

# Milton meets Einstein

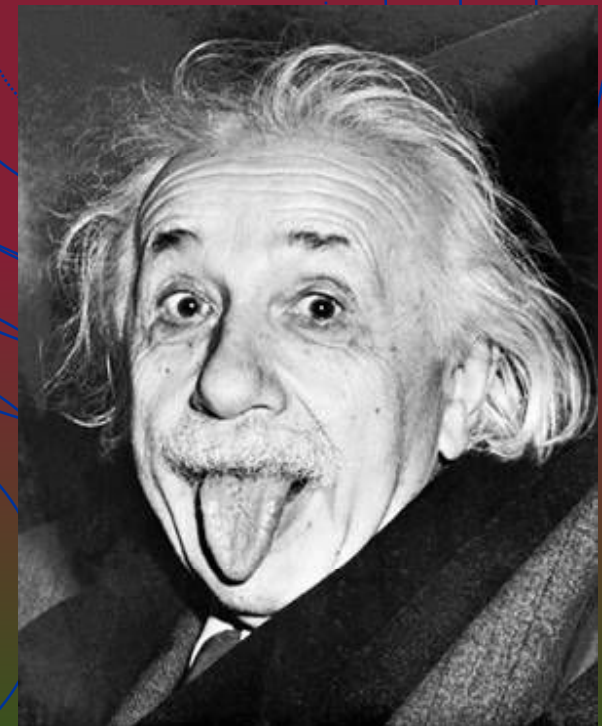
## Inquiring Minds want to Know

Mary Hynes-Berry and Gordon Berry  
the University of Western Michigan - 23 November 2009



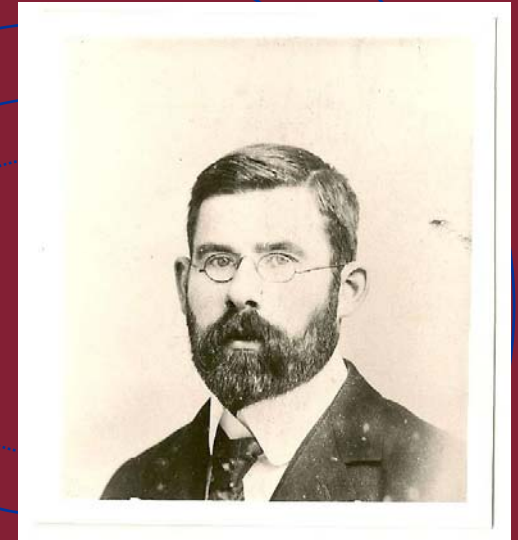
### INQUIRY

in Science  
and  
in Literature



## From Sorensen (2005)

**G.G. Berry** was one of the first individuals to produce new **semantic paradoxes**. Berry's paradox was first presented to Russell (1905) in the following sentence: "The least integer not namable in fewer than nineteen syllables" is itself a name consisting of eighteen syllables; hence the least integer not namable in fewer than nineteen syllables can be named in eighteen syllables, which is a contradiction"



**Another Berry commentary** - about zero :  
(he and Russell had been discussing the related concepts of infinite sets)

## In a letter to Bertrand Russell Oct 8, 1905

"If you are still interested in the **possibilities of nothing**, you may like to see the enclosed which is the result of further meditation on the same fertile topic"

A forerunner of the energy of the vacuum? ....

## Failure produces learning

A paradox (a more gentle form of failure) can help learning –

### *The incompleteness of mathematics*

Gödel (1931) strikes down the completeness of axiomatic set theory postulated by Whitehead and Russell in "*Principia Mathematica*" (1912), Hilbert and others were also looking for this promised land... Continued by work of Greg Chaitin in "*Meta Math*", etc

Another parallel to  
the incompleteness of science

Refinement of Newtonian theory (the Principia, 1702) by Einstein's theory of relativity (1905)  
What's next?

## Incompleteness in literature too!

These Inquiring Minds both want to know



BUT... They ask different questions!

Inquiring minds may want to know  
different answers to the same question:

In Physics, Literature, Life

The **two body** problem has satisfactory  
solutions

The **three body** problem remains  
challenging

## ELEGANT SOLUTIONS

- Concise synthesis
- Deceptively “simple” but comprehensive in what they explain
- Compelling

### Physics/sciences/math

Open-ended question concerning the nature of the physical universe

Uses causal reasoning  
Result is **reproducible**  
Solution can be validated by reproducing the proof and is verified by other/new experiments or demonstrations

**Einstein** : Why time's passage of time depends on relative speeds?  
**Euclid**: Simple set of propositions have a wide application (scientists/math in general)

### Poetry/arts

Open-ended question concerning Human nature

Uses inference, analogy, metaphor  
Result is **unique, irreproducible**  
Truth or validity resonates with the human experience  
Imitations lose the elegance of the solution

**Milton** : How does imagery of the sun shining on a man-centered universe justify God's ways to man? (artists in general)

**Key Concept 1**

**Elegant Solutions**

are the highest order of what might be termed

**Quality Intellectual Work**

To produce  
good scientists,  
good humanists,  
good world citizens,

our goal must be to support **q**uality **i**ntellectual **w**ork in teaching and learning at all levels,

.... from earliest childhood til' death do us part.

Key concept 2

**Learning**

**Play**



**INQUIRY**

**Quality Intellectual Work**

Quality intellectual work, learning, and play  
are different angles in the process of

**INQUIRY**



# Quality intellectual work

Has three essential features:

- **Construction of knowledge** that actively involves the learner in developing his/her understanding (motivation)
- The use of **Guided/disciplined Inquiry** (experiential learning)
- Discourse, products, or performances that have **Value beyond** the classroom (publishing to peers)

*cf: adapted from* Newman, F. and associates. (1996) *Authentic achievement: Restructuring schools for intellectual quality*. San Francisco: Jossey-Bass.

**Key Concept 3:**

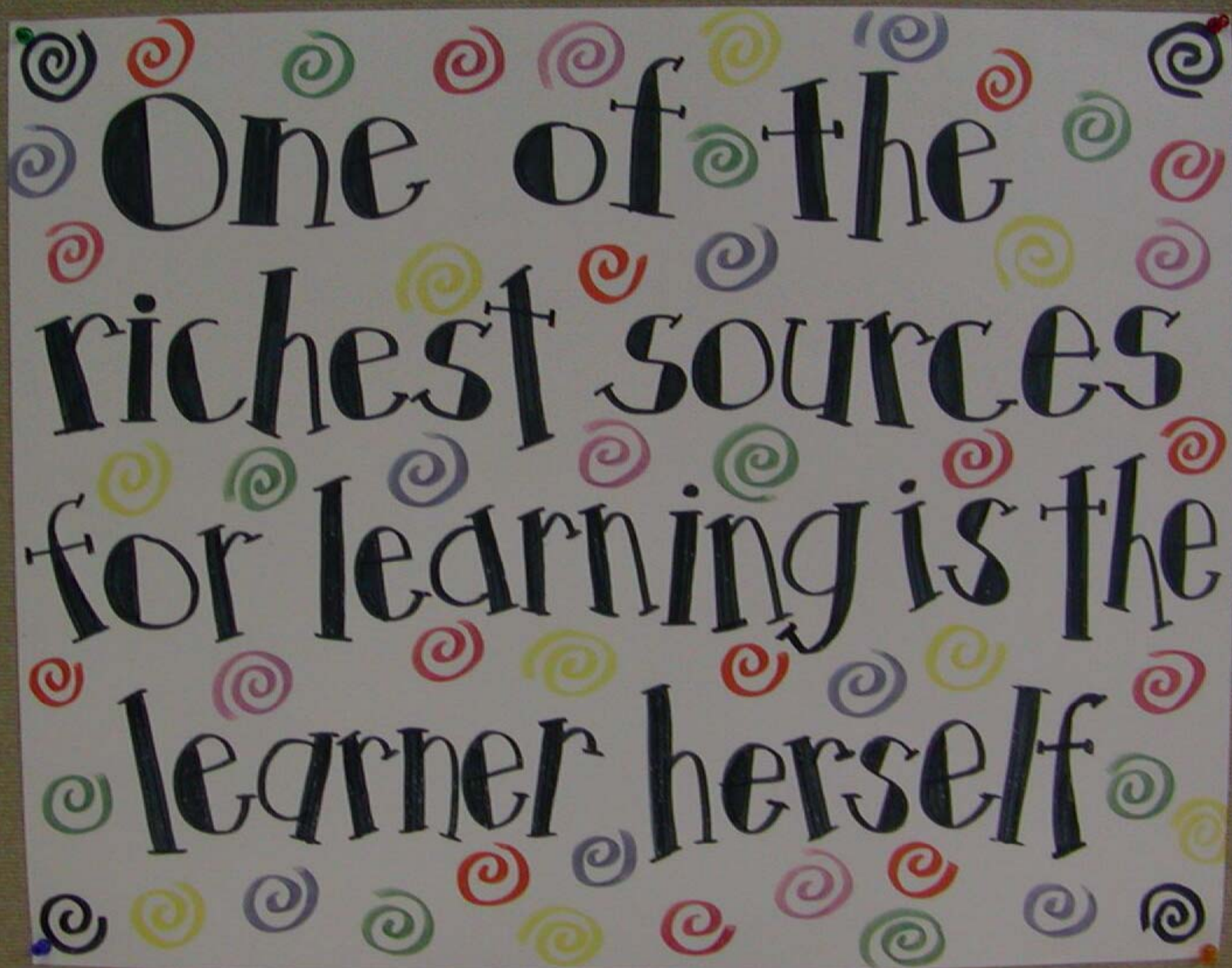
**Inquiry**

calls for deep engagement  
with the question;

**Misconceptions and error**

are essential to the process  
of

**problem-solving**

A handwritten quote on a light-colored background, surrounded by a decorative border of colorful swirls. The text is written in a dark, bold, serif font. The quote is: "One of the richest sources for learning is the learner herself". The swirls are in various colors including red, green, yellow, purple, and blue, and are scattered around the text.

One of the  
richest sources  
for learning is the  
learner herself

# Let's Take a Sip\* of Play

- S – It's satisfying
- I – It's intentional
- P – It's problem solving



**Do you feel the same way about your work?**

**\* The SIP Principle**

*Mary Hynes-Berry – "Don't Leave the Story in the Book" - in publication*

**Learning**

**Play**



**INQUIRY**

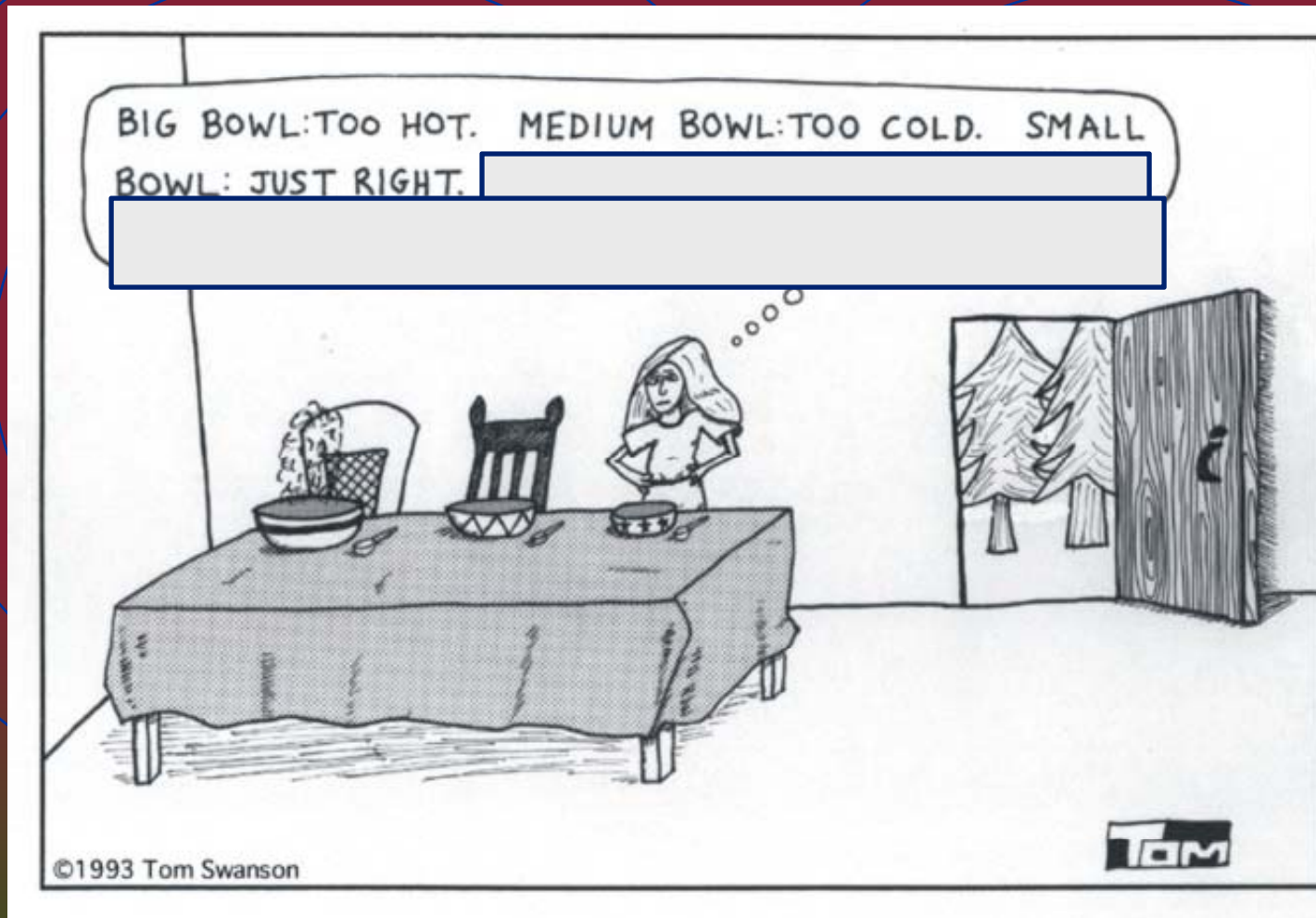
**Quality Intellectual Work**

**Every child is a scientist at play:**

Wondering and problem-solving about how the world works.

**Every scientist was (is?) a child at play.**

# Goldilocks and the Three Bears



Has the science in this story ever worried you?

**How could the porridge in the Bears' bowls be too hot, too cold and just right?**

Working with 1 or 2 others:  
write an explanatory scenario **in your "log book"**  
that is consistent  
with your scientific understanding.

**Do we have any volunteers with solutions....!**

# What Makes Guided Inquiry?

Engagement

Exploration

Evaluation



# What makes Guided Inquiry?

## Engagement

**ENGAGEMENT** is triggered by posing an interesting, open-ended question about a specific problem that does not have a unique solution

Whatever the solution, it must be well-supported...

# What Makes Guided Inquiry?

## Exploration

**EXPLORATION** is carried out by the learners, Drawing on prior knowledge and experience, using methodology appropriate to the discipline (in this case, physics - the laws of thermodynamics).

The Teacher facilitates by raising clarifying, probing questions.

**NOT** full frontal lecture, cookbook science lab; fill-in-the blank worksheets

**Example...**

(measure using "Labquest" – if we have time)

# What Makes Guided Inquiry?

## Evaluation

**EVALUATION** should be intrinsic:

*Is this a sufficient answer to the problem, as far as I'm concerned?* Possibilities include

- Yes, it's Good—or at least it's good enough
- Yes, but it raises a new question/problem I now want to pursue....
- No, I need to decide if
  - ❑ the question needs revising or
  - ❑ there was a problem with the investigation (identify new variables, refine data collection, use tools better or use better tools)

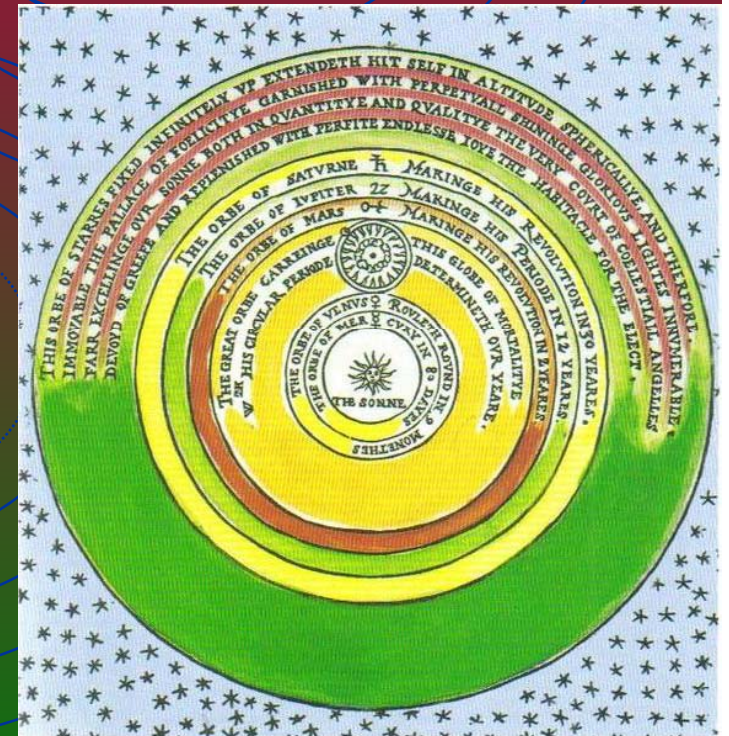
**NOT:** *Is this the teacher's right answer?*

Mis-Guided  
Inquiry

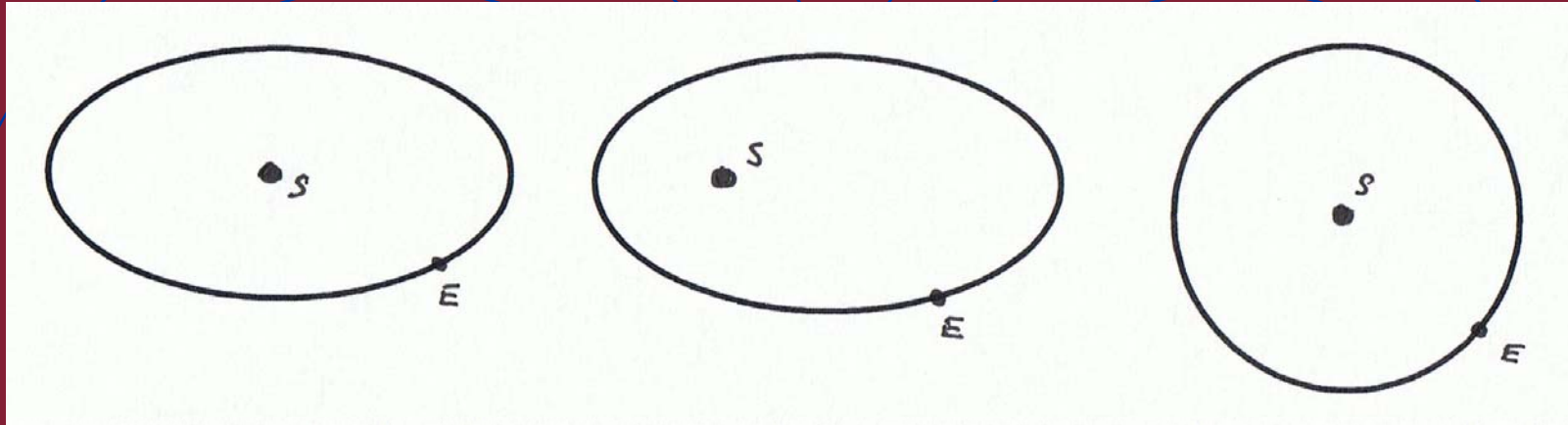




Ptolemaic  
vs  
Copernican  
Universe  
Better Poetry  
Vs  
Better Science



## Representations of the Solar System



**A**

**B**

**C**

Which of these three figures best represents the earth moving in orbit around the sun?

**Let's VOTE.... A blind test....**

**Preconceptions/misconceptions  
affect the ability to learn**

# Preconceptions/misconceptions affect the ability to learn

How do Harvard professors and students compare with Western Michigan professors and students?

**Graduation at Harvard.....** (a short video)

## **Notes:**

1. Why are these misconceptions so strong?  
(even after taking several physics courses)
2. How do you verify prior learning or mis-learning of your students?

# A more personal view of one's UNIVERSE.....







**Consider**

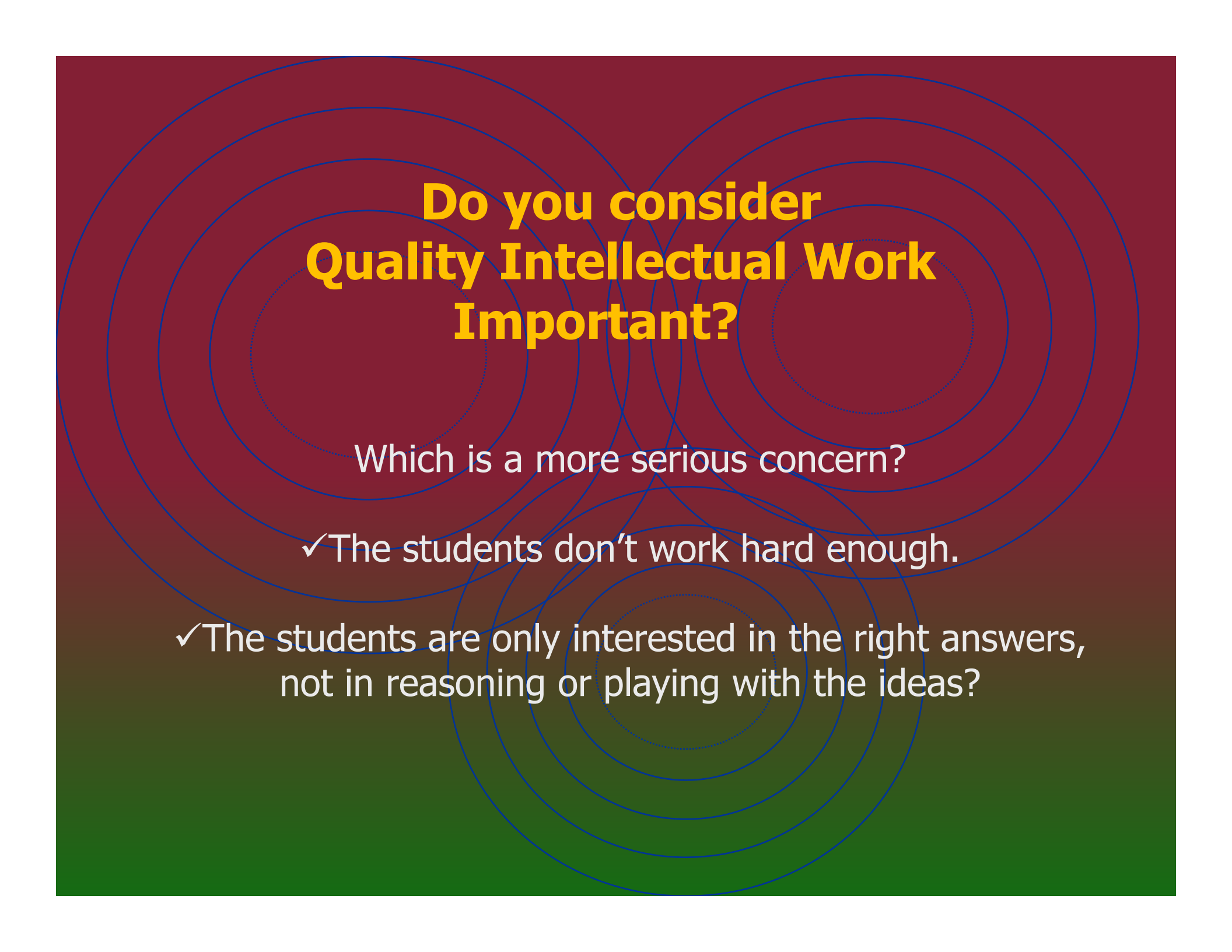
**The science you do**

The science you **teach**

**IS IT WORK?**

or

**IS IT PLAY?**



# Do you consider Quality Intellectual Work Important?

Which is a more serious concern?

- ✓ The students don't work hard enough.
- ✓ The students are only interested in the right answers, not in reasoning or playing with the ideas?

## Science Daily (Feb. 1, 2009)

Researchers Tested Nearly 6,000 Students Majoring In  
Science And Engineering At 7 Universities -  
4 In The United States And 3 In China.

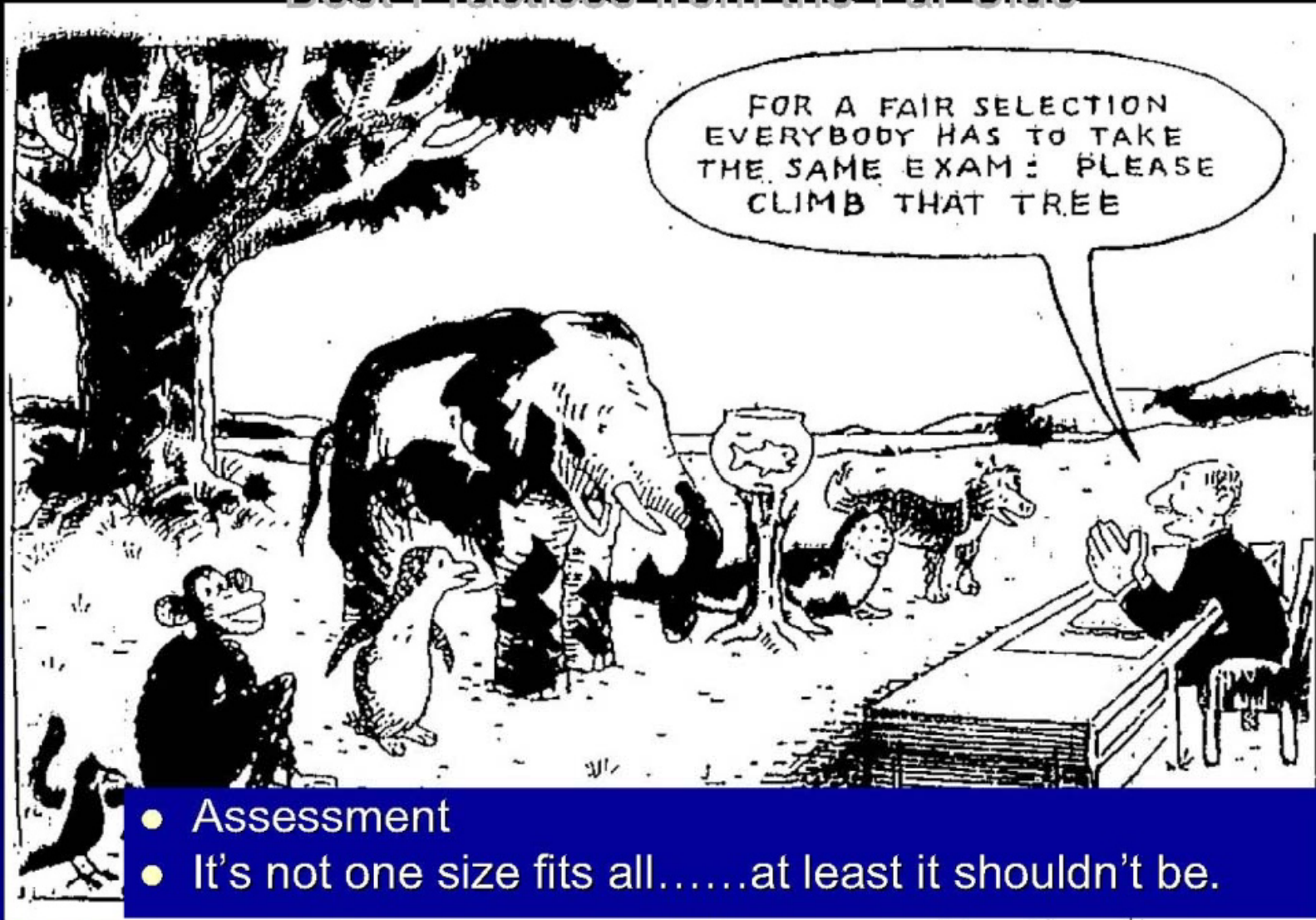
Chinese Students Greatly Outperformed American Students  
**On Factual Knowledge Of Physics** -  
Averaging 90 Percent On One Test,  
versus The American Students' 50 Percent

But **In A Test Of Science Reasoning,**  
Both Groups Averaged Around 75 Percent -

**Not A Very High Score,** Especially For Students Hoping  
To Major In Science Or Engineering.

# Does your testing of students follow this model?

## Best Practices from the Far Side



- Assessment
- It's not one size fits all.....at least it shouldn't be.

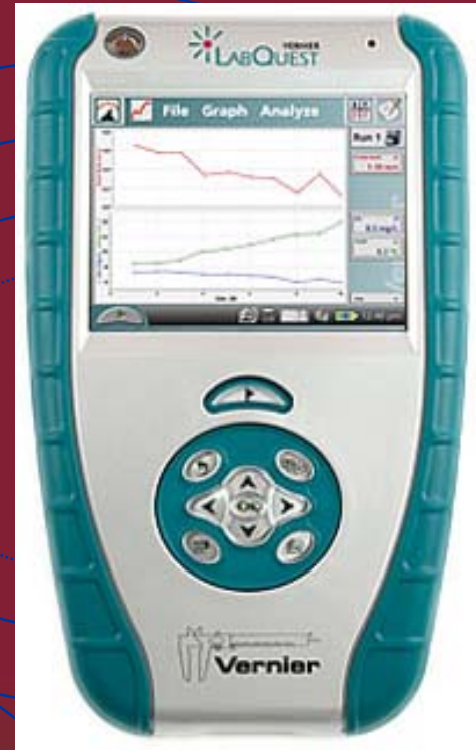
Experience is  
a better  
teacher than  
the voice of  
experience.

We tend to  
remember  
Inquiry -  
Based  
Learning



# The Labquest module

an example of how technology  
can enhance/speed-up **LEARNING**



**Experiment 1** - Measuring Temperature – a scalar quantity!  
Time and spatial dependence...

How can it be used for learning?

**Experiment 2** - Measuring a magnetic field - a vector quantity!

How can it be used for learning?

Did you ever  
wonder why?



When you take pictures of people, the photographs often show the subject's eyes as shiny or red. This happens due to the flash from the camera being reflected from the back of the eye. In humans, the red color comes from light that reflects off of blood vessels in the retinas. In many animals, including dogs, cats, and deer, the red or other color is not changed by the blood vessels. In animals, the retina has a special reflective layer called the tapetum lucidum which acts almost like a mirror at the backs of their eyes. Among many nocturnal vertebrates the white compound guanine is found in the retina of the eye. This provides a mirror-like surface, the tapetum lucidum, which reflects light outward and thereby allowing a second chance for its absorption by the rods. This action allows more light to be absorbed by rods, helping animals to see in dark conditions, and the camera also sees it when light reflects outward from the eye. Thus, if a flashlight or light is shown into eyes of animals at night, the eyes shine back bright light.

## Two questions for you about this presentation

1. What surprised /interested/ delighted you?
2. What applications do you see this having to your own teaching

Please write your answers in your "log book"

They will help us in our research on  
Learning how to learn

- Thank you  
Mary and Gordon

**The END**



## Love Song from a Hollow Cathode

LINES WRITTEN AFTER SEEING WARREN KREYE'S  
SPECTROSCOPY EXPERIMENT TO MEASURE THE  
DOPPLER PROFILE OF THE SPECTRUM OF GOLD FROM  
AN ARGON-FILLED GOLD HOLLOW CATHODE.

Ares' fleece is too solid sullied stuff for  
Love the golden light has an airy  
Function we cannot do without.  
If this present argonaut would seek  
To know the warmth of golden thrust  
In hollowness and thus to find the peak,  
Some alchemy must breathe through his air,  
A colorless odorless element  
That penetrates but will not bind—  
Argon makes such golden atmosphere.  
So breathe you argon on these my golden walls  
And gold to airy thinness beat.

The poem has literary as well as spectroscopic allusions: the Golden Fleece sought by Jason and the Argonauts hung in the temple of Ares, the Greek god of war and strife. The first line is an experimental application of a theoretical debate on Shakespeare's spelling. Critics cannot decide whether Hamlet said: "O that this too too solid flesh would melt/Thaw and resolve itself into a dew" or "too too sullied. . ." Either is possible and both are meaningful. The last line echoes John Donne, from *A Valediction Forbidding Mourning*:

Our two souls therefore, which are one,  
Though I must go, endure not yet  
A breach but an expansion  
Like gold to airy thinness beat.

Author Mary Hynes, Department of English

Submitted by Gordon Berry, Department of Physics  
University of Wisconsin

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W. C. Kreye and F. L. Roesler, *J. Opt. Soc. Am.* 60, 1100 (1970). For preliminary observations, see also M. Hynes, *Appl. Opt.* 7, 1809 (1968)

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A pdf file of this presentation can be found at the website:

<http://www.nd.edu/~hgberry/berry1.html>