Reform at the District Level: A Case Study in Science

American Association for the Advancement of Science

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Closing the Student Performance Gap in Science, Math, Reading and Writing through Active Science Teaching
A Field Trip to El Centro, California
Case Study Critical Questions

- What is the context?
- What is the infrastructure?
- What is the evidence?
- What are the implications?
Context

- Need
- Our Region
- Our Community
- Our Students
Where is El Centro?
Our Community and Students

- Mean income $16,322
- Poorest of all 58 counties in California
- 30% unemployment rate
- 36,000 students in 14 participating Districts

In El Centro
- 6,500 K-8 students
- 11 Title I, School-wide Project Schools
- 73% Free/Reduced Lunch
- 51% English Language Learners
- 10% Migrant
- 81% Hispanic, 12% Caucasian,
- 4% African-American, 3% Asian
Five Critical Elements for Reform

- High Quality Curriculum
- Sustained Professional Development
- Materials Support
- Administrative and Community Support
- Assessment and Evaluation
<table>
<thead>
<tr>
<th>GRADE</th>
<th>LIFE</th>
<th>EARTH/SPACE</th>
<th>PHYSICAL</th>
<th>*Optional Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>KA Myself and Others (I)</td>
<td>KB Sunshine &amp; Shadows (D)</td>
<td>KC Wood (FOSS)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1A Living Things (I)</td>
<td>1B Finding the Moon (D)</td>
<td>1C Solids &amp; Liquids (STC)</td>
<td>1D Senses (I)</td>
</tr>
<tr>
<td>2</td>
<td>2A Life Cycle of the Butterfly (STC)</td>
<td>2B Soils (STC)</td>
<td>2C Sink or Float (D)</td>
<td>2D Growing Things (I)</td>
</tr>
<tr>
<td>3</td>
<td>3A Brine Shrimp</td>
<td>3B Earth Materials (FOSS)</td>
<td>3C Sound (I)</td>
<td>3D Amazing Air (D)</td>
</tr>
<tr>
<td>4</td>
<td>4A Microworlds (STC)</td>
<td>4B Solar System (D)</td>
<td>4C The Mysterious Powder (I)</td>
<td>4D Changes of State (I)</td>
</tr>
<tr>
<td>5</td>
<td>5A Bones &amp; Skeletons (I)</td>
<td>5B Solar Energy (FOSS)</td>
<td>5C Circuits &amp; Pathways (I)</td>
<td>5D Reading the Environment (I)</td>
</tr>
<tr>
<td>6</td>
<td>6A Experiments with Plants (STC)</td>
<td>6B Measuring Time (STC)</td>
<td>6C Magnets &amp; Motors (STC)</td>
<td></td>
</tr>
</tbody>
</table>

* These units may be requested at any time with a minimum of two week notice to the Science Center. SMRC#: 353-2860
Description of Assessment: Post unit assessment includes revisiting list from lesson 1; Self-evaluation; Evaluating student work (e.g. Science Notebook)

Science Process Skills: Observing, Questioning, Comparing, Communicating, Interpreting, Relating, Predicting, Inferring, Applying, Organizing

National Science Standards: 5-8 Life Science; History and Nature of Science; Science as Inquiry

California Science Standards: Investigation and Experimentation 7a-c

Unifying Concept: Systems, Order, and Organization; Evidence, Models, and Explanation; Constancy, Change, and Measurement; Evolution and Equilibrium; Form and Function

Big Idea: Science experiments include variables (conditions that change) and controls (conditions that remain constant). In a controlled experiment, only one variable is changed. Variables for the optimal growth of *Wisconsin Fast Plants* include continuous water and cool light, fertilizer, space, cross-pollination, and temperature between 70º F and 80º F.

Sub Concept I: Experiments Part 1
A good experiment is like a “fair test,” during which only one variable is tested at a time.

Sub Concept II: Plants Part 1
Pollination allows fertilization and seed production to take place.

Sub Concept III: Experiments Part 2
Conclusions from an experiment are based on careful record keeping.

Sub Concept IV: Plants Part 2
Germination is the beginning of new growth from a seed.

Sub Concept V: Plants Part 3
Tropism is the growing or bending of a plant in response to external stimulation.
High Quality Curriculum
Using what we know
High Quality Curriculum

♦ Developmentally Appropriate
♦ Researched Based
♦ Leads to a “big idea” in Science
♦ Balanced
  ♦ Physical
  ♦ Earth
  ♦ Life
♦ 3-4 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 - Inservice 100 hours minimum
  ♦ Initial Training
  ♦ Advanced Training
♦ Study Groups
♦ Institutes
♦ Debriefing
♦ In-classroom Support
♦ Leadership
♦ Advanced Degrees
Professional Development Design

Context

Set Goals

Plan

Do

Reflect

Critical Issues

Knowledge & Beliefs

15 Strategies

Loucks-Horsley (1998)
School District Level Inservice
100 Hours Minimum

- Initial Training
- 2 Year Sequence
- Two Units Each Year
- Grade Level Teams
- Led by
  - Leadership Teachers
  - Scientist Volunteers
  - VIPS Staff
School District Level Inservice

- Advanced Content
- Training
- Study Groups
- Institutes
- Debriefing
- Literacy Links
- Assessment
School District Level In-Service
LessonLab
Valle Imperial Project in Science

- **VIPS Introduction**
  Teachers will receive an overview of VIPS program, curriculum, resources available, the role of resource teacher in the classroom and the university connection. (30-45 minutes)

- **Debriefing**
  Teachers will have the time to revisit VIPS units. They will have the opportunity to make any needed changes to improve the curriculum. These sessions can be organized by specific units, grade level (all units at a grade level), or by science strand (physical, life, earth). (1-3 hours)

- **Notebooks**
  Teachers will study examples of student’s science notebooks in order to establish and discuss common components of exemplary work and strategies for assessment. (1-3 hours)

- **Inquiry**
  **Part 1**
  Teachers will explore unusual phenomena to develop and advance the critical inquiry skill of questioning.

  **Part 2**
  Teachers will choose one of their questions developed in Part 1, and build an inquiry investigation around it.

- **Three Kinds of Hands-On Science**
  Teachers will experience and discuss three methods of teaching hands-on science using the medium of spinning tops. (3 hours)

- **Process Skills**
  Through hands-on experiences, teachers will identify and discuss the major science process skills. They will have an opportunity to share how these skills influence teaching and moving students toward further and deeper science understanding. (3-3 hours)

- **Standards**
  Teachers will learn about the VIPS units alignment to the National and California Science Standards. (30-45 minutes)

- **Writing Prompts**
  The inquiry-based hands-on activities of the VIPS program create numerous opportunities for students to write about their investigations and observations. Teachers will receive a list of suggested writing prompts for each of the VIPS units. (30-45 minutes)

The following will be available during Spring 2001

- **ELD-Language Acquisition**
  Teachers will have the opportunity to acquire teaching strategies in integrating ELD and VIPS units.

- **Math Integration**
  Teachers will have the opportunity to acquire teaching strategies in integrating Math and VIPS units.

- **Assessment Performance**
  Teachers will have the opportunity to learn the processes of implementing, scoring, calibrating, and assuring the reliability of performance and embedded science assessment.

- **Literature Integration**
  Teachers will have the opportunity to review literature that can be integrated into the VIPS science units. Literature lists and additional resources compiled by VIPS staff and county educators will be made available.

Valle Imperial Project in Science

Science & Math Resource Center
2370 Main Street
El Centro, CA 92243
Phone: (760) 353-2860
Fax: (760) 352-6429
www.ecsd.k12.ca.us/vips
School District Level Inservice

In-classroom Support
School District Level Inservice
Leadership Development
Curriculum Support

- Curriculum Support
- Curriculum Integration
- Monthly Networking
Institutes and Seminars

- Facilitation/presentation skills
- Change management
- Deepen content understanding
- Language institute
  - Academic content language
  - ELD strategies
- Assessment institute
  - Examining student work
  - Performance tasks
- Immersion in inquiry
Building Capacity

Lesson Study Teacher Leadership Cadre

- Grade Level Team
- Facilitated by Science Resource Teacher
University Level Preservice

Coordinated Experiences

- Content
- Pedagogy
- Student Teaching
- Supervision
University Advanced Degrees

Masters in Science Education

- Curriculum
- Pedagogy
- Assessment
- Content
- Field Experiences
Materials Support

SMRC • VIPS Offices • Training Center • Materials Center
Materials Support

Training Center

- University Classes
- District Inservice
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

- Recruitment Strategies
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
Administrative and Community Support

Science Volunteers

• Training
Administrative and Community Support

Volunteer Scientists

- Content Consultant
- Validate the Curriculum
- Model Questioning
- Model Inquiry
- Community Advocates
Administrative and Community Support

Periodicals

**FLY AWAY HOME**

J.M. Detwiler Elementary School students Brian and Jessica's (right) and then Matthiessen, B. release a butterfly, no teacher knew.

**WRITE FOR SCIENCE**

Ana Rangel, 8, reads from a science book she wrote during a "We Write for Science" play Monday at De Anza Elementary School in El Centro. Ana's present was Monday, and her classmates wrote books on science themes such as brine shrimp, rockets, desert plants and rocks.
Administrative and Community Support

- Parent Education
- Family Science Nights
- School Board Meetings
Assessment and Evaluation

- Performance Tasks/Products
- Standardized Tests
- Notebooks
Evidence

- SAT 9
- Science-Literacy Connections
- Science-Mathematics Connections
# Assessment and Evaluation

## Stanford Achievement Test: Science Scores

**1998-99 NPR**

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<tr>
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<td>638</td>
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<td><strong>Mean NPR</strong></td>
<td>36</td>
<td>40</td>
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<td><strong>Participating</strong></td>
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## Assessment and Evaluation

### Stanford Achievement Test: Science Scores

1998-99 NPR - Sorted by Years in Program

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<tr>
<th>Years</th>
<th>Gr4</th>
<th>Gr6</th>
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<td>53</td>
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<td>n=91</td>
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</table>
Student Achievement
Science Raw Scores By English Proficiency  Grade 4 - 1999

Limited Proficiency
English Fluent
50th %ile
Student Achievement

Science Raw Score By Gender  Grade 4 - 1999

Year 0  Year 1  Year 2  Year 3  Year 4

Female  Male
Student Achievement

Science Raw Score By Gender  Grade 6 - 1999
A Model of a Student’s Cognitive Process: Glynn and Muth (1994)
Science/Literacy

Chapter 10

Focus on:

- Coherence
- Context
- “Real World” Experiences
School and Classroom Libraries
Trade Books
<table>
<thead>
<tr>
<th>Years</th>
<th>LEP</th>
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Evidence from El Centro, California

Stanford Achievement Test: Reading Scores
1998-99 NPR – Grade 6 Sorted by Years in Program

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<td>32</td>
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<tr>
<td>3</td>
<td>35</td>
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<tr>
<td>4</td>
<td>51</td>
<td>69</td>
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</table>
Science and Mathematics
February 21, 2001
Mock Rocks

We are weighing Mock Rocks.
We used a Balance to weigh the Mock Rocks. It weighed 66 g.
It is fun to weigh the Mock Rocks. We used little plastic weights. The yellow weights were the heaviest weights and the red ones were not that heavy. The green ones are not heavy. But weighing the 2...
Science and Mathematics
Evidence from El Centro, California
Stanford Achievement Test: Mathematics Scores
1998-99 NPR – Grade 4 Sorted by Years in Program

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<td>3</td>
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<td>4</td>
<td>48</td>
<td>60</td>
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</table>
Evidence from El Centro, California

Stanford Achievement Test: Mathematics Scores
1998-99 NPR – Grade 6 Sorted by Years in Program

<table>
<thead>
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<th>Years</th>
<th>LEP</th>
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</tr>
</thead>
<tbody>
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<td>CUM = 53</td>
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<tr>
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<td>28</td>
<td>30</td>
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<td>63</td>
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<td>3</td>
<td>59</td>
<td>63</td>
</tr>
<tr>
<td>4</td>
<td>74</td>
<td>81</td>
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</tbody>
</table>
Assessment and Evaluation

Notebooks
What should a science notebook contain?

Day 16
February 21, 2001
Mock Rocks

We are weighing the Mock Rocks. We used a balance to weigh the Mock Rocks. It weighed 66.9 g. It is fun to weigh the Mock Rocks. We used little plastic weights. The yellow weights were the heaviest weights and the red ones were not that heavy. The green ones are not heavy. But it was fun weighing the Mock Rocks.
Components and Criteria

- Question/Problem/Purpose
- Prediction
- Planning
- Data/Observations
- What have you learned?
- Next steps/New questions
What Others Have to Say

“Writing provides a status of our thoughts and forces us to grapple with what we know and what we don’t know.”

Santa and Havens (1991)

“If you cannot – in the long run – tell someone what you have been doing, your doing has been worthless.”

Nobel laureate Edwin Schrödinger (1951)
Prediction

5-29-01

My prediction what happened

The ball went further each time.

Kindergarten,
Whittier City
Balls & Ramps - Insights
Question, Problem, Purpose

Which string had the highest pitch? - the lowest pitch?

Highest: fishing line
    : floss
    : string

lowest: yarn

Today I learned that tighter the string was, pulled the higher the pitch. And the looser the string, the lower the pitch.

Tension - how tight or loose string is
Identifying Variables and Planning a Fair Test

The one variable we will test is space. The controlled plants will plant one seed, and the experimental plant will plant two seeds.

We will keep the variables of light, water, fertilization, and temperature. The special equipment we need are extra: seeds. We will count how many leaves and flowers the two plants have. We will observe which plant has grown more leaves and flowers than the other, and compare the numbers. My hypothesis is that the controlled plants will grow more leaves and flowers than the experimental plant because the experimental plant has two seeds, and there will not be enough fertilizer and/or the plants will overcrowd possibly causing them to die. We have chosen the experimental plants.
Measuring Time

Grade 6
Data/Observation
STC – Measuring Time, Grade 6

[Image of a hand-drawn sketch of a mechanical device with annotations like "wheel", "bushing", "blue rod", "grooved wheel", "post", "towel", "red rod", "cloth pulley", "wheels", "bearing", "18cm purple rod", "end cap", "base", and "ball (with bottle in it)".]
What Have You Learned?

STC – Measuring Time
Grade 6

Clock Escapement
9:00 am 6/12/01

1. How does the escapement work?*

1. Weight pulls the crank counter-clockwise

2. Crank hits clothespins

3. Clothespins are attached to the pendulum so the pendulum moves back and forth so the crank can move

* Ticking is made by the crank hitting the clothespins
3-17-99

What's inside a seed?
toothpicks, paper towels, hand lens, dry lima bean, presoaked lima bean.

Today we saw two parts of lima beans. Today we tore off the coat of the outside lima bean. Today we saw two different kinds of lima bean. One was hard and the other one was soaked because it was in water.

I found out that lima beans had little seeds. I found out that the seeds were different. I found out that the seeds were different colors and shapes. I found out that the seeds don't just grow into a plant.

Do all plants grow into a flower?
A motor needs electricity, magnetism and a special switch in order to function.

Today we made motors. I learned that one magnet has to repel and one has to attract in order for the motor to work. My motor did not work, but it moved and spun half way at one time. I wonder would two batteries make my motor spin? The question I have is does it need more power?
Other Interesting Things
Assessment and Evaluation

Notebooks

Today we learned that size doesn't matter. What matters is the material.
2-2-98
2:54

Today was the saddest day in my life. I had to kill half of my plants.

Here is one of the plants.

[Hand-drawn plant illustration]
<table>
<thead>
<tr>
<th>Elements and Criteria</th>
<th>NA</th>
<th>Not present</th>
<th>Lacking</th>
<th>Meets</th>
<th>Exceeds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Big Idea</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Question Purpose</strong></td>
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<td></td>
</tr>
<tr>
<td>Student generated; in own words/</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Relates to purpose/Big Idea'</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Clear and concise</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Investigable</td>
<td></td>
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<tr>
<td><strong>Prediction</strong></td>
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<tr>
<td>Connects to prior experience</td>
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<tr>
<td>Is clear and reasonable</td>
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</tr>
<tr>
<td>Relates to question</td>
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<tr>
<td>Gives an explanation/reason</td>
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<tr>
<td><strong>Planning</strong></td>
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</tr>
<tr>
<td>Relates to investigable question</td>
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</tr>
<tr>
<td>Has clear sequence/direction</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Identifies variables/control</td>
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</tr>
<tr>
<td>Includes data organizer</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>States materials needed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data/Observations</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Relates to question and plan</td>
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<tr>
<td>Includes student generated drawings, charts, graphs, narrative</td>
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<tr>
<td>Organized</td>
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<tr>
<td>Accurate</td>
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<tr>
<td><strong>What Have You Learned?</strong></td>
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<td>Student generated: in own words</td>
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<tr>
<td>Clear statement of what was learned</td>
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<td>Based on question/planning/evidence</td>
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<td>Reflective</td>
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<tr>
<td>Shows rigor in thinking</td>
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<tr>
<td><strong>Next Steps/New Questions</strong></td>
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<td>Student generated</td>
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<td>Extension/new application of original question</td>
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<td>Researchable or investigable</td>
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<tr>
<td>WOW factor</td>
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<tr>
<td>Can be recorded throughout</td>
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<td><strong>Remarks/Considerations</strong></td>
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<tr>
<td>Creativity in Evidence</td>
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<tr>
<td>Growth over time (process and content)</td>
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</tbody>
</table>
Chapter 8

Importance of:
- feedback
- goal setting

Impact on achievement
District Writing Proficiency
Grade 6
Spring 1999 Results

Cumulative Pass 64%
   n=636

Participating Classes 82%
   n=357

Non Participating Classes 41%
   n=279
## Assessment and Evaluation

### District Writing Proficiency

#### Grade 6 Spring 1999

<table>
<thead>
<tr>
<th>Years</th>
<th>%Pass</th>
<th>n</th>
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<tbody>
<tr>
<td>0</td>
<td>23%</td>
<td>174</td>
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<tr>
<td>1</td>
<td>68%</td>
<td>119</td>
</tr>
<tr>
<td>2</td>
<td>71%</td>
<td>132</td>
</tr>
<tr>
<td>3</td>
<td>90%</td>
<td>107</td>
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<tr>
<td>4</td>
<td>89%</td>
<td>104</td>
</tr>
</tbody>
</table>

Cumulative Pass: 64%  n=636
Implications

- Project design which develops a local and regional K-16 collaborative partnership between districts, business, volunteer scientists and the university.

- How can you develop similar partnerships to enhance teacher professional development and community support?
Implications

- Project design which is data driven
- How are you prepared to collect and use data to drive your decisions regarding teacher enhancement and student performance in your project?
Implications

- Project design resulted in improved student achievement in science and other core areas of the curriculum.

- How does your project plan for the integration of science and other core areas without sacrificing the science content?
This work is supported, in part, by National Science Foundation Grant #ESI-9731274. The opinions expressed in this work are those of the authors and not necessarily those of the National Science Foundation.