促进
深度学习
的有效策略和具体方法

何淑冰博士
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我们的共识

- 我会采用4-T方法：
  * **Task**（学习活动）
  * **Team**（小组协作）
  * **Thinking**（思考）
  * **Talking**（发言）
  请配合

- **请包涵我的普通话和香港用语**

教育部高教司吴岩2019.4.29讲话

国家级一流课程申报条件

突出学生中心，注重能力培养，
有效提升课程的高阶性、创新性、挑战度

- 目标融合创新：立德树人+专业人才培养
- 内容融合创新：基本内容+学科发展前沿+"四新"
- 技术融合创新：教育教学方法+现代技术
- 模式融合创新：流程重组+结构再造

高阶性　创新性　挑战度

中华人民共和国教育部
Ministry of Education of the People's Republic of China

新工科EECS圈

您在工作坊前应填写了
《促进学生深度学习:思索-困惑-探索》工作纸
请在小组中分享您的答案

4

您满意您的学生的学习深度吗？
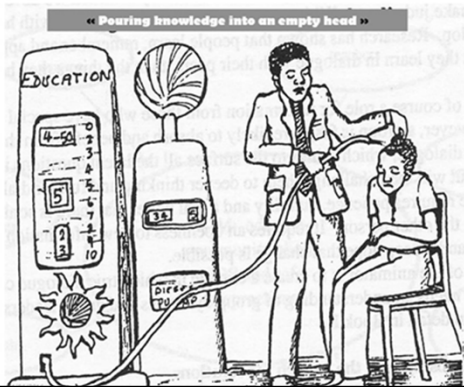什么因素影响他们学习的深度？

5

「涵盖内容」是理解的最大敌人😈

We've got to do fewer things in school. The greatest enemy of understanding is coverage .. You've got to take enough time to get kids deeply involved in something so they can think about it in lots of different ways and apply it.

— *Howard Gardner* —

AZ QUOTES

为了「涵盖内容」要满堂灌

« Pouring knowledge into an empty head »

EDUCATION

7

Effective teachers don't 'cover' curriculum, they **uncover** it

Ann Parker
Kannapolis City Schools

不图「涵盖内容」

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uncover
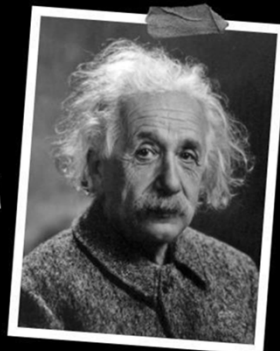
帮助学生

♦ 发现 …

♦ 找出 …

♦ 解开…

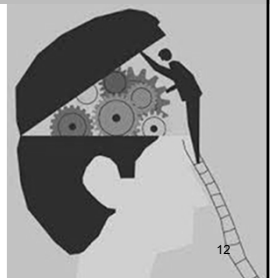♦ 弄清楚 …

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Uncover … 发现

发现什么?
如何发现?

"Education is not the learning of facts, but the training of the mind to think."
-Albert Einstein

培养学生的认知思维

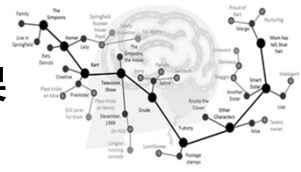Uncover cognitive thinking

发现
认知思维

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你认为大脑是如何
学习和储存知识的呢?

个性化知识框架

- 大脑将积累的信息、概念、经验 … 等等,
  透过思想活动建构出自己所理解的知识框架

  图式 (Schema 从数 schemata)
- 人在其一生中不断建立、重建图式中的连接,
  使其变化和成长, 这就是学习

满堂灌教学法是基於错误概念

- 大脑是一个容器
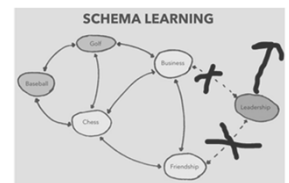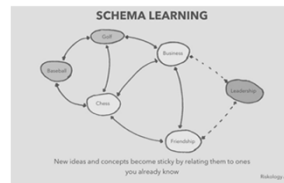- 老师可以把知识
  按原样"加"进
  学生的脑袋里
- 学生的大脑容器
  越装越满,
  知识就多了!

当代认知心理学理论

深度学习 (deep learning)	浅度学习 (surface learning)
▪将新信息整合, 融入到现有图式中 ▪成为重建的知识一部分	▪信息不能植根于图式, 不能被用于建立知识 ▪孤立的信息很快被遗忘

请细读后面两段谈联系知识点的文字圖,
并在小组中讨论

1) 他们的视觉、思想焦点有分别吗?
   怎样不同?
2) 他们和这个工作坊有关联系知识的
   概念有异同吗?

历史是一门社会科学, 具有综合性特点。
内容涉及政治、经济、文化、科技、社会
生活诸领域, 与现实生活及初中开设的人
文和自然学科知识相联系。因此, 教学中
联系现实生活、渗透相关学科知识是必要
的。加强这种横向联系, 有利于学生更为
全面深入地了解和读懂历史, 克服历史与
现实、理论与实际相脱离的弊端, 使历史
课更加贴近现实, 贴近生活, 贴近学生。
……

(来源:9/2006 《安徽教育》月刊)

知识点，联系成线

https://www.douban.com/note/587607984/

Peter_Kuma　2016-10-19 19:25:55

不知不觉看了有3个月书了，看的各种各样的书，有美食、生活、科普、儿童、哲学、小说、励志和一些名著。

今天读了一本关于谈判的书，在书中看到了博弈论的概念和锚定效应的介绍，突然眼前一亮豁然开朗的感觉，发现之前了解的知识可以串联在一起了，连起来了之后就是一条叫做谈判的线，我还想深入地了解这方面的知识，进入了这个世界之后，发现现实充满了可以充分应用这些知识的案例，就感觉整个世界都不一样了，开始从新的角度去看世界。我也发现了以前的我是多么的渺小了，现在也很渺小，但是也发现了各种不一样的自己，不一样的可能性。

阅读真的很有趣啊，思考真的很有意思啊，脑袋本来就是一个应该多工作的天赐之物，不要将它荒废了，它会带比你不一样的力量！！！

我们应该学会看世界，不是让世界塑造我们。

来自 豆瓣App

联系知识：两种视角和焦点，

以老师教学为中心	以学生学习为中心
老师整理知识点间的联系，作为新知识内容的部分讲授给学生	学生把新信息自行与自己大脑里已有的概念框架整合，重建构成自己新的知识图式
焦点主要放在外在的事实, 概念	焦点同时放在外在的事实, 概念和学生的已有知识

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帮助学生 建立新旧知识的联系

1) 激活 背景知识

2) 建立新旧知识的联系

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第一步：激活背景知识

WAKE UP YOUR BRAIN

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第二步：把新知识联系到……

- 旧知识、概念
- 过往相关经验
- 现实生活
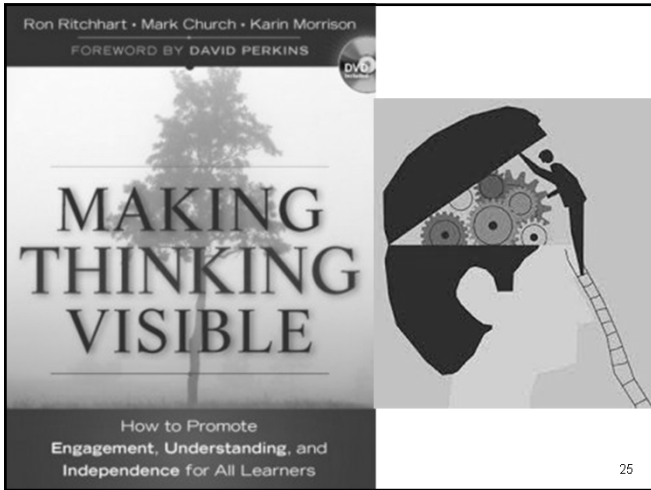- 相关学科
- 专业实况
- ……

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## 培养学生的认知思维（一）

Uncover relational cognition

发现 联系认知

MAKING THINKING VISIBLE

Ron Ritchhart · Mark Church · Karin Morrison
FOREWORD BY DAVID PERKINS

How to Promote
Engagement, Understanding, and
Independence for All Learners

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VISIBLE THINKING

Visible Thinking in Action
Getting Started
Thinking Routines
Introduction
Core Routines
Understanding Routines
Fairness Routines
Truth Routines
Creativity Routines
Thinking Ideals

Thinking Routines

Routines exist in all classrooms; they a
the job of learning and working togethe
thought of as any procedure, process, o
manage and facilitate the accomplishm
routines that serve to manage student b
of learning, and to establish rules for co
have routines that structure the way stu
learning routines can be simple structu

「可视思维套路」工作纸
联系新旧知识三步曲
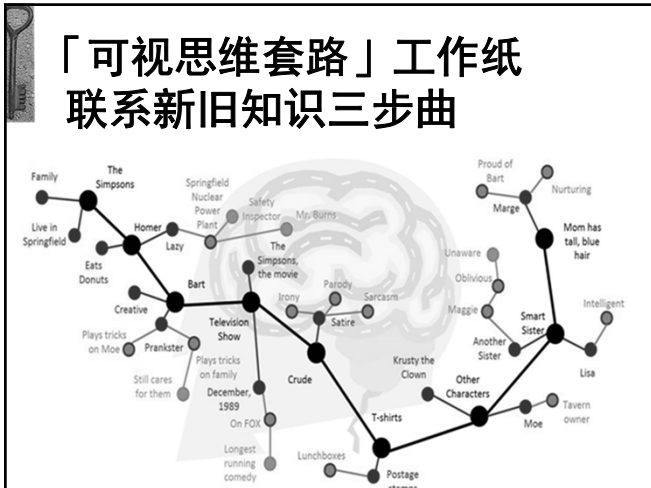
「可视思维套路」工作纸
联系新旧知识三步曲

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第一式:
啟动联系思维
(开始新课题时用)

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Think – Puzzle – Explore

思索	你对这个课题了解多少？ (激活背景知识)
困惑	关于这个课题你有什么困惑? (激发兴趣)
探索	您计划如何对这些困惑进行探索? (为自主学习奠定基础)

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这个学习活动对您有帮助吗？

您在工作坊前应填写了
《促进学生深度学习:思索-困惑-探索》工作纸
请在小组中分享您的答案

例一:教师培训班

THINK / PUZZLE / EXPLORE

Think about what you may have read as part of the pre-reading activity for this workshop as well as what you already know about the SBAC Assessment. Take a few post-it notes and generate responses to the prompts below. Place them accordingly on the large chart.

1. What do you already **think/know** about the SBAC assessment that do you want to discuss with your colleagues?

2. What **questions/puzzles** do you have about how the implementation of this assessment or how it will impact teaching/learning in your classroom?

3. How would you like to further **explore** the questions/puzzles we have around the SBAC assessment or performance tasks?

例二：“可持续旅游”

Sustainable Tourism

思索	· 你对“可持续旅游”了解多少？
困惑	· 你对“可持续旅游”有什么困惑？
探索	· 您将如何探索和了解有关“可持续旅游”的概念？

Table 1: Sustainable Transportation

Think	Puzzle	Explore
-Increase the standard living	-What are countries doing to "stop" or improve air quality?	-National Geographic Documentaries on youtube
-Improve public health	-How to make bikes safer?	-Primary Sources: someone who lived in a polluted area
-Mexico city is one of the world's top polluted cities	-How to incorporate into poorer cities	-Research bike/bus transportation
-Traffic still is a problem in Mexico city	-Can horse-drawn carriages help with pollution problems	-Research ITDP
-cars can make traffic bad	-What ever happened to walking?	-Ask anyone who has ever been to Mexico city?
	-cost of program?	
	-Get electric car chargers in cities?	

Table 2: Sustainable Design

Think	Puzzle	Explore
Printers melts plastic and builds up an impaler figure layers	Can it handle making things out of more than one material?	Look into articles and online find uses it to see how it works.
Efficient because there are less transportation costs and faster production.	What is the extent that the 3-D printers go? - could we make them weak?	Further information can come from the inventor of the 3-D printer.
Its already being used today	- could they provide hand new arms and legs?	If plastic is used to print out 3-D objects, what happens if dangerous objects can be made from it? easily too
Cuts down on prototyping, waste, transportation emissions.	What are the factors of production?	
Coming to domestic markets	Is it costly or cheap?	
The world + the technologies are developing quickly.	What are the disadvantages and advantages of the manufacturing?	
	What raw materials can be inserted?	
	Is it only limited to plastic?	
	Why is it not well-known around the world?	

Table 3: Sustainable Textiles

What positive effects to the harm chemicals...

Think	Puzzle	Explore
There are 4 factors	What things go into making clothes?	textiles
Textiles/fabrics can be harmful to the actual consumers?	How source are the chemicals?	wool
Add chemicals affect textile workers health	Have the chemicals ever killed anyone?	raw materials
Natural methods = better for your body (ex. wool)	Does the price of the chemicals harm the economy?	landfills
Harmful additives are added to fabrics, and alternatives that are safer exist	positive vs negative health risks?	cancer (restriction, etc)
PFC's harm animals too!	self cleaning fabrics?	textile production
Wool is naturally sustainable	benefits vs hurting? CFC	textile workers
Harsh chemicals in clothes harm the environment/your health	not deteriorating-(landfills growing)	Look into different companies
Chemicals harm thyroid gland	How are health concerns of performance additives effecting humans?	Whom to ask: Anyone in the washing company - the guardian.com
Harmful chemicals used on clothes.	Why keep making such harmful textiles?	Keywords: textiles, raw materials
i wear, or hospital-we	What is the difference b/w polyester & nylon?	term chemical used in clothing industry
	I wonder what the health costs amount to for human additives	ask people who have chemicals in washing and those who don't
		history channel
		Discovery channel

例三：小学课题-海盗与海岛

THINK, PUZZLE, EXPLORE {Pirates and Islands}

Think	Puzzle	Explore
• steal treasure	• where they come from	• books
• unkind	• what they eat	• maps
• have cannons	• what they drink	• TV or movies
• they fight	• what they do	• diaries
• climb rigging	• why they live on a boat	• online – Google, iPad, computer, phone
• use telescopes	• why they fight	
• talk funny	• are they still alive	• museum
• have ships	• how they steal treasure	• letters
• look for buried treasure		

第二式：
深化联系思维

Connect – Extend – Challenge

联系 新信息和概念与你已知的有什么联系？
（把新知识与背景知识联系起来）

延伸 新概念使你的思维扩展到那些新方向？
（鼓励拓宽思维）

挑战 新信息和概念使你想到什么挑战或困惑？
（提示对困惑和困难作评估）

例一：统计学

例二：探讨社会问题（例：安乐死）

Watch and make notes

'CONNECT –EXTEND – CHALLENGE'

How are the ideas and information connected to what you already know?

What new ideas did you get that extend your thinking in new directions?

What is still challenging or confusing for you?

关于安乐死视频
http://www.youtube.com/watch?v=UiPFeluy3rA

例三：小学课题 – Poetry

例四：用于教师培训班

Your Picture of an Effective Classroom

Connect/Extend/Challenge

- **Connect:** What connections did you see or hear between your description of an effective classroom and the brief description of the 5Ds?
- **Extend:** What extended your thinking?
- **Challenge:** What challenged your thinking?
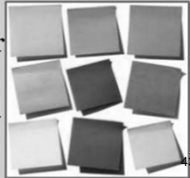
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第三式：
总结联系思维

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I used to think ... but now I think

我以前认为	但现在我认为
（反思以前对主题的看法）	（巩固新的学习和理解）

我的想法改变了，因为 ...
（思考思维改变的原因：帮助学生发展<u>元认知</u>）

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用来总结一个课题 （e.g.社会科学）

I Used To Think...
Now I Think...

With a partner on a notecard...

Write down I used to think and answer what you used to think about Social Studies and ELAR Integration

Write down Now I think and answer what you now think about Social Studies and ELAR Integration

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HARVARD
GRADUATE SCHOOL of EDUCATION

Twenty leading educators reflect on the work of school reform

Harvard Education Press   Browse   New Releases

I used to think...   And now I think...

Edited by Richard F. Elmore

JEAN ANYON · ERNESTO J. CORTÉS JR. · RUDY CREW · LARRY CUBAN · HOWARD GARDNER · BEVERLY L. HALL · THOMAS HEHIR · JEFFREY R. HENIG · FREDERICK M. HESS · DEBORAH JEWELL-SHERMAN · BRAD JUPP · DENNIS LITTKY · DEBORAH MEIER · RON MILLER · SONIA NIETO · CHARLES M. PAYNE · LARRY ROSENSTOCK · MARK SIMON · MARSHALL S. SMITH

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「可视思维套路」工作纸的用处

- 向学生<u>展示</u>联系思维的方法 **Making thinking VISIBLE**

- 帮助学生在不同的学习阶段运用适合的联系思维，达至对知识的深层理解

- 经常使用帮助学生养成积极思考的习惯

MAKING THINKING VISIBLE

Ron Ritchhart · Mark Church · Karin Morrison
FOREWORD BY DAVID PERKINS

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培养联系认知思维
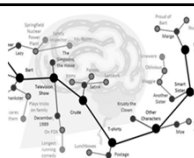
Uncover relational cognition

可以在你的课堂用这些工作纸让学生耍「思维套路」吗?

培养学生的认知思维(二)

Uncover metacognition

发现
元认知

解题需要：知识+元认知能力

成功的问题解决者掌握知识同时演示良好的元认知意识,例如:

- 小心的理解问题中事实之间的关系
- 将复杂的问题分解成简单的步骤
- 检查自己的推理,不作出盲目猜测
- 常常停下来自我提问，理清思路
- …

Metacognition

Thinking About Thinking

方法(一)：老师示范"大声思考"

在教学时,
不单解释课程知识,
同时说出自己怎样思考,
演示专业的思考范式。

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方法(二)：学生进行"大声思考"

- 鼓励学生在做功课或温习时"大声思考"
  - 帮助内化理解
- 大声思考解决问题二人组组员说出自己怎样思考,更要相互提问
  - 互相监控思维
- 大声思考进展性评价
  - 评估解决问题的能力/弱点
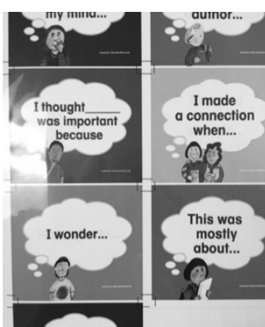
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方法(三)："猜猜这步为什么"

老师	学生
逐步演示解决问题	猜测为什么要采取这些步骤 提出替代路线来解决

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培养元认知思维

Uncover metacognition

这些"Think-about-thinking"
的方法可以
在您的课堂用吗?
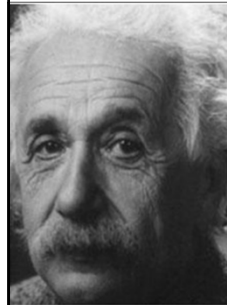
True knowledge comes with deep understanding of a topic and its inner workings.

— Albert Einstein —

AZ QUOTES

Uncover ... 发现

From *covering* information to

UNcovering
our
CURRICULUM

帮助学生深度理解（一）

Uncover big ideas in the curriculum

发现
大概念
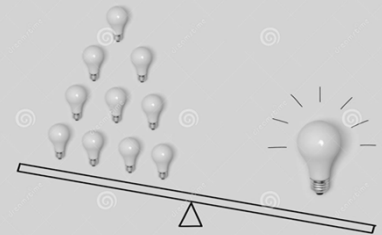
What is a Big Idea?
Grant Wiggins
Jun 10, 2010
return to Big Ideas Home
http://www.authenticeducation.org/ae_bigideas/

Big idea 是关键的概念，像一个 透镜
有效地看到零散的、看似无意义的、混乱
不清的知识点之间的连接， 有助于达到
深层理解

Meanings

例一：微积分

- 学生经常只记住不同积分方法的公式

$$\int \frac{dx}{\sqrt{a^2-x^2}}, \int \frac{dx}{\sqrt{x^2-a^2}}, \int \frac{dx}{\sqrt{x^2+a^2}},$$
$$\sqrt{a^2-x^2}\,dx, \sqrt{a^2+x^2}\,dx,$$
$$\sqrt{x^2-a^2}\,dx \quad \text{How to Memorise}$$
Integration Formulae

Slide 61

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Slide 62

微积分的大概念

- 工作纸圈帮助他们看到**所有数值积分公式都是**
  - 将积分的平面区域划分成合适的形状
  - 找这些形状总面积
- 形状可以是矩形、梯形和用抛物线段代替矩形顶部形成的图形 (rectangles, trapezoids, and figures formed by replacing the top of a rectangle with a parabolic segment)

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Slide 63

例二:历史科
常用教学法：涵盖大量历史内容

Slide 64

Slide 65

历史大概念:
历史是对过去重要事情的解释

History is the interpretation of the significance that the past has for us.

— Johan Huizinga

AZ QUOTES

Johan Huizinga (Dutch pronunciation: [ˈjoːɦɑn ˈɦɑyzɪŋxɑ]; 7 December 1872 – 1 February 1945) was a Dutch historian and one of the founders of modern cultural history.

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Slide 66

帮助学生发现历史概念

National Academy of Sciences (2017). *Effective Teaching: Examples in History, Mathematics, and Science*, Chapter 7.

- 学生们创造他们认为过去最重要的东西的时间胶囊
- 学生阐明他们对什么是历史意义的基本假设
- 老师把所有假设写成巨幅海报称为"确定历史意义的规则"，并以此作为全年的课堂讨论的聚焦
- 最初学生严格跟循"规则"来评价史料，後来发现规则是他们订的, 他们也可以改，理解了为什么有不同意见的历史学家和历史的"解释性"。

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帮助学生深入学习大概念

大概念不应该作为事实或定义来教授

1) 明确**识别**大概念，重点帮助学生加深理他们
2) 设计需要学生**应用**这些概念的**学习任务**
3) 在整个课程中**重温和强化**对大概念的理解

Schrock, J. and Benko, S. (2015). *Using Fundamental Concepts and Essential Questions to Promote Critical Thinking*. Retrieved from http://www.facultyfocus.com/author/julieschrockphdandstevenbenkophd/

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科学科大概念例子

- 物料的化学特性和物理特性可以用它的原子、离子和分子的结构和排列以及这些粒子之间的力来解释。
- 化学反应速率是由分子碰撞的细节决定的。
- 内稳态是生物体通过保持动态平衡而保持稳定和存活的能力。
- 热量不断从较暖的物体移动到较冷的物体，直到所有物体处于相同的温度
- 能量不能被创造或毁灭。它只能从一种形式转换为另一种形式。能量的转换会导致状态或运动的改变。
- 每一个作用力都有相等的反作用力。
- 地球由漂浮在称为软流圈的液体层上的板块构成。 这些板块的运动是许多地质事件的起因。

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人文学科大概念例子

- 历史是对过去对我们的重要意义的事的解释
- 文明需要地域，政治，经济，宗教和社会结构才能生存和繁荣。艺术家选择代表主题的方式来传达他们的想法
- 什么是公平？
- 什么使艺术伟大？

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以下网页有不同课程大概念例子

NYU STEINHARDT New York University Steinhardt
http://steinhardt.nyu.edu/teachlearn/science/resources/ideas

Big Ideas & Guiding Questions
https://thebigideas.wikispaces.com/

GO-LAB Go-Lab Project (Global Online Science Labs for Inquiry Learning at School)
http://www.golabz.eu/big-ideas

WhatItMeansForArt acstratten's website
https://whatitmeansforart.wordpress.com/2014/08/27/big-idea-2/

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a) 您教的学科有那些大概念？

b) 设计有效并有趣的方法引导您的学生探索它

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72
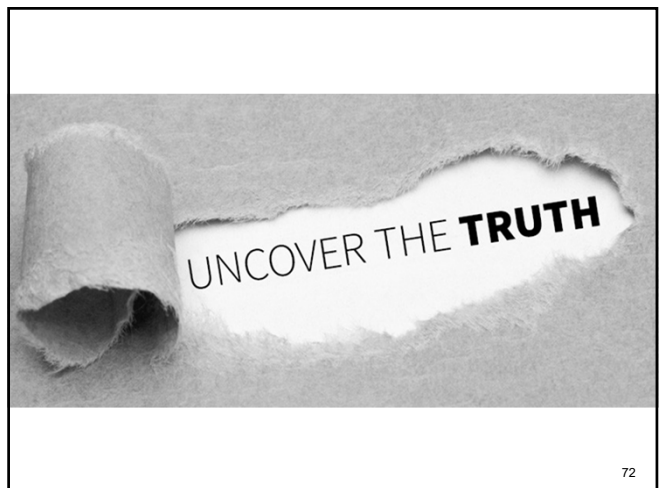
12

对或错？

电池存电
Batteries store
Electricity

73

对或错？

SPIDERS are insects.

蜘蛛是昆虫

74

对或错？

价值决定价格
VALUE JUDGMENT

75

对或错？

ARE YOU READY YET SIR?

I THINK I'M GOING
TO NEED A BIT
MORE TIME...

葡萄酒是
越陈越好

对或错？

朱门酒肉臭，路有冻死骨。

77

我的"朱门酒肉"是香的！
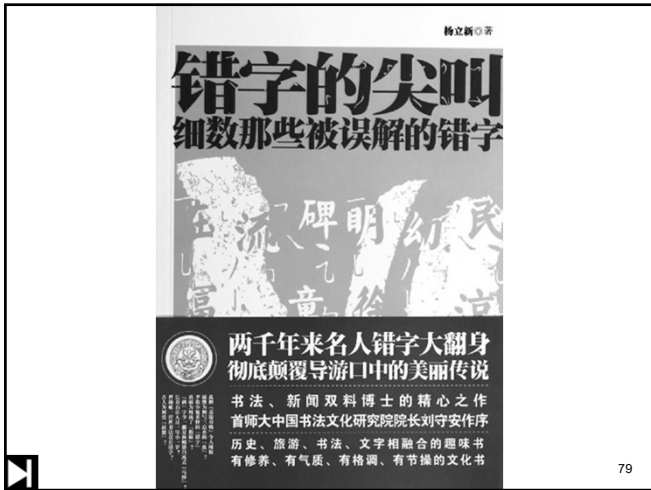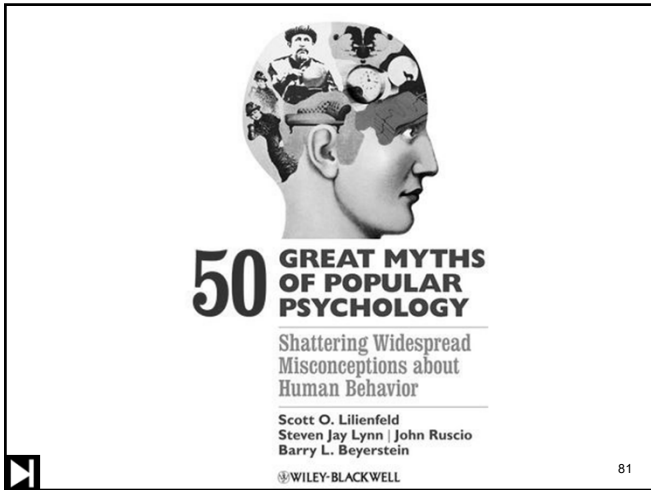
Misconceptions

- 1) Marketing is Advertising
- 2) Marketing is spin, buzz and sizzle
- 3) Marketing is selling
- 4) Marketing is unethical and wasteful
- 5) only marketers do Marketing
- 6) Marketing is a cost center and costly
- 7) the goal of Marketing is to maximize customer satisfaction
- 8) the goal of Marketing is to maximize sales

错误背景概念 (Misconceptions)

- 从小到大由日常生活经验而形成
- 常有不科学的误解

根深蒂固!!!
顽强难改!!!

错误背景概念对学习的影响

- 学生不会轻易放弃错误观念
- 干扰或扭曲对新知识的理解

Misconception　　New Idea

错误背景概念扭曲了对力学的理解

地心引力拉向下 · 向上的力用完了 · Moving Up · Moving Down · 向上的力

85
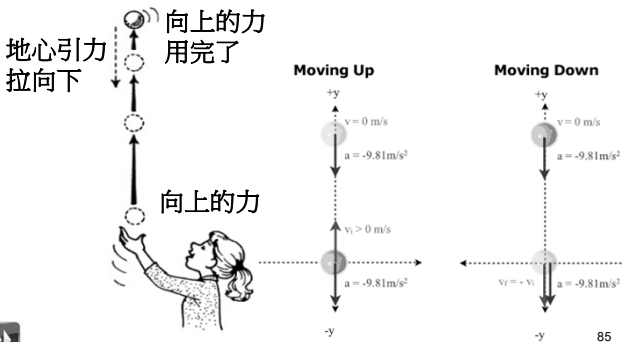
帮助学生深度理解（二）

Uncover misconception

发现
错误背景概念

INCORRECT

深度学习：改变错误背景概念

CONCEPTUAL CHANGE
How New Ideas Take Root

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88
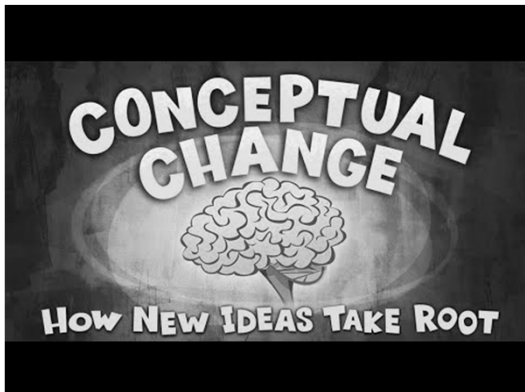
概念改变教学法
Conceptual Change Teaching

1. **揭露**学生的错误观念

2. 安排就错误作讨论，迫使学生**无法回避，正视并处理**他们的误解

3. 帮助学生**重建并内化**正确的新概念

Unfreezing · Moving · Refreezing

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教师识别学生的错误观念

WIKIPEDIA
The Free Encyclopedia

- 常见错误概念汇编
- 聆听学生
  - 课网、课外的讨论
  - 大声思考解决问题二人组
  - 大声思考进展性评价
- 阅读学生的写作
  - 作业
  - 课堂短写, e.g.
    - 最混淆的内容
    - 最明白的内容
    - 与 XX 课题的关系
    - 仍待解答的疑问

ASSIGNMENT

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小组讨论

有什么方法可以
帮助学生发现自己的错误背景概念?

方法（一）：错误概念检查

1. 老师提出关于主题的一个常见的误解

2. 学生们表明同意或不同意这一观点
   并解释为什么

3. 可安排学生互相质疑

方法（二）：Predict Observe Explain
预测 ➡ 观察 ➡ 解释

1. 实验或示范前
   - 学生**预测**其结果,
     并说明基于什么背景知识作出预测
2. 实验或示范进行时
   - 学生**观察**结果
3. 实验或示范后
   - 学生讨论并**解释预测**和**结果**之间的分歧
   - 纠正并背景知识,实现更深入的了解
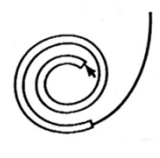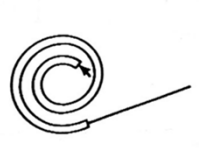
POE：迫使学生正视他们的误解

CONFRONTING STUDENTS' MISCONCEPTIONS

Problem: Movement of a ball exiting a curved metal tube

Two Possible Answers

Curved Path | **Straight Path**

College Student Answers

51% | 47%

方法（三）： 及时的教学

http://jittdl.physics.iupui.edu/jitt/

及时针对错误概念的教学

课前
- 老师预备**课前学习材料**
- 学生在截止时间前完成**课前学习**和数条**热身问题**
- 老师在上课前**阅读学生的答案**,了解学生的错误概念或困难

课时
- 老师根据学生答案**调整**教学活动,让学生讨论反映误解的答案
  及时针对学生的**错误概念和困难**

设计好的热身问题 📄📄 warm up!

- 配合**课程学习目标**
- **开放式**的
- 测试对下一课的**重点概念的理解/误解**
- 包括**最有趣**, 或**最混淆**的理念
- 相对**简单, 不要花太多时间**(大约30分钟)
- **大约三至四条**问题

热身问题例（一）： Macromolecules warm up!

- Starch (e.g. bread, pasta) is a glucose polymer that we eat for energy, but cellulose an almost identical glucose polymer, is indigestible. Why do you think that ONE of these almost identical molecules can be digested, while the other can't?

- Butter and oil are both fats. Why is butter a solid at room temperature, but corn oil is liquid?

热身问题例（二）： Scientific Method, Evolution warm up!

- What is the difference between a theory and belief?

- *(Optional): I will not share these answers with the class* Do you feel that there is an 'either/ or' choice between your religious beliefs and evolutionary theory – i.e. that you must reject the idea of evolution because of your religious beliefs, or that you can't believe in God if you accept the evidence for evolution? Is it possible to have both a belief in God and an acceptance of the evidence supporting evolution?

热身问题例（三）： Cloning / GenEthics warm up!

- Dolly the sheep is a genetic twin, or clone, of a sheep that was born 6 years earlier than Dolly. Does Dolly have parents? If so, who were her generic parents? Is Dolly a "virgin birth"?

- What is the flaw in thinking that if we were ever do clone a person, like Einstein, we would end up with another brilliant physcist?

- Can you think of a way that a person's generic information might be used to discriminate against them for employment or insurance coverage? Give an example.

- Can you think of any movies that center around cloning? Is so, what is the 'take-home message' of that movie?

Predict what you think the shape of the distribution of desired weight for students in this class looks like. Explain why you think it will look that way.

预期正确答案: weight would be either bimodal, because male and female classmates differ in weight, or that it would be normally distributed

一个答案揭示了意想不到的误解
"I think the shape of the distribution would be skewed to the left because people want to weigh less, …". This reviewed an error in interpreting the statistical concept of skewness with the height of the curve rather than a long tail in the horizontal direction, i.e. they reverse the x and y axes in their understanding of the term skewness.

热身问题例子 warm up! B📄 C📄 E📄 S📄

http://jittdl.physics.iupui.edu/jitt/sampler/biology/bio_archive/bio_wu.html
Biology WarmUps by Kathy Marrs

Warm Ups:
Warm Up 1: Scientific Method, Evolution
Warm Up 2: Cells and Organelles
Warm Up 3: Macromolecules
Warm Up 4: DNA / Mutation
Warm Up 5: Mitosis / Chemotherapy
Warm Up 6: Meiosis / Nondisjunction
Warm Up 7: Human Embryonic Stem (hES) Cells
Warm Up 8: Mendelian Genetics
Warm Up 9: Human Genetics
Warm Up 10: Cloning/ GenEthics
Warm Up 11: Three Domains of Life
Warm Up 12: Student Study Skills in N100
Warm Up 13: Photosynthesis / Respiration
Warm Up 14: Human Population Growth / AgBiotech

⊙ See All Warm Ups on One Page ⊙

http://jittdl.physics.iupui.edu/jitt/sampler/chemistry/warmups/chem_wu.html
Chemistry WarmUps by Bob Blake

Dimensional of Analysis
States of Matter
Chemical Reactions
Atomic Structure
Stoichiometry
Stoichiometry II
Solution Chemistry
Chemical Reactivity
Acid and Heavy Metal
Thermochemistry
Thermochemistry II
Nuclear Chemistry
Light Waves
Electronic Structure
Periodic Properties
Periodic Trends
Periodic Trends II
Exam III
Molecular Shapes
Molecular Shapes II

促进学生深度学习教学设计练习

- 请按您教的学科分组 ▤
- 在您的学科小组中

  I. 商定一个**大概念/重要概念**
     合作设计**有效并有趣的方法**
     引导您的学生探索它

  II. 商定一个**常见的错误背景概念**
      合作设计**有效的方法**帮助学生
      a) **发现**自己的错误背景概念
      b) **正视**自己的错误背景概念，并
      c) **纠正**这些错误背景概念

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工作坊後请填写以：
《促进学生深度学习:联系-延伸-挑战》工作纸▤
《促进学生深度学习:我的想法》工作纸▤

我鼓励您跟您的朋友分享答案

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谢谢您的参与！