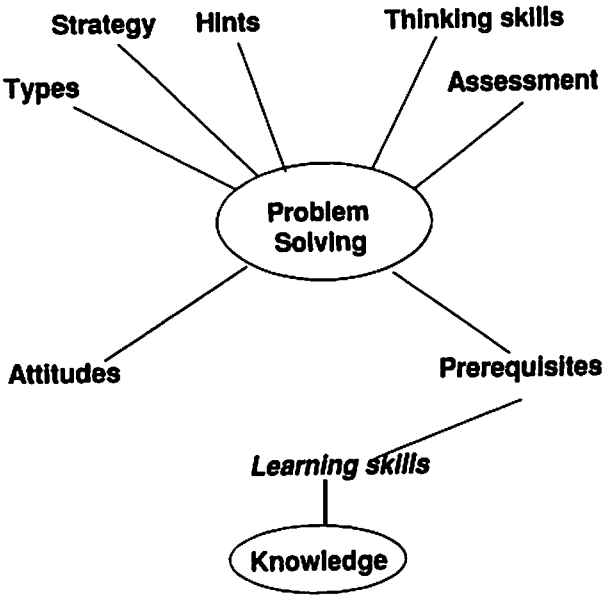
Def: Acquiring new skills, attitudes or knowledge.

WHY IMPORTANT?
1. Survive formal education.
2. Develop lifetime learning skills.
3. Provide knowledge in a form needed for problem solving.
4. Learn with and from others.
5. Prepare for small group, self-directed, self-assessed, interdependent problem-based learning.

Where it fits in....



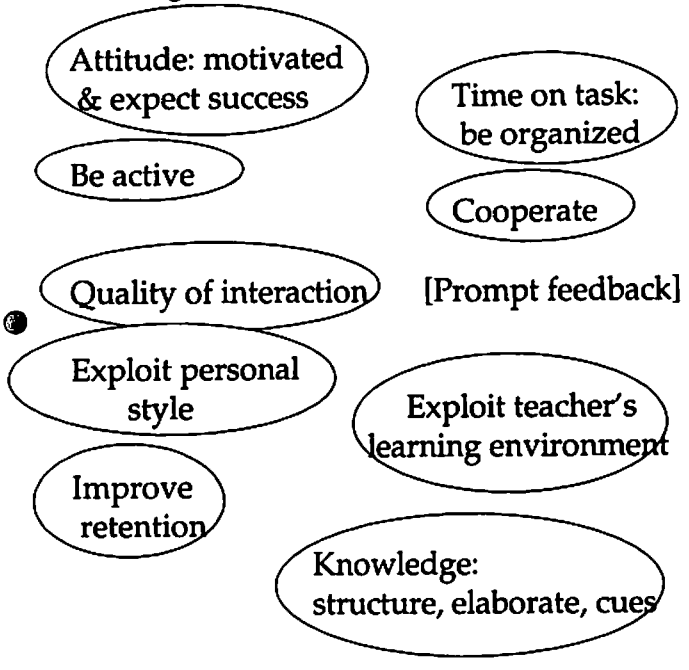
Pretest: Use an "x" to rate your Awareness & Skill

Time 10 s Finish by _____

Objectives...
Read over...

Time _____ Finish by _____

Address issues based on Research about learning:



MPS 12: Learning . **Research says:**

Learning improves if students (learners) are:

1. Motivated.
2. In an environment that expects *Success.*
3 Clear for time and task
4. Actively engaged in the learning (not passively listening/reading).
5. Working cooperatively together (not competitively).
6. Experiencing quality interaction with instructor inside & outside of class. High social environment.
7. Receive prompt feedback.
8. In an environment that caters to the learner's personal learning style.

MPS 12: Learning **1. Be motivated & 2. Expect success. Research says... expect success**

Visualize yourself in control:

who is in charge of your learning?

You? the Prof? the University?

Set *your* learning goals

Reward yourself

Activity: Be proactive

as an individual

list opportunities for motivation & to show that you expect success.

TIME min

MPS 12: Learning: **Ideas:**

Write reflections _____

MPS 12: Learning **3. Clear time on task**

Research says... have clear time on task

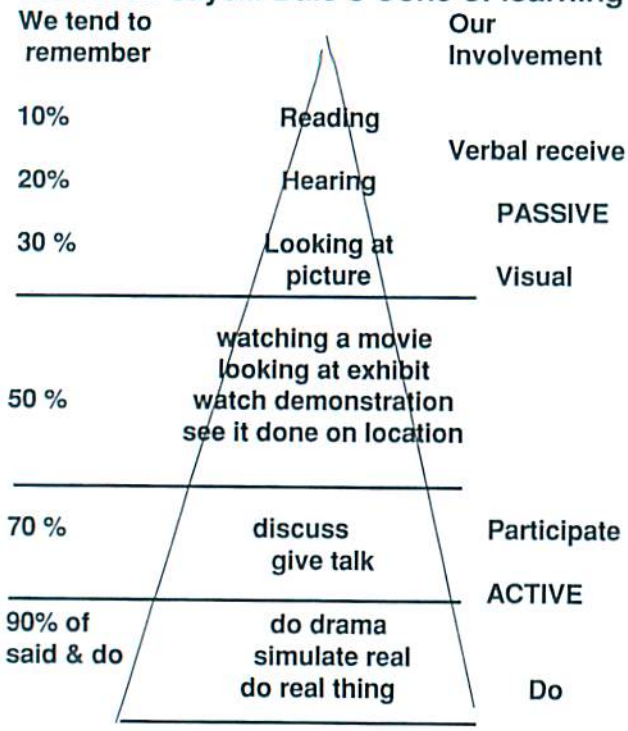
Related to motivation &

to time management MPS 17:

Have clear idea of what task you are going to do, the resources you will use and then do it!

MPS 12: Learning **3. Be Active**

Research says... Dale's Cone of learning



MPS 12: Learning

Research says... Be an active learner

To some extent, the prof "owns" *much of the* learning environment. If the Professor elects to lecture, then it may be hard to be active. But is it? What does "be active mean" for your learning?

Activity

Form groups of _____ or individual share ideas about how you can be **active.**

TIME _____

MPS 12: Learning Being active: Ideas

Read

Read + underline

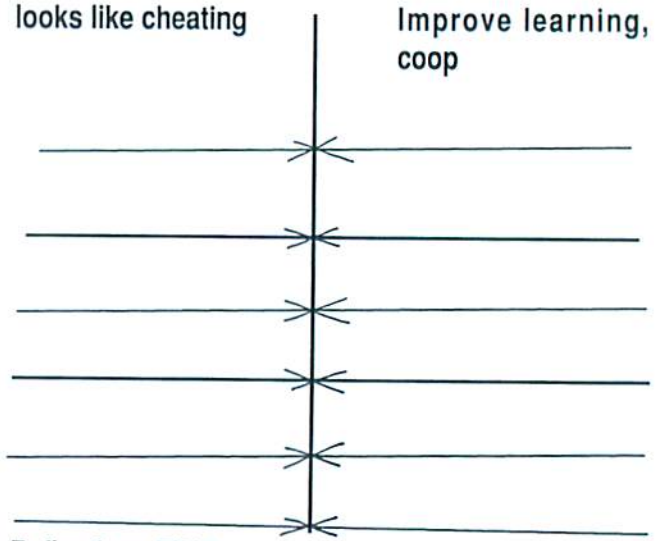
read + underline + concept map/notes

Read + underline + map + summary

Read + underline + map +sum + elaborate

MPS 12: Learning **Work cooperatively & not competitively . Research says... cooperate**

Force field diagram : How to do this without being accused of copying/ cheating



Reflections TIME _____

MPS 12: Learning High Quality & numerous interactions with professors & students outside of class

What can you control?

Activity as __individual____ group of _____
Brainstorm ideas on this

TIME _____

Share

MPS 12: Learning : Ideas

Reflections _____

MPS 12: Learning Get Prompt feedback

Teacher owns this one.... or does he/she?

How might you get prompt feedback on your learning task?

Activity: as group of _____ Brainstorm ideas

TIME _____

MPS 12: Learning Ideas

Reflections _____

MPS 12: Learning **Exploit teacher's learning environment.**

You don't have control over what environment the teacher elects to use:
lecture
cooperative groups
teams
Discussion
Presentations
Laboratories
Problem-based learning
But... you can understand and exploit the uniqueness of each.
Often, professor uses the lecture
This is passive, you sit, make notes....

10 to 50% from Dale's cone for learning

Is the lecture for Learning?

MPS 12: Learning **Lecture :**

Activity: as groups of 3 to 4 what is the purpose of the lecture? Why go? What can you gain from a lecture that you cannot gain from reading the required text?

TIME 5 min

Report ideas

MPS 12: Learning **Purpose of the lecture**

get personal experience of prof.
repetition
ask questions
get hints for tests
see examples worked
see problem solving style
get information that is not in text
get verbal explanations
keep up a routine
I paid for it!
Feel good about myself
feel I am accomplishing something
all my friends go
forces me to keep up
get the emphasis
clarification of difficult stuff
different viewpoint
take notes

MPS 12: Learning **Purpose of the lecture**

Write reflections _____

MPS 12: Learning **Lecture notes**

Bring your lecture notes from day _____ for course _____.

In a set of information; there is usually
- the subject knowledge eg. Fundamentals of Chemical Engineering
- examples values, applications
- suggestions for problem solving

Activity As _____ For the first 15 min , classify the information into these categories and then Identify for the Subject knowledge:
1. The most important information for you to learn
2. The most important concept introduced
3. The fundamental law behind that concept

TIME _____

MPS 12: Learning Lecture notes

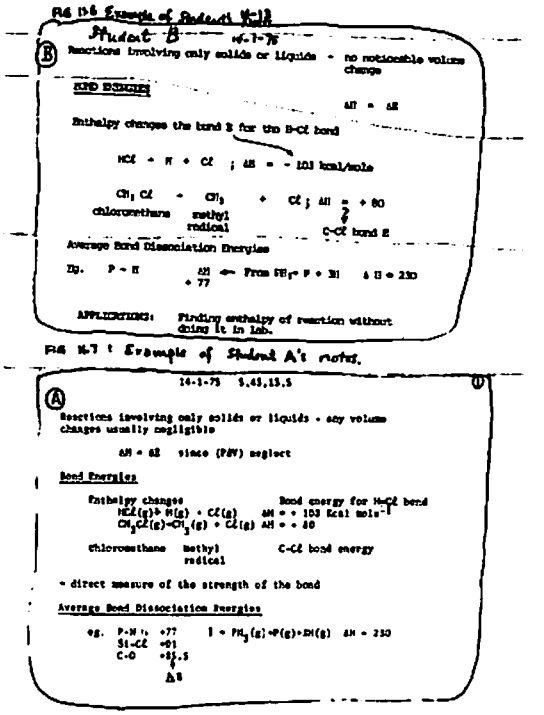


Fig 11-6 Example of Student A's notes

Student B 16-1-76

(B) Reactions involving only solids or liquids - no noticeable volume change

KIND ENERGIES

$\Delta U = \Delta H$

Enthalpy changes the bond E for the H-Cl bond

$HCl \rightarrow H + Cl$; $\Delta H = +103$ kcal/mole

$CH_3Cl \rightarrow CH_3 + Cl$; $\Delta H = +80$

chloromethane — methyl radical — C-Cl bond E

Average Bond Dissociation Energies

Eg. P - H $\Delta H = +77$ ← From PH_3: P + 3H $\Delta H = 230$

APPLICATIONS: Finding enthalpy of reaction without doing it in lab.

Fig 11-7 : Example of Student A's notes.

14-1-75 9.45,13.5

(A)

Reactions involving only solids or liquids - any volume changes usually negligible

$\Delta H = \Delta E$ since (PV) neglect

Bond Energies

Enthalpy changes — Bond energy for H-Cl bond

$HCl(g) \rightarrow H(g) + Cl(g)$ $\Delta H = +103$ Kcal mole^{-1}

$CH_3Cl(g) \rightarrow CH_3(g) + Cl(g)$ $\Delta H = +80$

chloromethane — methyl radical — C-Cl bond energy

- direct measure of the strength of the bond

Average Bond Dissociation Energies

eg. P-H $+77$ $P + PH_3(g) \rightarrow P(g) + 3H(g)$ $\Delta H = 230$

Si-Cl $+81$

C-O $+85.5$

ΔE

MPS 12: Learning Lecture notes
With the lecture notes in hand,
Form a line based on Jungian typology

S N

Number off, # 1 (dominant S) get together with number middle of line ,
#2 with _____ with next; and so on until middle is together with dominant N.

In pairs, compare lecture notes.

TIME _____

Reflections _____

MPS 12: Learning Lecture notes

You receive of copy of the lecture notes taken by the instructor who has a Jungian SN indicator of _____

In groups of _____ Compare your notes with those of instructor.

Report:
Similarities Differences

Reflections TIME _____

MPS 12: Learning **Lectures.**

Your professor uses the lecture format.
Your professor is SN..... _____

Activity: Form small groups of 3 or 4 that have similar SN Jungian typology.

In the context of the lecture, what might you request of the instructor to improve your learning.

TIME _____

Share ideas

MPS 12 Learning **Lecture: Ideas to request of professor to improve your learning.**

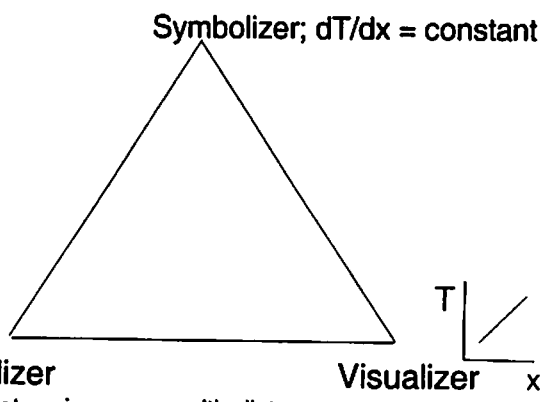
MPS 12 Learning Lecture: ideas of requests of professor to improve your learning

- summarize key ideas
- present major ideas visually, verbally & symbolically
- use ombudspersons
- give us 2 minutes every 20 minutes to write reflections about what we have learned so far
- help us to see the main points
- give us his/her version of concept maps for sections
- tell us what to read ahead of time before class
- let us complete the Course Perceptions Questionnaire after midway through the course.
- tell us his/her Jungian SN and TF dimensions
- tell us his/her view of the purpose of the lectures.
- ask the Chair of the Department to ask professor to do the above

MPS 12: Learning Your personal learning style

From MPS 11, p. 1112 Consider the results of inventories and reflect.... does this represent me?
Implications for studying and learning.

Visual	symbolic	verbal
diagrams?	Equations?	Word
Show me	Write equns	Explain it



Temperature increases with distance

MPS 12: Learning Learning style

Example: how do you think about this problem?

A tolquot is equal to 4 quamquats. Vessel A has a base of 1 tolquot by 1 tolquot with a height of 1 quamquat. Vessel B has a base of 1 quamquat by 1 quamquat with a height of 1 tolquot. Which vessel holds more water?

Draw a sketch?

Use symbols 1 T = 4 Q
Vessel A is TxTxQ = volume = 4Q x 4Q x Q
Vessel B is QxQxT = volume = Q x Q x 4Q

MPS 12: Learning Your learning style

In clusters with similar learning styles based on Visualizers, verbalizers, symbolizers and on Jungian SN

S Visualize	S Verbalize	S symbol
Visualize	Verbalize	Symbol
N Visualize	N verbalize	N symbol

Activity Discuss:
lectures, Lecture note taking
selection of textbooks
selection of study partners.

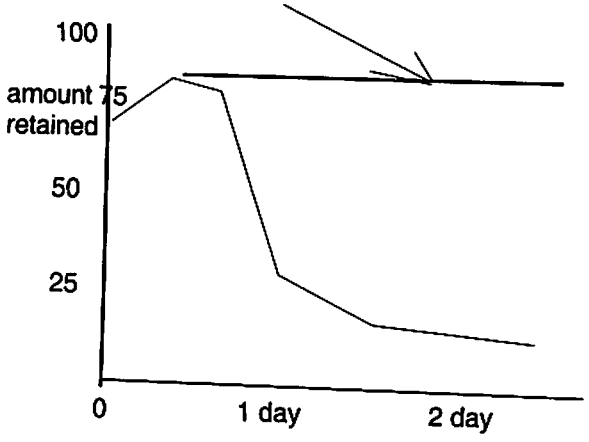
TIME _____

MPS 12: Learning Improving retention

Research says.....

- write it
- review systematically To maintain need

first review for 10 min after 10 after
2nd review 2 min after 24 h
3rd 10 min after 1 week
4th 10 min after 1 month
5 th 10 min after 6 months



MPS 12: Learning Research says:

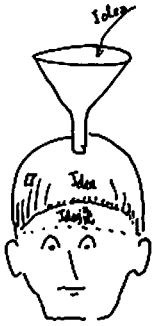
1. New Knowledge is understood in the context of old

2. Knowledge has structure

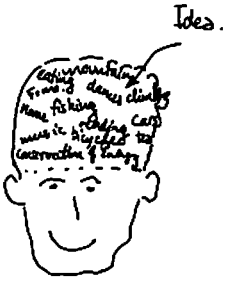
3. Knowledge is used for a purpose

1. New knowledge is understood in the context of old knowledge

not an empty vessel to be filled



Where does new fit in?



my head is full

 New into old, So What?

Possible misconceptions.

Examples in Physics.

	Misconception
Mass	cannot discriminate from weight
Friction	cannot establish casual relationship between normal force & retarding force
Acceleration due to gravity	is dependent on mass of object

Electric power & current describe same physical quantity

Electrons get used up as a battery wears down

Concept	**Possible misconception**
_____	_____

 New into old. So what?

- Identify new concept carefully; think about past experience. Do you think of it this way?
  Misconceptions? Work as defined in Physics.
  Acceleration, Velocity
  Force, work energy, power, heat
  Many examples in Physics
  Note differences between precise definitions used in science & engineering and the everyday use.

- Elaborate on new ideas in context of old.
  What is this related to? Similar to? Different from? Easy to confuse with?

Activity: for the concept of _____
list 10 everyday experiences that might be related

TIME _____

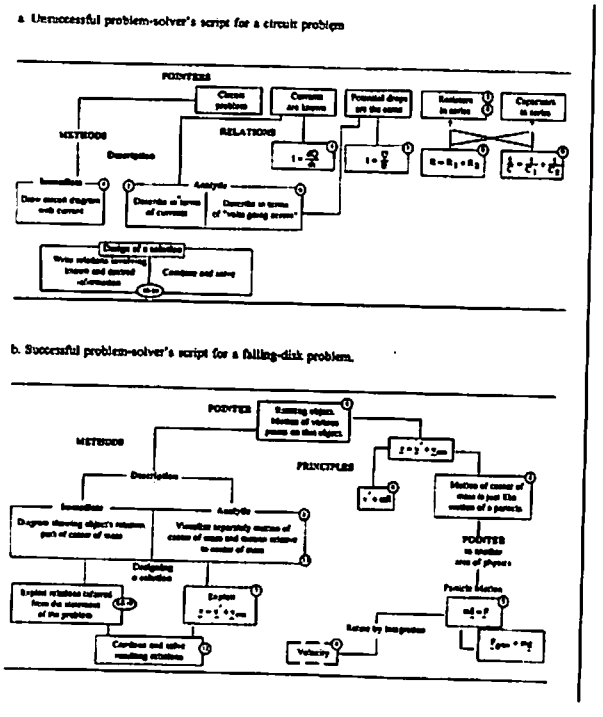
MPS 12: Learning New into old, So What? Ideas

List How related?

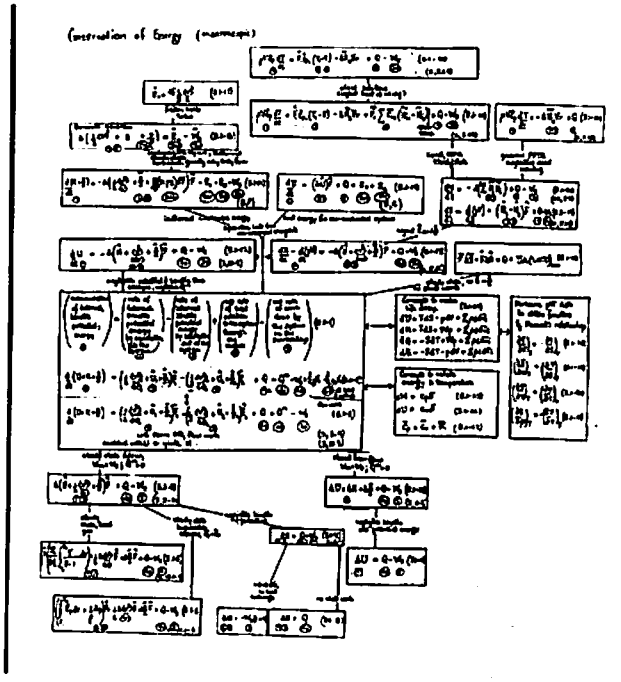
MPS 12: Learning Knowledge has structure & vital interconnects and conditions

- hierarchical
- with fundamental laws on top, - surface structure, approximations, simplifications, special cases are at the lower levels.
- encoded with the fundamentals are *chunks* that encode the fundamentals to identify the conditions, constraints when the knowledge is applicable .
- "concepts" are defined to allow us to apply the fundamentals easily.
- encoded with subject knowledge should be experience or tacit knowledge that allow us to work qualitatively with the knowledge.
- knowledge is organized in *chunks* for convenient processing.

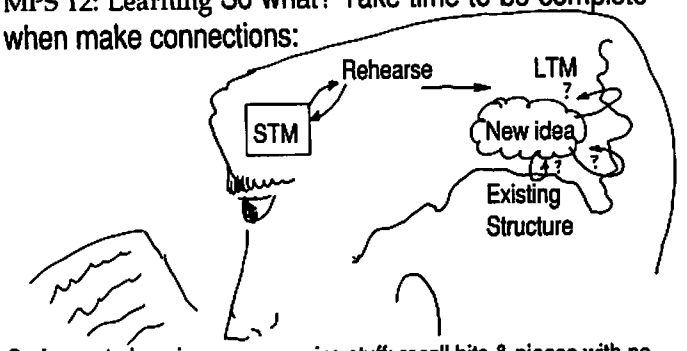
MPS 12: Learning Knowledge Structure, eg.



MPS 12: Learning Knowledge Structure



MPS 12: Learning So what? Take time to be complete when make connections:



Surface rote learning: memorize stuff; recall bits & pieces with no idea of main theme

Semi-deep recalls conclusions but no idea of reason, evidence, basis fundamentals underlying it.

Deep conclusion, equations, main theme, context, evidence, conditions

Use Approaches to Studying LASQ to provide idea of current emphasis.

MPS 12: Learning Examples from Physics

~~force~~

force.. acts on < >
force... on <particle> by <other particles>

~~acceleration~~

acceleration of < particle> at <time> relative to <reference plane>.

~~Model correlation law~~

correlation that applies for <condition>, <condition> and <condition> to
< ± accuracy > and that needs <input data>.

MPS 12: Learning Fundamentals in Science & Engineering. Fundamental law is a *universally applicable explanation of how things behave.* We have about 8 laws.

1. Conservation of mass (& of elements) except for nuclear reactions or $E = mc^2$
2.. Conservation of momentum
3. Conservation of charge
4. Conservation of energy except for nuclear reactions or $E = mc^2$
5. Second law of thermodynamics: criteia for stable equilibrium: Systems at constant pressure and temperature adjust to try to minimize the total Gibbs free energy in the system.
6. Reactions occur in stoichiometric proportions. *Think moles!.*
7. At equilibrium, to every action there is an equal and opposite reaction.
8. F = ma
9. You can't push on a rope.

Most of the so-called "laws" are *wishes.* Ideal gas wish. Raoult's wish. Henry's wish. Einstein's wish for viscosity, Newton's wish for viscosity, Fourier's wish for thermal conductivity; Fick's wish for diffusion.

MPS 12: Learning

1. Law	always
2 (Wish/ constrained law)	simplified definition, use of a law
3. Theory	relates dependent and independent variables & mostly based on laws or wishes
4. Model	representation to explain behavior
5. Balance	equation applied to a conserved entity
6. Empirical correlation	no model used. Curve fit and "constants" determined from experiments.
7.Semi-empirical correlation	model where the "constants needed to match reality are determined from experiments. Identify conditions.
8. Concept	general term for idea
9. Convention	agreed-upon set of rules
10. Postulate	simplified set of agreed-upon conditions

MPS 12: Learning vapor-liquid equilibrium

At equilibrium, & constant T and P the Gibbs free energy in one phase for the species (chemical potential) = Gibbs free energy for that species in the other phase.

$$\sum x_i d\mu_i = 0$$

$$x_i = \frac{y_i}{x_i} = \left(\frac{\gamma_i^L}{\gamma_i^V}\right)\left(\frac{P_i^s}{\pi}\right) \exp\left[\frac{1}{RT}\int_0^{\pi} (v_i^L\, d\pi)\right] \exp\left[\frac{1}{RT}\int_{\pi}^{P} (v_i^V - \frac{RT}{P})\, dP\right] \quad (33)$$

Mixture V.P. Activities; Liq. fugacity corr. (Poynting); Vapor fugacity corr.; Pure component; ISOTHERMAL; Gibbs equation 2

Liquid incompressible (v_i^L = const.):

$$x_i = \frac{y_i}{x_i} = \left(\frac{\gamma_i^L}{\gamma_i^V}\frac{P_i^s}{\pi}\right) \exp\left[\frac{v_i^L(\pi - P_i^s)}{RT}\right] \exp\left[\frac{1}{RT}\int_{\pi}^{P} (v_i^V - \frac{RT}{P})\, dP\right] \quad (37)$$

Poynting correction negligible (π < 20 atm and T > 0°C):

$$x_i = \frac{y_i}{x_i} \left(\frac{\gamma_i^L}{\gamma_i^V}\frac{P_i^s}{\pi}\right) \exp\left[\frac{1}{RT}\int_{\pi}^{P} (v_i^V - \frac{RT}{P})\, dP\right] \quad (38)$$

Vapor solution ideal (γ_i^V = 1), (π < 20 atm), (T > 0°C):

$$x_i = \frac{y_i}{x_i} \left(\frac{\gamma_i^L P_i^s}{\pi}\right) \exp\left[\frac{1}{RT}\int_{0}^{P} (v_i^V - \frac{RT}{P})\, dP\right] \quad (39)$$

Liquid solution ideal (γ_i^L = 1), (close members of homologous series, and π < 10 atm), (T > 0°C):

$$x_i = \frac{y_i}{x_i} = \left(\frac{P_i^s}{\pi}\right) \exp\left[\frac{1}{RT}\int_{0}^{P} (v_i^V - \frac{RT}{P})\, dP\right]. \quad (40)$$

Vapor follows ideal gas law (π < 2 atm), (T > 0°C):

$$x_i = \frac{y_i}{x_i} = \frac{\gamma_i^L P_i^s}{\pi} \quad (41)$$

Completely ideal system (γ_i^L = 1, π < 2 atm), (T > 0°C):

$$x_i = \frac{y_i}{x_i} = \frac{P_i^s}{\pi} \quad (42)$$

Option-42

MPS 12: Learning: vapor-liquid equilibrium

example concept map

Option-43

MPS 12: Learning

For the concepts, "laws" and wishes you are learning, identify which of the 10 pertains (TR 39).

With the help of the professor or the TA find the connection.

Jill Larkin created a checklist to be used to remind us of the types of information we need to determine (and internalize) for equations, "laws", concepts.

Larkin found that concepts and equations that are most difficult are...

Those that use symbols or concepts that have multiple meanings:

x mole fraction? Mass fraction?

Option-44

MPS 12: Learning Larkin's research

Physics :

$F = ma$
$F = \Sigma F$
$f = \mu N$
$N = mg \cos \theta$
$F"g = mg \sin \theta$

$x = v_o t + \frac{1}{2} a t^2$
$v = v_o + a t$
$v^2 = v_o^2 + 2 a x$
$v = (v_o + v)/2$
$x = v t$

$\Delta K = \frac{1}{2} m v^2 - \frac{1}{2} m v_o^2$

$W = \Delta K$

$W = Fx$

Option-45

MPS 12: Learning

Which symbols have different meanings depending on the context?

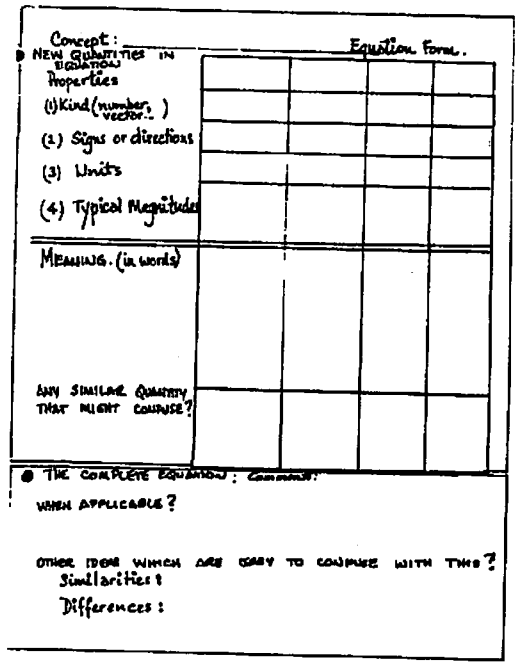
Do you experience similar challenges in the subject you are studying?

Activity: Complete a Larkin checklist for

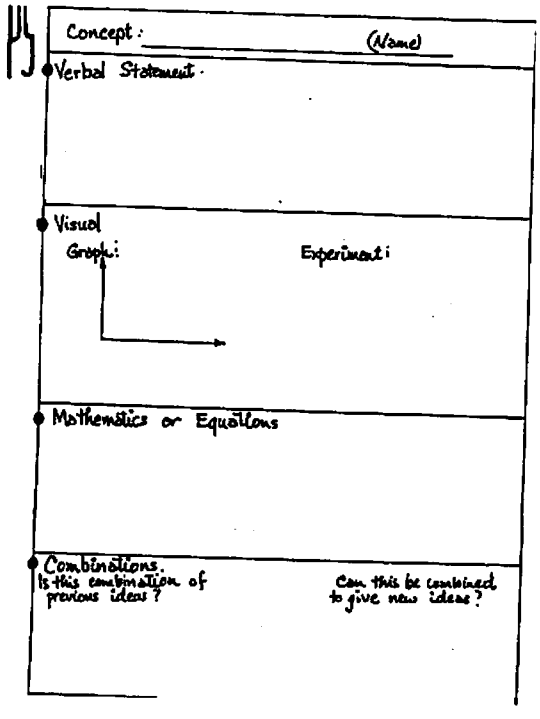
_____

TIME _____

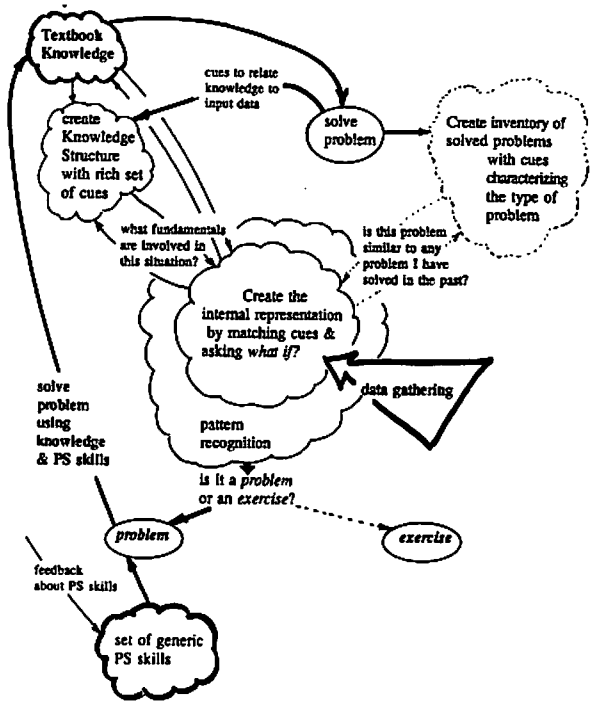
MPS 12: Learning Larkin checklist



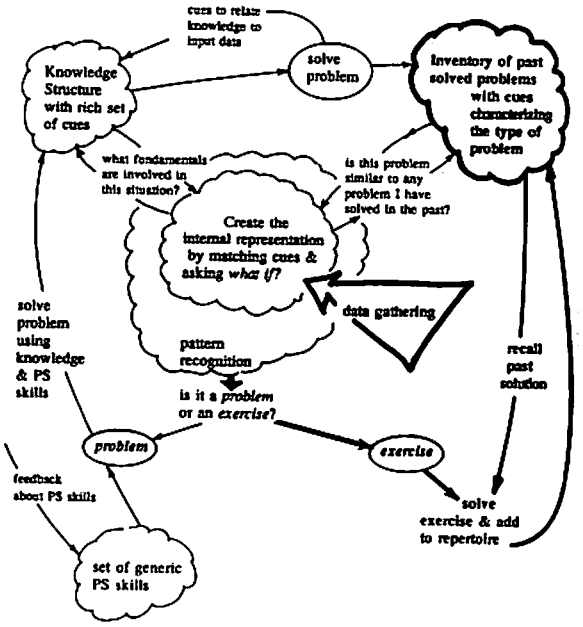
MPS 12: Learning Larkin checklist



MPS 12: Learning Knowledge has a purpose .... to solve problems Problem solving



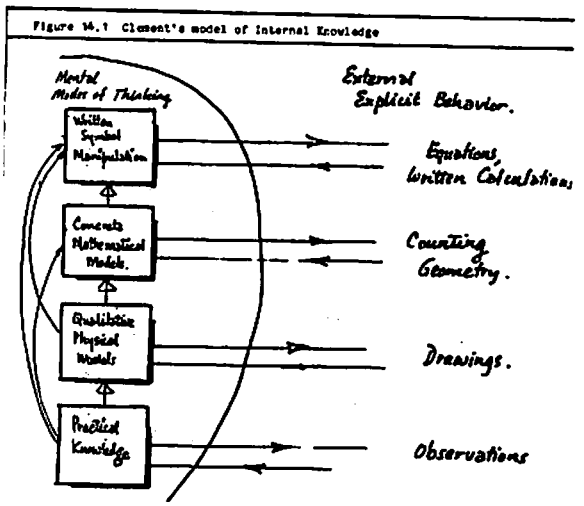
MPS 12: Learning: Knowledge has a purpose:
... to solve problems: exercise solving



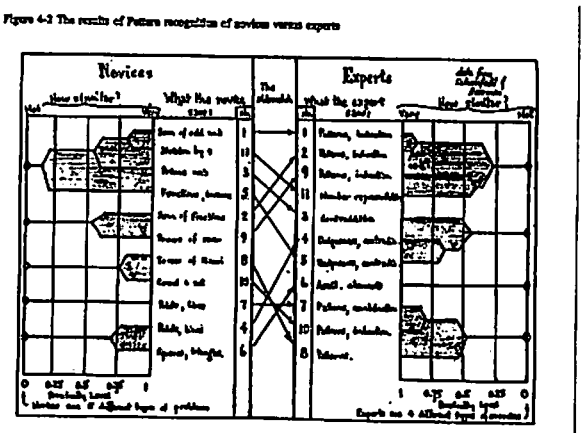
MPS 12: Learning Knowledge & problem solving
So what? Research says....

Unsuccessful	Successful
immediately translate into symbols and focus on symbol manipulation without understanding what is really going on. "*I know, this is the equation that applies*"	Focus on the observations; describe in words what's going on. Tend to start with concrete events in Kolb's cycle.
Tend to start on the abstract end of Kolb's learning cycle or recalling worked examples	Focus on identifying the fundamentals & later relate to possible worked examples.
Use a strategy of cooking past sample solutions to match the current situation.	Look beyond the surface wording and identify the fundamental phenomena that pertains. *"Which of the fundamental laws applies?"*
Use "surface wording" of the problem statement to incorrectly identify what they think is going on.	

MPS 12: Learning Clement's research



MPS 12: Learning Schoenfeld's research



Unsuccessful
looks at words

Successful
considers principles

MPS 12: Learning Memorize *pointers* and *cues* that identify fundamental law that applies and conditions.

MPS 12: Learning When creating the internal representation we need to be able to estimate, approximate, play around with ideas. We need *Experience knowledge*: Memorized, values to allow us to use the knowledge.

Velocity: how fast does a car travel 2000 km/h? 1 km/h?

What is a reasonable value for Henry's law constant?

For the density of water

for the density of benzene?

For the molar mass of carbon dioxide?

Activity: create a list of memorized values... with units... for the course so far.

TIME _____

MPS 12: Learning

SUMMARY:

Use an "O" to summarize your

current **awareness** and **skill**

TIME ____ FINISH BY _____

OBJECTIVES.....

MPS 12: Learning

DISCOVERY

Discovered Application