turn the plate 90°...
 - Hepatitis
 - Red blood cells are about 7µm in diameter
 - Hemolyzed
 - CSF rule of thumb – If low glucose & high protein, then bacterial meningitis
 - According to Westgard multirule QC, reject the run if the control value is outside 3SD...

When is a RULE a “principle” or not?

- If the rule is about a relationship between variables, then it is a principle (e.g. Rule of 3)
- If the rule is about what is to be done in a given situation (i.e. a decision rule or an action directive), then it is not a principle (e.g. Westgard). It is a rule to be followed.
- If it is a rule of thumb – guidance that is not always applicable – it may be a principle BUT more likely it is a concept (e.g. CSF example)



A principle expresses a relationship between variables

- Relationship between variables (concepts) often cause and effect
- Usually stated as:
 - If-then statements (sometimes)
 - Mathematical relationships
 - Scientific laws
 - Theories (which are usually a collection of principles)
 - And sometimes as rules
- If a person understands a principle s/he can:
 - Predict outcomes/consequences
 - Plan ahead to control variables
 - Infer cause when given outcomes
 - Explain an observation

How to recognize “principles” in what you teach

- Statements/headings like these are clues to find underlying principles:
 - “factors affecting...”
 - “...effect of X on Y...”
 - “if you want to achieve X, then...”
 - “if X changes in this way, then Y changes in that way...”
 - Any mathematical formula
 - Sometimes rules, if they demonstrate a relationship between variables

	Concept	Principle	Neither
White blood cells			
Predicting relative migration of molecules of different MW on gel e'phoresis			
Alkaline vs acid			
Inferring genotype from phenotype			
Selective vs differential micro media			
The reagents of the Jaffe reaction			
Steps to set up a sed rate			
Distinguish primary and secondary literature examples			
The gas laws			
Recognize (interpret) a liver function panel consistent with hepatitis			
Interpret a liver function panel			

How to teach “principles” by deduction

- 1) Find likely principles in your content
- 2) Prepare statements of the relationship(s) between the variables
 - Use “if-then” statements if the content is not an obvious principle
 - Example: Factors affecting zone size on disc diffusion tests like Kirby-Bauer
 - If the inoculum is too heavy then the zone sizes will be falsely small
 - If the inoculum is too light then the zone sizes will be falsely large

How to teach “principles” by deduction

- 3) Prepare the instructional examples
 - At least 2 examples that demonstrate the application of the principle in the manner that the objective specifies
- 4) Prepare practice examples for students with answers/feedback

How to assess “principle” learning

- Follow the objective and provide situations asking students to:
 - Predict outcomes
 - Infer cause
 - Plan to achieve an outcome
 - Explain a given outcome

	FACTS	CONCEPTS	PRINCIPLES	PROCEDURES
REMEMBER				
USE			X	
FIND			X Especially with induction	

How to teach “principles” by deduction

2. Prepare the objective –
 - Given an unfamiliar, perhaps hypothetical, [type of] situation, predict the outcome based on the X principle.
 - Given an unfamiliar result of [type of] situation, perhaps hypothetical, infer the cause based on X principle.
 - Given an unfamiliar, perhaps hypothetical, starting [type of] situation and a desired outcome, make a plan to achieve the desired result based on X principle.
 - Given an unfamiliar, perhaps hypothetical, [type of] situation and the outcome, explain how the outcome occurred based on the X principle.

Good verbs: predict, infer, plan, explain outcomes, conclude, deduce, surmise, extrapolate, forecast, expect, design, strategize, develop

How to teach “principles” by deduction

- 5) Conduct instruction
 - Present the statement of the principle
 - Present at least 2 examples and explain how the principle is applied in the manner defined in the objective
 - Restate the principle
- 6) Allow students opportunities to use the practice examples with feedback

	Concept	Principle	Neither
White blood cells			
Predicting relative migration distance of molecules of different MW on gel e'phoresis			
Alkaline vs acid			
Inferring genotype from phenotype			
Selective vs differential micro media			
The reagents of the Jaffe reaction			
Steps to set up a sed rate			
Distinguish primary and secondary literatures			
The gas laws			
Recognize (interpret) a liver function panel consistent with hepatitis			
Interpret a liver function panel			

A demonstration of a principle lesson

- Principles
 - The presence of an ag or ab can only be established by using the antithetical ab or ag.
 - If either the ag or ab is known to be present in a reaction system, the presence of the other (ab or ag) is indicated by a positive test result.

Examples for students of application of the principles

- Cells known to possess ONLY the L antigen are mixed with serum whose antibody content is unknown. If the result is positive, you conclude... L antibody is in the serum

What if the result is negative?

L antibody is not in the serum

See full lesson in the Bonus Content at the end of the presentation slides

When things get complicated

Two special circumstances

Examples for students of application of the principles

- If you want to be able to detect Q antigen, you need..... Anti-Q
- If you want to detect anti-Sr, you need.... Sr ag
- Anti-P is mixed with red cells whose antigenic make up is unknown. If the result is positive, you conclude... P ag is on the cells
- Anti-G is added to red cells whose antigenic make-up is unknown. If the result is negative, you conclude... G ag is Not on the cells

Summary on this example

- Principles may not always present themselves as such – you might have to find them
 - Bonus slides at the end to help with this
- Restatement of content in the form of if-then statements or clear statements of the relationship between the variables changes the content AND the learning automatically from remembering to applying/using

1. When is a principle a concept?

- In the laboratory, we use the word PRINCIPLE (as in the principle of an assay) essentially synonymously with methodology
- This type of laboratory principle is actually an instructional concept e.g.
 - Agglutination
 - Atomic absorption
 - Phase microscopy
 - Flow cytometry
- It meets the definition as being a “process” and you would expect someone to recognize and name it if the features of the assay were described

How to know when students have learned a given laboratory principle (which is a concept)?

- Test them in the abstract or hypothetical
 - E.g. An immunoassay for serum cement is developed in which the test wells are coated with a goat-derived anti-cement antibody. The sample is allowed to incubate in the well and then is washed away. A mouse-derived anti-cement antibody is added with (choose your signal system). This is an example of which type of immunoassay?
 - Sandwich ELISA
 - Radioimmunoassay
 - Immunoprecipitation
 - Competitive homogeneous assay

2. Can given content be both concept and principle?

- Yes – and depending on your goals, you can choose which way to teach it (or both)
- Example: mean cell volume
 - Concept because I want students to be able to define it and distinguish it from the other indices (superordinate concept)
 - Principle because it can be expressed as a mathematical relationship

The type of information you are teaching dictates how it should be taught even within the cognitive domain.




Concepts



Principles

Then your students can get beyond memorizing

	FACTS	CONCEPTS	PRINCIPLES	PROCEDURES
REMEMBER				
USE		X	X	
FIND		X	X	



BONUS CONTENT

A principle lesson

This lesson, in the abstract, takes students through all the logic needed to interpret blood bank tests: Forward/reverse ABO, ag typing, screening, ab ID and confirmation (planning 3 cells positive/3 cells negative). Also applies in immunology and immunoassays.

Good Reading

- Davis RH, Alexander LT, Yelon SL. 1974. Learning System Design: An approach to the improvement of instruction. (McGraw-Hill Book Co. – New York). Pg. 219-245.
- Merrill MD. 1994. Instructional Design Theory. (Englewood Cliffs, NJ: Educational Technology Publications) Chapters 7, 8 and 9 available at <http://mdavidmerrill.com/Papers/papers.htm>

- Can be used at the very start of ImmunoHeme/Immuno class. Requires no prereq knowledge.
 1. Go through the first few examples as a class so they get the idea of what you expect.
 2. Let them solve the others in duos or small groups. They have to solve them in order as the complexity increases.
 3. Go over the answers as a group
- As the various tests you teach require that particular logic, bring back these examples “remember this example (do it again), that’s the logic we will be using here but the difference is (more cells/more antigens)”

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- Principles
 - The presence of an ag or ab can only be established by using the antithetical ab or ag.
 - If either the ag or ab is known to be present in a reaction system, the presence of the other (ab or ag) is indicated by a positive test result.

Note: Later they can learn what positive and negative results are in various test systems and how to recognize them (Those are concepts!), but it isn't needed now.

Examples for students of application of the principles

- Cells known to possess ONLY the L antigen are mixed with serum whose antibody content is unknown. If the result is positive, you conclude... L antibody is in the serum
 - What if the result is negative?
L antibody is not in the serum
- Anti-Z is mixed with serum whose soluble Z antigen content is unknown. If the reaction is positive, you conclude... Z ag is in the test serum

Examples for students of application of the principles

- Cells (all the same) that possess a variety of antigens whose specific identities are unknown are mixed with serum whose antibody content is unknown, if the reaction is negative you conclude... No antibody in the serum that reacts with any of the ags on the cells

If the reaction is positive you conclude...
There is at least one antibody in the serum that reacts with at least one antigen on the cells

Examples for students of application of the principles

- If you want to be able to detect Q antigen, you need.... Anti-Q
- If you want to detect anti-Sr, you need.... Sr ag
- Anti-P is mixed with red cells whose antigenic make up is unknown. If the result is positive, you conclude... P ag is on the cells
- Anti-G is added to red cells whose antigenic make-up is unknown. If the result is negative, you conclude... G ag is Not on the cells

Examples for students of application of the principles

- Cells possessing only the antigens B, K and M on every cell are mixed with a serum whose antibody content is unknown. If the result is negative, you conclude... No anti-B,K or M in the serum
If the result is positive, you conclude...
Could be anti-B,K or M in the serum or any combination of the 3

Examples for students of application of the principles

- You have cells all known to possess both the antigens L and M and known to lack both the antigens R and S. A serum of unknown antibody content is allowed to react with these cells under optimum conditions. If the reaction is positive you conclude...
There is an antibody in the serum to antigens L or M or both

What conclusion can you draw about the presence of anti-R and/or anti-S in the serum?
Nothing because you don't have the antigens

What would you need in order to decide whether the serum contain anti-R and/or anti-S?
Cells containing antigens R and S

Examples for students of application of the principles

- You have one sample of cells all known to possess the antigens p,q, and r while all lacking the antigens f, g, and h. You have another sample of cells all known to possess the antigens p, q and g while all lacking the antigens r, f and h. A serum of unknown antibody content is allowed to react with each cell sample separately under optimum conditions. The serum reacts negatively with the first cell but positively with the second. What can you conclude about the antibody content of the serum?

It possesses anti-g

- Do you know if it possesses anti-f or anti-h? Why or why not?
No because neither cell had those antigens

MORE BONUS CONTENT

Finding principles in concepts

- When you have a concept/rule of thumb, ask yourself, “why are the defining features what they are?”
 - E.g. Why is the glucose low in bacterial meningitis? Because the bacteria metabolize the glucose.
- The answer to “why” may point to a principle
 - E.g. If bacteria are present in a sample, then the glucose can be expected to be lower than it would be otherwise (and it doesn’t matter whether the bacteria entered the sample in vivo or in vitro.)

Finding principles in concepts cont.

- What are the variables in this principle?
 - E.g. Presence of bacteria and glucose concentration
- Can it be applied in other circumstances to predict, infer cause, plan or explain outcomes?
 - What happens when bacteria are present in a urine sample? If present, the glucose will drop over time.
 - What happens if bacteria are present in a blood sample (sepsis)? Glucose would drop over time.
 - What happens if bacteria are present in donated blood? Glucose will drop over time.
- Decide if you want to teach the overarching principle AS a principle