

Research on Developing a Generalized Framework for Conceptual Change in Science Education

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❖ **Why to study conceptual change?** 为什么研究概念转变?

Learners come to science classroom with their prior experiences and preconceptions. These preconceptions are always different from science concepts, influencing on learner's observation and thinking and they are hardly to be changed by traditional teachings.



❖ **Why do some learners' preconceptions change so difficultly? How to improve learners' preconceptions (misconceptions) to science concepts? These issues are highlighted by researchers in science education in the late three decades.**



Different theories 理论争鸣

1

**Conceptual change model
Based epistemology**

2

**Conceptual change
theory Based ontology**

3

**Conceptual change theory
based on framework theory**



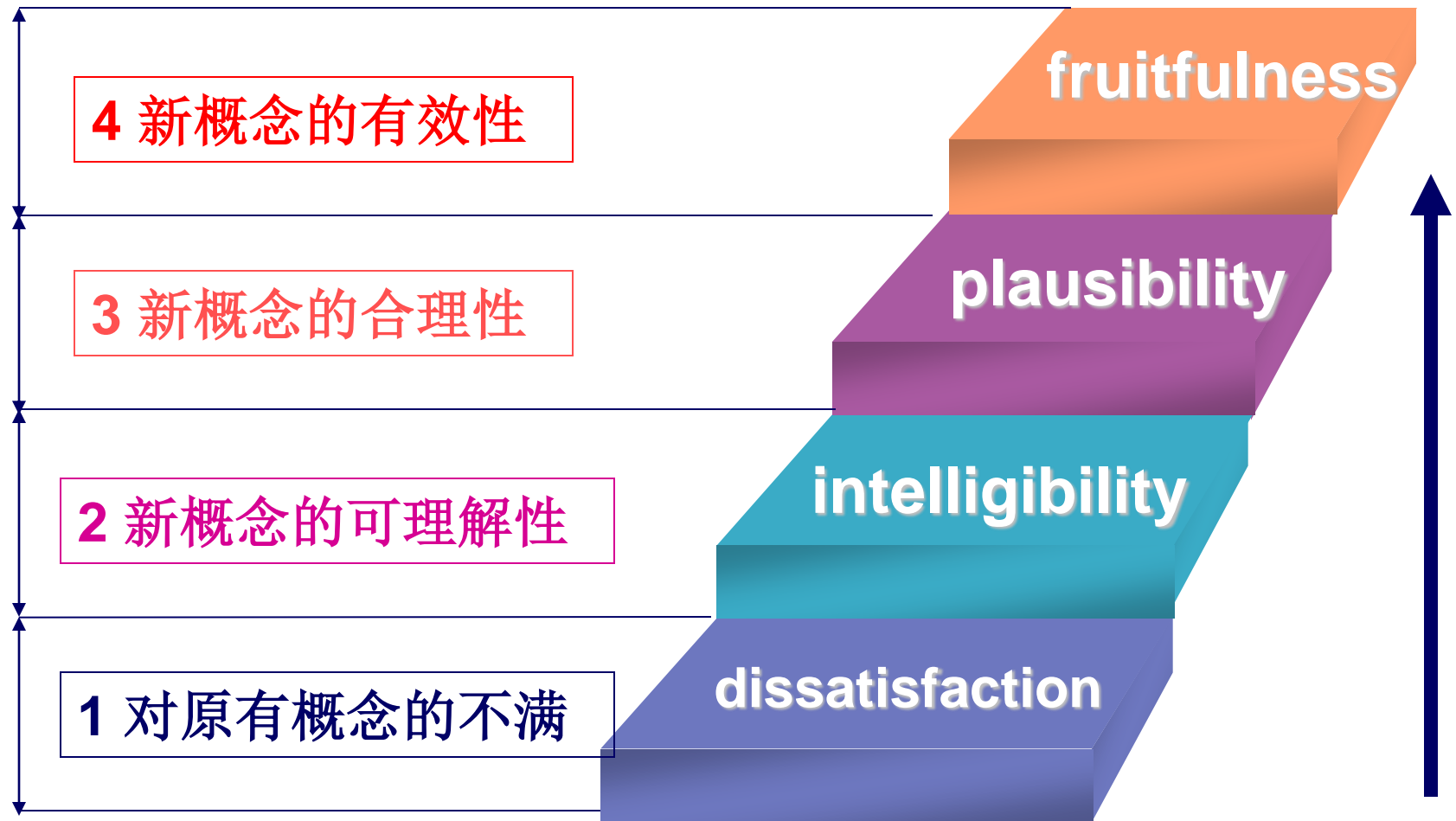
Conceptual change model

Claimed by Posner (1982, 1992)

Two types of conceptual change:

- ❖ **assimilation**
- ❖ **accommodation**

“Accommodation” needs four conditions:





concept ecology

anomalies

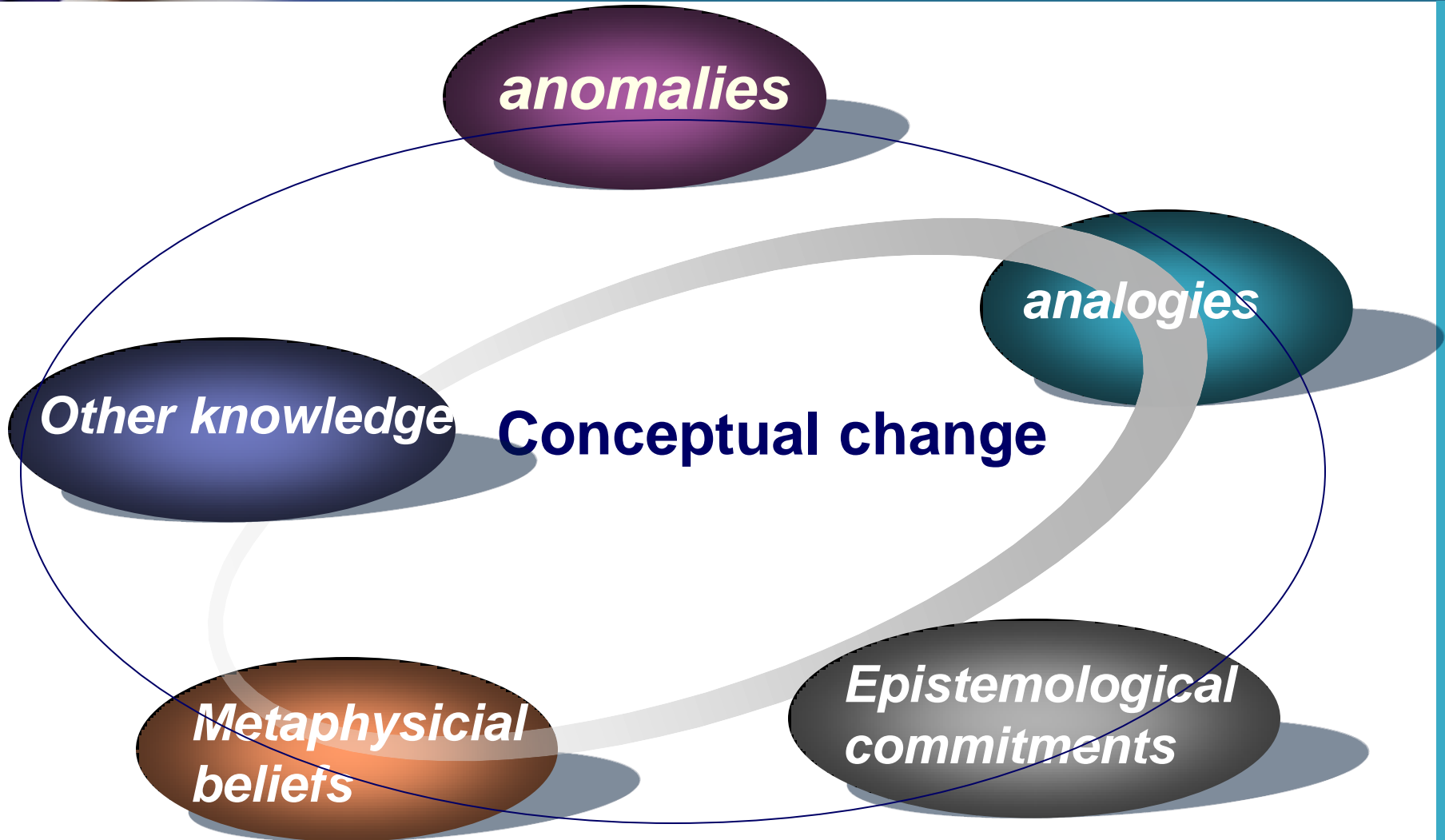
analogies

Other knowledge

Conceptual change

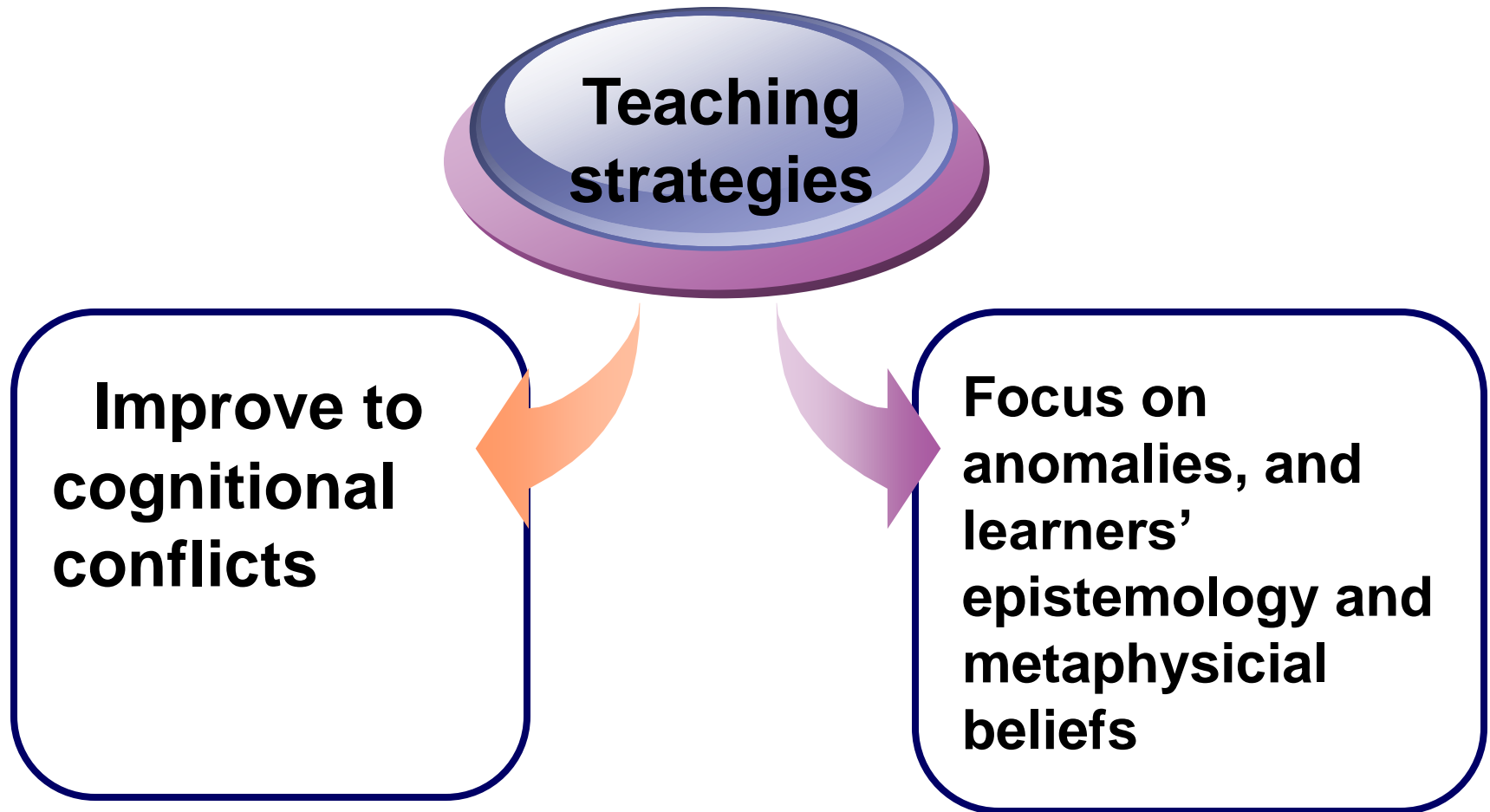
*Metaphysical
beliefs*

*Epistemological
commitments*






Conceptual change model



❖ **Thorleys' status analysis categories (1990)**



Status of Conceptions

Status Elements (in Upper Case)

INTELLIGIBILITY

Representational modes:

INTELLIGIBILITY ANALOGY (analogy or metaphor to represent conception)

IMAGE (use of pictures or diagrams to represent conception)

EXEMPLAR (real-world exemplar of conception)

LANGUAGE (linguistic or symbolic representation of conception)

PLAUSIBILITY

Consistency factors:

OTHER KNOWLEDGE ('reasoned' consistency with other high-status knowledge)

LAB EXPERIENCE (consistency with laboratory data or observations)

PAST EXPERIENCE (particular events consistent with conception)

EPISTEMOLOGY (consistency with epistemological commitments)

METAPHYSICS (refer to ontological status of objects or beliefs)

PLAUSIBILITY ANALOGY or P ANALOGY (another conception is invoked)

Other factors:

REAL MECHANISM (causal mechanism invoked)

FRUITFULNESS

POWER (conception has wide applicability)

PROMISE (looking forward to what new conception might do)

COMPETE (explicitly compare two competing conceptions)

EXTRINSIC (associate new conception with experts)

From: Chi-Yan Tsui, David F. Treagust (2007)

Understanding Genetics: Analysis of Secondary Students' Conceptual Status

Status analysis categories

Status of science concept I

intelligibility

Multiple presentations:

- metaphors
- painting
- examples
- language

IP plausibility

Consistency factors:

- Other knowledge
- past experience
- epistemology
-

IPF

fruitfulness

- power
- promise
- compete
-



Status analysis categories

Status of misconception

I

intelligibility

Multiple presentations:

- metaphors
- painting
- examples
- language

IP

plausibility

Consistency factors:

- Other knowledge
- past experience
- epistemology
-

IPF

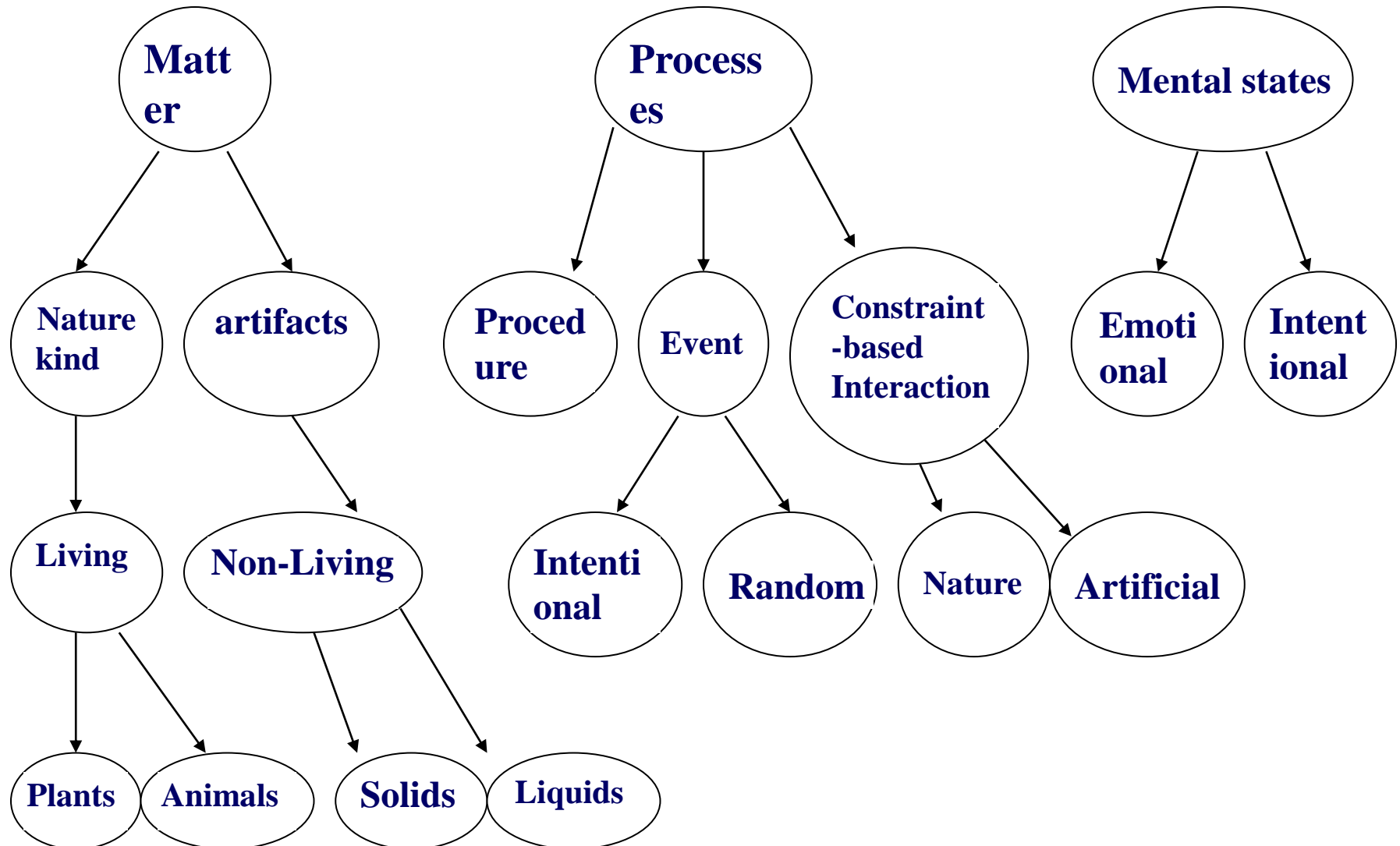
fruitfulness

- power
- promise
- compete
-

❖ **Claimed by Chi (1992, 1994)**



ontological categories trees (本体论树)

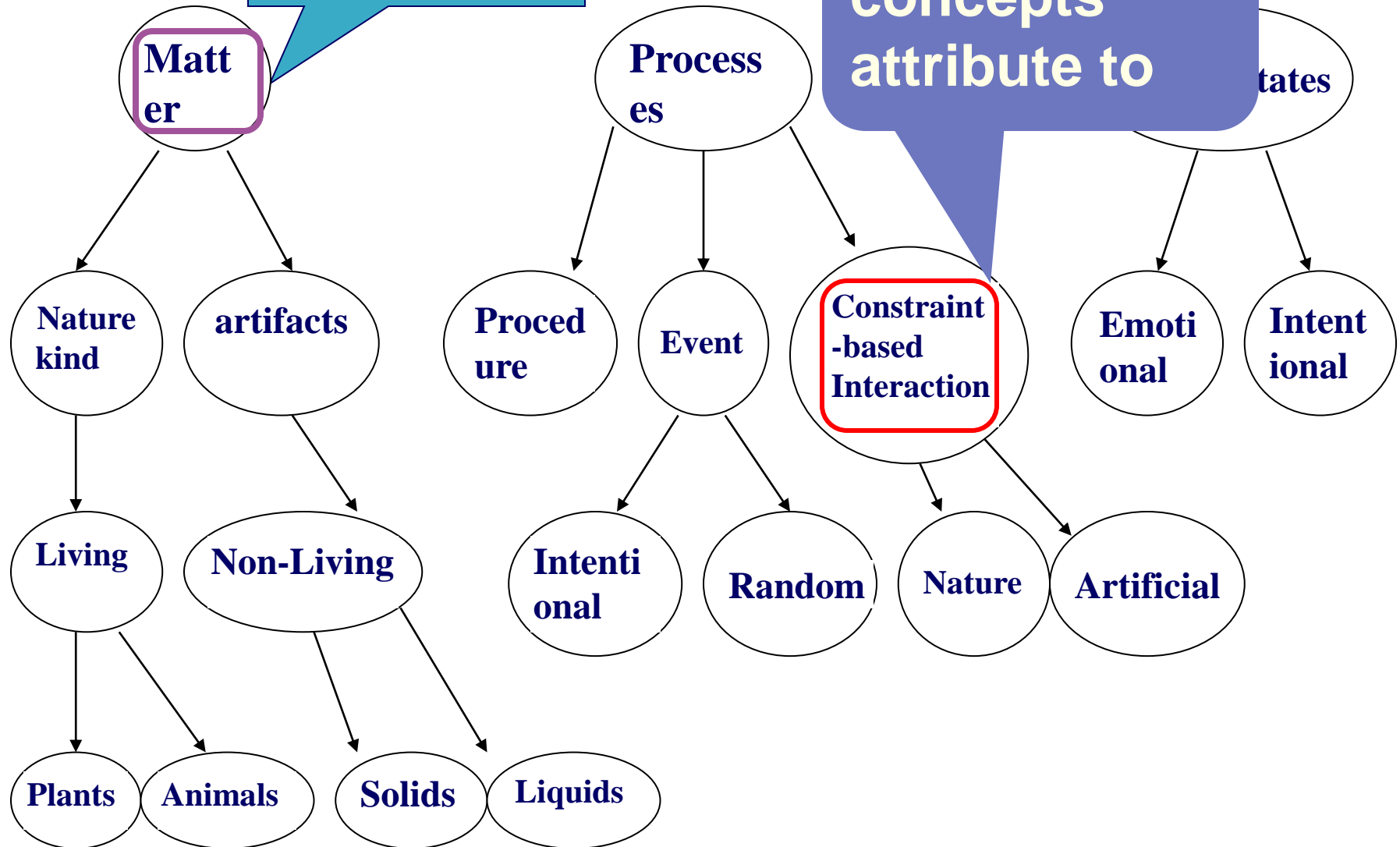




Students
classified

unmatchable

Most science
concepts
attribute to



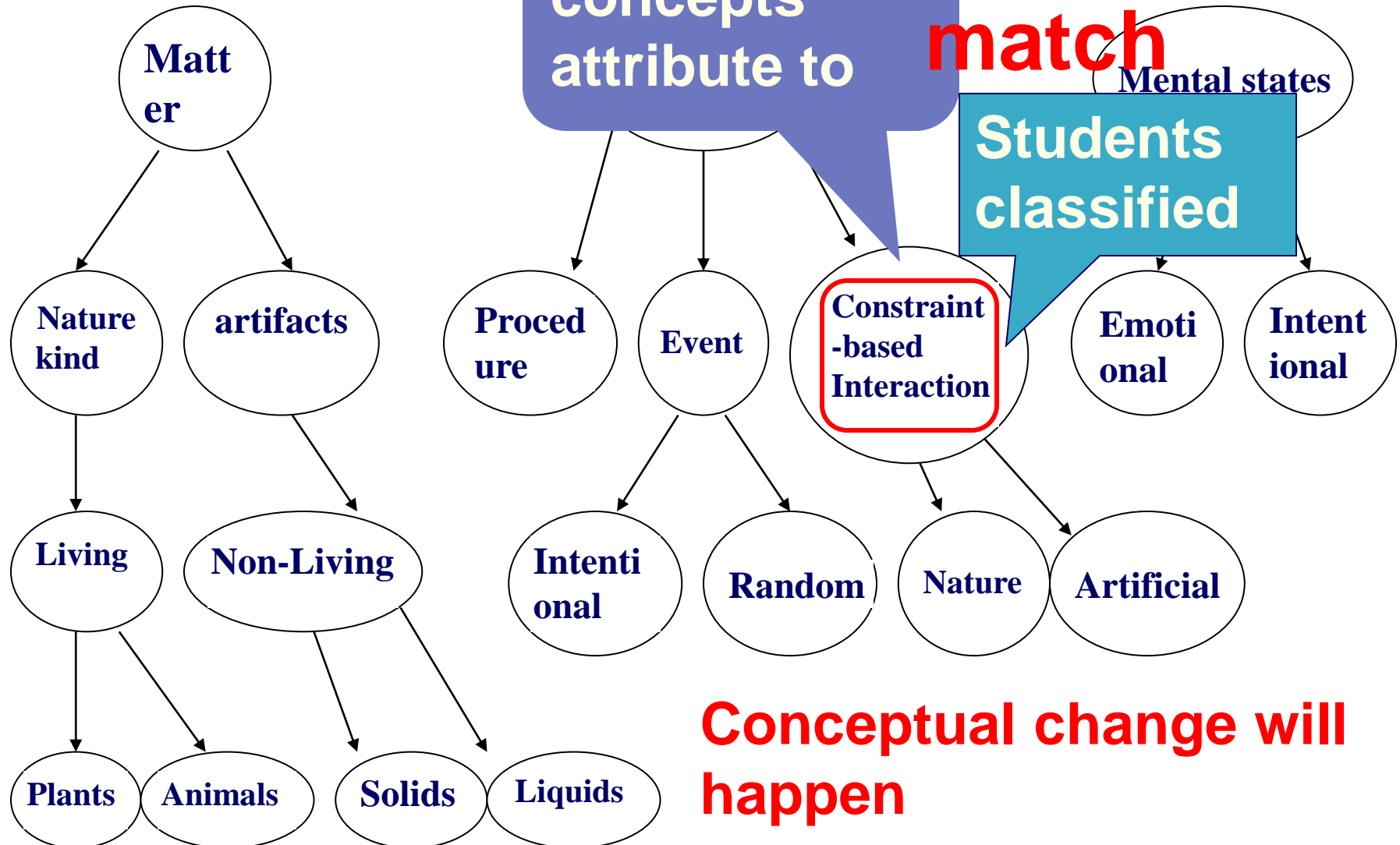
- **Tow types of conceptual change**
- branch jumping “枝节转移” ;
- tree switching “主干变换” .



Most science
concepts
attribute to

match

Students
classified





Empirical evidence

Substance *Predicates*

Examples

Block	"keeps," "bounces off," "hits," "stops"
Contain	"holds in," "stores," "keeps in"
Move	"goes," "leaves," "comes," "flows through"
Rest	"stops," "stays," "sits"
Consume	"gets used up," "gets burned up," "burns out," "drains"
Absorb	"absorbs," "soaks up," "takes in"
Quantify	"some," "all," "most," "less," "none of," "lots," "little bit," "as much"
ColorAdd	"adds like colored paints," "red and blue make purple," "just like with paints"
Accumulate	"fills up," "builds up," "adds on," "keeps building"
Supply	"gives off," "provides," "comes from," "comes out of"
Equivalent amounts	"the same amount to all of the bulbs," "divides up equally"



Empirical evidence

Process Predicates

Examples

Movement process

“... charged particle moving in an electric field,” “the light is a traveling electromagnetic wave.”

Transfer

“energy propagates through (the cup),” “. . . transfer from one to another.”

Excitation

“a lot of phonon nodes to excite,” “. . . need a lot of energy to excite them.”

Interaction

“the interaction of the electric and magnetic fields,” “the light energy is absorbed and transformed.”

Equilibrium seeking

“The system finds its way into equilibrium.”

Systemwide

“These are all in parallel,” “. . . there’s an electric field throughout the wire,” “there’s a field present throughout the wire,” “all see the same potential.”

Simultaneous

“They all see (the potential) at the exact same time.”

Light as combined waves

“It would have red (spectral) lines and green lines in it.”



Some related literature

❖ “electronic current”

James D. Slotta, M. T. H. Chi, and Elana Joram. Assessing Students' Misclassifications of Physics Concepts: An Ontological Basis for Conceptual Change. *Cognition and Instruction*, 1995,13(3), 373-400

Mei-Hung Chiu, Jing-Wen Lin. Promoting fourth graders' conceptual change of their understanding of electric current via multiple analogies. *Journal of Research in science Teaching*, 2005, 42(4): 429–464.



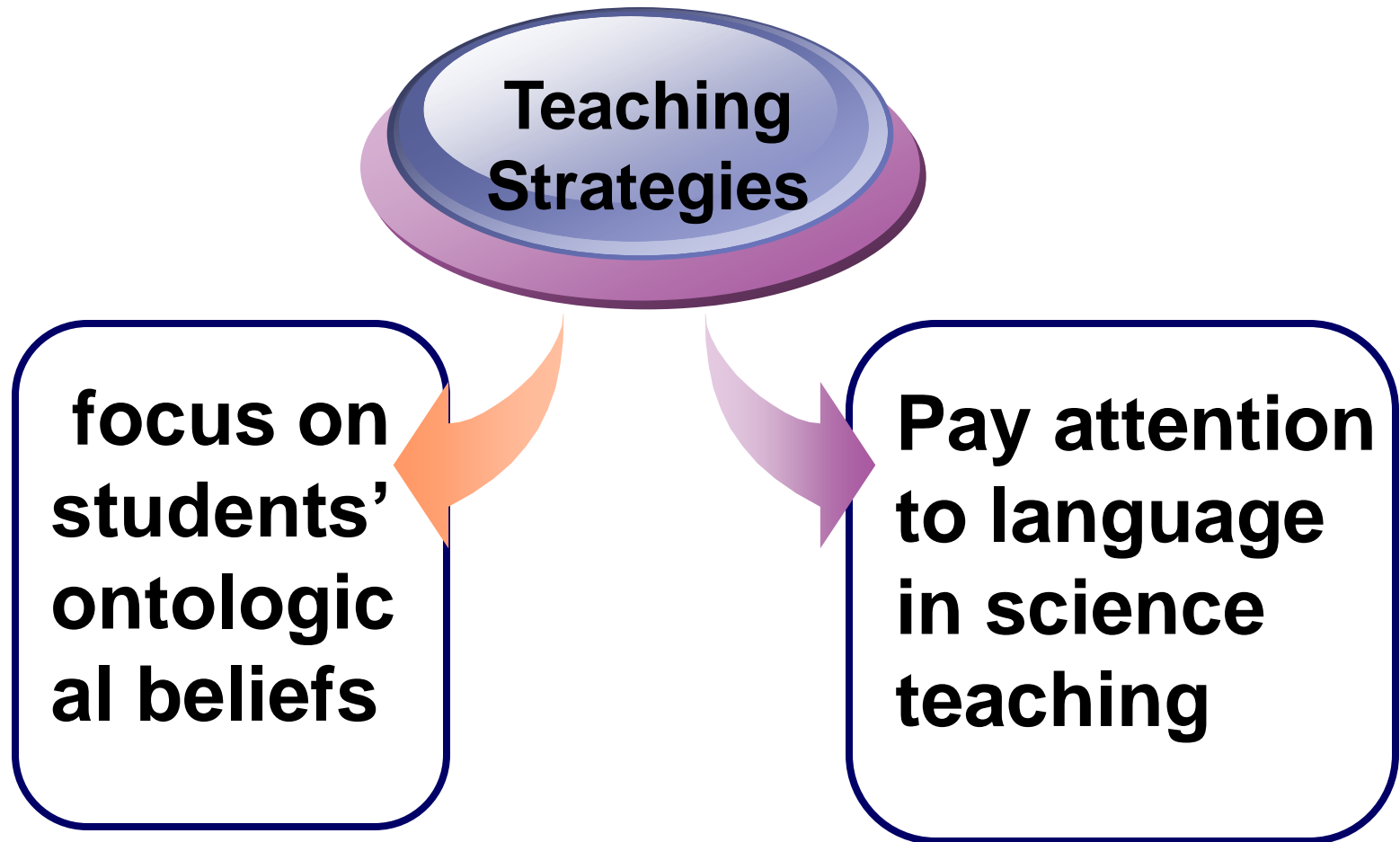
❖ “heat” and “light”

James D. Slotta, M. T. H. Chi, and Elana Joram. Assessing Students' Misclassifications of Physics Concepts: An Ontological Basis for Conceptual Change. *Cognition and Instruction*, 1995,13(3), 373-400

J. Lautrey, K. Mazens. Is children's naïve knowledge consistent? A comparison of the concepts of sound and heat. *Learning and Instruction*, 2004: 399-423

❖ “sound”

K. Mazens, J. Lautrey. Conceptual change in physics: children's naïve representations of sound. *Cognitive Development*, 2003: 159-176





Framework theory

Claimed by Vosniadou (1994)

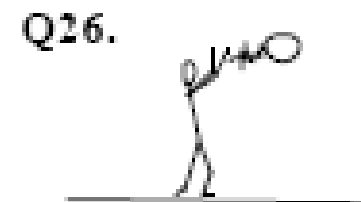
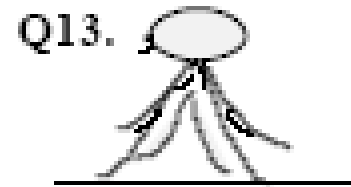
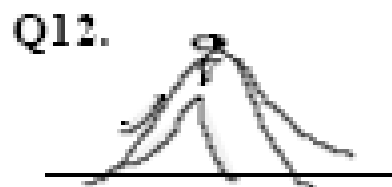
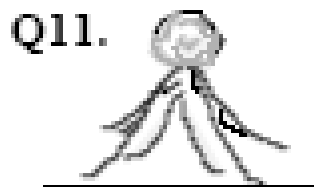
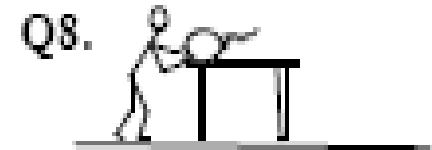
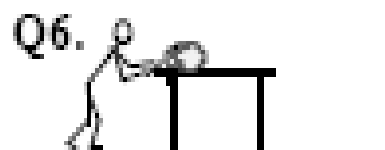
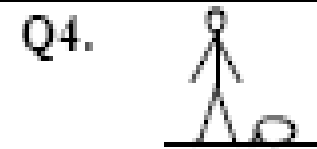
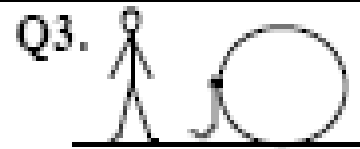
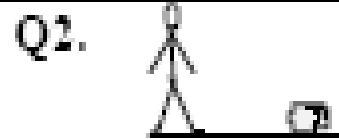
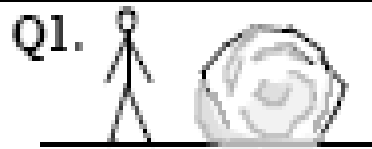
- **framework theory** 框架理论
- **specific theory** 具体理论

two types of conceptual change

Enrichment 丰富

Revision 修正

Empirical material about “force”



force is an
internal
property in
objects

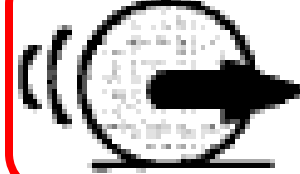
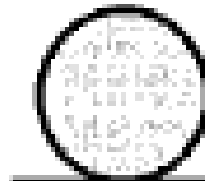
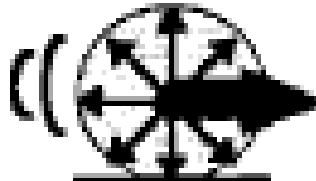
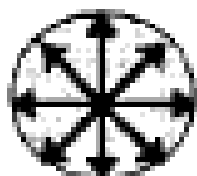
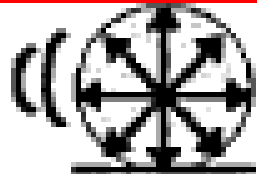
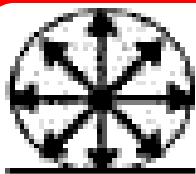
Students' metacognitive force

force is an
acquired
property of
moving objects

internal

internal and gained

gained

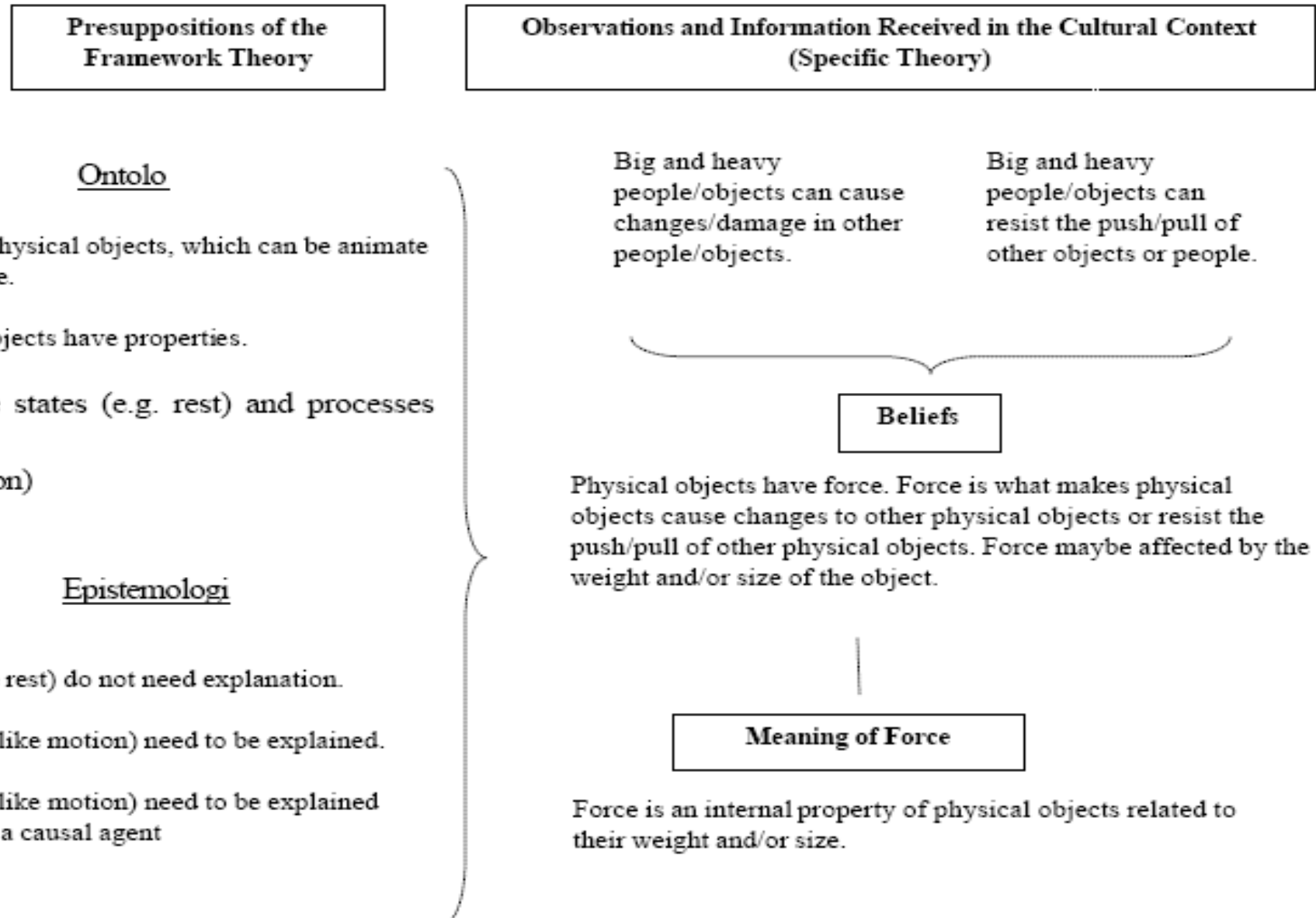


- kindergarten: 60%
- grade 4: 20%
- grade 6: 0
- grade 9: 0

- kindergarten 26.7%
- grade 4: 33.3%
- grade 6 :30%
- grade 9 :3.3%

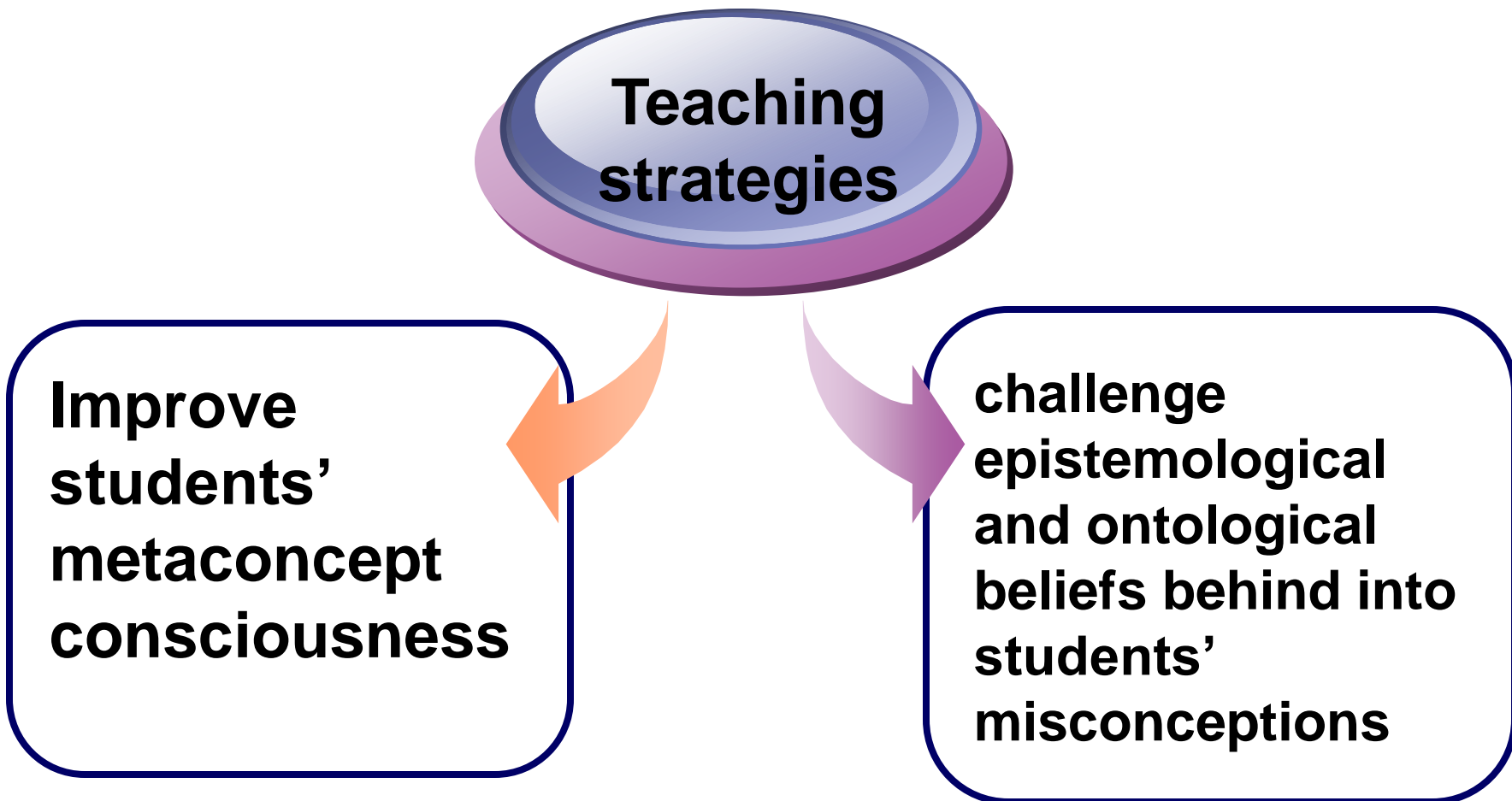
- Kindergarten: 0
- grade 4 16.7%
- grade 6 36.7%
- grade 9 6.7%

Figure 1. Hypothetical conceptual structure for the interpretation of force as an internal property of physical objects





Framework theory



**Teaching
strategies**

**Improve
students'
metaconcept
consciousness**

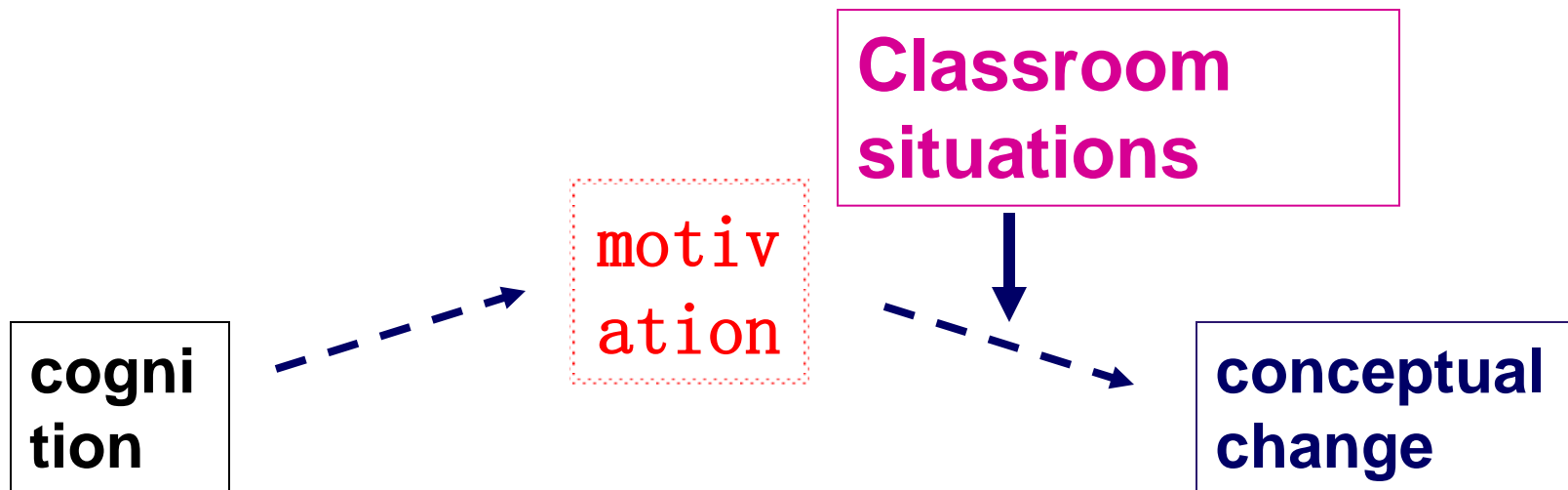
**challenge
epistemological
and ontological
beliefs behind into
students'
misconceptions**



Beyond cold conceptual change

❖ **Claimed by Pintrich (1993)**

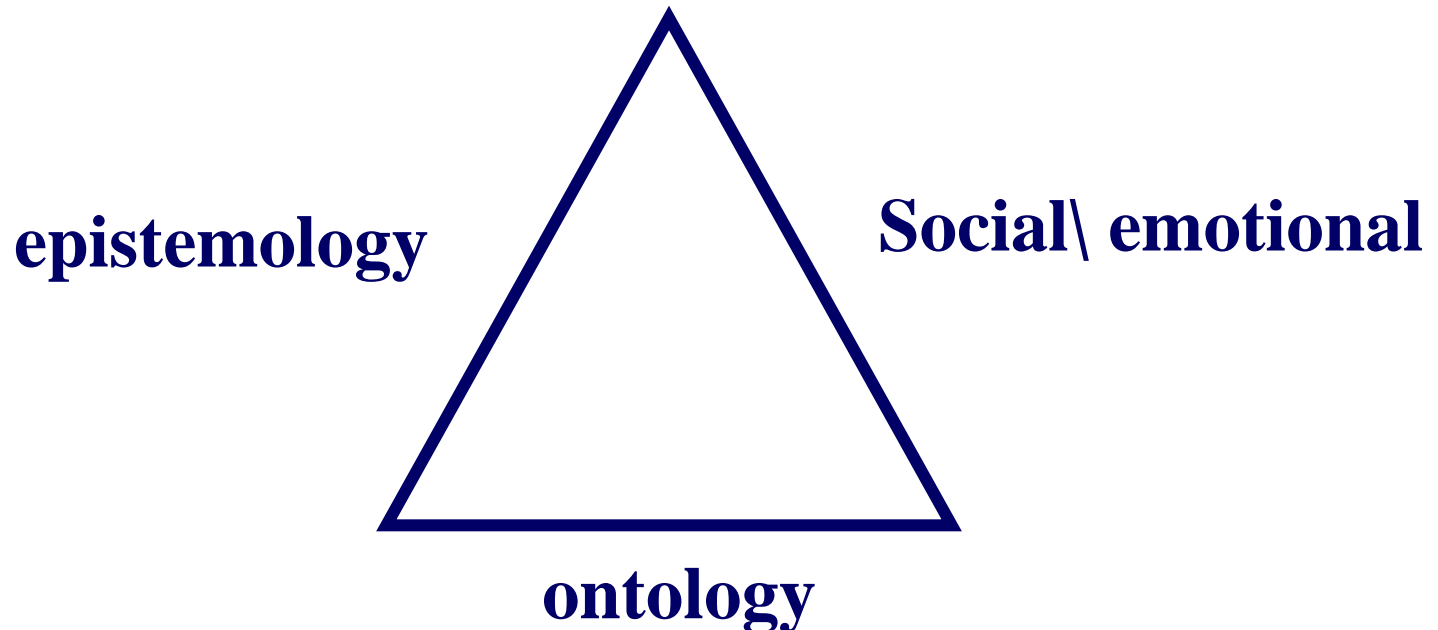
Students' motivation and emotion have to be paid attention in real classroom.



Developing theory

❖ Claimed by Treagust (1997,2003)

A Multidimensional Framework for Interpreting Conceptual Change Events in the Classroom




- ❖ **However, prior researches about conceptual change always focused on the learners aspects without thinking the characteristics of science contents.**
- ❖ **This study will develop a generalized framework for conceptual change in science education, which not only focus on the learners' situations, but also take science content into consideration.**



“dimensions of content”

Claimed by White (1994)

- **Abstraction/Complexity** 抽象度/复杂度
- **Mix of types of knowledge** 知识类型的混合程度
- **Demonstrable VS Arbitrary** 可论证的 还是 任意的
- **Extent of links** 与其他内容的联系程度
- **Alternative models with explanatory power** 相异概念的解释力
- **Openness to common experience** 常识经验的开放度
- **Presence of common words** 日常相关语言的存在
- **Social acceptance** 社会的接受度
- **Emotive power** 情感力



A generalized framework for conceptual change in science education(GFCCSE)

Science concepts

Science content

- Abstraction/Complexity
- Alternative models with explanatory power
- Openness to common experience

Learner situation

- cognition
- epistemology\ontology
- motivation/emotion

fruitfulness

plausibility

intelligibility

misconception





My research questions

- ❖ **How to develop the generalized framework for conceptual change in science education (GFCCSE) in detail to get it feasible;**
- ❖ **How the validity and reliability of the GFCCSE ?**
- ❖ **What can we gain from empirical data to revise the GFCCSE?**



My research methods

- ❖ **The empirical part of this research will be taken face to face interview individually and collaboratively. The subjects of this research will be from mainland China, who have been learned the science concepts of thermodynamics in their regular science classroom.**

A close-up photograph of a hand holding a silver pen, poised to write on a white document. The background is slightly blurred, showing a yellow folder and a purple shirt. The text "Thank You !" is overlaid in a large, stylized font.

Thank You !