

# PCP as a bridge between Theory and Practice in Chemistry Education

Enda Carr, Dr. Odilla Finlayson, Dr. Eilish McLoughlin

17.VI.16

E401

1520hr

7<sup>th</sup> biennial SMEC, DCU, Ireland



SMEC 2016

# Objectives

- Why PCP & Science Education
- Information Processing Model
- Permeable Constructs & Experience Cycle to gauge ourselves as teachers
- A Model of learning through a lens of PCP
- Conclusion

# Science Education and Personal Construct Psychology

J. Gilbert, (2005): as of circa 1985, the British Association for Science Education suggested that alternative models of psychology, such as that of George Kelly (1955), should be considered for their implications with respect to science education.

Although a Physicist originally George Kelly's theory offers a useful prism for chemistry teachers to interpret their students' explanations.



# Science Education and Personal Construct Psychology

- Talanquer (2012): chemistry is a science built upon a wide variety of dichotomous concepts including: acid/base, oxidation/reduction and exothermic/endothermic.
- Frequently, chemical processes are driven by the tension between opposite poles: stable versus unstable and static versus dynamic etc.
- Kelly's PCP theory envisages an individual carrying out 'sense making' by construing and re-construing. Construing is the act of interpreting idea or '*concept*' (Ravenette, 1999)

# Personal Construct Psychology

Is developed in terms of a fundamental postulate (basic assumption) and eleven corollaries (simple deductions). The fundamental postulate states: 'A person's processes are psychologically channellised by ways in which they anticipate events' Kelly (1955/1991).

Using his root metaphor 'Man: the scientist', states his belief that a person's behaviour in the present is determined by the way he/she is anticipating some future event by using their constructs.



## Today's Context

Nersessian (2008): human cognitive apparatus is capable of mental modelling, analogy-making, abstraction, visualization, and simulative imagining.

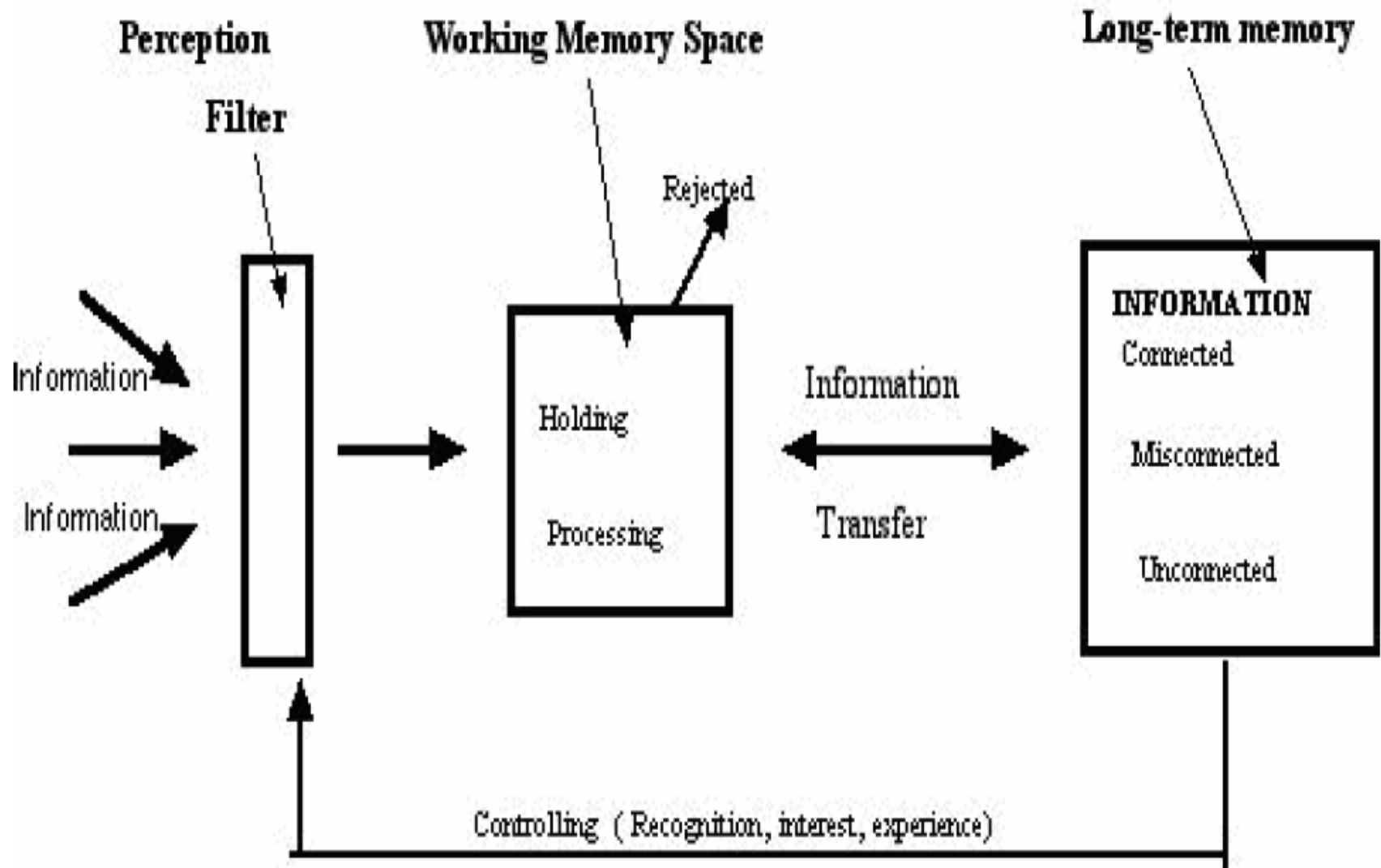
Yenawine (2012): reasoning clearly, listening constructively and thinking critically to speculate and consider alternatives



Cracolice et al. (2008): Challenge - very low % of students in junior secondary school have sufficient reasoning skills to become successful conceptual problem solvers (genuine understanding)

Gabel (1999): the nature of this problem may be explained by the *Information Processing Model* of learning

# Information Processing Model (IPM)



## IPM in Context

Taskin & Bernholt (2014): *intelligence* alone does not necessarily lead to a better understanding of chemical representations. Problem solving by becoming conscious of how to put ideas into operation is known as metacognition.

Hewson (1992): when students “step back” from ideas held by themselves and/or others in order to think about them and express an opinion. (Metacognition)

Machamer (2007): ‘understanding our understanding’ reflects the difference between the capacity to perform *intelligently* rather than *mechanically* and is critical to the self-correction of ideas.



# Objectives

- Why PCP & Science Education
  - Information Processing Model
- 

- Permeable Constructs & Experience Cycle observe to gauge ourselves as teachers
- A Model of learning through a lens of PCP
- Conclusion

# Observing Alternative Understanding

## Alternative Conceptions and PCP

Driver and Leach (1993) The term ‘alternative conception’ is used to describe students’ ideas that are incommensurate with scientific conceptions (canonical knowledge).

Taber and Watts (2000) describe alternative conceptions as at variance with a good scientific explanation and can lead to ‘alternative explanations’.

Hewson (1992): advises that “alternative” is not a synonym for “inadequate” or “unacceptable”.

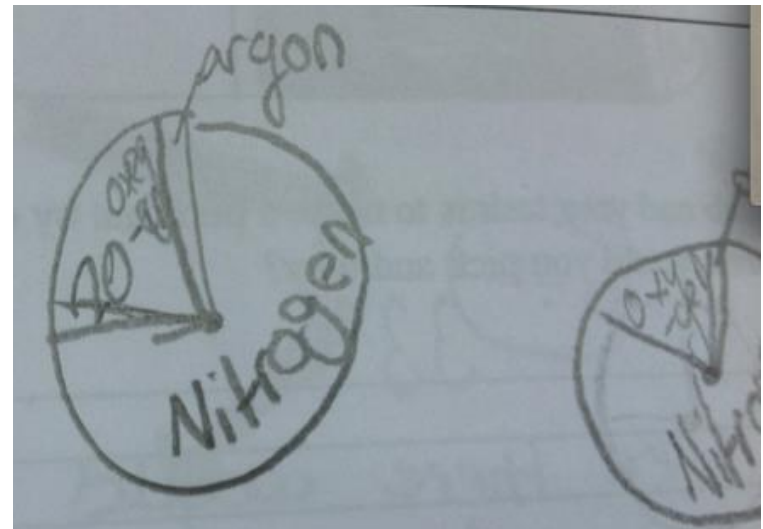
Gilbert (2005): argues that it is favourable that students’ ‘errors’ are “recognised as being natural developmental phenomena, personally viable constructive alternatives – rather than the result of some cognitive deficiency, inadequate learning, ‘carelessness’ or poor teaching.”

## Observing Alternative Understanding

Taber and Franco (2009): more than just giving children's ideas 'credence', but rather to see them as starting points and resources to be developed towards target knowledge in future.

(Talanquer, 2010): student explanations offer 'an opportunity to explore' how scientific concepts are interpreted and how those concepts are linked.

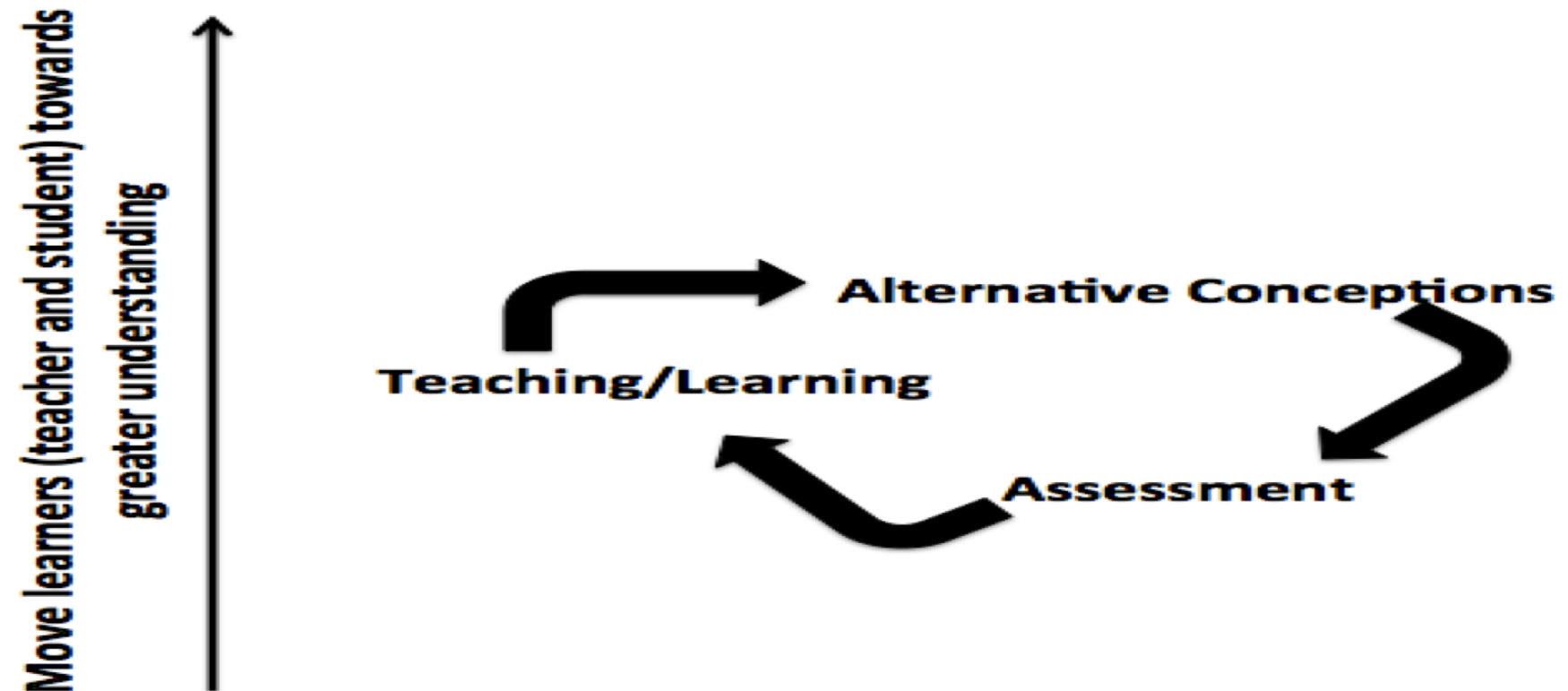
(Talanquer, 2014) revised view of *random guessing* to *interpreting as the natural outcome of intuitive reasoning heuristics* used by all people in their daily lives.



# Observing Alternative Understanding

According to (Kelly, 1955/1991), it is the learning which is the experience leading a person's construct system to vary and become revised

'Mutatis Mutandis': with those things having been changed that had to be changed (evolutionary)



## Themes in Literature re Organisation Corollary

The structural nature of knowledge has been acknowledged by Thagard (1992), Kiel and Newman (2008) and Clement (2008) Schneider & Stern (2010).

(Duit, 1996) describes this structure as being prone to revisions along pathways from prior knowledge towards scientific concepts.

Bell (2003): these pathways involve a construing process.

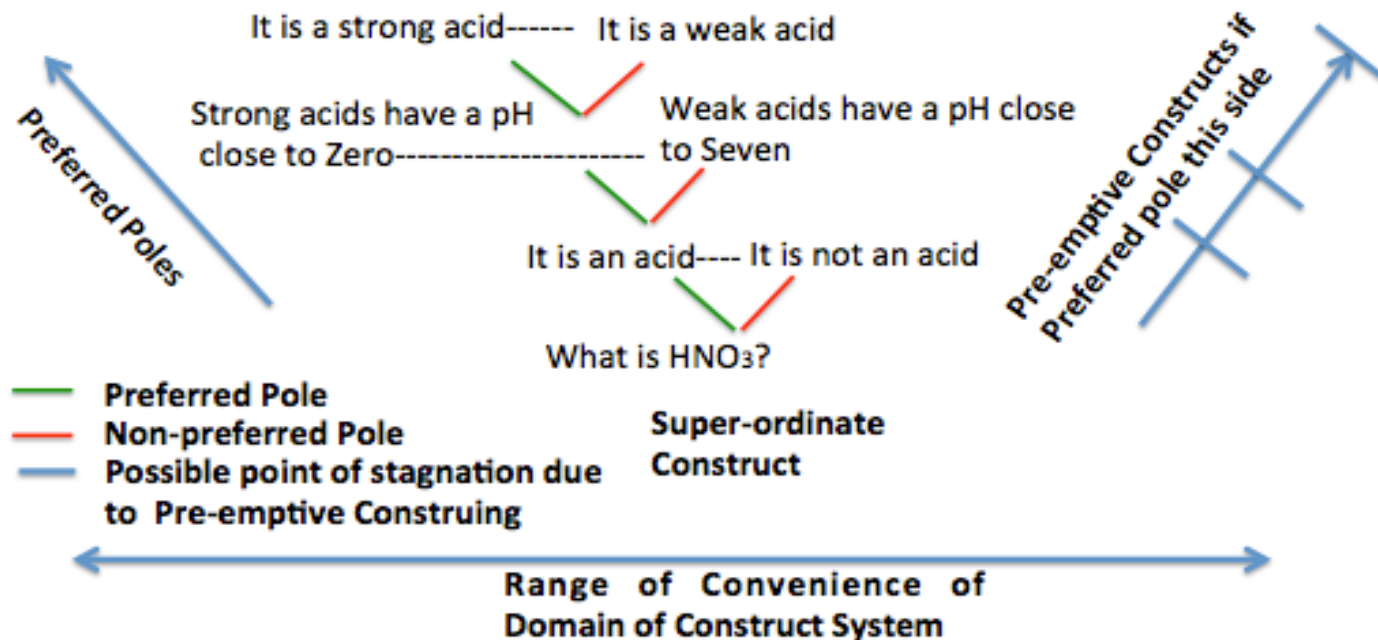
Davidowitz & Chittleborough (2009): students learn by the active selection of information they perceive relevant and the subsequent organisation and integration of this new information with prior knowledge into a mental schema.

Hewson (1992) and Sanger (2000): conceptual change of this nature represents knowledge extension from a known to an unknown. These ideas are aligned with Kelly's n Organisation Corollary hierarchical personal construct system offering a learner growth in "sense-making" capability including concept development, as opposed to stagnation, and has implications for learning.

# Themes in Literature re Organisation Corollary

Ainsworth (2006): abstraction involves the creation of mental entities that serve as a basis for new concepts at a higher level of organization.

Fransella (2016): a construct is an abstraction involving pathways of movement of meaning based on the interpretation of recurrent themes in information that is encountered.



## Themes in Literature re Individual and Commonality Corollaries

Davidowitz & Chittleborough (2009): knowledge structures exhibit both idiosyncratic features and commonalities.

Taber (2015): learners' existing ideas have consequences for the learning of science and that their conceptual structures exhibit both commonalities and idiosyncratic features.

Talanquer (2006): different individuals may select different cues to guide their reasoning about a phenomenon and generate *different* explanations.

## Themes in Literature re Fragmentation

Gabel (1999): it is possible for isolated information with little or no linkages to prior knowledge to be added to long-term memory

This fragmented phenomenon is noted by (Talanquer, 2008), (Nakhleh et al., 2005), (Ainsworth (2006), (Cook et al. (2008), and Taber (2013) as a problem for learners.

Kelly (1991/1955) in his Fragmentation Corollary states: a person may successively employ a variety of construction subsystems which are inferentially incompatible with each other.



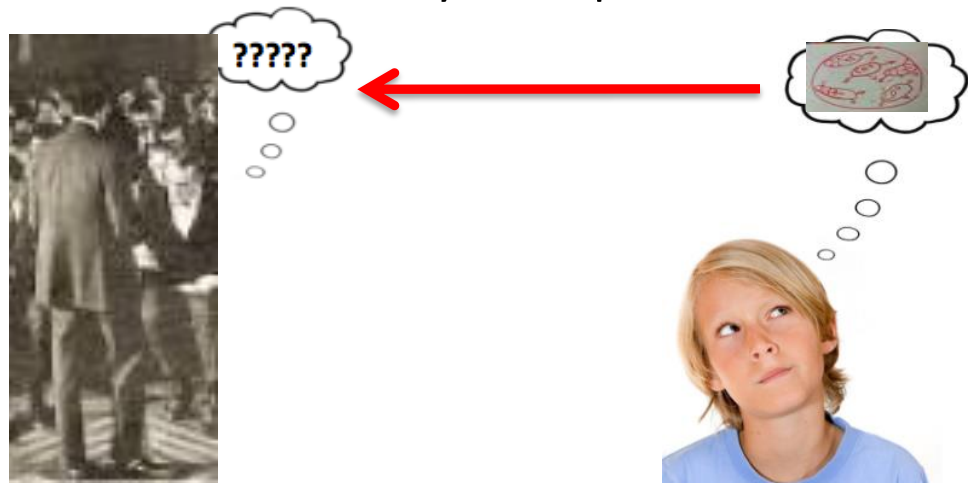
# Permeable Constructs to Question our Teaching

(Pope and DeNicolo 2016): Emphasise the importance of teachers questioning their teaching.

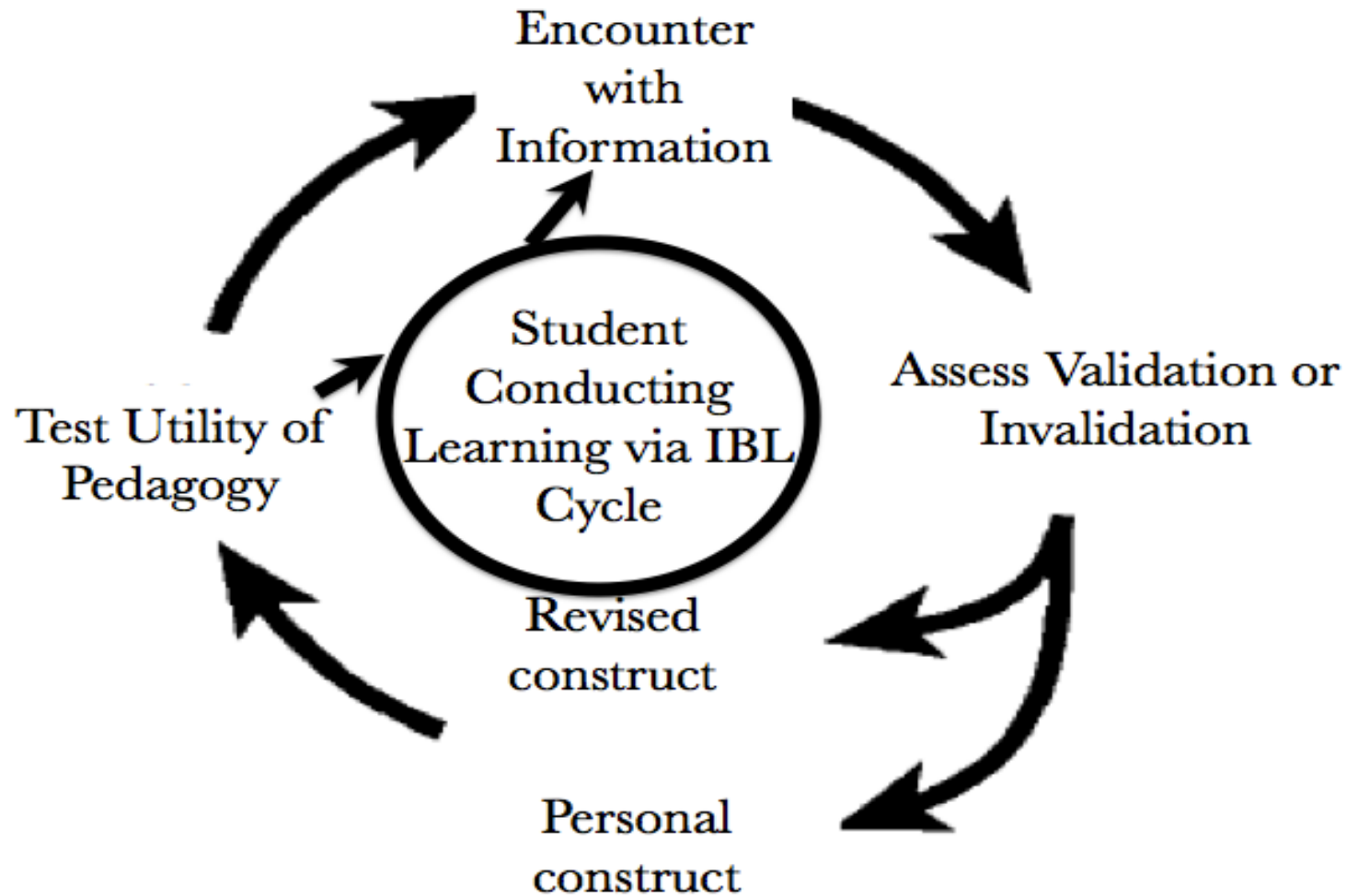
Pope and DeNicolo (2001): The freedom, which a person has to undergo conceptual change in order to respond to new events depends on the '*permeability*' of their constructs.

Kelly (1955/1991): psychologists need to use more 'permeable' constructs in their own (construct) systems so that they could better subsume the construct system of their clients.

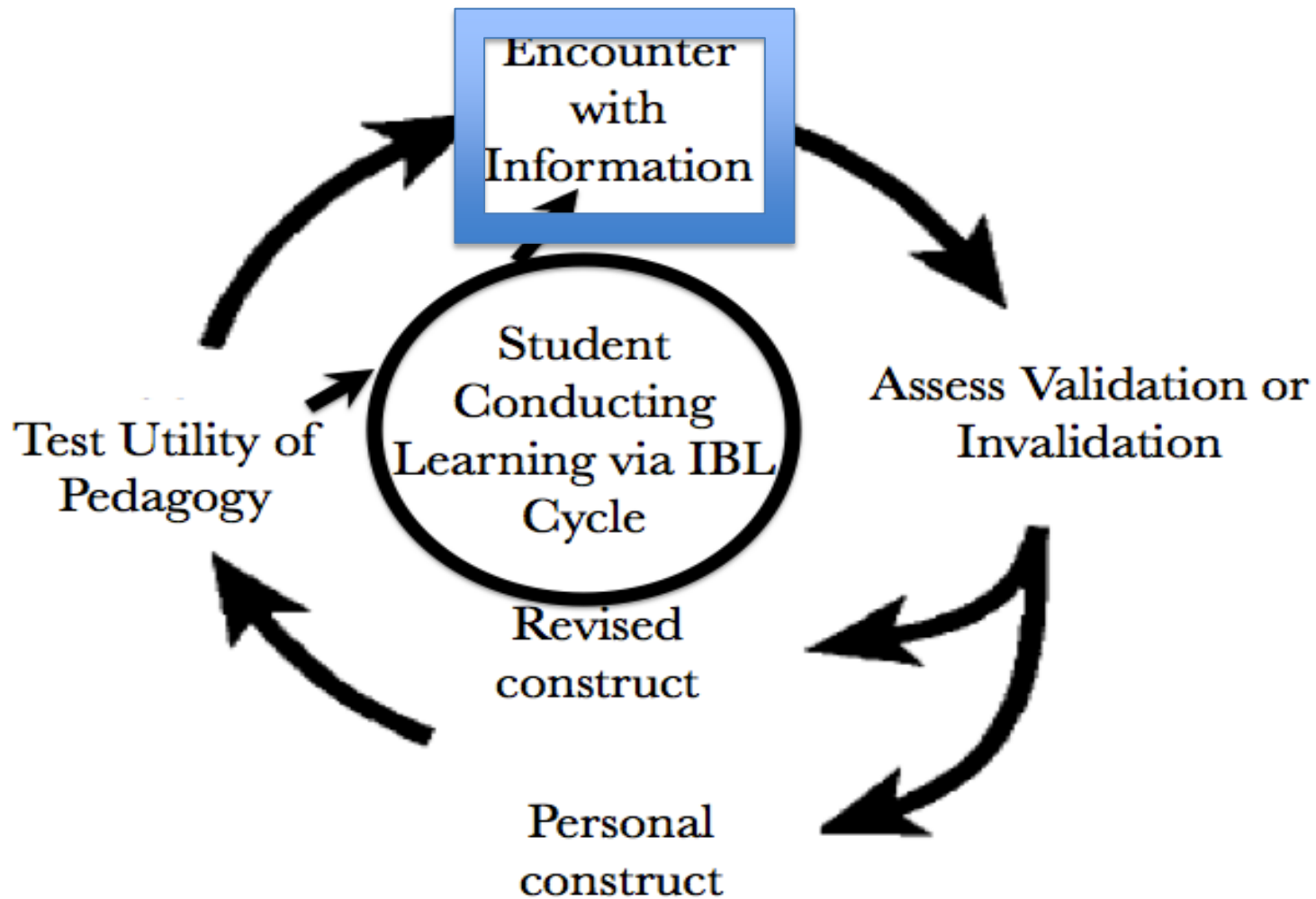
Pope and DeNicolo (2016): Teachers could reflect on if they are using a range of permeable constructs which allows them carry out optimum assessment of their students' learning.



# Experience Cycle for Constructive Adaptability towards Students



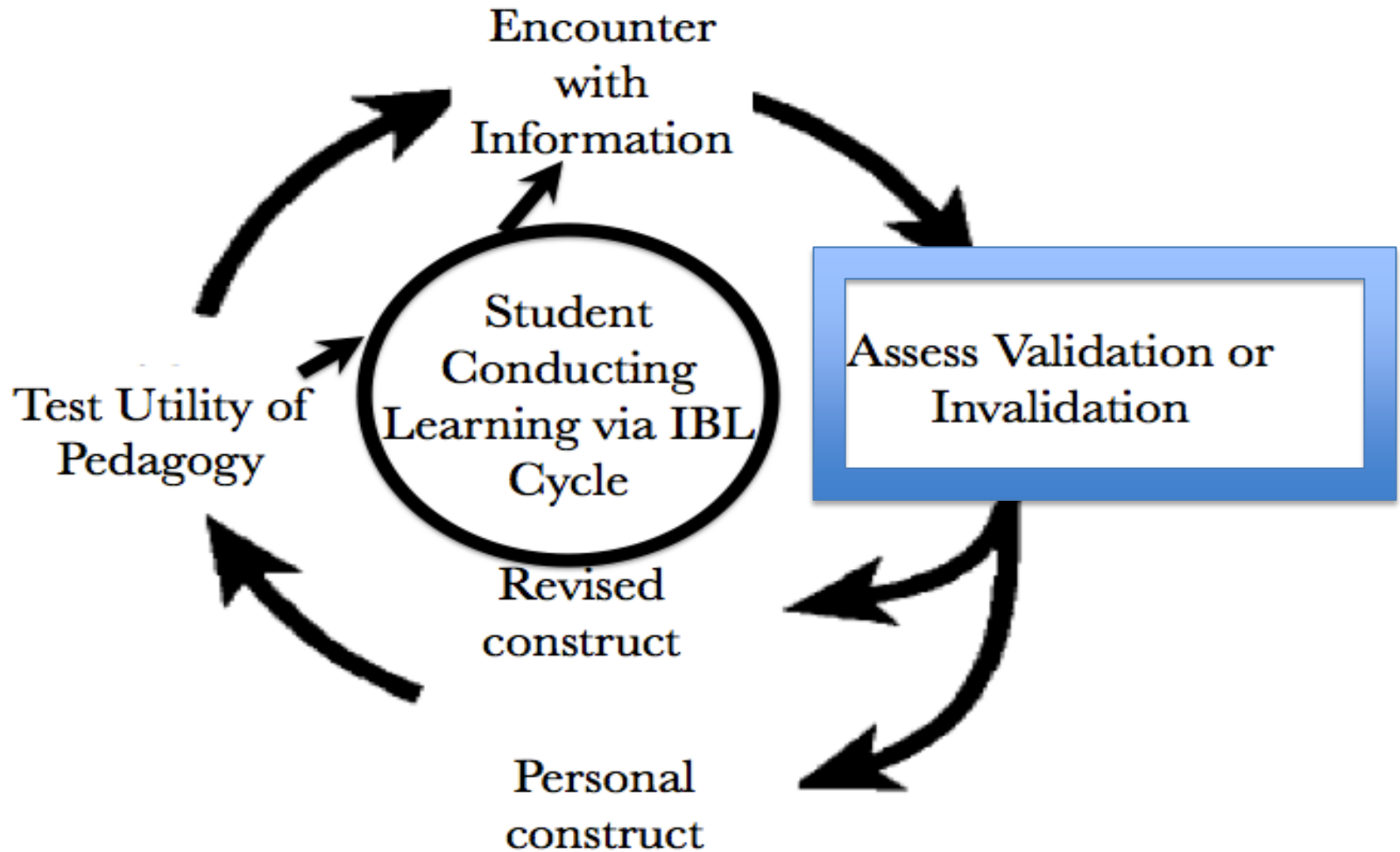
# Teacher: Experience Cycle



# Teacher: Permeable Constructs to assess students at Encounter with Information Stage

Encounter with Information	Permeable Construct to question teaching
Encounter with Information	<i>Did I allow students to link prior knowledge to new knowledge----</i> <i>Did not allow students to link prior knowledge to new knowledge</i>
Encounter with Information	<i>Am I presneting this topic as a topic with connectedness to other topics ---- Am I presenting it as isolated from other topics</i>
Encounter with Information	<i>Isolated exposure to a theme or topic offered ----Frequent exposure to a theme or topic offered</i>
Encounter with Information	<i>Alternative ways of experiencing re-curring themes ----Singular ways of experiencing re-curring themes offered</i>
Encounter with Information	<i>I considered an appropriate audio-visual balance----- Did not consider an appropriate audio-visual balance</i>
Encounter with Information	<i>Employed epistemic pluralism-----Allowed constructive singularity</i>

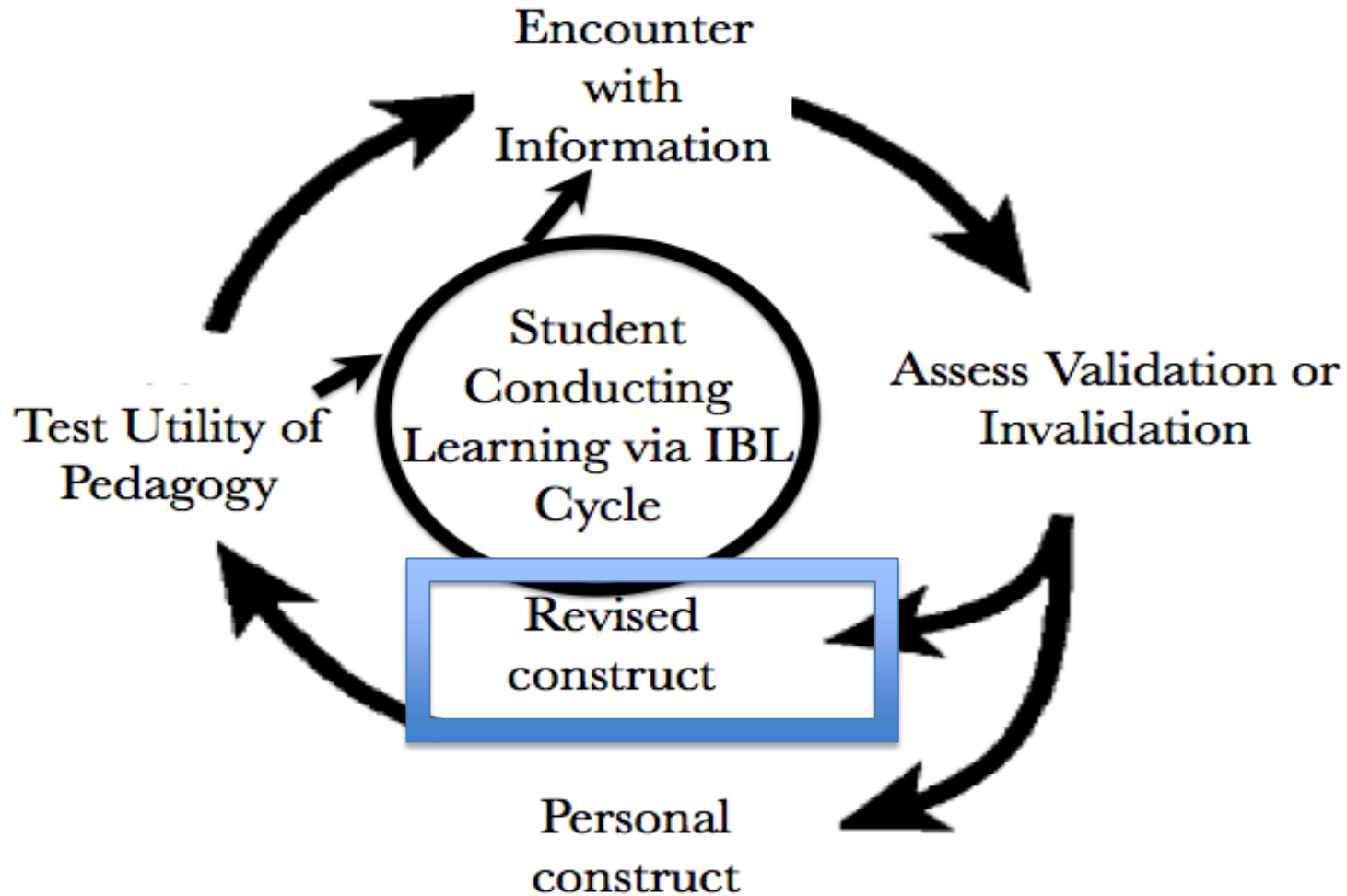
# Teacher: Experience Cycle: Validation/Invalidation



# Teacher: Permeable constructs to assess students at Validation/Invalidation Stage

Validation/Invalidation	Permeable Construct to question teaching
Validation/Invalidation	<i>Am I scaffolding new learning for students----Is there an absence of scaffolding in my teaching</i>
Validation/Invalidation	<i>Allow student opportunity to ask 'how do I best construe'---- Neglect to give the opportunity to ask how they best construe?</i>
Validation/Invalidation	<i>Am I considering student hostility---- I am not considering student hostility</i>
Validation/Invalidation	<i>Is my student's knowledge coherent----- Is my student's knowledge fragmented</i>
Validation/Invalidation	<i>Am I aware of inaccurate automatic cognitive processes that might be employed by students in this topic----Unaware of potential automatic cognitive processes in this topic</i>
Validation/Invalidation	<i>Are students being aggressive towards new concepts (making wagers regarding new information)---- My students are lacking in aggression (not making wagers regarding new information)</i>
Validation/Invalidation	<i>Are students going beyond surface features to understand --- Are students focusing on surface features for understanding</i>

# Teacher: Experience Cycle: Revised Constructs Stage

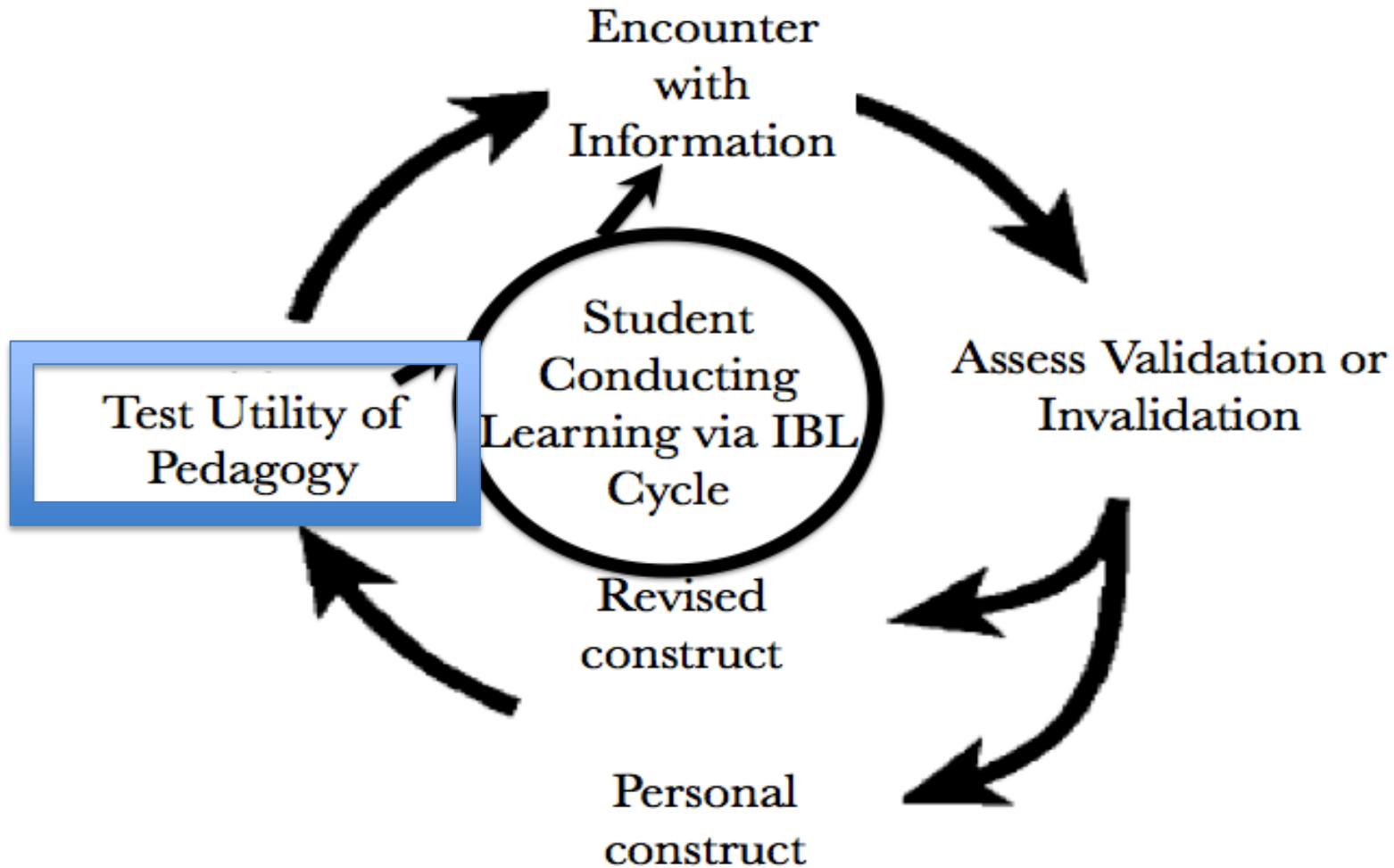


# Teacher: Permeable constructs to assess students at Revised Constructs Stage

Hypothesis Revision	Permeable Construct to question teaching
Hypothesis Revision	<i>I acknowledged the affective nature of learning---- Did not attend to the affective nature of learning</i>
Hypothesis Revision	<i>Am I listening to what my students are saying---- I did not listen to what my students are saying</i>
Hypothesis Revision	<i>Am I allowing my students to become epistemic agents----I am not allowing my students to become epistemic agents</i>
Hypothesis Revision	<i>Are my students learning in a pre-emptive/dismissive fashion----- Are my students being circumspect regarding how they learn</i>



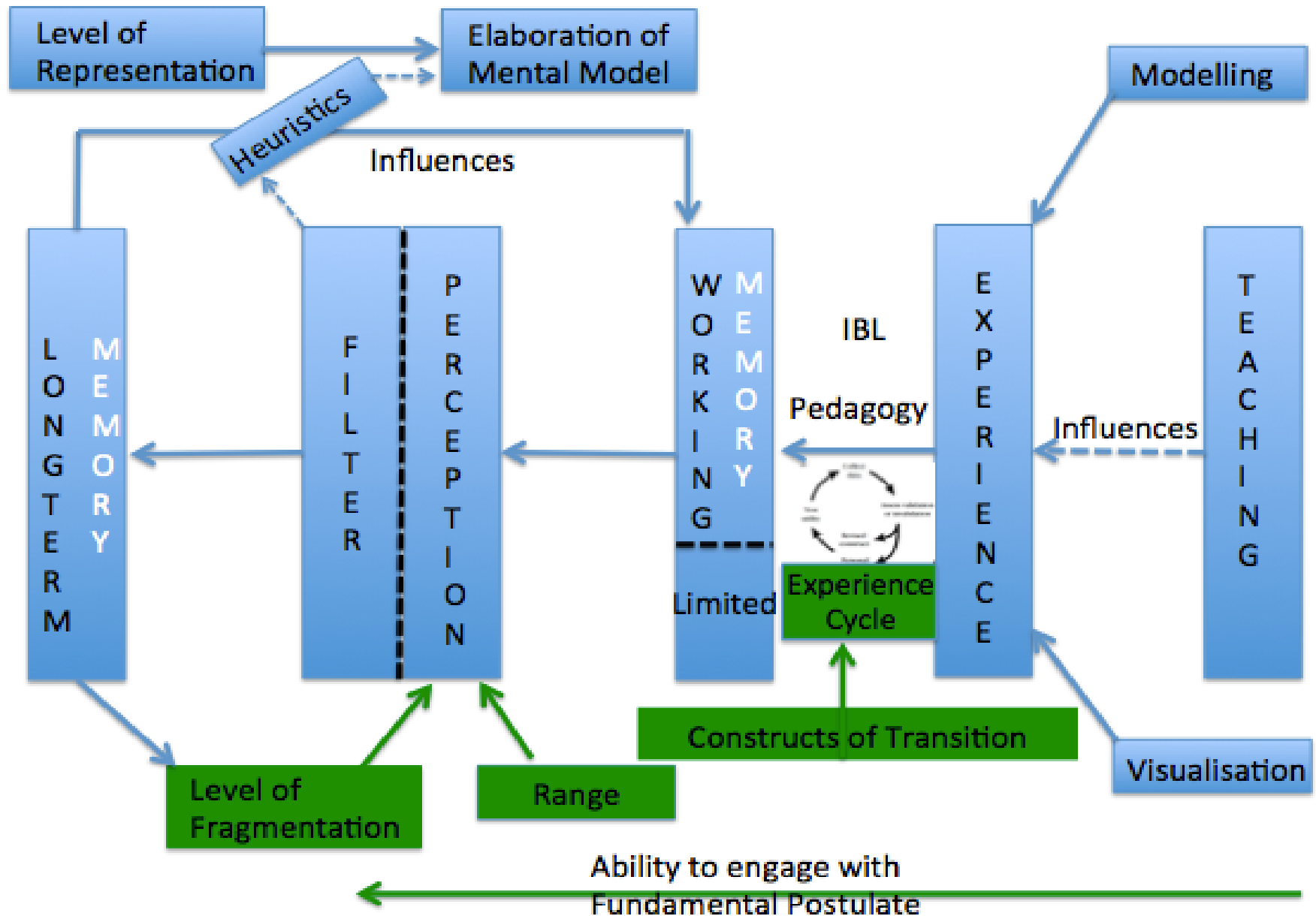
## Teacher: Experience Cycle: Test Utility Stage



## Teacher: Test Utility Stage

Tested Hypothesis	Permeable Construct to question teaching
Tested Hypothesis	<i>Students are testing the utility of their hypotheses----Students are not testing the utility of their hypotheses</i>
Tested Hypothesis	<i>My students are applying their knowledge----My students are unable to engage in knowledge application</i>
Tested Hypothesis	<i>Students are activating relevant associated knowledge----- Students are not distinguishing between relevant and irrelevant knowledge</i>
Tested Hypothesis	Students are selecting appropriate features of a problem---- Students are tentatively selecting features of a problem
Tested Hypothesis	Students are answering the actual question they are being asked- ---Students are substituting features they are familiar with into the question posed

## A View of Learning through the lens of PCP



# Objectives

- Why PCP & Science Education
- Information Processing Model
- Permeable Constructs & Experience Cycle to gauge ourselves as teachers
- A Model of learning through lens of PCP
- Conclusion

