

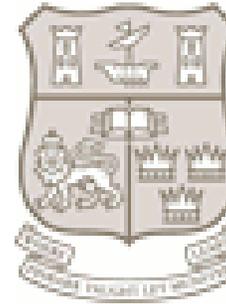


Teaching to assist students fulfil Learning Outcomes: An Engineering perspective

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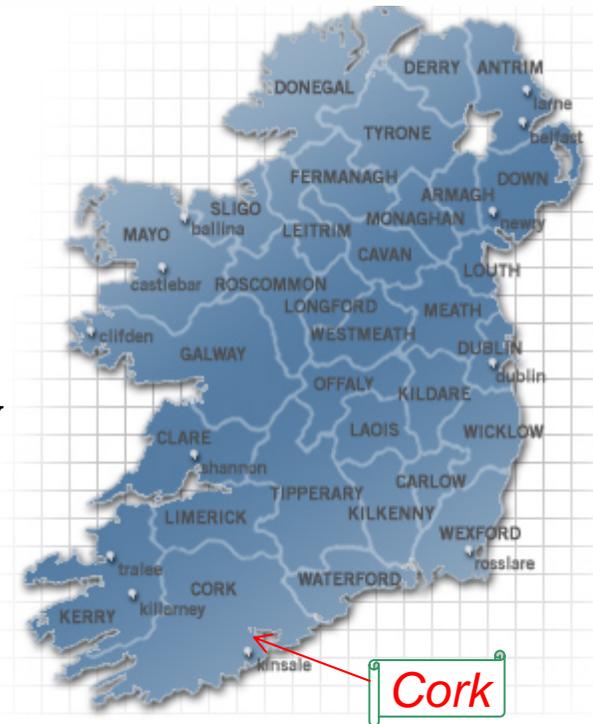


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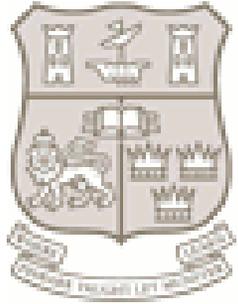


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University College Cork is situated on a city campus in the Munster capital of Cork. It was founded as one of three Queen's Colleges in Ireland, endowed by Victoria at Belfast, Cork and Galway in 1845.



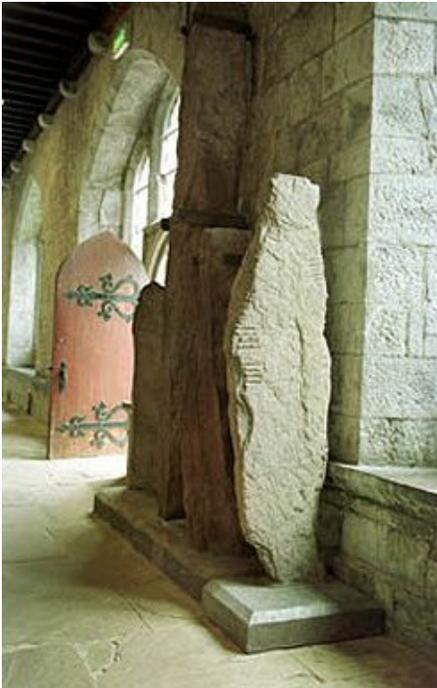
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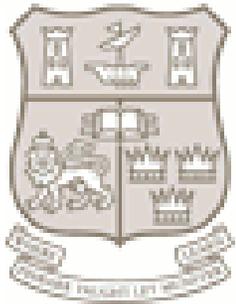
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The university has 16,000 full-time students including 13,000 undergraduates as well as 2,000 in part time Adult Continuing Education, from 80-plus countries worldwide

..and will host

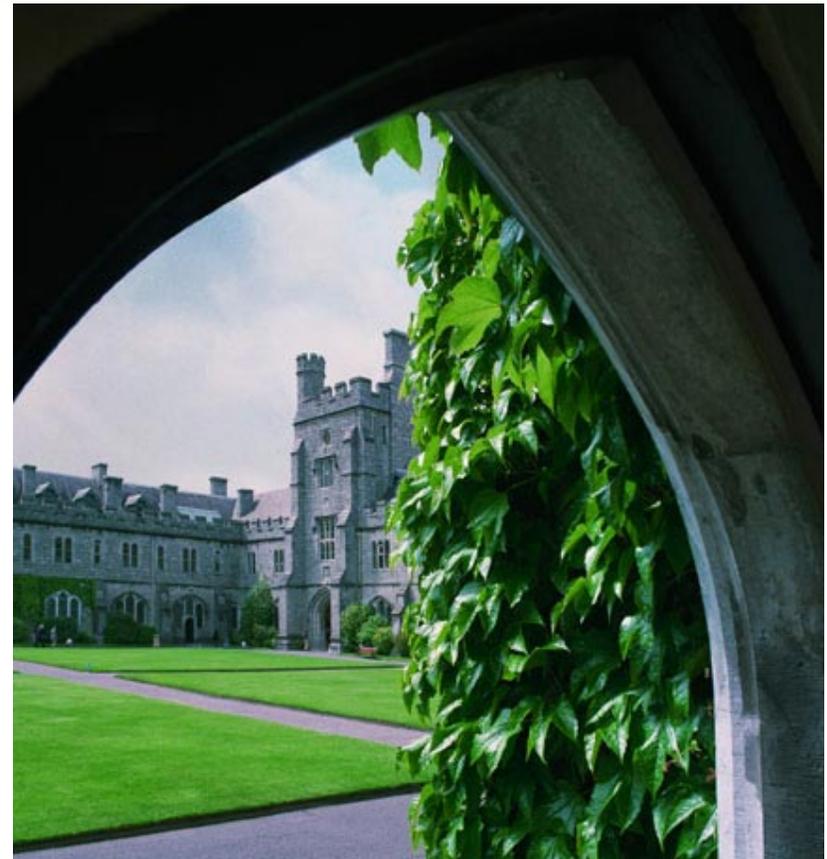
ISEE 2010





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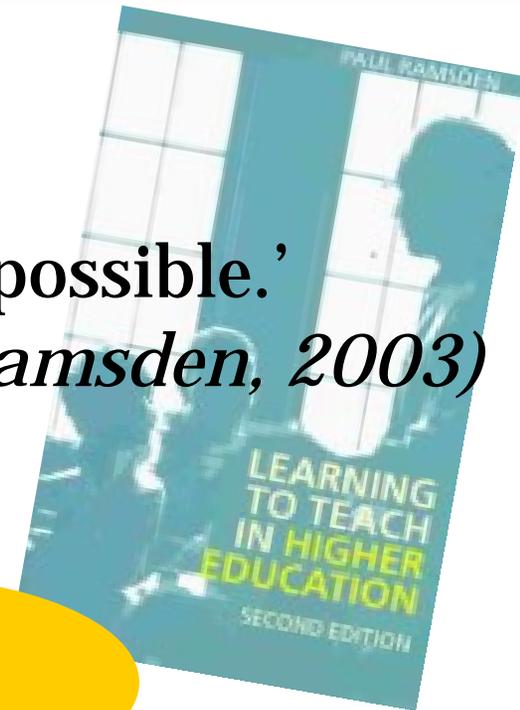
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We look forward to welcoming you there!
ISEE 2010 website will be online by end of year to include dates,
information, etc. <http://www.ucc.ie>



‘The aim of *teaching* is simple:
it is to make student *learning* possible.’
(Ramsden, 2003)

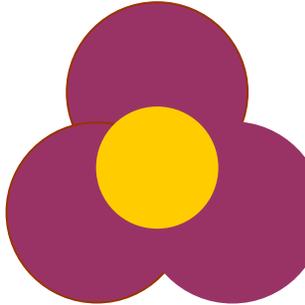
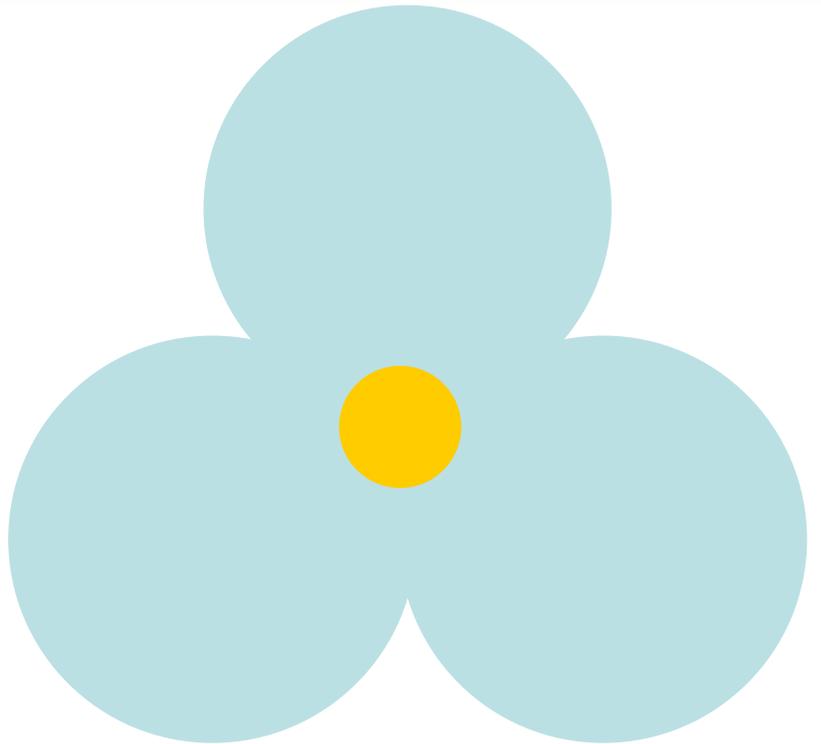




‘***Learning*** is something that you do in order to ***understand*** the real world.’

‘Teaching always involves attempts to ***alter student’s understanding***, so that they begin to conceptualise phenomena and ideas in the way ***experts*** conceptualise them.’ (Ramsden, 2003)





‘Knowledge is constructed, not received;

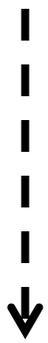
We see, hear, feel, smell and taste, and we begin connecting all those sensations in our brains to ***build patterns*** of the way we think the world works.

(Bain, 2004)

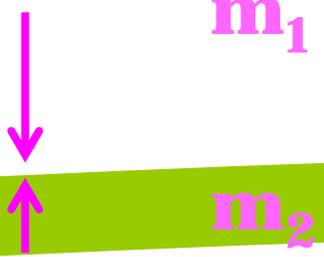


Learning:

- Creating a model of the world
- Altering one's conceptual understanding
(i.e. developing new improved models)



$$F = G \frac{m_1 m_2}{r^2} = m_1 g$$





‘Success in learning how to ***improve your own your own teaching*** is related to the extent to which you are prepared to conceptualise your teaching as a process of ***helping students to change their understanding*** of the subject matter you teach them.’



(Ramsden, 2003)

“I thought I felt a paradigm shift, but it was just my undershorts riding up.”

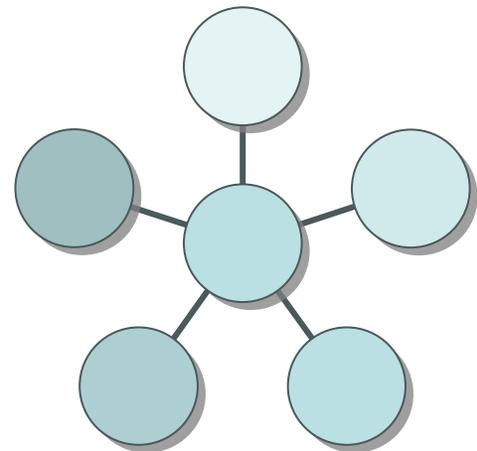
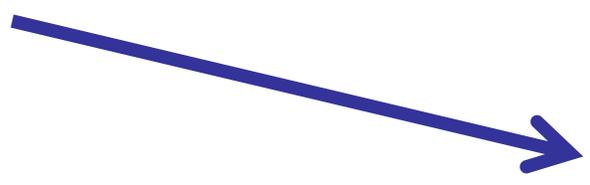


Learning about 'Teaching & Learning':



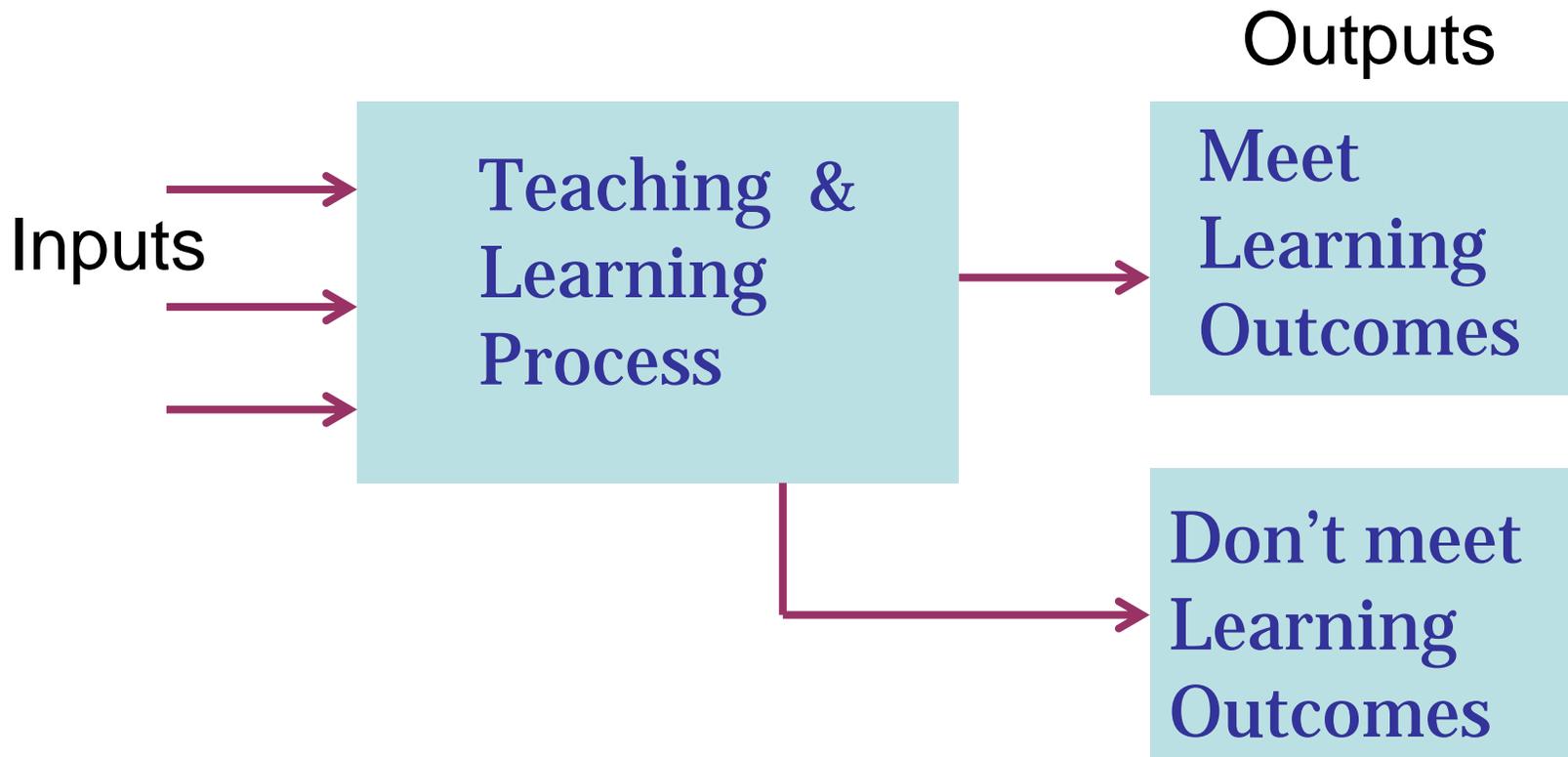
- Create a model of T&L
- Alter one's understanding of T&L (developing a new model)

'Most science courses are taught with the belief that students are "empty vessels" that need to be filled with large amounts of information.' ? ?
(Barman & Allard, 1993)





A conceptual teaching & learning model;





‘Learning Outcomes are..

..what a student is expected to know, understand and/or be able to demonstrate after completion of a process of learning.’

*ECTS Users Guide, 2005
(definition adapted by Kennedy (2007))*



Learning Outcomes approach:

- developed in **1970's** in **USA** (Mager, 1975)
- consistent with the ***student-centred 'progressive'*** or ***'constructivist'*** approach, which is *now mainstream for 'all forms of education, including tertiary'* (Carpenter & Tait, 2001)
- adapted by Engineering education via ***ABET2000*** (1996) and since by ***all accreditation institutions***
- intrinsic to ***Bologna*** process (ex 1999)



What lecturers want..

Ramsden (2003): 'Australian, Canadian and British studies broadly show three educational objectives among third level lecturers:

- To develop students' **intellectual/thinking skills**
- To teach students to **analyse ideas** or **issues critically**
- To teach students to **comprehend principles** or **generalisations**

Evaluation

Synthesis

Analysis

Application

Comprehension

Knowledge

Bloom's
Taxonomy
(1956)

Many of the lecturers interviewed were apprehensive about over-emphasising **factual knowledge.**



What lecturers want...

In addition ‘***professional*** faculties generally stress the importance of developing professional ***problem-solving skills*** and the ability to apply information to new problems, together with the development of ***professional values*** to the vocation.’

‘It seems that ***high quality student learning*** is a concept which ***is well understood*** by teachers ***in higher education.***’

Ramsden (2003)



PE1003 Introduction to Process & Chemical Engineering

Learning Outcomes: *On successful completion of this module, students should be able to:*

- Apply strategies of process engineering ***analysis*** and problem solving (specifically in relation to units and measurement, unit operations, basic process control, material & energy balances, process flow diagrams, cost engineering) to ***design*** basic industrial processes.
- ***Expound*** the importance of safety, the environment and professional ethics in chemical process engineering and in the broader world.
- ***Research*** information on an engineering topic, ***compile*** a brief report using relevant computer software, ***make*** a technical presentation to peers and ***construct*** a case to ***defend*** one's position on technical grounds.



Developing the model:

Learning ??

Inputs

Teaching &
Learning
Process

Outputs

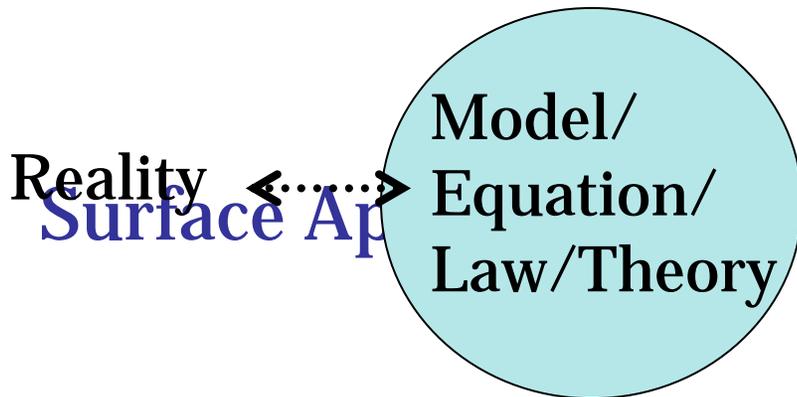
Meet
Learning
Outcomes

Don't meet
Learning
Outcomes

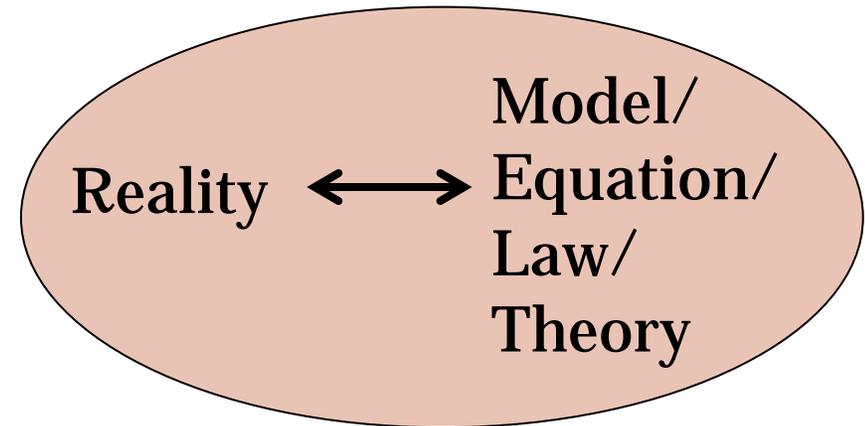


Learning Approach:

‘Many research studies have shown that the **outcomes** of students’ **learning** are associated with the **approaches** they use.’
(Ramsden, 2003)



Separate perspectives & vague awareness of connections between models and reality



A **holistic view** of subject material and its relationship with reality



Learning Approach	<i>Surface*</i>	<i>Deep*</i> <i>*Marton & Saljo (1976)</i>
<i>Characterised by:</i>	Atomistic/discrete accumulation of facts/equations	Holistic understanding in context
<i>Learning Outcomes Jargon:</i>	‘Knowledge’ LO’s: Define; Identify; Show; State	All incl. ‘Higher’ LO’s: Analyse; Assess; Defend; Design; Evaluate

‘An approach is not about learning facts versus learning concepts: it is about learning just the unrelated facts (or procedures) versus ***learning the facts in relation to the concepts.***’



(Ramsden, 2003)



“Entropy: Definition

The entropy (denoted by the symbol S) is a state function. In a system in which there are flows of both heat and conduction (Q) and work [W_s and P (PV/dt)] across the system boundaries, the conductive heat flow, but not the work flow, causes a change in the entropy of the system; this rate of entropy change is Q/T , where T is the absolute thermodynamic temperature of the system at the point of the heat flow. If, in addition, there are mass flows across the system boundaries, the total entropy of the system will also change due to this convected flow. That is, each element of mass entering or leaving the system carries with it its entropy (as well as internal energy, enthalpy, etc.).

Using this definition, and equation Eq. 2.1.4 [material/general balance equation], we have the following balance equation for entropy*:

$$\frac{dS}{dt} = \sum_{k=1}^K \dot{M}_k \hat{S}_k + \frac{\dot{Q}}{T} + \dot{S}_{gen}$$

where: [..etc]

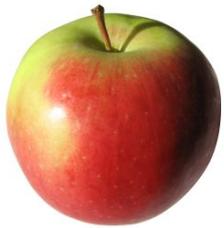
*For simplicity, we have assumed that there is only a single heat flow into the system. If there are multiple heat flows by conduction, the term Q/T is to be replaced by a $\sum Q_j/T_j$, where Q_j is the heat flow and T_j the temperature at the j th heat flow port into the system.

Stanley I. Sandler, p. 100 (Chapter 4: Entropy: An additional balance equation),
Chemical, Biochemical & Engineering Thermodynamics, 4th Ed., Wiley, 2006.



'The entropy of the universe increases with any spontaneous process'

..Second Law of Thermodynamics



time



Concentrated Energy

2nd Law

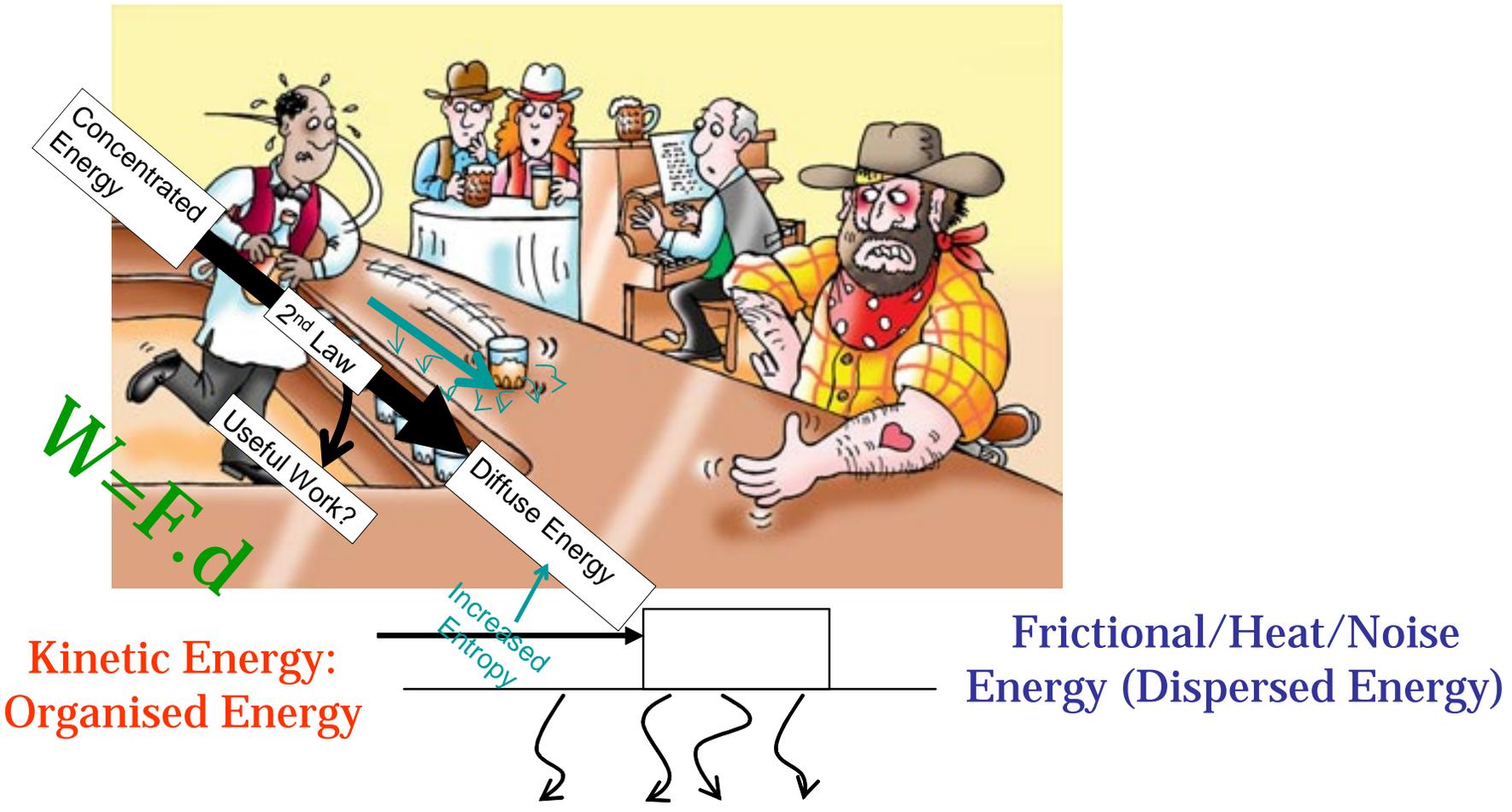
Diffuse Energy

Useful Work?

Increased Entropy

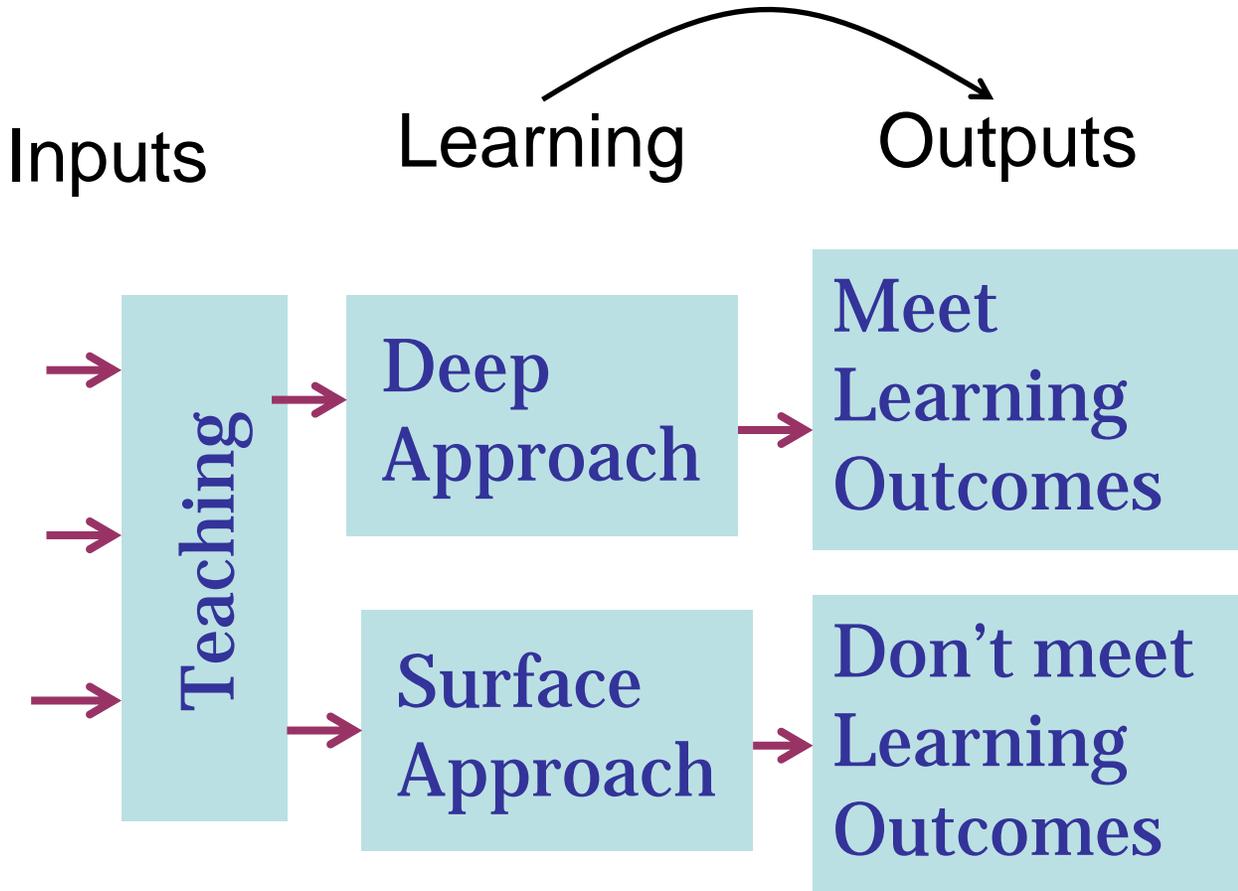


Greater frictional losses, less Work done..





‘Many research studies have shown that the **outcomes** of students’ **learning** are associated with the **approaches** they use.’





‘Deep approaches are related to higher-quality outcomes and ***better grades***. They are also ***more enjoyable***.’

(Ramsden, 2003)

‘Rote learning is ***frustrating*** because the brain resists meaningless stimuli.’

(Forrest, 2004)

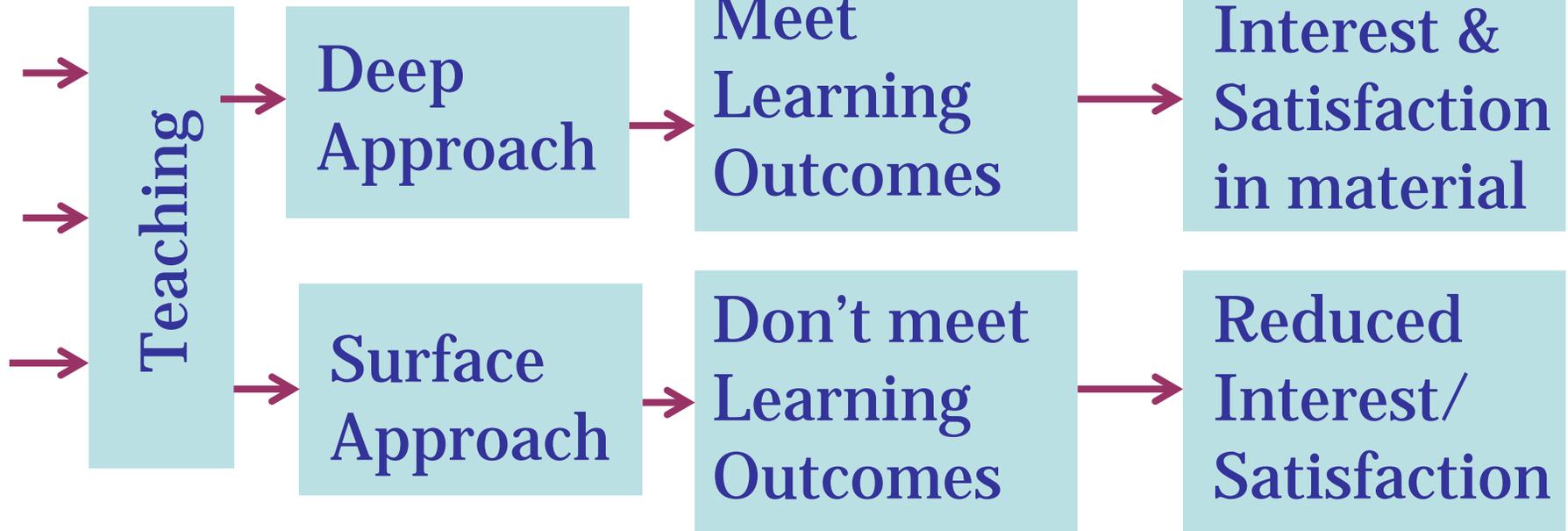


A conceptual teaching & learning model;

Inputs

Learning

Outputs





Learning Outcomes and Assessment

‘Learning outcomes specify the **essential** learning for a module’

It is important that the **assessment** tasks **mirror** the **learning outcomes** since, as far as the students are concerned, the assessment **is** the curriculum.’



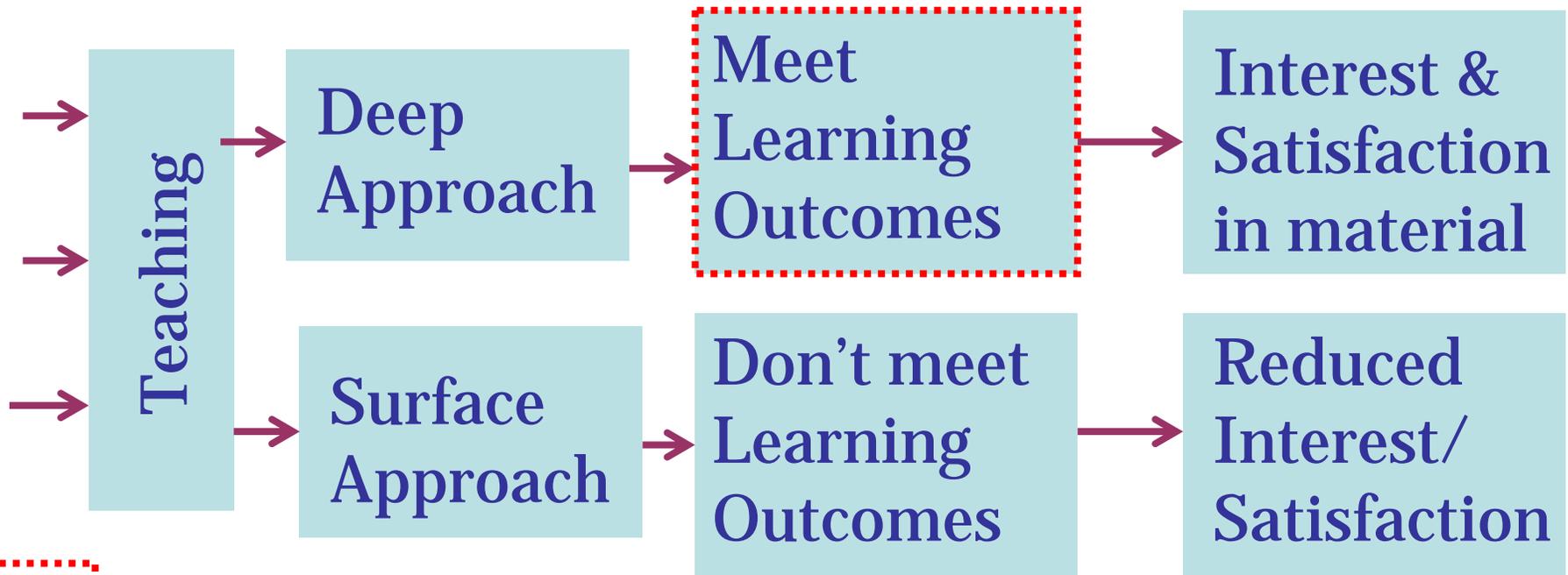


A conceptual teaching & learning model;

Inputs

Learning

Outputs



 Pass module = f (Assessment)



However...

‘Many ***assessment*** methods ***do not test understanding***, although we may believe they do.

Students ***may succeed*** in an examination or a degree course despite using a ***surface approach***.

The most important criterion that a competent lecturer will use in choosing an ***assessment method*** is its ***relevance*** to the ***aims*** and ***objectives*** it is supposed to test.’
(Ramsden, 2003)

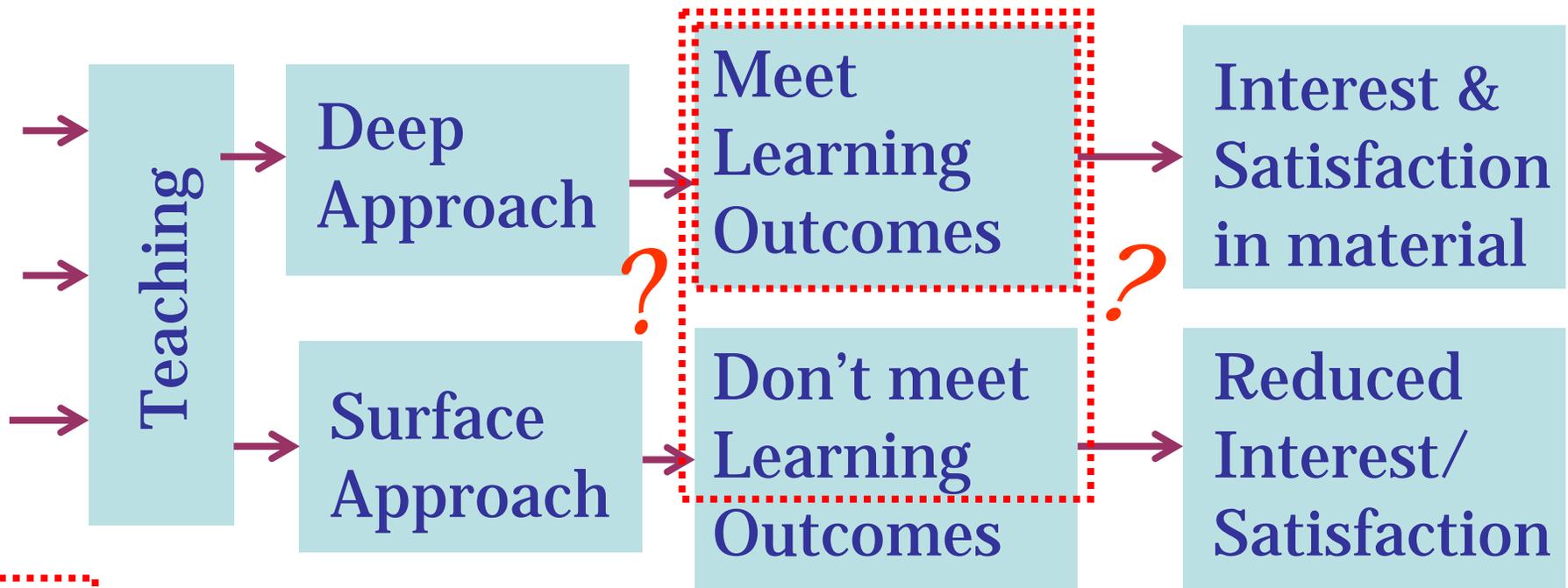


A conceptual teaching & learning model;

Inputs

Learning

Outputs



Pass module = f (Assessment)



‘It is as if two different worlds existed

- a ***manifest*** one, defined by staff and the ***written curriculum*** [including written learning outcomes],

and a ***latent*** one, defined by ***students’ perceptions***

(*Ramsden, 2003*)



Expanding the model;

Teaching → Learning → Outputs

Lecturer
Dependent
Factors

Student
Dependent
Factors

Student Perception

Deep
Appr'ch

Surface
Appr'ch

Meet Learning
Outcomes

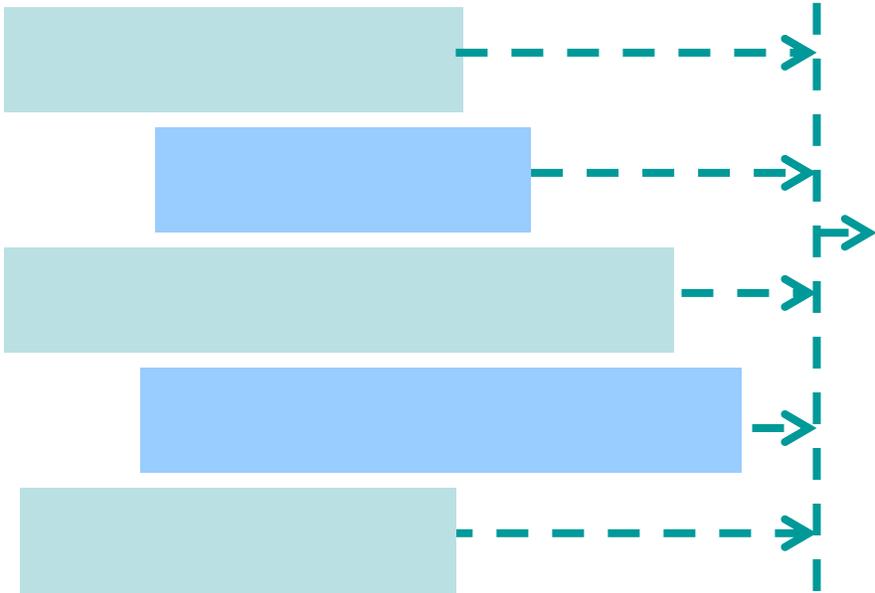
Don't meet
L. Outcomes

 Pass module



Teaching → Learning → Outputs

Assessment



Student Perception

Deep Appr'ch

Surface Appr'ch

Meet Learning Outcomes

Don't meet L. Outcomes

Interest/Motivation

Existing Knowledge Base

Previous Student Learning Experience

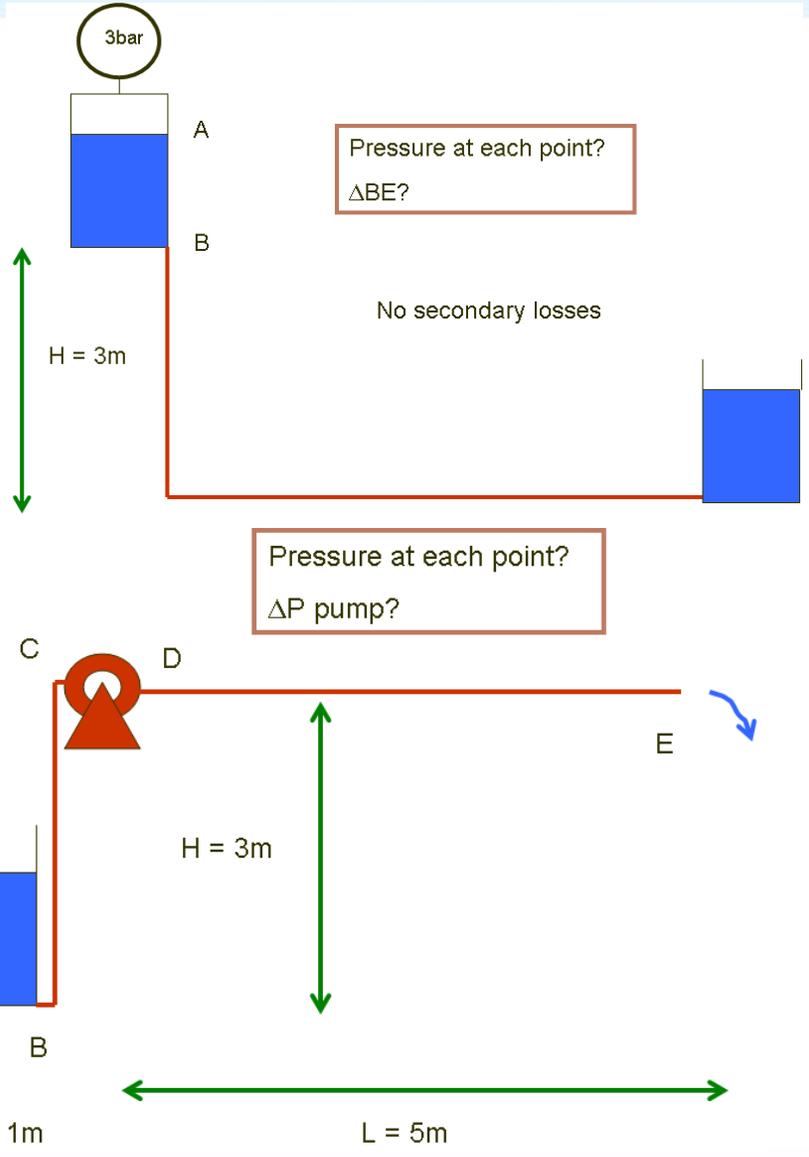
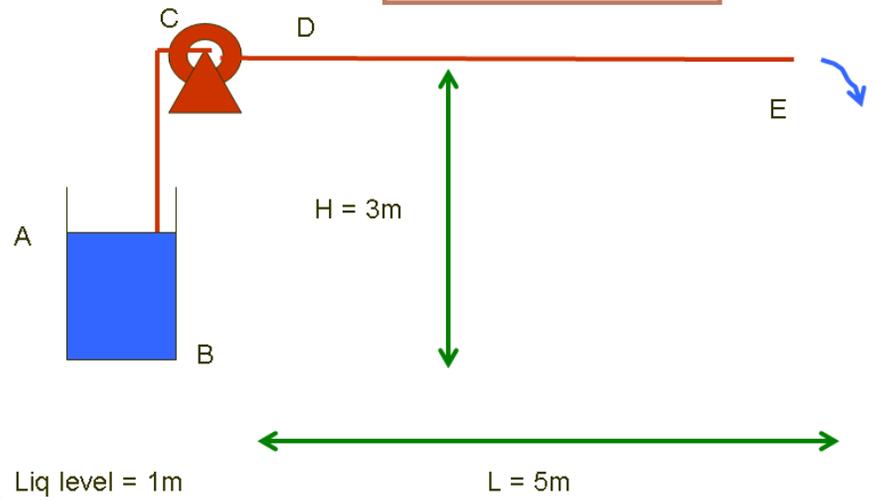
- -> Lecturer dependent
- ·> Learner dependent
- ⊞ Pass module



Concept Questions (target deep learning): Applying Bernoulli equation to practical applications

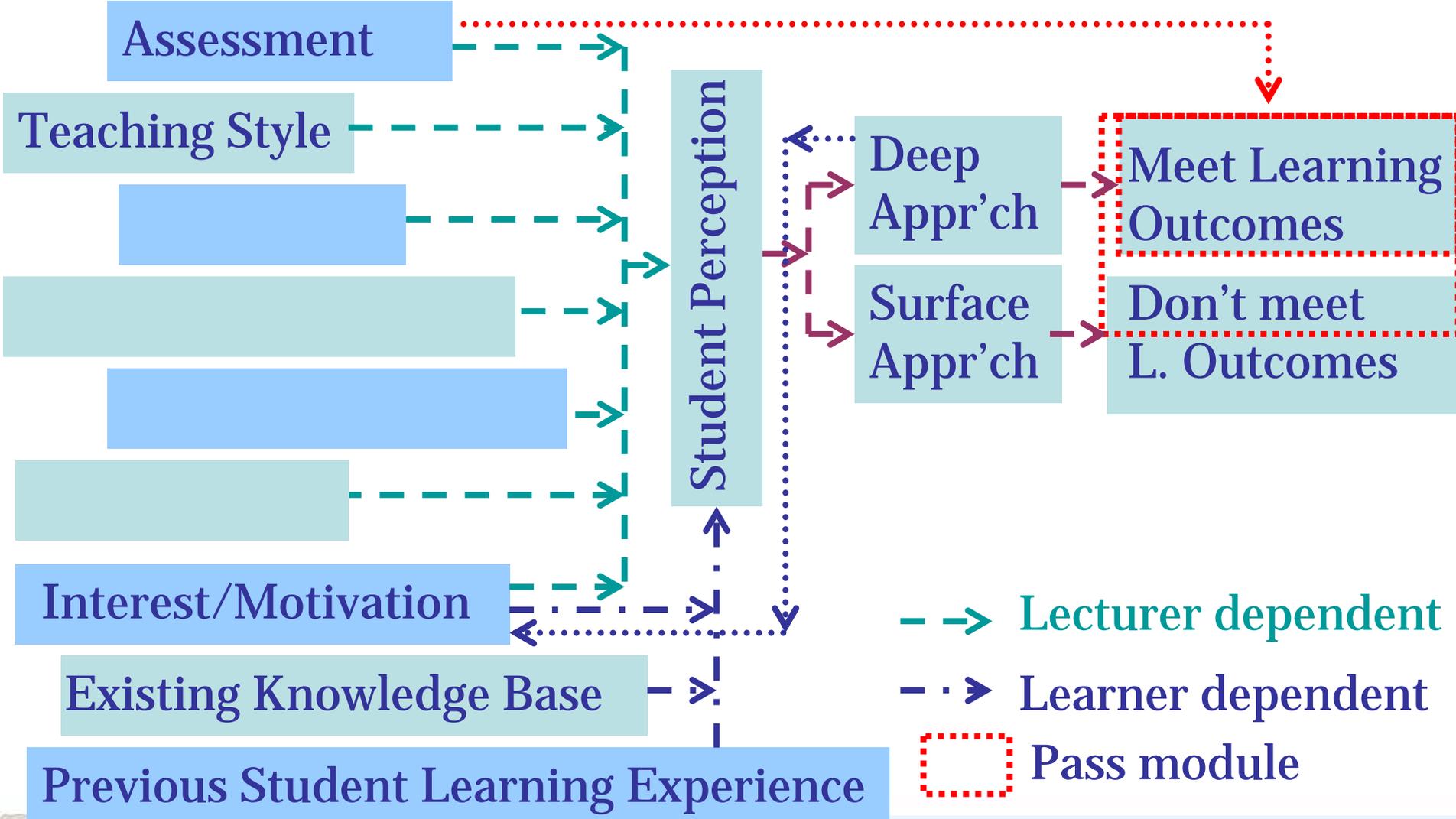
$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + \left(\frac{4flv^2}{2gD} + \sum K \frac{v^2}{2g} \right)$$

Pressure at each point?
ΔP pump?





Teaching → Learning → Outputs





Felder (2004): ‘I had always viewed low grades on tests as the natural order of things in engineering, but now I started to wonder whether the responsibility for the terrible performance of some of my students might be at least partially mine.

It is not that I was a careless or unconcerned teacher. I spent a lot of time preparing lecture notes and delivered them in a clear and well-organized manner, consistently got high ratings from my students, and even won several teaching awards.



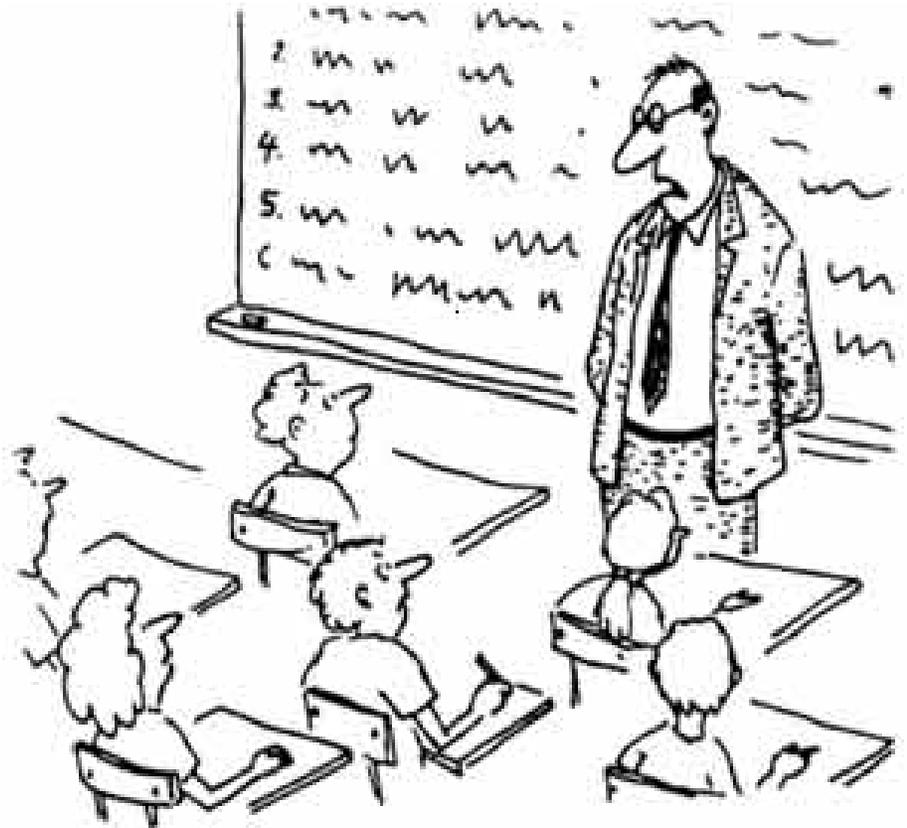
‘But the true measure of teaching effectiveness is the ***quality of student learning***, and the more I thought about those low grades the more I had to acknowledge that my teaching was clearly not effective.

I was doing all the intellectual work of ***organizing and illustrating the course concepts***, which the students really appreciated, but doing all that is ***precisely what leads to real understanding***. The result was that ***I was learning*** the course material extremely well, but ***they were not***. At that point I began for the first time in my career to think whether there might be better ways to do it.’



‘Active engagement is what I try to achieve now in every class I teach.

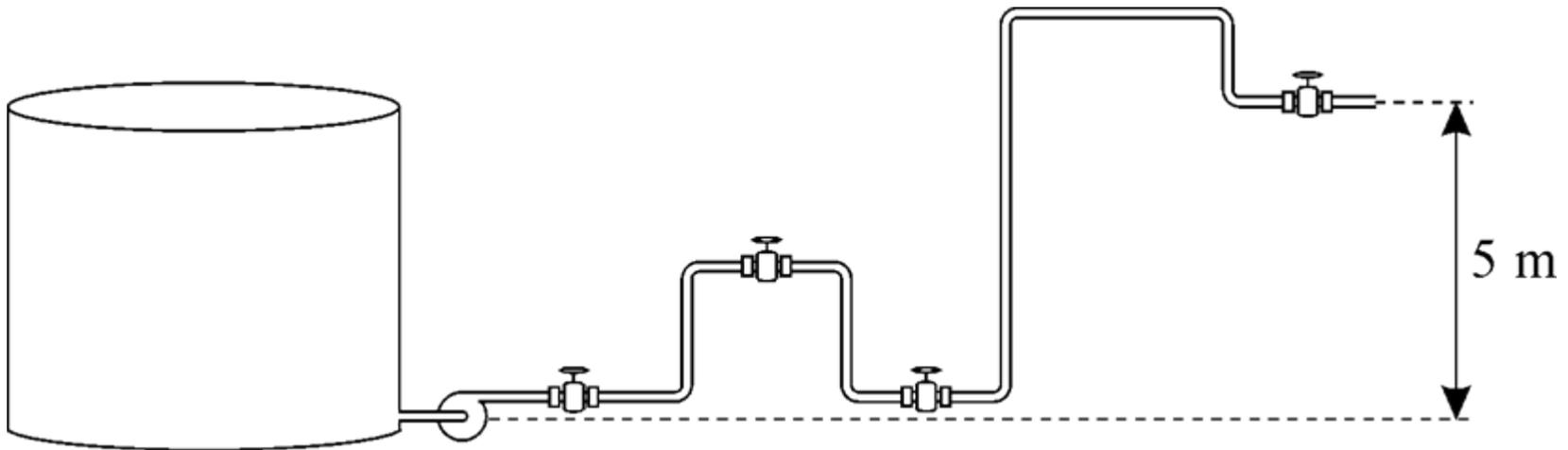
Instead of spending all my time **writing detailed derivations** and **problem solutions** on the board for the students to copy, I get them - sometimes working individually, sometimes in small groups - to **confront problems themselves** during class.’ Felder (2004)



“I expect you all to be independent, innovative, critical thinkers who will do exactly as I say!”



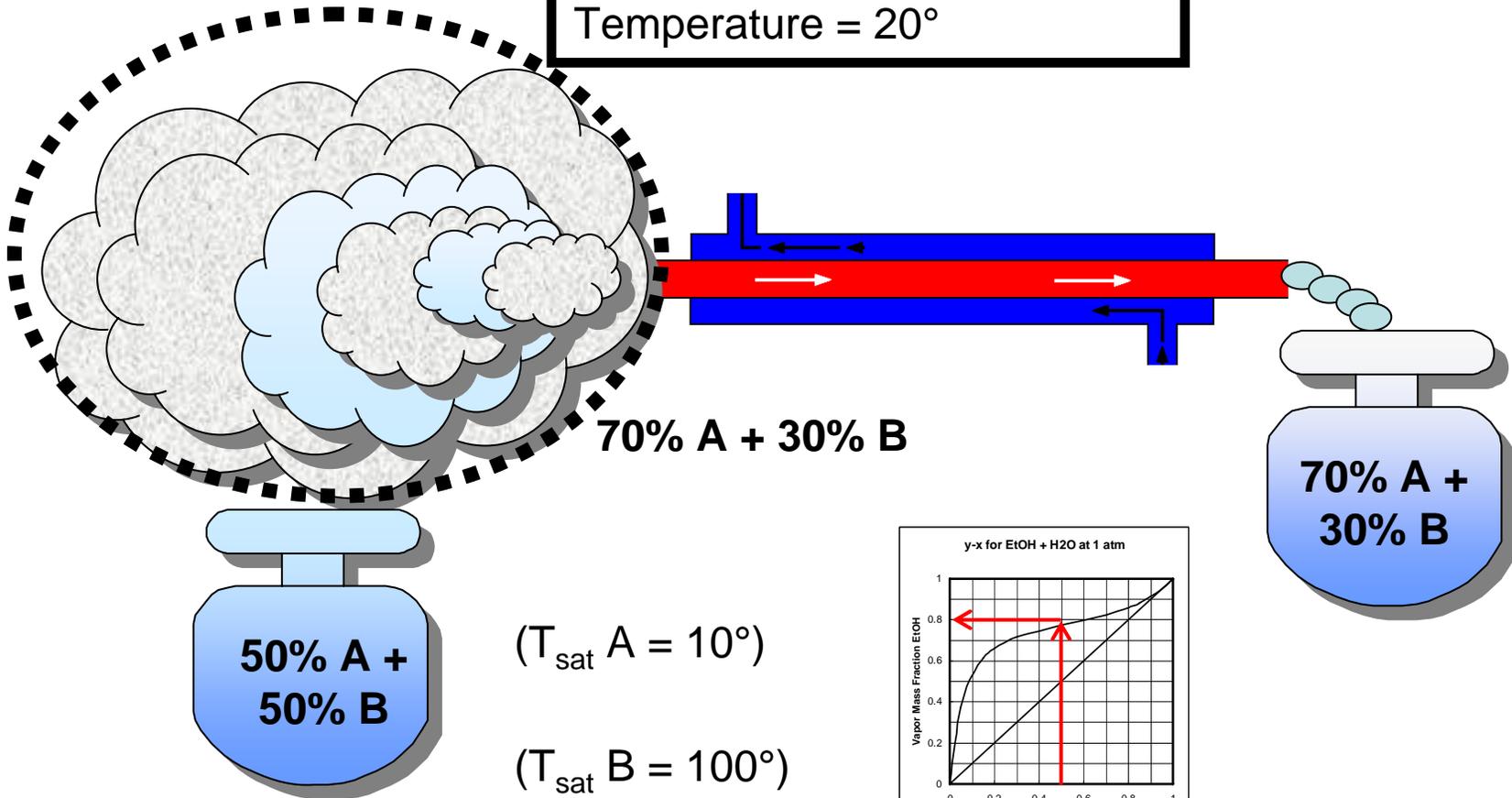
Active engagement; get students *to do* past papers/problems/design ***in class & discuss issues:*** with each other/lecturer



Create some! e.g. use **workbook** (with blanks) to compile lecture notes ^{No time?!} along with images on PowerPoint/slides (Demirel, 2004; Larsen et al., 2004)

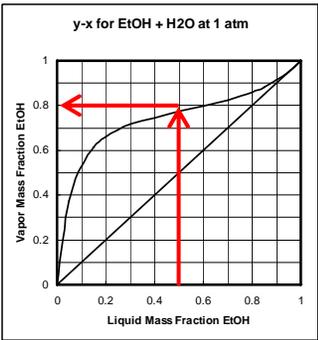


Pressure = 1.013bar (1 atm)
Temperature = 20°



$(T_{\text{sat}} A = 10^\circ)$

$(T_{\text{sat}} B = 100^\circ)$





Estimate activity coefficients using Wilson/Margules/Van Laar/etc; $\gamma = f(x_i, 12 \text{ system parameters})$

Estimate fugacity coefficients using equation of state $\phi = f(z, T)$

$$\ln \gamma_1 = x_2^2 [A_{12} + 2(A_{21} - A_{12})x_1]$$

$$\ln \gamma_2 = x_1^2 [A_{21} + 2(A_{12} - A_{21})x_2]$$

e.g.

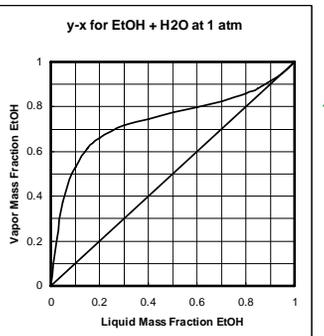
$$\hat{\phi}_i^V = \exp \left[(Z-1) \frac{B_i}{B} - \ln(Z-B) - \frac{A}{B} \left(2\sqrt{\frac{A_i}{A}} - \frac{B_i}{B} \right) \ln \left(1 + \frac{B}{Z} \right) \right]$$

$$K_1 = \frac{y_1}{x_1} = \frac{\gamma_1^L P_1^{\text{SAT}}}{\hat{\phi}_1^V P}$$

$$K_2 = \frac{y_2}{x_2} = \frac{\gamma_2^L P_2^{\text{SAT}}}{\hat{\phi}_2^V P}$$

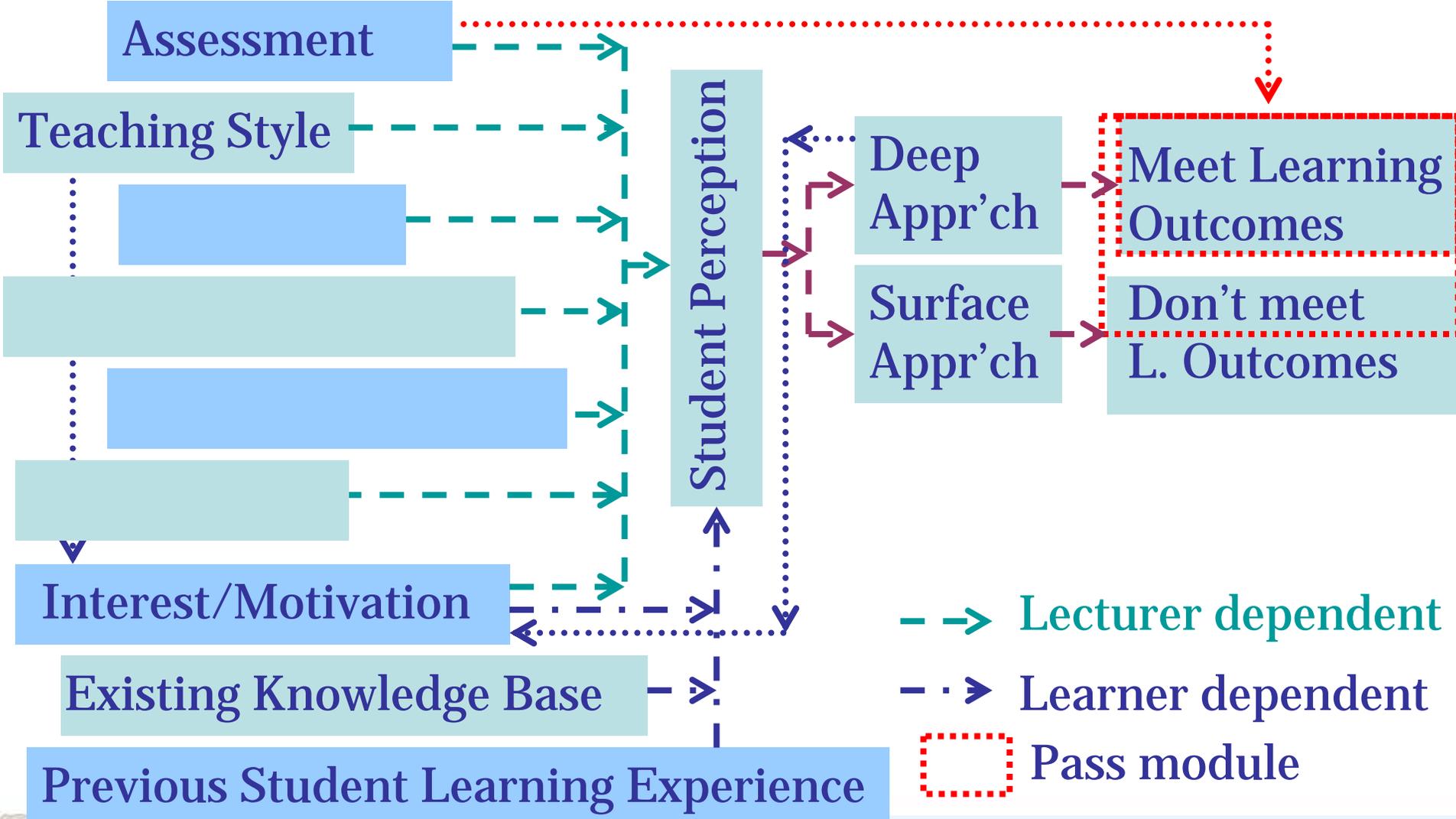
$$\frac{K_1}{K_2} = \alpha_{12}$$

$$y_1 = \frac{\alpha_{12} x_1}{1 + x_1 (\alpha_{12} - 1)}$$





Teaching → Learning → Outputs

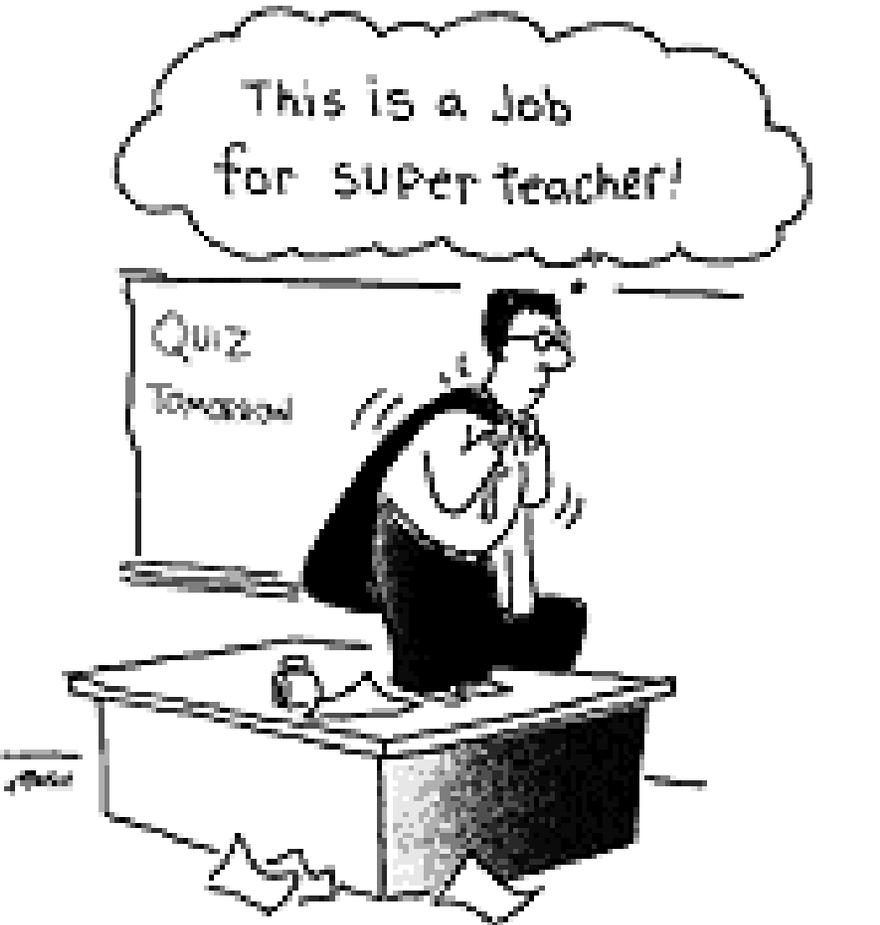


- -> Lecturer dependent
- ·> Learner dependent
- ⊠ Pass module



‘Student **motivation** represents a somewhat subconscious influence that **improves learning** because of a **very conscious effort** on the part of the **teacher.**’

White (2004)





Teaching → Learning → Outputs

Assessment

Teaching Style

Student Perception

Deep
Appr'ch

Meet Learning
Outcomes

Surface
Appr'ch

Don't meet
L. Outcomes

Interest/Motivation

Existing Knowledge Base

Previous Student Learning Experience

- -> Lecturer dependent

- ·> Learner dependent

Pass module

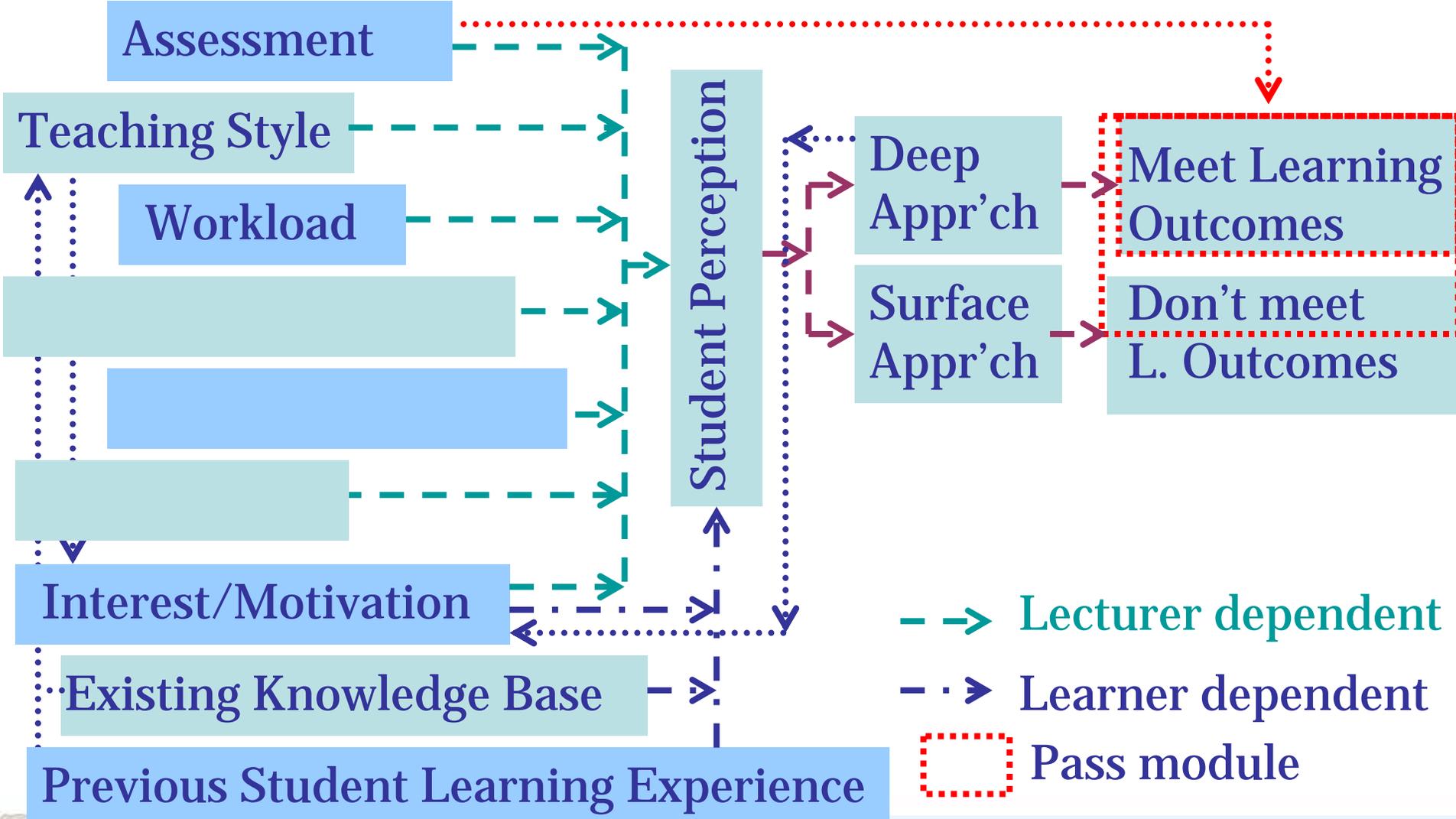


‘Good teachers down the ages have continually used what they **learned from their students** to improve their practice.’
(Ramsden, 2003)

Students learn by **building upon** their **existing knowledge bases**. Successful teaching is an iterative process and requires ongoing *dialogue* with students to uncover their **previous conceptions**, so that these can be **challenged, reconstructed, extended and built upon**.



Teaching → Learning → Outputs





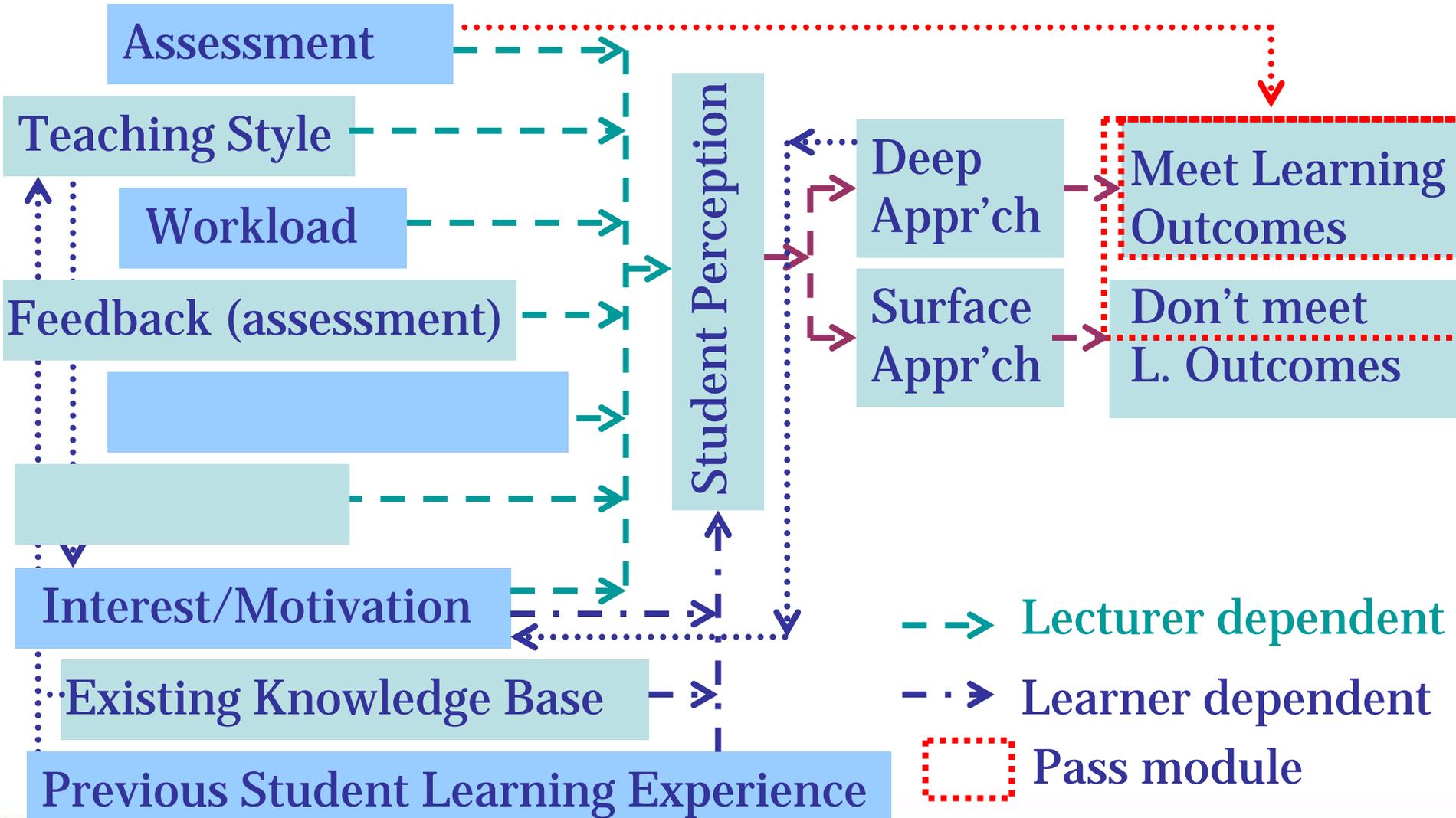
‘We should rather strive to **include less**, but to ensure that students **learn** that smaller part *properly*.’



THINK OF IT AS A SUCCESS... THEY LEARNED EVERYTHING IN THE FIRST HOUR, AND DIDN'T NEED THIS NEXT HOUR.



Teaching → Learning → Outputs





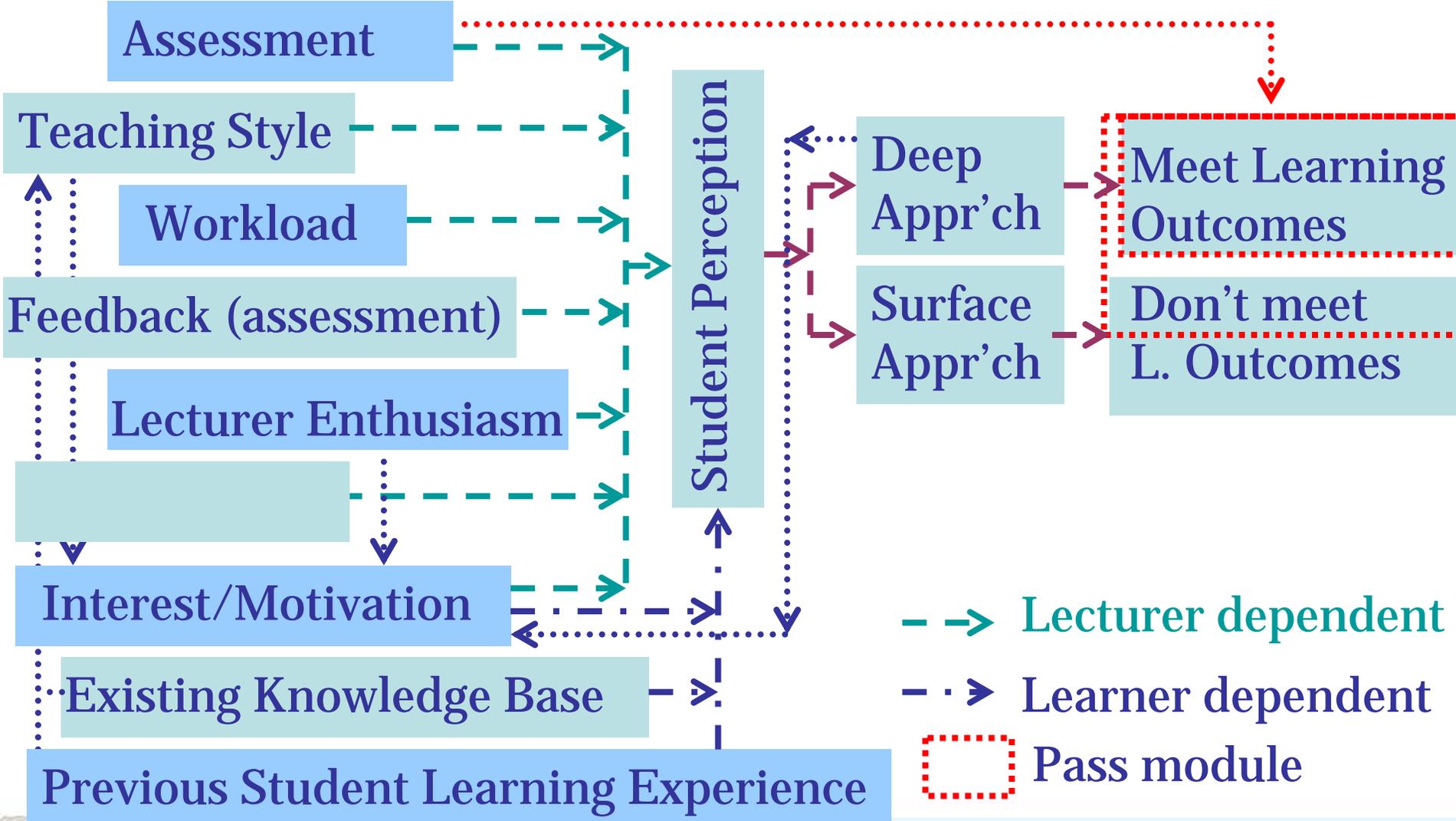
‘No assignment should be set unless the lecturer who sets it is prepared to discuss with students what an appropriate answer to it would have consisted of. The prudent use of **model answers** is an excellent form of **feedback**.

...this way of teaching conceptualises the relationship between student and teacher as an **interaction** or **dialogue** rather than a one-way communication.’

(Ramsden, 2003)

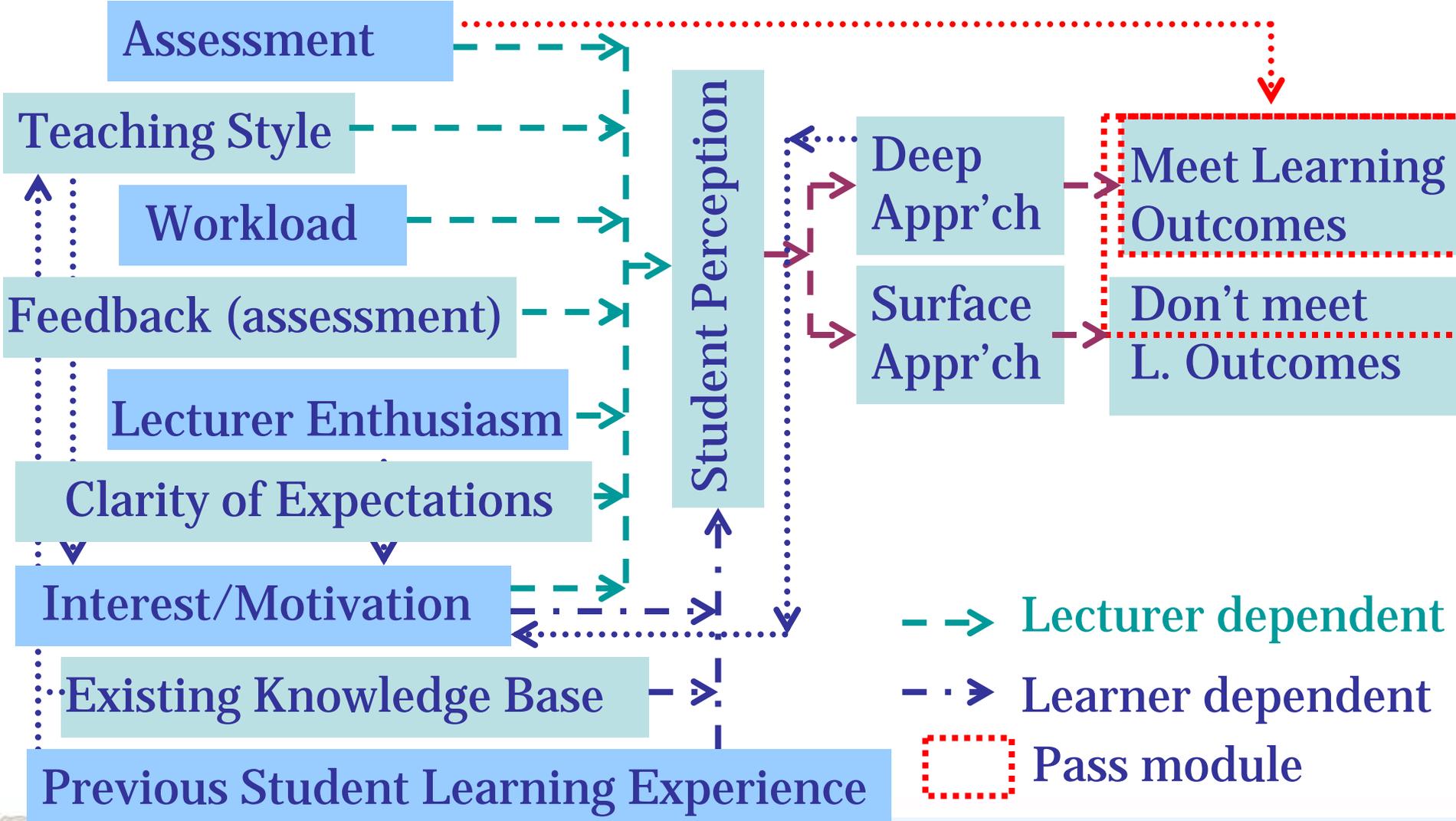


Teaching → Learning → Outputs





Teaching → Learning → Outputs





‘The first question in teaching anything should be:

‘What do I want my students to learn?’

followed by:

‘How can I express my requirements to my students.’

Learning Outcomes?

Deep Learning?

Assessment?

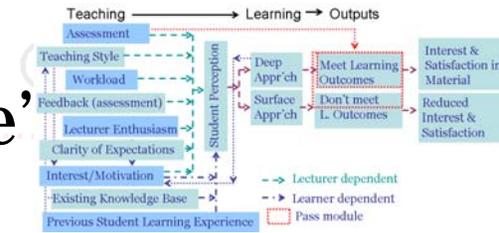
.. satisfactory answers to these questions must **precede** attempts to address problems such as how to present a lecture, manage a tutorial, or use ICT.’

Ramsden (2003)



Applying this Teaching & Learning model:

1. Outline module content; 'Less is more'
2. Devise Learning Outcomes
3. Set up ***matching*** Assessment Methods
4. Employ appropriate Teaching Style/s (active, two-way dialogue, visual, inductive, etc.) enthusiastically
5. Provide appropriate Feedback continuously
6. Present model to students & **continually** remind them of approach required to succeed in assessment.





‘University teaching is a very complicated and detailed subject.

It takes many years of practice to do well, and even then you will not have learned enough.’

(Ramsden, 2003)

‘Doing world class research is essentially a full time job. So is doing outstanding teaching’

Felder (2004)



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Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

Thank you!

..see you in 2010?!

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