NISMEC
Northern Indiana Science, Mathematics & Engineering Center

South Bend Community School Corporation

Seal of the State of Indiana
Indiana Commission for Higher Education
1816

Indiana Commission for Higher Education

University of Notre Dame

ND-SBCSC -Math-Science Partnership

Developmental Biology Modeling Workshop
SBCSC+ High School Science Teachers

18 July – July 2011
at
Notre Dame Jordan Hall of Science

Let’s introduce ourselves….

Do you have a favorite concept in biology?

"Teaching by Telling" is Ineffective

Students…

- Systematically miss the point of what we tell them.
- do not have the same "schema" (background) associated with key ideas/ words that we have.
- do not improve *their* problem-solving skills by watching the *teacher* solve problems

The Lecture System in Teaching Science
Robert T. Morrison, New York University

…….. Let me begin by describing a little scene to you. This scene is set in a beginning organic chemistry classroom. The time is any time from a hundred years ago to this very morning. The professor has come into the room and is looking out at the class. There may be forty students, there may be four hundred students — it really doesn't matter. In fact, he could be looking into a television camera and teaching all the beginning organic students in the country.

The bell rings, and the professor shuffles his dog-eared notes — they're twenty, even thirty years old, but they're just *as good as* the day he first wrote them. The students come to attention, notebooks opened and pencils poised; they're ready to go. The professor clears his throat, and the pencils move. He says "Good morning," and the pencils begin to move in earnest. Then he turns toward the blackboard and starts to talk. And as he talks, he writes. As he writes, the students write. Whatever he writes, they write. When he draws an arrow, they draw an arrow; when he underlines a word, they underline a word. He finishes one section of the board and goes on to the next. He continues until he reaches the lower right-hand comer of the last section. Then he erases the board, or pushes it up, and away he goes again. …….

……Suddenly, disaster strikes! A student drops his pencil! ……

And so on….. *http://entropysite.oxy.edu/morrison.html*

Traditional Instruction

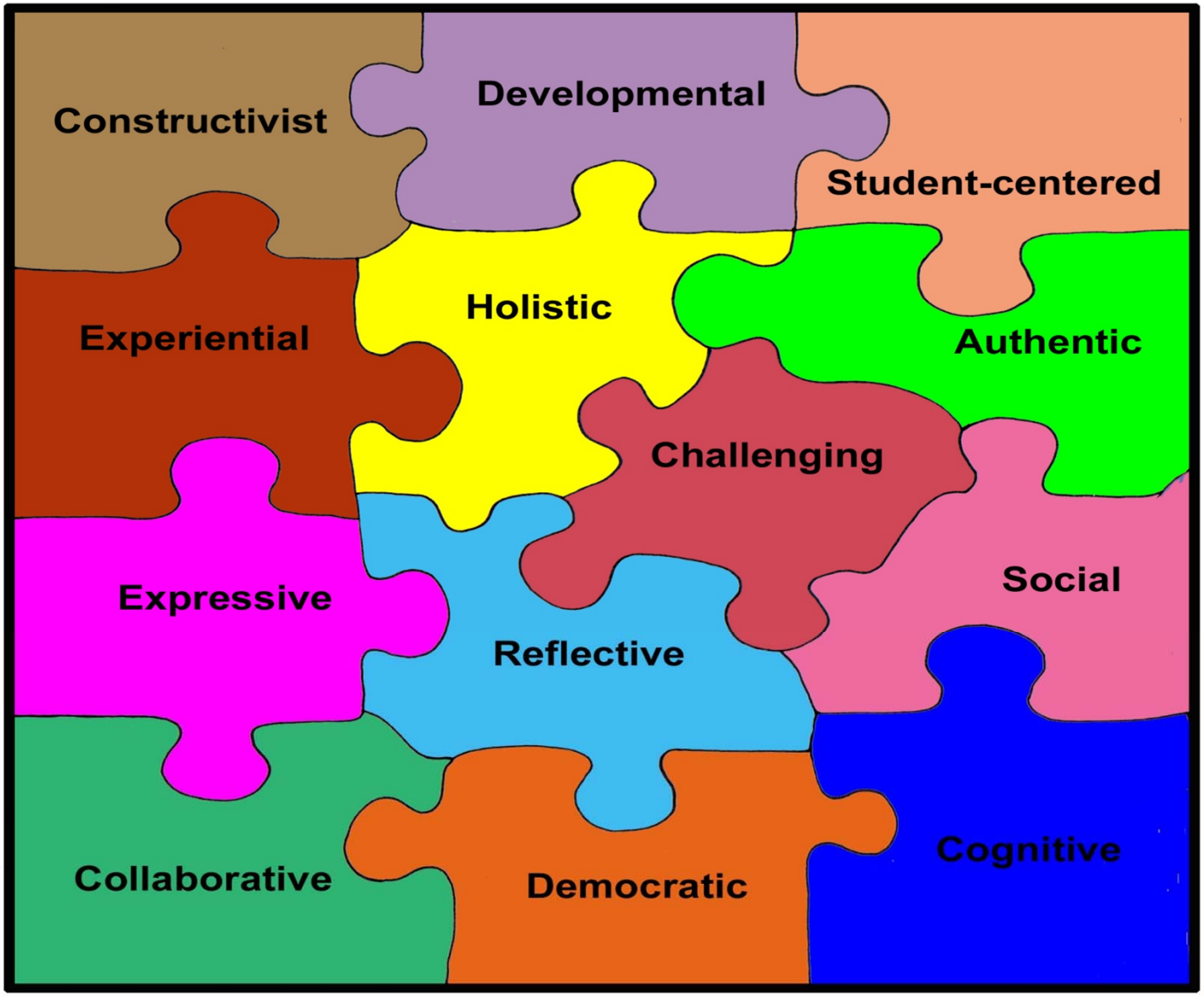
- Presumes two kinds of knowledge:

"the-pouring-into-the empty-head" principle

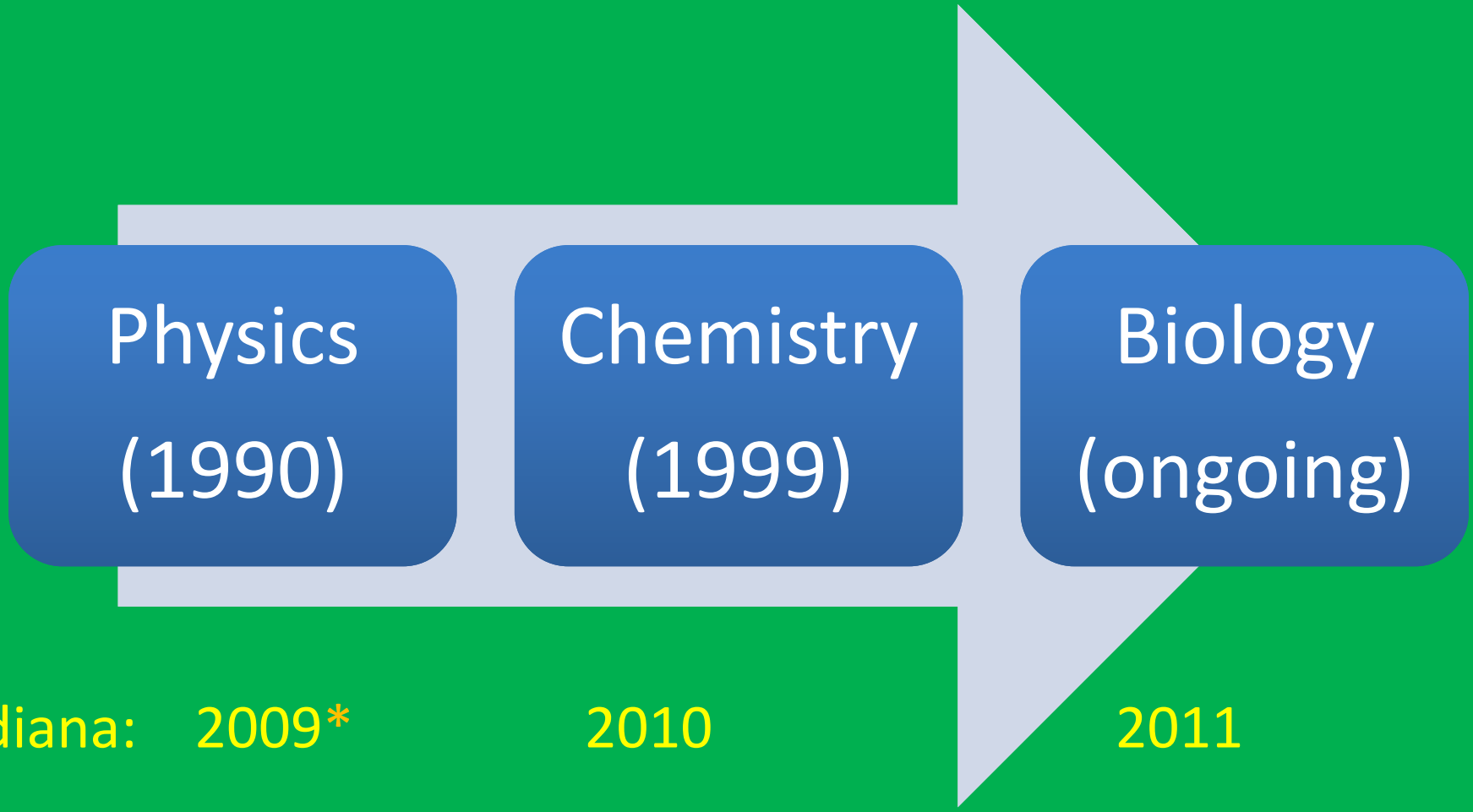
  - Facts and ideas - *things* packaged into words and distributed to students.
  - Know-how - skills packaged as rules or procedures.

- Assumes students will see the underlying concepts in the content.

The 13 Principles of Best Practice Teaching:



Development of Modeling (ASU)



Indiana: 2009* 2010 2011

*some sessions about 10 years ago

Chemistry (& Biology) Modeling in Indiana

- **Summer 2010**: 39 Indiana chemistry teachers at workshops at

at Marian University and at Notre Dame

» Summer 2011: 46 teachers (chemistry and biology)

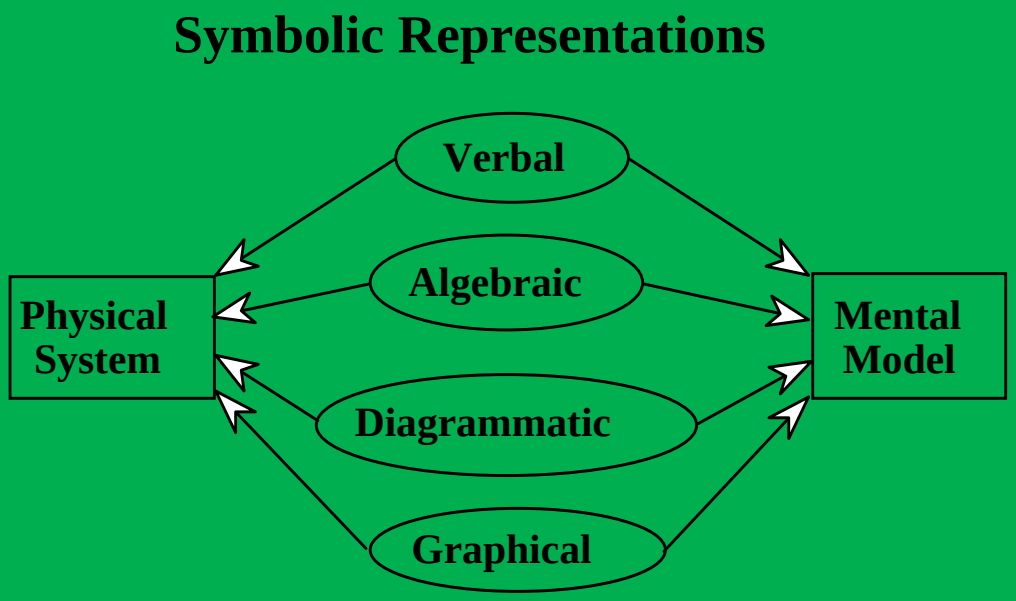
Workshops at University High School and at Notre Dame

followed by

US

Developmental Biology modeling workshops at Marian and at Notre Dame

What Do We Mean by a Model*?



Models are representations of structure in a physical/chemical/biological system or process

*Modeling in physics as developed at the Arizona State - http://modeling.asu.edu/

Why Models?

- Models are basic units of knowledge
- **In all Science Research:**
  - A few basic models are used again and again with only minor modifications.
- Models help students connect
  - Macroscopic observations
  - Sub-microscopic representations
  - Symbolic representations

The students become SCIENTISTS – learning by DOING

Why modeling?!

- To help students see science as a way of viewing the world rather than as a collection of facts.
- To make the *coherence* of scientific knowledge more evident to students by making it more explicit.
- *Models and Systems* are explicitly recognized as major unifying ideas for all the sciences by the *AAAS Project 2061* for the reform of US science education.
- Learning becomes a story – a story that the students want to follow……

Just the Facts - NO **Concepts and Ideas – YES**

The goal of learning is the effective use of **concepts**

Naked numbers Arithmetic->(merchant) math

Naked Science Facts -> everyday use

Naked words -> Stories! Reading with/for meaning

Naked Dates -> Stories! Experiencing experience

We are all connected! We all are stories….

How to Teach it?

The good	*vs*	*the bad and the ugly*
constructivist	*vs*	*transmissionist*
cooperative inquiry	vs	lecture/demonstration
student-centered	vs	teacher-centered
active engagement	vs	passive reception
student activity	vs	teacher demonstration
student articulation	vs	teacher presentation
lab-based	vs	textbook-based

Guided Inquiry -> group investigations -> peer learning of concepts

Modeling and Guided Inquiry

A 3-part lesson-plan: PIP and the SIP* Process

Problem-setting (Engagement)

Investigate (Explore)

Publish (Problem explain, Evaluate)

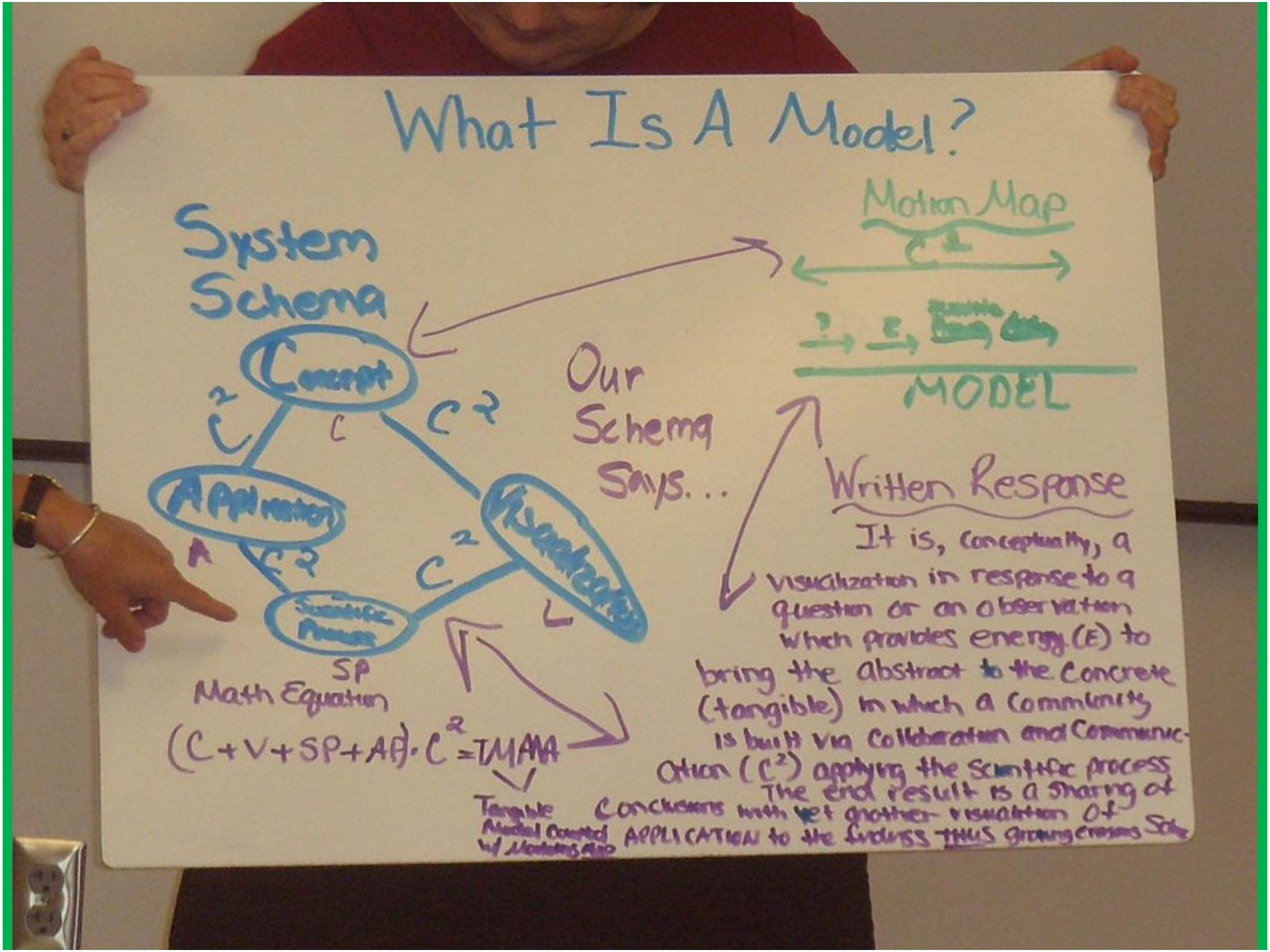
Each part must be Satisfying, Intentional Problem-solving*

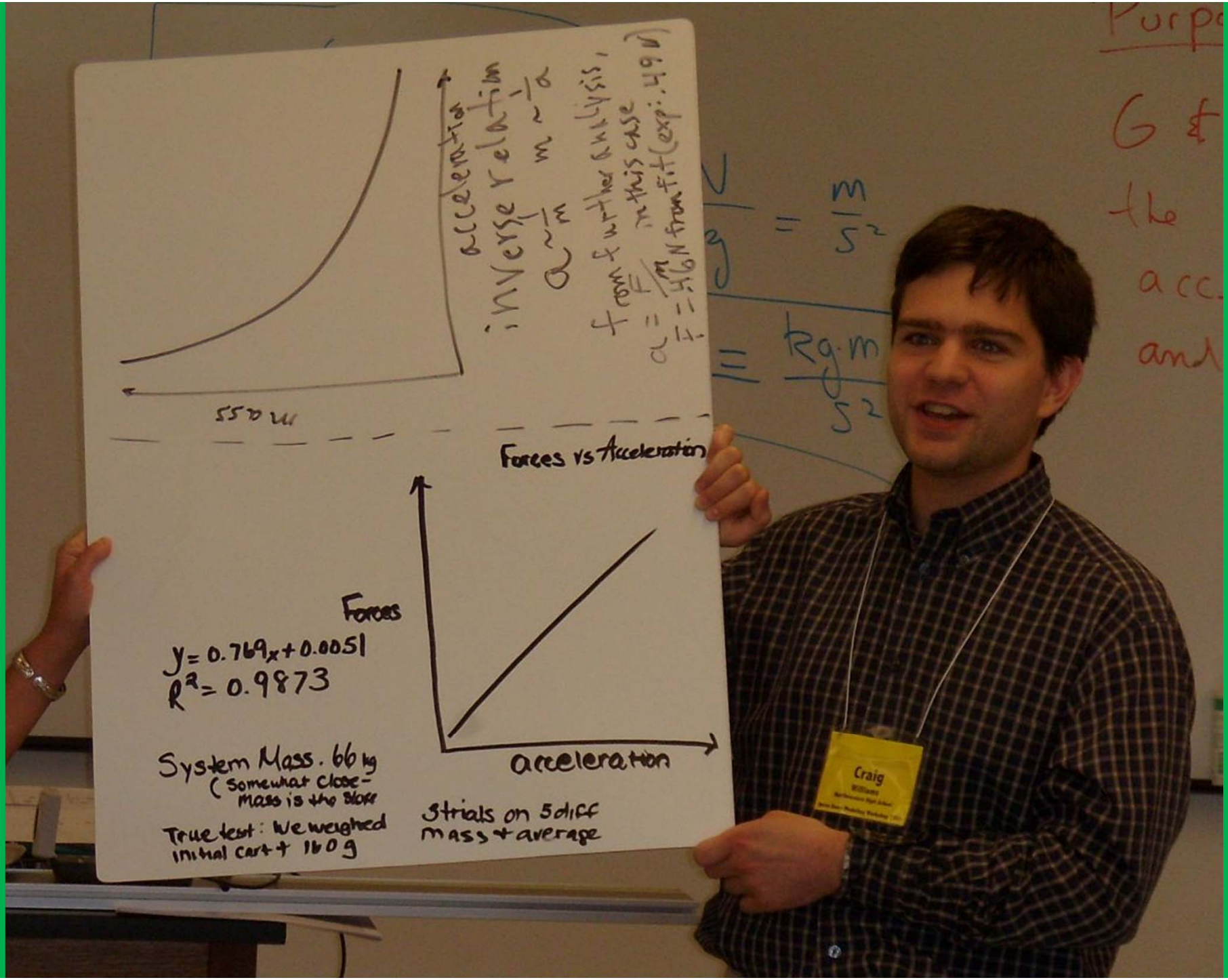
*SIP - concept – ref. - Mary Hynes-Berry – “Don’t Leave the Story in the Book”

What is a model?

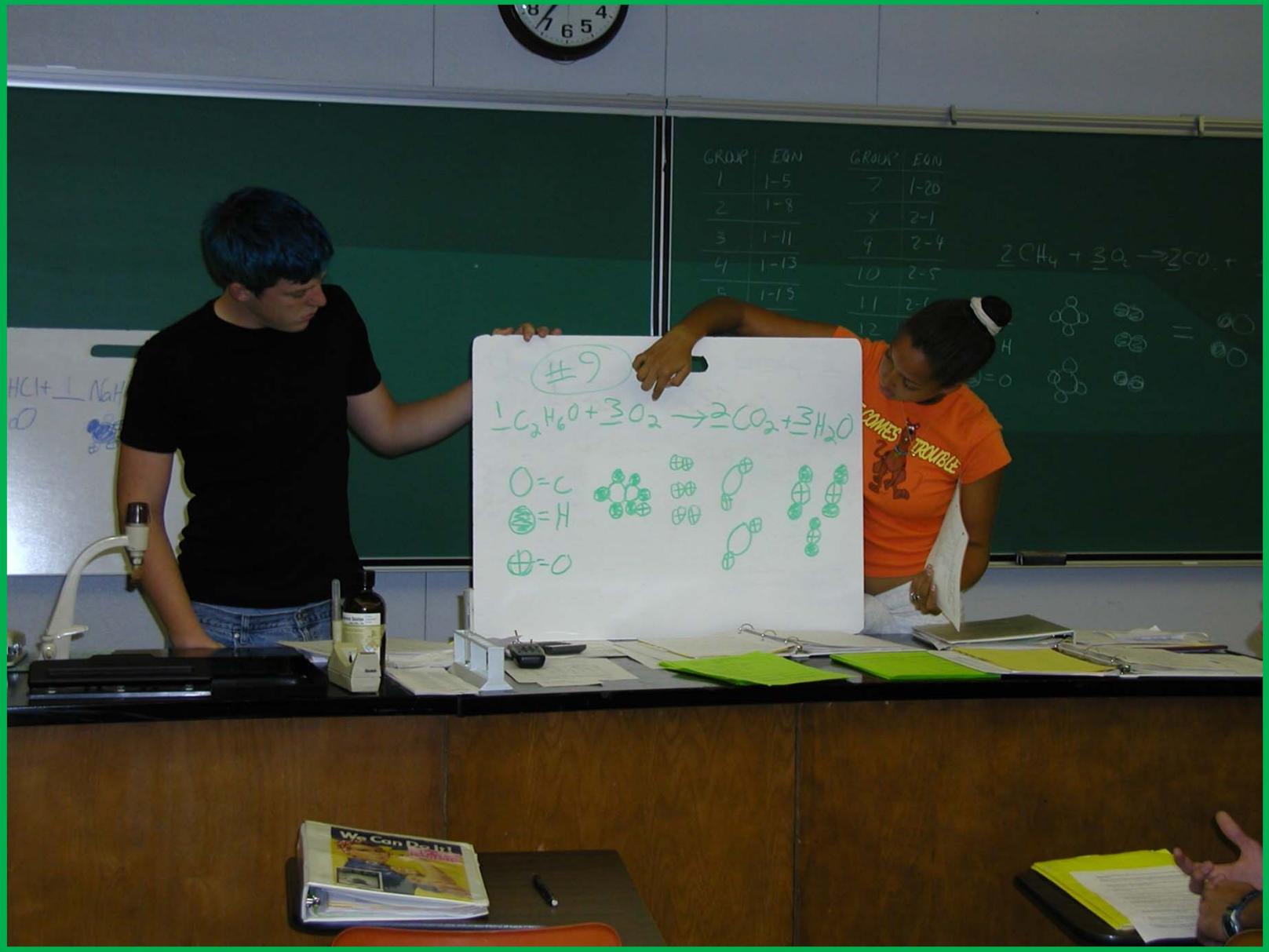
Review:

You and your neighbor: Try answering the question on a whiteboard…


What Is A Model?
System Schema
Concept
Application
Visualization
Scientific Process
SP
Math Equation
$(C+V+SP+AP)\cdot C^2=TMAA$
Tangible Mental Created w/ Modeling App
Conclusions with yet another visualization of
APPLICATION to the business
Our Schema Says...
Motion Map
MODEL
Written Response
It is, conceptually, a visualization in response to a question or an observation which provides energy (E) to bring the abstract to the concrete (tangible) in which a community is built via Collaboration and Communication (C^2) applying the Scientific process
The end result is a sharing of


acceleration
inverse relation
$a \sim \frac{1}{m}$
$a = \frac{1}{m}$
550 g
Forces vs Acceleration
Forces
acceleration
$y = 0.769x + 0.0051$
$R^2 = 0.9873$
System Mass. 66 kg
(somewhat close-
mass is the block
True test: We weighed
initial cart + 160 g
3 trials on 5 diff
mass + average
Craig

STUDENTS Making a Presentation



Goals for this workshop

- Develop a set of modules for teaching first year biology using the modeling format
- These modules/investigations will address specific (identified) Indiana Biology Standards
- Write descriptions of these investigations so that
    1. They are understandable to other modeling teachers – to the **"Biology Modeling Community"**
    2. They are in a consistent format.
    3. Ensure that the completed lesson descriptions tell a consistent biology story (the modeling format) consistent with the story of the standards