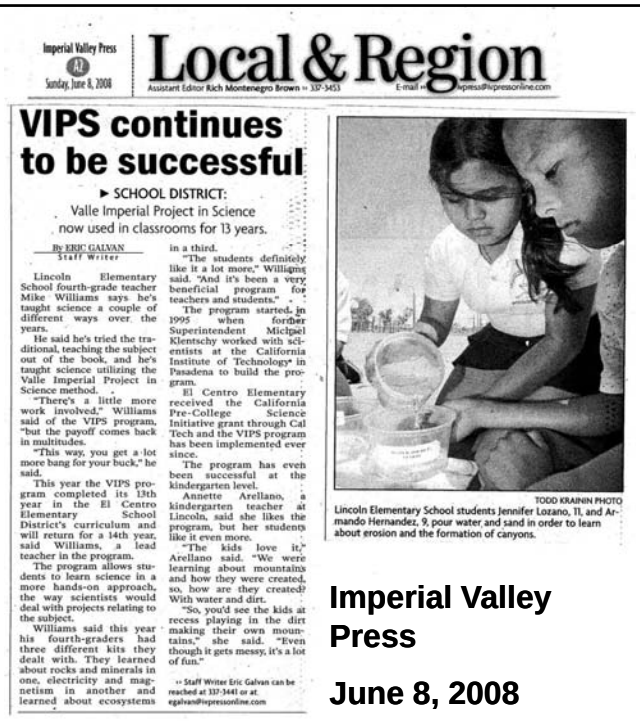
Strengthening Pedagogical Quality in Inquiry-Based Science Education

5th International Conference
Quality Growth of Inquiry Based Science Education Programs

Case Study Critical Questions

- What is the context?
- What is the infrastructure?
- What is the evidence?
- What are the implications for teacher development?



Imperial Valley Press
Sunday, June 8, 2008

Local & Region

Assistant Editor Rich Montenegro Brown • 337-3453 E-mail • ivpress@ivpressonline.com

VIPS continues to be successful

► SCHOOL DISTRICT:
Valle Imperial Project in Science now used in classrooms for 13 years.

By ERIC GALVAN
Staff Writer

Lincoln Elementary School fourth-grade teacher Mike Williams says he's taught science a couple of different ways over the years.

He said he's tried the traditional, teaching the subject out of the book, and he's taught science utilizing the Valle Imperial Project in Science method.

"There's a little more work involved," Williams said of the VIPS program, "but the payoff comes back in multitudes.

"This way, you get a lot more bang for your buck," he said.

This year the VIPS program completed its 13th year in the El Centro Elementary School District's curriculum and will return for a 14th year, said Williams, a lead teacher in the program.

The program allows students to learn science in a more hands-on approach, the way scientists would deal with projects relating to the subject.

Williams said this year his fourth-graders had three different kits they dealt with. They learned about rocks and minerals in one, electricity and magnetism in another and learned about ecosystems in a third.

"The students definitely like it a lot more," Williams said. "And it's been a very beneficial program for teachers and students."

The program started in 1995 when former Superintendent Michael Klentschy worked with scientists at the California Institute of Technology in Pasadena to build the program.

El Centro Elementary received the California Pre-College Science Initiative grant through Cal Tech and the VIPS program has been implemented ever since.

The program has even been successful at the kindergarten level.

Annette Arellano, a kindergarten teacher at Lincoln, said she likes the program, but her students like it even more.

"The kids love it," Arellano said. "We were learning about mountains and how they were created, so, how are they created? With water and dirt.

"So, you'd see the kids at recess playing in the dirt making their own mountains," she said. "Even though it gets messy, it's a lot of fun."

•• Staff Writer Eric Galvan can be reached at 337-3441 or at egalvan@ivpressonline.com

TODD KRAININ PHOTO
Lincoln Elementary School students Jennifer Lozano, 11, and Armando Hernandez, 9, pour water and sand in order to learn about erosion and the formation of canyons.

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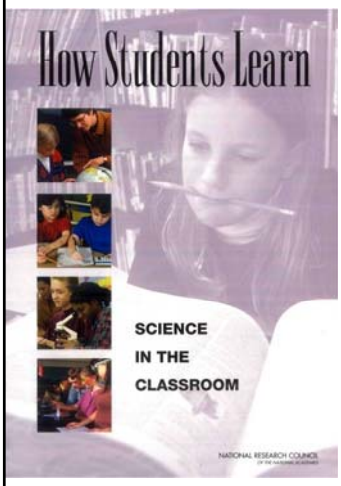
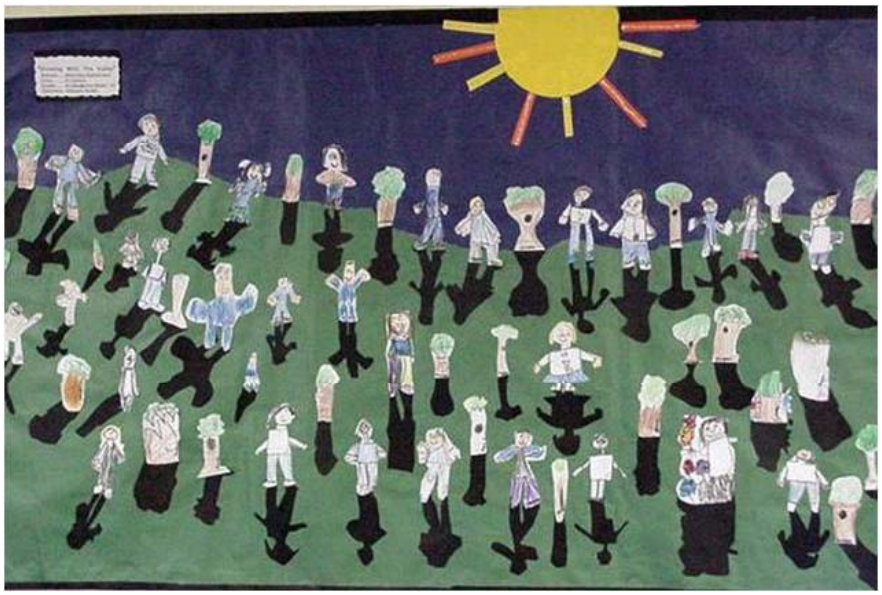
How Students Learn Science

National Research Council (2005)

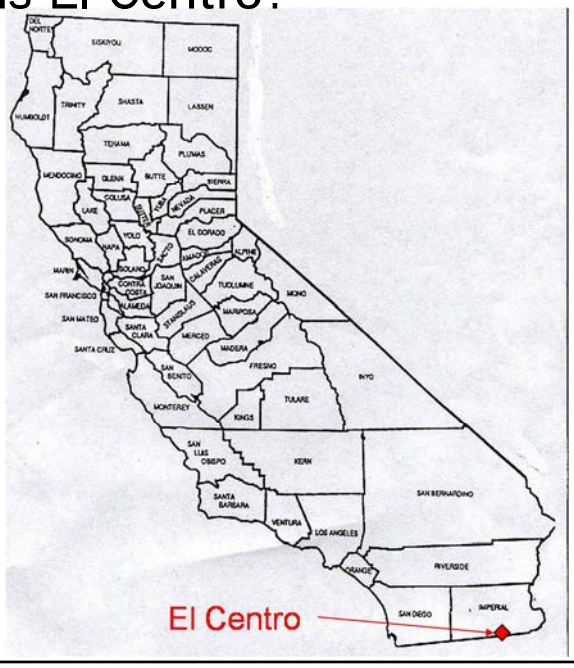


- Engage to activate prior knowledge
- Develop competence
  - **Deep foundation of factual knowledge**
  - **Understand facts in the context of big ideas**
  - **Organize knowledge to facilitate retrieval and application**
- Utilize metacognitive approaches to instruction

A Field Trip to El Centro, California



Where is El Centro?



Our Community and Students

In Imperial County

- **Mean income $16,322**
- **Poorest of all 58 counties in California**
- **30% unemployment rate**
  (among highest is USA)
- **22,500 students in 14 Districts**

In El Centro

- **13,200 K-12 students**
- **9 elementary, 2 middle, 2 high school**
- **77% Poverty**
- **61% English Language Learners**
- **10% Migrant**
- **81% Hispanic, 12% Caucasian, 4% African-American, 3% Asian**

Student Achievement – Imperial County, CA

- Stanford Achievement Test: Science Scores

1998-99 NPR - Sorted by Years in Program

Years	Gr4	Gr6
CUM	36	40
0	21 n=137	27 n=174
1	32 n =150	32 n=121
2	38 n=141	42 n=132
3	47 n=111	50 n=107
4	53 n=91	64 n=104

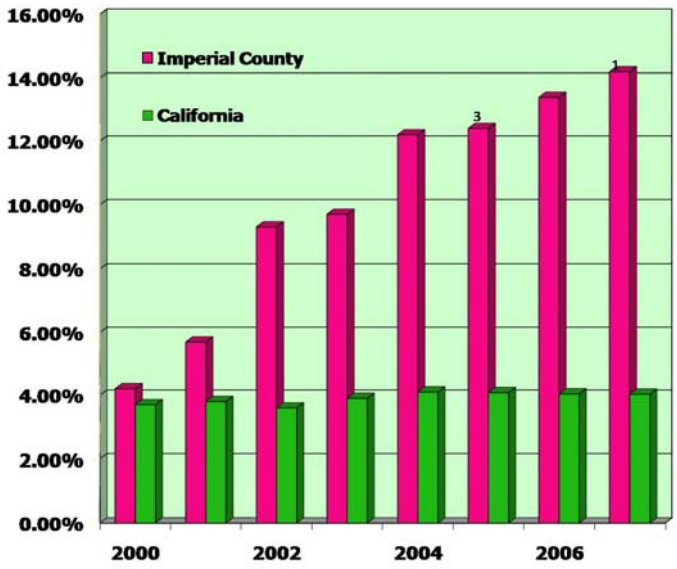
Student Achievement – Imperial County, CA

2000-2001 Mean Raw Scores- Sorted by Years in Program

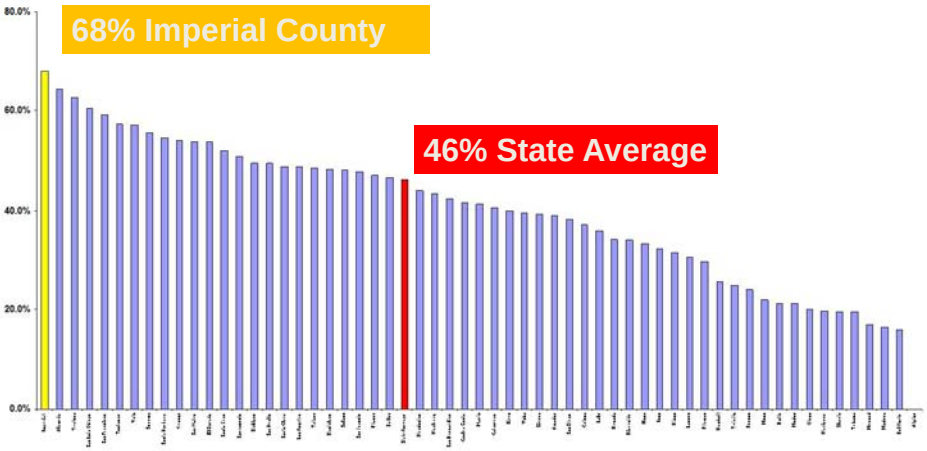
Years	Gr7	Gr8	Gr7/8
CUM	9.4	11.1	10.2
0	8.7 n=48	10.0 n=107	9.5 n=155
1	8.9 n =136	10.5 n=103	9.7 n=239
2	9.0 n=168	10.7 n=112	9.8 n=280
3	10.4 n=125	11.1 n=90	10.7 n=215
4	11.0 n=84	13.3 (1) n=93	12.7 (2) n=177
	p<.023	p<.001	p<.01

1=Singapore
2=Hong Kong

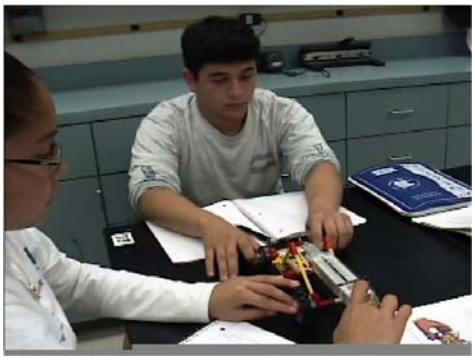
UC Eligibility Rate for Underrepresented Students



College going rate to any California College from known high schools in California 2003



For additional information on this research and how a strong inquiry based science program also increased achievement scores in reading and mathematics...

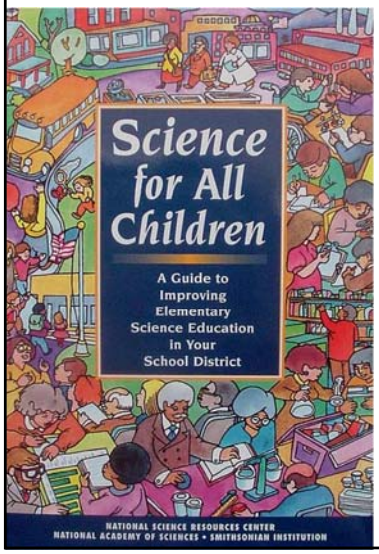


Amaral, O., Garrison, L. and Klentschy, M. (Summer 2002). Helping english learners increase achievement through inquiry-based science instruction. Bilingual Research Journal, 26:2, 213-239.

http://brj.asu.edu/content/vol26_no2/pdf/ART2.PDF

Infrastructure

Five Critical Elements for Reform



- High Quality Curriculum
- Sustained Professional Development
- Materials Support
- Administrative and Community Support
- Assessment and Evaluation

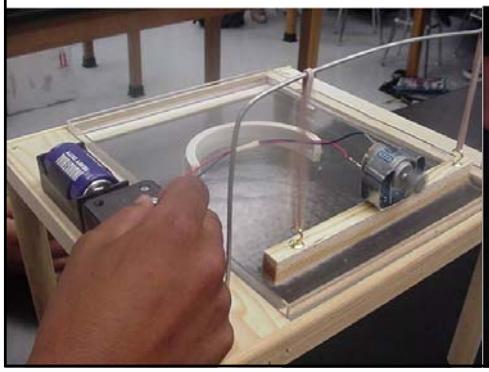
High Quality Curriculum

GRADE	LIFE	EARTH/SPACE	PHYSICAL	*Optional Units
K	KA **Myself and Others** (I)	KB **Sunshine & Shadows** (D)	KC **Wood** (FOSS)	
1	1A **Living Things** (I)	1B **Weather** (STC)	1C **Solids & Liquids** (STC)	1D **Senses** (I)
2	2A **Life Cycle of the Butterfly** (STC)	2B **Soils** (STC)	2C **Sink or Float** (D)	2D **Growing Things** (I)
3	3A **Brine Shrimp**	3B **Rocks and Minerals** (STC)	3C **Sound** (I)	3D **Amazing Air** (D)
4	4A **Microworlds** (STC)	4B **Land and Water**(STC)	4C **Electric Circuits** (STC)	4D **Food Chemistry** (STC)
5	5A **Ecosystems** STC)	5B **Solar Energy** (FOSS)	5C **Mixtures and Solutions** (FOSS)	5D **Motion and Design** (STC)
6	6A **Experiments with Plants** (STC)	6B **Measuring Time** (STC)	6C **Magnets & Motors** (STC)	* These units may be requested at any time with a minimum of two week notice to the Science Center. SMRC# 353-2860

High Quality Curriculum

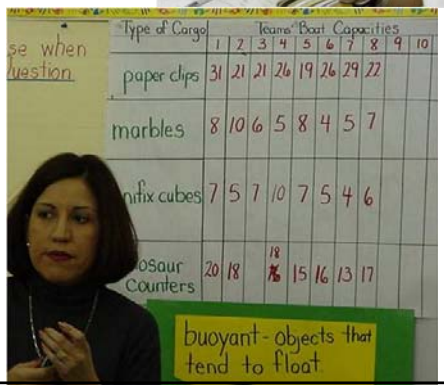
Middle School (STC)

- Weather and Water
- Micro – Macro
- Catastrophic Events
- Light
- Properties of Matter
- Energy, Machines and Motion



High Quality Curriculum

- Developmentally Appropriate
- Researched Based
- Leads to a “big idea” in Science
- Balanced
  - -Physical
  - -Earth
  - -Life
- 4 Units Per Year



High Quality Curriculum

Provides Opportunities to:

- Explore
- Investigate
- Inquire
- Question
- Test Hypothesis
- Collect Data
- Analyze Data

Sustained Professional Development

- University Level - Preservice
- School District Level-100 hours minimum
  - Initial Training
  - Advanced Training
  - Study Groups
  - Institutes
  - Debriefing
- In-classroom Support
- Leadership
- Advanced Degrees

Materials Support

- SMRC
- VIPS Offices
- Training Center
- Materials Center

Materials Support

- Materials Center
  - -Order
  - -Manufacture
  - -Inventory
  - -Refurbish
  - -Deliver
- Cost Sharing

Materials Support

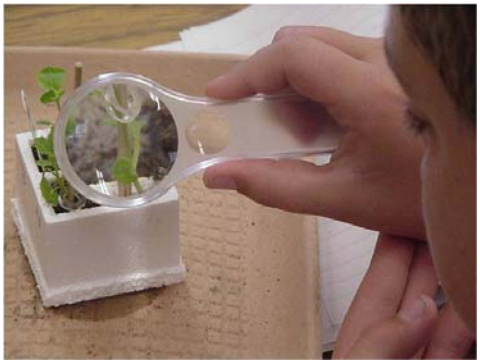
- Materials Center Staffing
  - Director
  - 2 Media Technicians
  - Administrative Clerk

Administrative and Community Support

- Vertical Team
- Administrative Training
- Science Volunteers
- Parent Education
- Periodicals

Administrative and Community Support

- Vertical Team
  - Superintendents
  - Central Office
    - Curriculum and Instruction
    - Business Services
  - Principals
  - Science Director
  - Business and Industry
  - University
- Decisions by Consensus



Administrative and Community Support

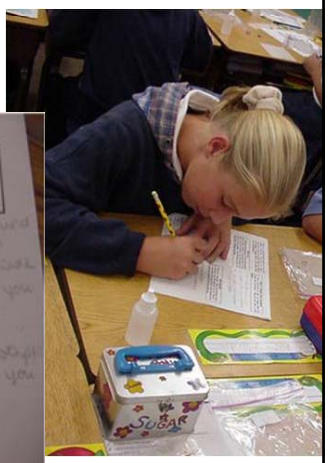
- Administrator Training
  - -Content
  - -Pedagogy
  - -Classroom Supervision
  - -Teacher Evaluation
  - -Assessment

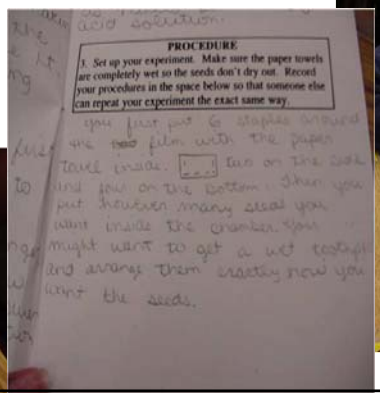
Administrative and Community Support

- Volunteer Scientists in El Centro come from
  - Cal Tech
  - Agriculture
  - Veterinarians
  - Pharmacists
  - El Centro Regional Medical Center
  - San Diego State University
  - University of California
  - Water and Power Company
  - El Centro Naval Air Station
  - Union Pacific Mining
  - Imperial County Sheriff's Dept

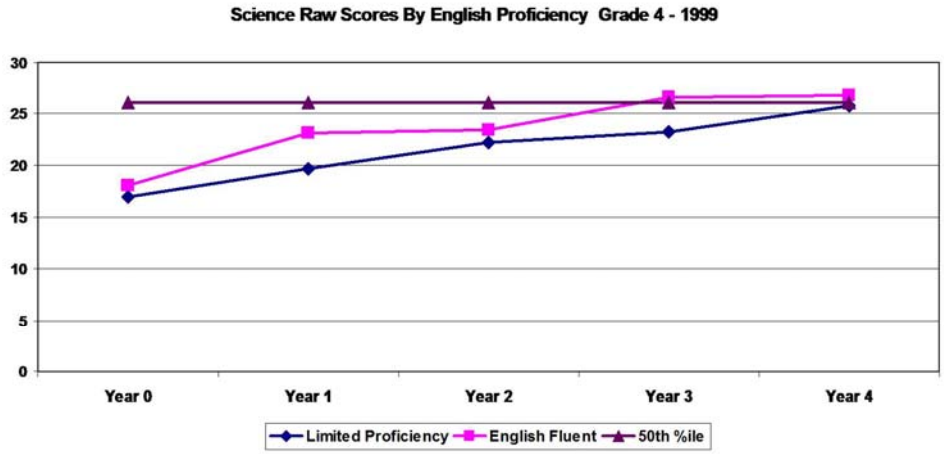
Assessment and Evaluation

- Performance Tasks/Products
- Standardized Tests
- Notebooks





Student Achievement



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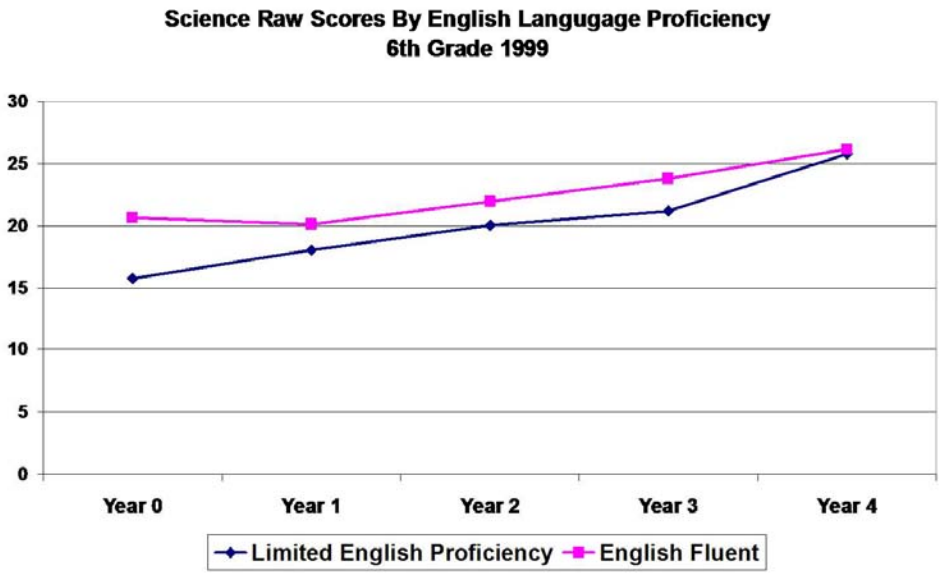

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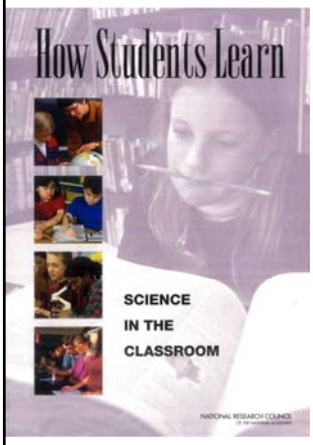

- Engage to activate prior knowledge
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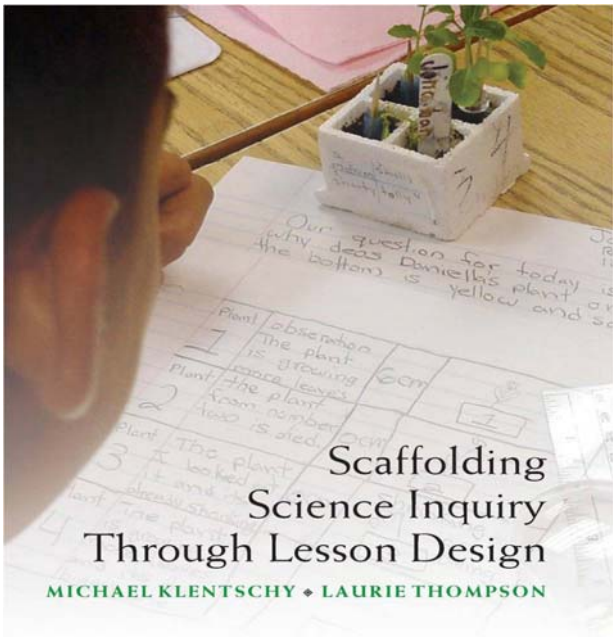
More Research to Consider

- Students benefit from strong scaffolding with respect to building explanations from evidence (Songer and Lee, 2003)
- Questioning, predicting, clarifying, and summarizing are strengthened through scaffolding. Clarifying promotes comprehension monitoring. Students benefit from scaffolding when analyzing data and building explanations from evidence.
  (Hug, Krajcik and Marx, 2005)
- A process of scaffolded inquiry, reflection and generalization developed students' metacognitive knowledge. (White and Fredrickson, 1998)

- Writing may force the integration of new ideas and relationships with prior knowledge and encourage personal involvement with the new information (Kleinsasser, et al, 1992)
- Written and oral language opportunities to explain, describe, predict and integrate new information allow students to make conceptual shifts and facilitate retention (Fellows, 1994)

Strengthening Lesson Planning



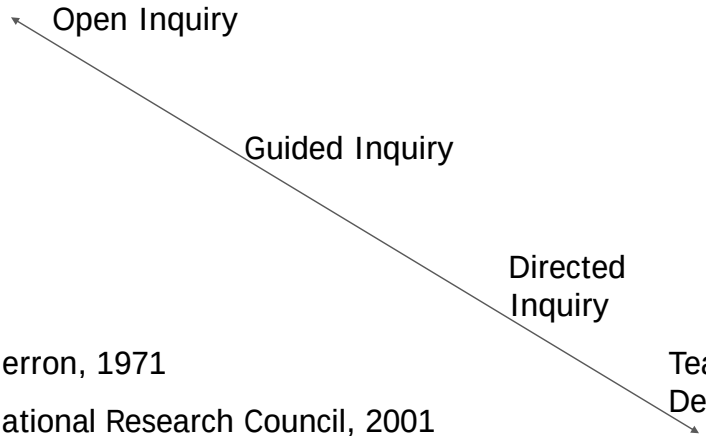
Scaffolded Guided Inquiry

Not Aligned

Aligned

Based on Marzano (2001)

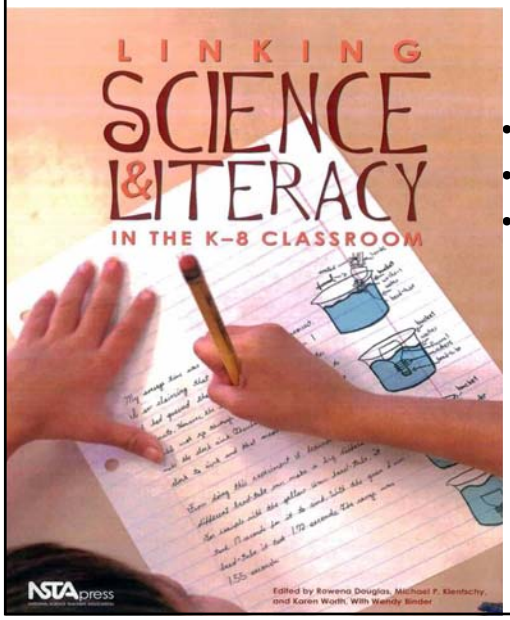
Scaffolded Inquiry



Herron, 1971

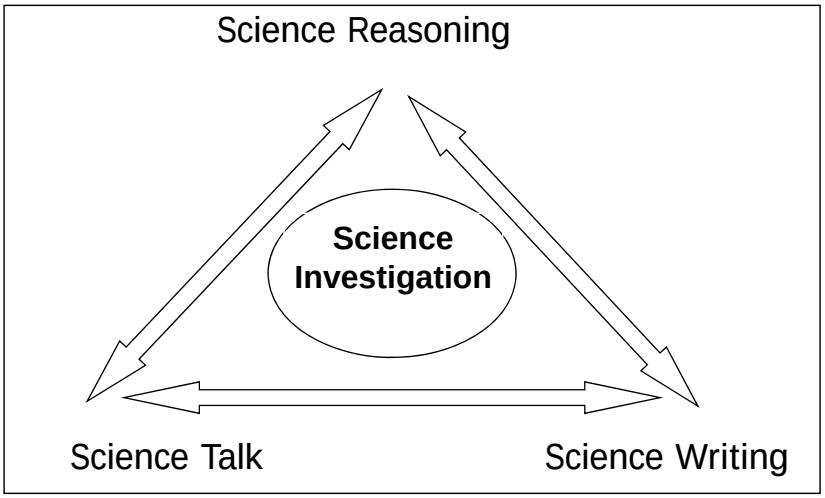
National Research Council, 2001

Science-Literacy Connection

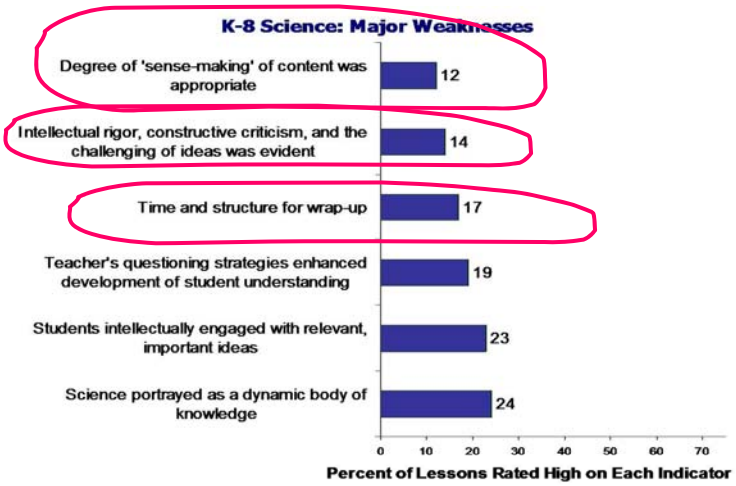


- Best Practices
- Research-Based Strategies
- Lessons Learned

Science Inquiry

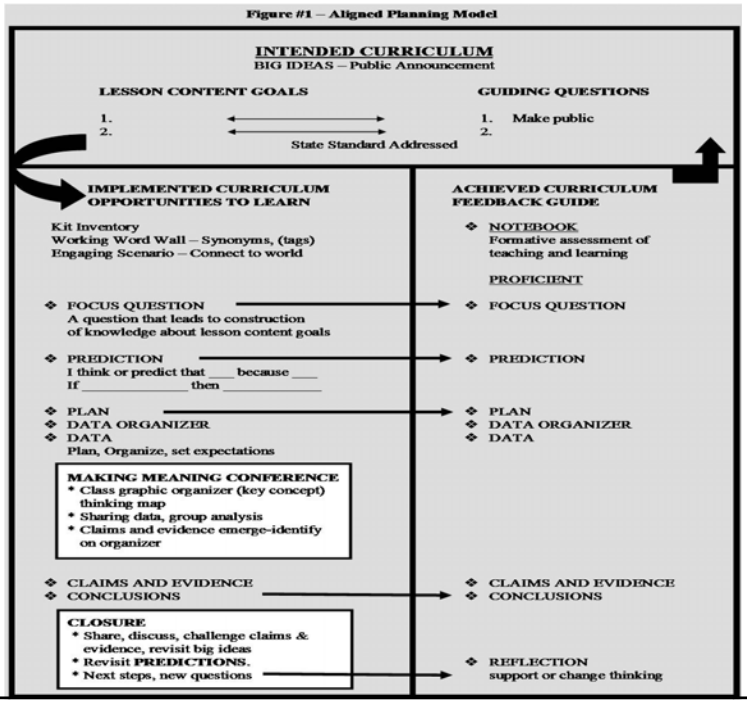


Worth, 2008



Horizon RESEARCH, INC.

Figure #1 – Aligned Planning Model



Implemented Curriculum

PHASE ONE: Setting the Stage for Learning

- Kit Inventory
- Vocabulary Development
- Working Word Wall

PHASE TWO: Formulating Investigable Questions and Predictions

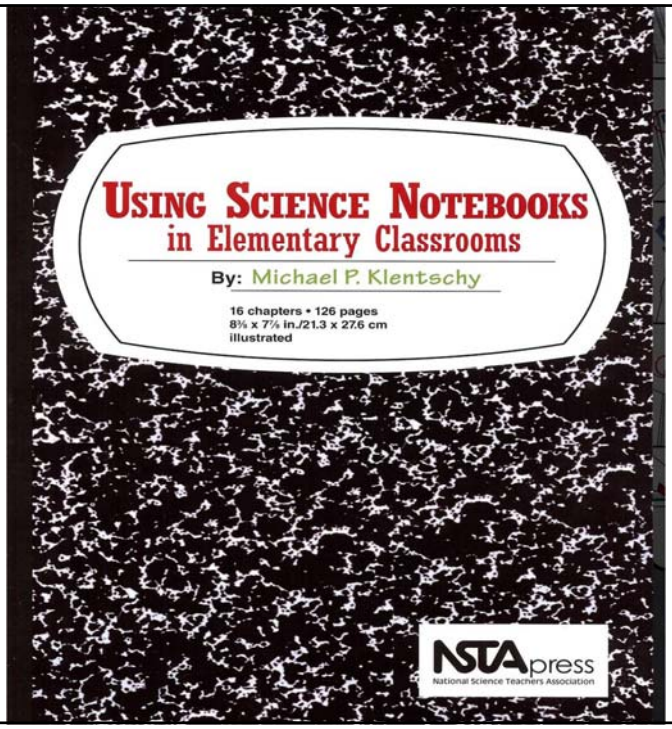
- Engaging Scenario
- Focus Question – Notebook Entry
- Prediction – Notebook Entry

PHASE THREE: Planning and Conducting the Investigation

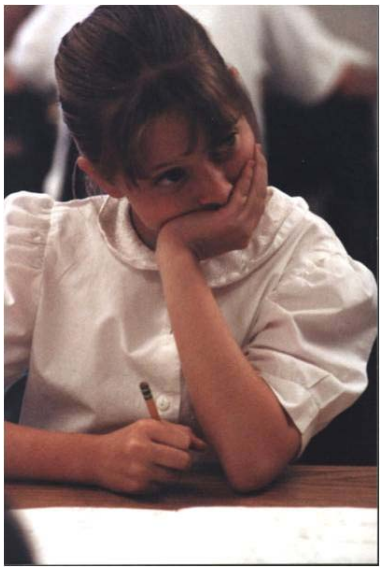
- Planning and Organizing – Notebook Entry
- Data Organizer – Notebook Entry
- Investigating and Entering Data – Notebook Entry

PHASE FOUR: Making Meaning

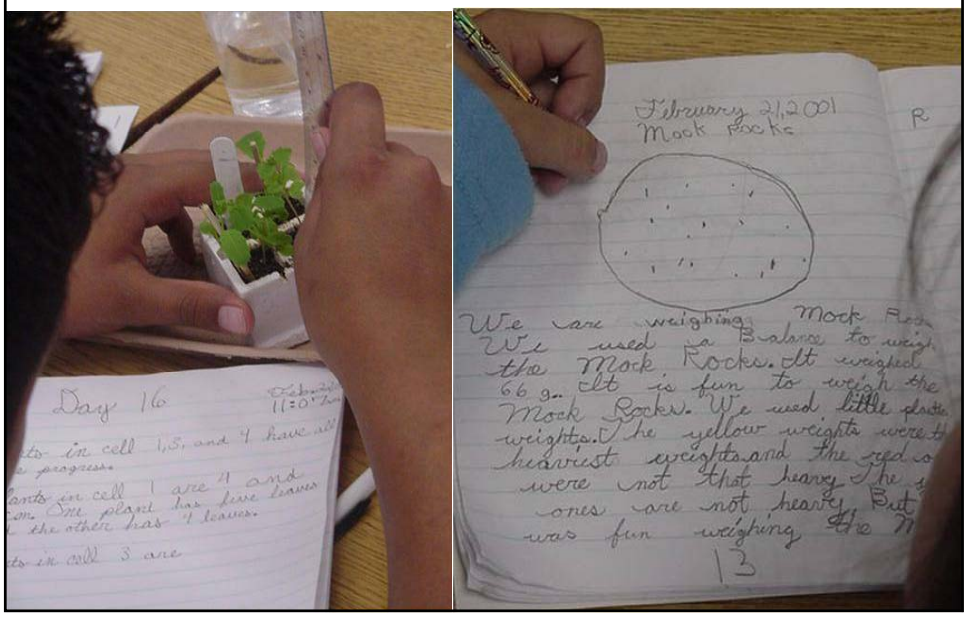
- Making Meaning Conference – Discussion/Analysis
- Writing Claims and Evidence – Notebook Entry
- Writing Conclusions – Notebook Entry
- Reflection – Notebook Entry


Using Science Notebooks
in Elementary Classrooms
By: Michael P. Klentschy
16 chapters • 126 pages
8⅜ x 7⅛ in./21.3 x 27.6 cm
illustrated
NSTApress
National Science Teachers Association

- Notebooks



What should a science notebook contain?



Components and Criteria

- Question/Problem/Purpose
- Prediction
- Planning
  - Data Collection Device
- Data/Observations
- Claims, Evidence, Reasoning
- Conclusions
- Next steps/New questions

Recent Evidence

In a study with more than 1200 5th graders using a process of scaffolded guided inquiry with embedded writing strategies experimental group students significantly outperformed the control group who received regular instruction using just kits and just testbooks on posttest, state science standards scores and writing scores.

- **EL closed achievement gap with EO students in experimental group**

At a middle school with 288 8th graders (99.7% Free and Reduced Lunch, 77.8% EL), a similar method was used. 63% of the students scored Proficient or Advanced on the 2006 administration of the California Science Standards Test.

(Vanosdall, Klentschy, Hedges and Weisbaum, 2007
(Klentschy and Thompson, 2008)

Recent Evidence

(Vanosdall, Klentschy, Hedges and Weisbaum, 2007
(Klentschy and Thompson, 2008)

Study 1 – Exp-Control SGI vs Text (Gain 42 %ile)	Effect Sizes
California Science Standards Test	1.392
Mixture and Solutions Post Test	1.095
Study 2 – Exp-Control SGI vs Kits (Gain 36 %ile)	**Effect Sizes**
California Science Standards Test	1.137
Mixture and Solutions Post Test	1.043
Study 3 – Quasi Exp Kits vs Text (Gain 12 %ile)	**Effect Sizes**
California Science Standards Test	0.320
Mixture and Solutions Post Test	0.408

Implications

- Project design which develops a local and regional K-16 collaborative partnership between districts, business, volunteer scientists and the university
- Project design which is data driven
- Project design resulted in improved student achievement in science and other core areas of the curriculum

Thank you

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if you have any questions.