Virtual Courseware for Inquiry-based Life Science Education

Robert Desharnais & Paul Narguizian

Department of Biological Sciences

California State University, Los Angeles

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Project Philosophy

Students Learn by Doing!

"Virtual Courseware" activities are interactive simulations that emphasize the scientific method: making observations, proposing hypotheses, designing experiments, collecting and analyzing data, synthesizing results.

5 Essential Features of Inquiry

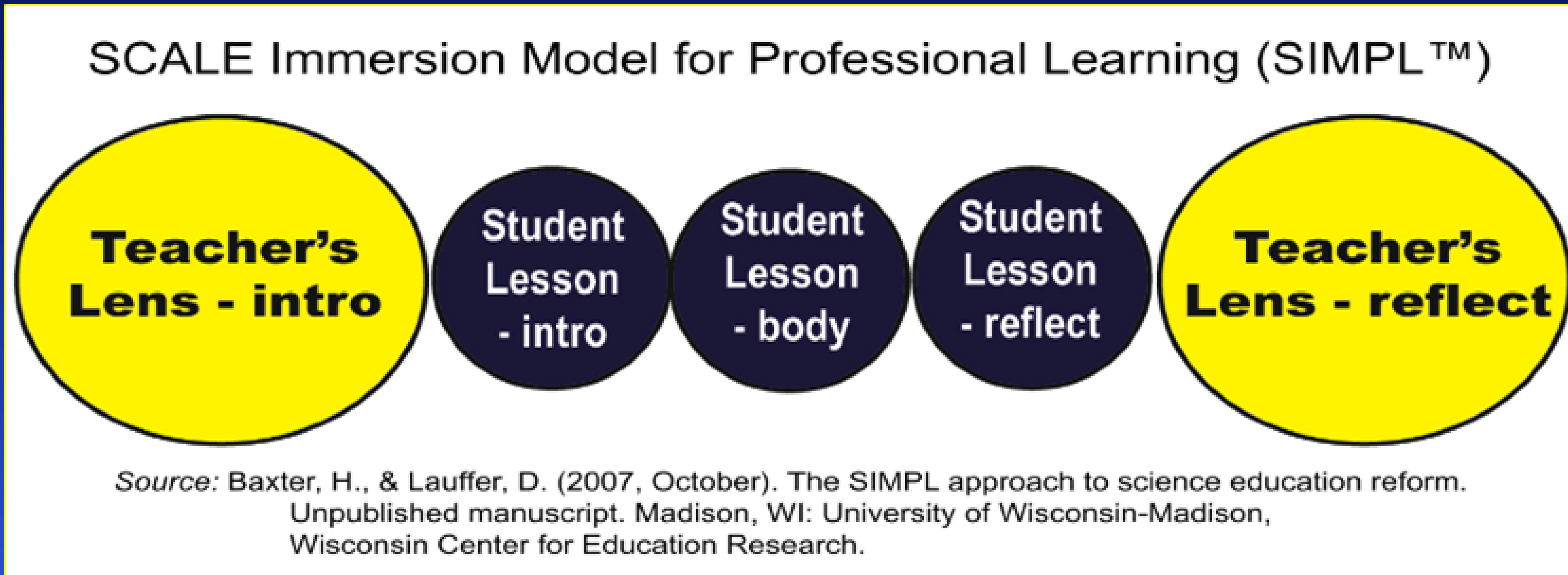
- *Inquiry and the National Science Education Standards*, describes five essential features of inquiry – five characteristics that define this way of understanding the natural world (National Research Council, 2000).
- These five essential features can be used to describe the process by which science inquiry takes shape in the classroom or in the "virtual world."

5 Essential Features of Inquiry

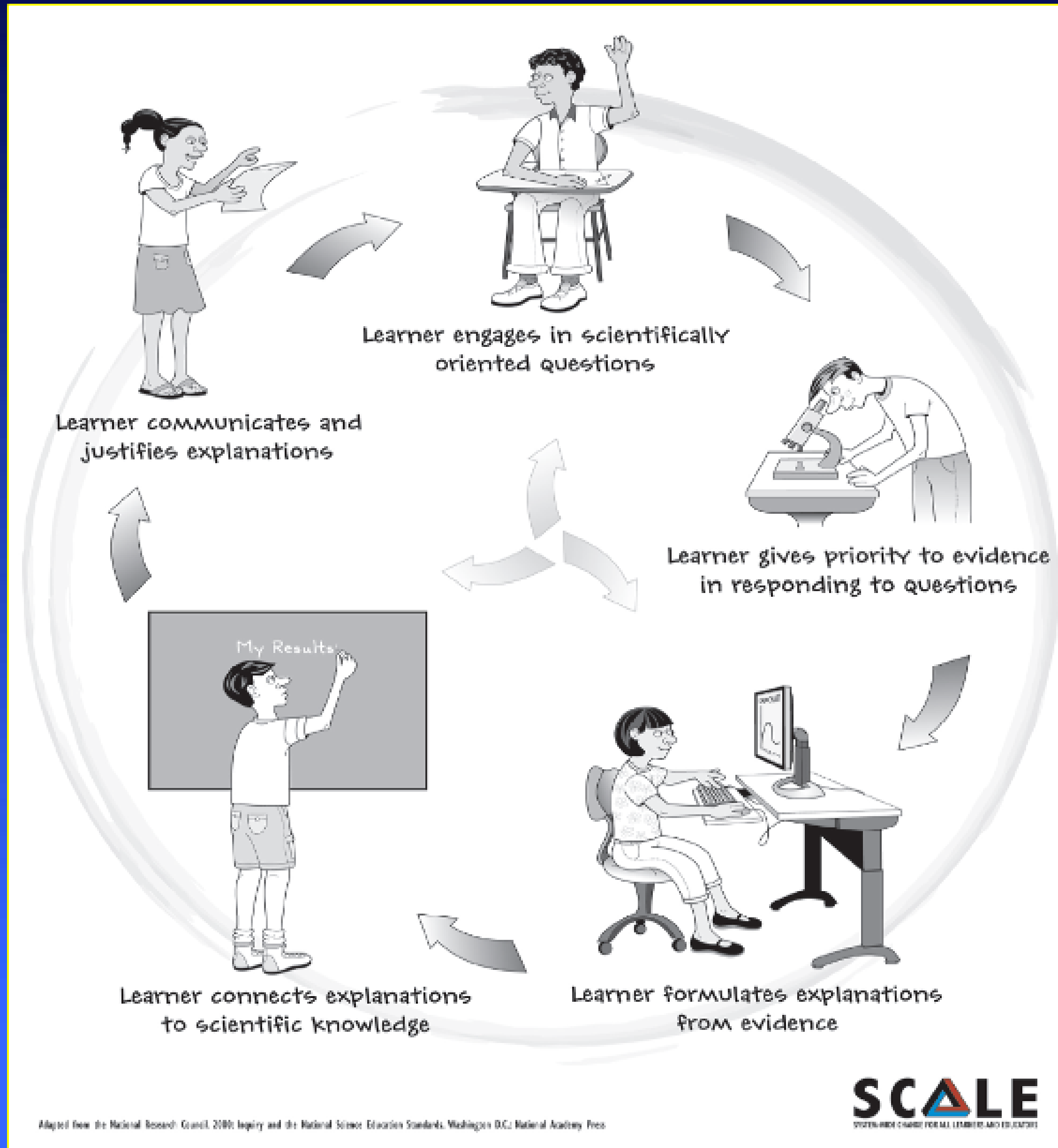
- The learner:

1. Engages in scientifically oriented questions;
2. Gives priority to evidence in responding to questions;
3. Formulates explanations from evidence;
4. Connects explanations to scientific knowledge; and
5. Communicates and justifies explanations.

SCALE Immersion Professional Learning Model (SIMPL™)



- Based on the Engage → Explore → Explain learning paradigm, aligned with the research summarized in *How People Learn*
- Modeling the way and applying learning research to experiences for adult learners


Learner engages in scientifically oriented questions
Learner gives priority to evidence in responding to questions
My Results
Learner formulates explanations from evidence
Learner connects explanations to scientific knowledge
Learner communicates and justifies explanations
Adapted from the National Research Council. 2000. Inquiry and the National Science Education Standards. Washington D.C.: National Academy Press
SCALE

What is Inquiry?

- *Inquiry and the National Science Education Standards: A Guide for Teaching for Teaching and Learning*, defines scientific inquiry as:

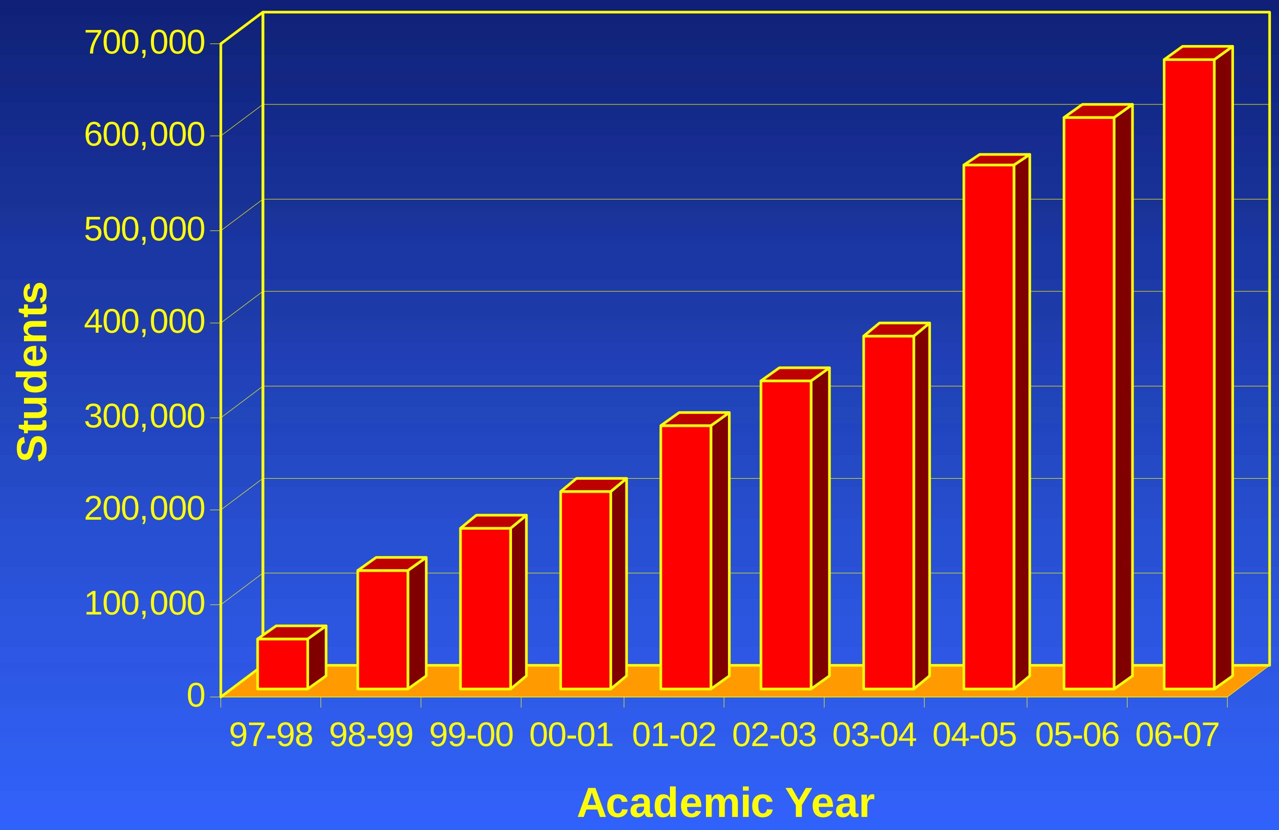
- *A multifaceted activity that involves observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative [scientific] explanations* (National Research Council 2000, p. 13).

- Enhancing mastery of subject matter;
- Developing scientific reasoning;
- Understanding the complexity and ambiguity of empirical work;
- Developing practical skills;
- Understanding the nature of science;
- Cultivating interest in science and interest in learning science; and
- Developing teamwork abilities.

Project History

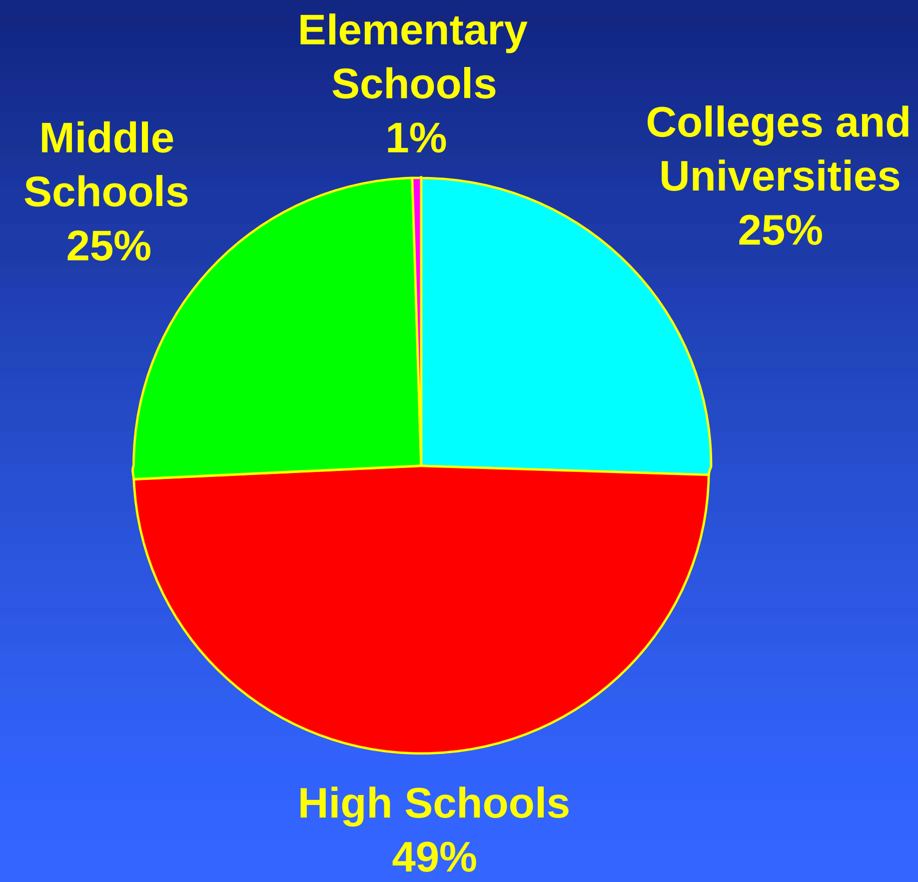
- *Virtual FlyLab* (1995)
- *Virtual Earthquake* (1996)
- *Biology Labs On-Line* (1999 –2002)
- *Geology Labs On-Line* (1999–2001)
- New *Earthquake* Activity (2000–2003)
- Global Warming Suite (2002 –2005)
- VCISE (2004 – present)

Virtual Courseware Usage



In addition, over 650,000 annual subscriptions to Biology Labs On-Line applets have been sold.

Users of Virtual Courseware



Current Project: *VCISE*

In March of 2004 Cal State LA was awarded an Instructional Materials Development grant from the NSF Division of Elementary, Secondary, and Informal Education.

Project Goals:

- develop and evaluate on-line instructional materials for secondary students in biology and earth science
- align the activities to both state and National Science Education Standards
- support science teachers in their efforts to implement inquiry based learning activities in their classrooms
- disseminate materials as widely as possible

http://www.ScienceCourseware.org/

Go to "Virtual Courseware for Inquiry-based Science Education."

Click on Drosophila.

Monohybrid Cross

P: *vg*/*vg* ♀ (vestigial) × +/+ ♂ (wild type)

F_1: +/*vg* ♀ (wild type) × +/*vg* ♂ (wild type)

F_2:

♂ \ ♀	(1/2) +	(1/2) *vg*
(1/2) +	(1/4) +/+	(1/4) +/*vg*
(1/2) *vg*	(1/4) +/*vg*	(1/4) *vg*/*vg*

Use of math: product rule for independent events.

Genotypes: (1/4) +/+ to (1/2) +/*vg* to (1/4) *vg*/*vg*

Phenotypes: (3/4) wild type to (1/4) vestigial wings

Dihybrid Cross

Mendel's principle of independent assortment holds for two unlinked traits. The F_2 generation can be predicted using probability theory: Prob(AB) = Prob(A) Prob(B).

Example: ♀ vestigial wings (*vg*) and ♂ ebony body (*e*)

	(3/4) +	(1/4) *vg*
(3/4) +	(9/16) +, +	(3/16) *vg*, +
(1/4) *e*	(3/16) +, *e*	(1/16) *vg*, *e*

Phenotypes follow Mendel's 9 : 3 : 3 : 1 dihybrid ratio.

Chi-squared Analysis

How do we know if the deviations from our hypothesis are just due to random chance?

Chi-squared test statistic: $$\chi^2 = \sum_i \frac{(O_i - E_i)^2}{E_i}$$

where O_i are the observed counts and E_i are the expected.

If our hypothesis is true, then χ^2 will depart from zero due to random chance. We know its probability distribution.

P = Prob(deviations bigger than observed due to chance)

If $P < 0.05$, we assume the deviations are not due to random chance and therefore we reject our hypothesis.

Sex-Linked Cross

P: X^w/X^w ♀ (white eyes) × X^+/Y ♂ (wild type)

F_1:

♂ \ ♀	(1/2) X^w	(1/2) X^w
(1/2) X^+	(1/4) X^+/X^w	(1/4) X^+/X^w
(1/2) Y	(1/4) X^w/Y	(1/4) X^w/Y

Genotypes: (1/2) X^+/X^w to (1/2) X^w/Y

Phenotypes: (1/2) white eye ♀ to (1/2) wild type males http://dev.ScienceCourseware.org/

User name: teched
Password: conference

Go to “Virtual Courseware for Inquiry-based Science Education.”

Click on Natural Selection.

Evolution by Natural Selection

Principles:

- *Heritability:* correlation between a trait in the parents and the same trait in their offspring. A trait must be heritable for it to evolve by natural selection.
- *Fitness:* a measure of reproductive success that includes survival and fecundity. A trait must affect fitness for it to evolve by natural selection.
- *Variability:* differences among individuals in a population. There must be variability in a trait for natural selection to be able to act on it .

Types of Selection

- *Directional selection:* natural selection "weeds out" individuals at the extremes and maintains intermediate forms.
- *Stabilizing selection:* natural selection favors one of the extremes. This can eliminate variability
- *Disruptive selection:* natural selection favors both extremes over the intermediate types. Can lead to divergence of populations. Outcome may depend on the initial composition of the population.

Virtual Courseware Project

ScienceCourseware.org