Science Education with English Language Learners

Okhee Lee
University of Miami

Purpose of Presentation

- To describe *P-SELL* as an example of research-based intervention
- To synthesize research literature on science education with ELLs

Promoting Science among ELLs

University of Miami
National Science Foundation ESI 035331

http://www.education.miami.edu/psell/

Goals

- A 5-year research and development project funded by the National Science Foundation
- Explores effective ways for elementary school teachers to teach science to all students, especially ELLs, from grades 3 through 5
- Supports English literacy and math
- Helps ELLs to perform well on high-stakes science tests at grade 5

P SELL
An NSF Funded Program

Setting

6 elementary schools in treatment and sustainability group

3 elementary schools in replication group

6 elementary schools in comparison group

Schools were selected based on three criteria:

1. Percentage of ELL students (Spanish or Haitian Creole) above the district average (24%)
2. Percentage of students on free and reduced lunch programs above the district average (72%)
3. School grades of C or D according to the state's accountability plan

The research is testing two common assumptions:

1. Can ELLs learn academic subjects, such as science, while also developing English proficiency?
   – *YES*

2. Can ELLs, who learn to think and reason scientifically, also perform well on high-stakes science tests?
   – *YES*

Achievement Data

- Project-developed assessments
  - science tests at grades 3, 4, and 5
  - reasoning interviews at grades 3, 4, and 5
  - writing test at grade 3
- High-stakes assessments
  - math (measurement strand) at grade 3
  - writing at grade 4
  - science at grade 5

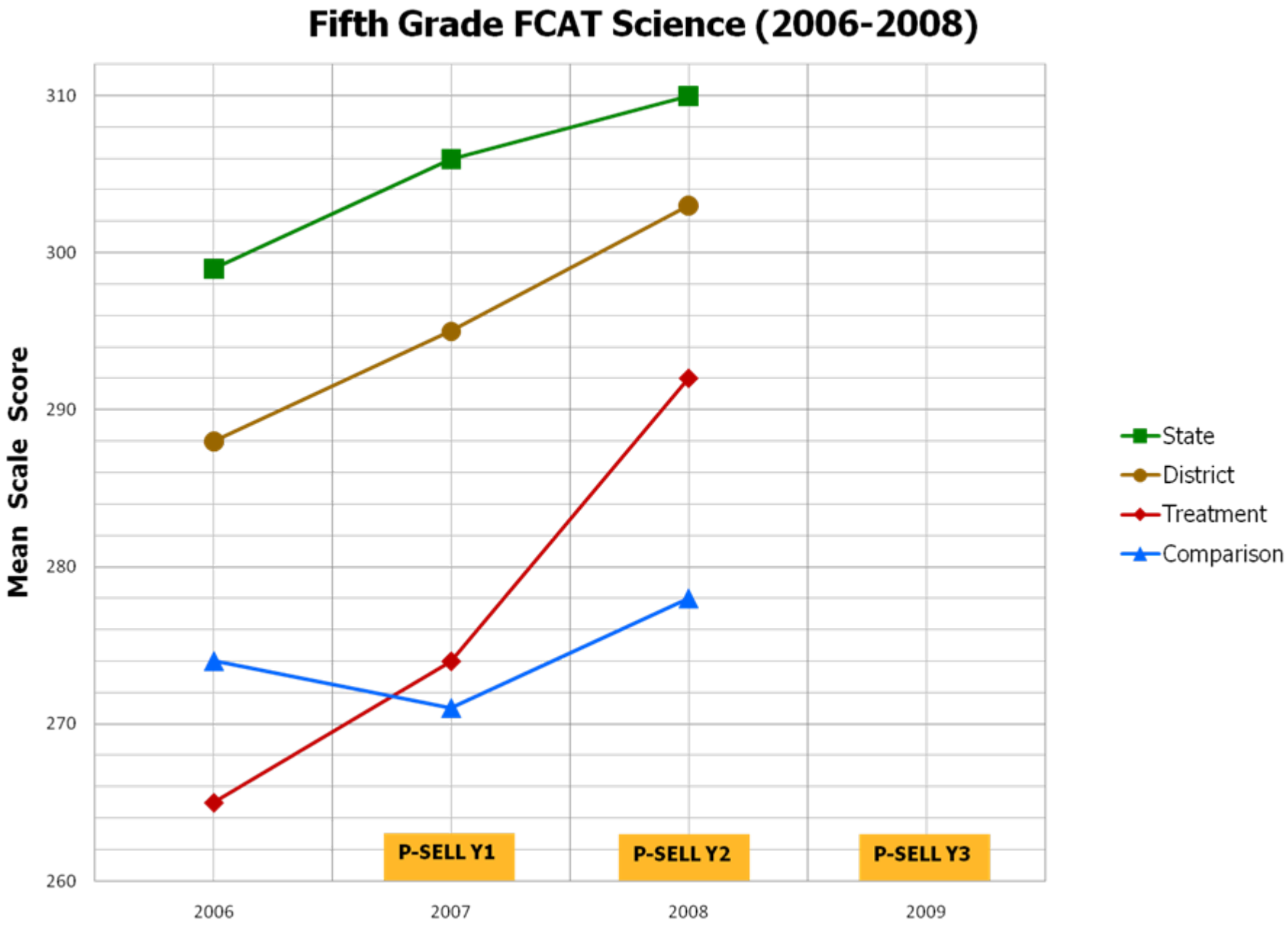
Achievement on Project-Developed Tests

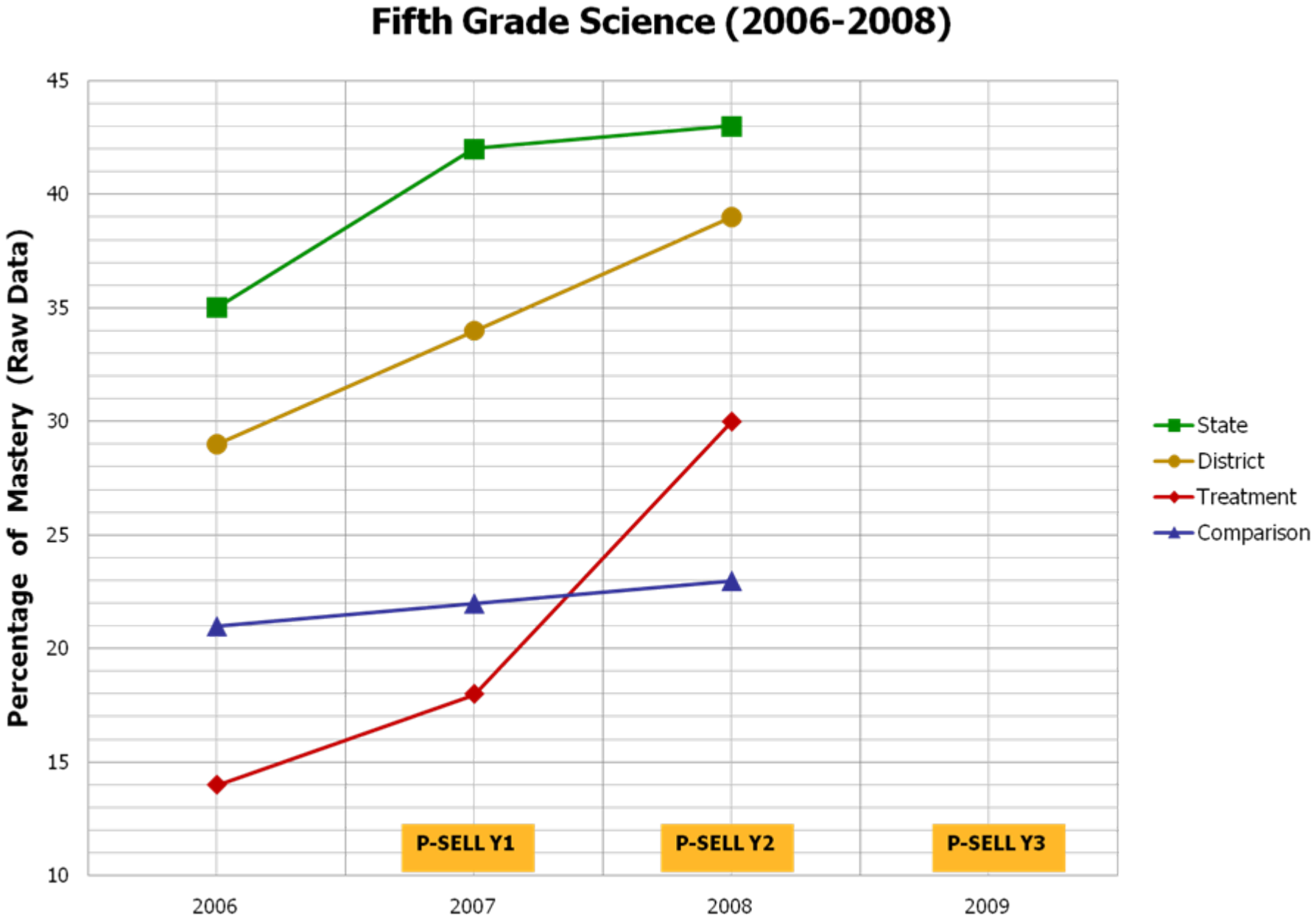
- Students at treatment schools displayed statistically significant increases (i.e., large effect sizes).
- Students currently enrolled in ESOL programs (ESOL levels 1 to 4) showed achievement gains comparable to ESOL-exited and non-ESOL students.
- Students during the monitoring period (ESOL level 5) performed the highest.

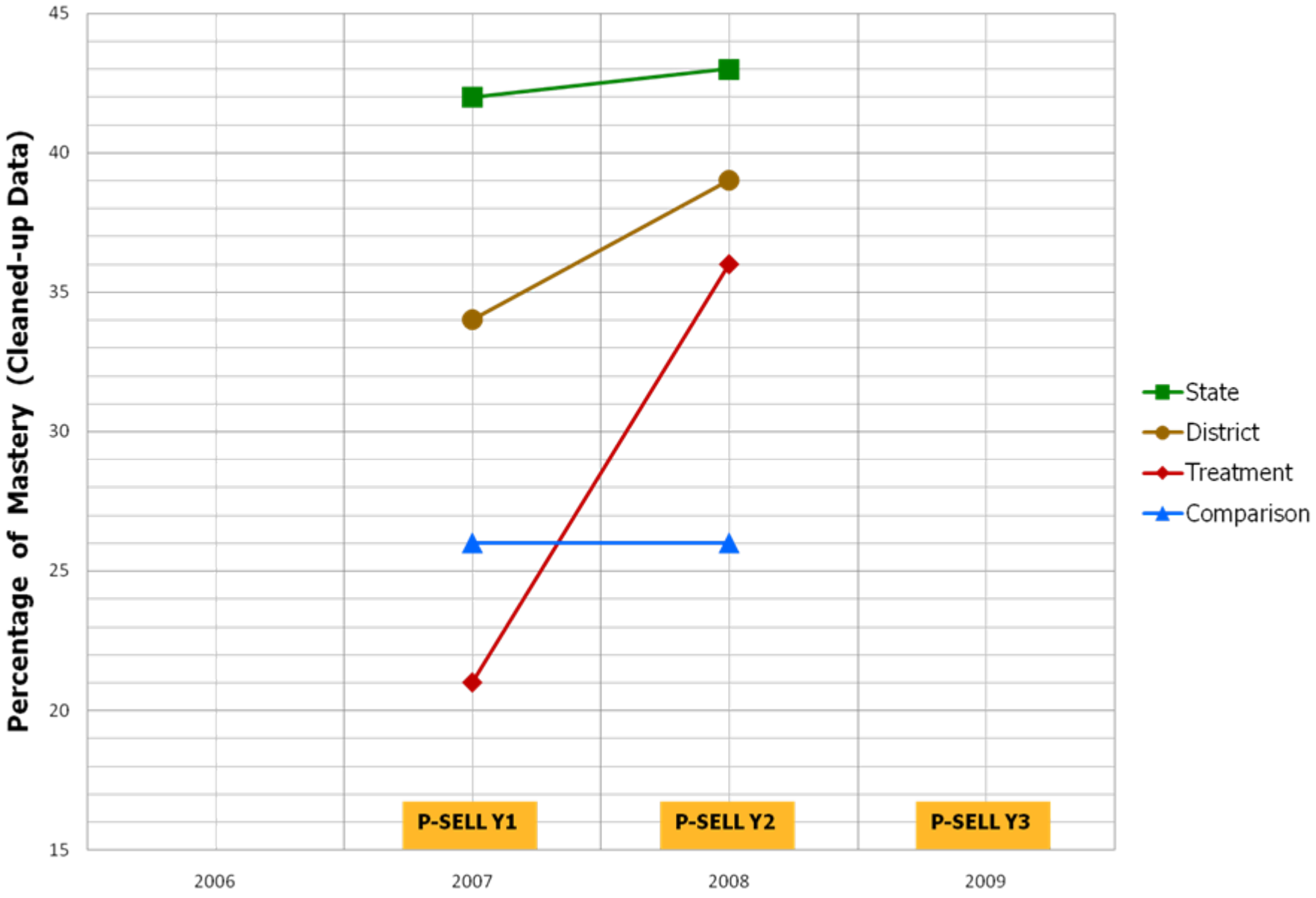
Achievement on High-Stakes Tests

Students at treatment schools showed higher scores than students at comparison schools on:

- the measurement strand of the math test at grade 3
- the writing test at grade 4, and
- the science test at grade 5 (see the charts).


Fifth Grade FCAT Science (2006-2008)
Mean Scale Score
310
300
290
280
270
260
2006
2007
2008
2009
P-SELL Y1
P-SELL Y2
P-SELL Y3
State
District
Treatment
Comparison


Fifth Grade Science (2006-2008)
Percentage of Mastery (Raw Data)
45
40
35
30
25
20
15
10
2006
2007
2008
2009
P-SELL Y1
P-SELL Y2
P-SELL Y3
State
District
Treatment
Comparison


Fifth Grade FCAT Science (2007-2008)
Percentage of Mastery (Cleaned-up Data)
45
40
35
30
25
20
15
2006
2007
2008
2009
P-SELL Y1
P-SELL Y2
P-SELL Y3
State
District
Treatment
Comparison

Published Online: September 29, 2008
Published in Print: October 1, 2008

Education Week

Finding the Language to Teach Science

Nathessa Petit-Frere, left, whose first language is Creole, gets help from Creole- and English-speaker Princiana Pierre, center, as English-speaker Kenyata Seide watches during Martina Perez's 4th grade science class at Gratigny Elementary School in Miami last week.
—Andrew Innerarity for *Education Week*

P SELL

An NSF Funded Program

Intervention:

Curriculum
Professional Development
Instruction

Curriculum Development

- P-SELL science curriculum for grades 3 through 5 covers all state science content standards in preparation for high-stakes science tests at grade 5.
- P-SELL provides class sets of:

  (1) student books,

  (2) teachers' guides, and

  (3) science supplies including trade books.

Teacher Professional Development

Workshops

- Year 1: five or six full-day workshops
- Years 2/3: three or four full-day workshops
- Year 4: no workshop and sustainability

Research Activities

- Teachers' participation in data collection activities fosters reflections on their knowledge and practices.

Targeted Areas

- Science focus
- Integration with
  - English language and literacy
  - Mathematics

ELL's Writing Sample

With a partner sitting next to you,

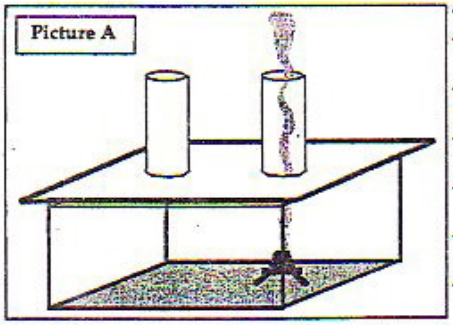
analyze writing sample (next slide) with regard to:

- what the student knows and is able to do in *science* and *English literacy.*

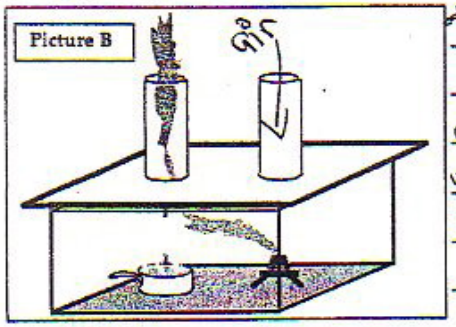
- what you will do to further enhance learning in *science* and *English literacy.*

5. Report and share the findings.

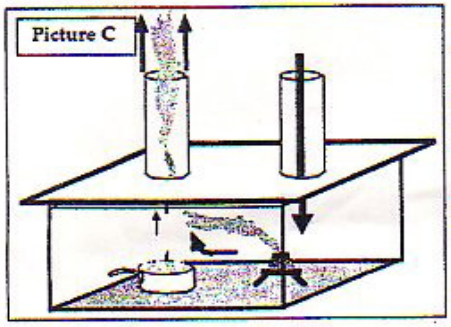
a. In your group, talk about the steps in the activity. Practice reporting these steps.
b. Write complete sentences to explain the events shown in the pictures.



I saw the smoke go up trough the right tub. because there was the heat sourse.



Then I saw that the smoke was going to the left with the stem. because cold air was going down from the right tub



Finally I saw air enter to righ tub and the smoke com binate with the stem to go up.
because the smoke cant not go up to the right tub because the air no se le permitio

(air didn't allow it)

Science

- Science content knowledge
- Science inquiry to promote science understanding

  - hands-on and minds-on (reasoning and application)

  - gradual shift from teacher-directed to student-initiated inquiry
- State science content standards

Inquiry Framework

1. Questioning

State the problem

- What do I want to find out? (written in the form of a question)

Make a hypothesis

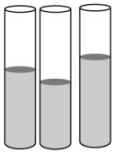
- What do I think will happen? (explain your reasoning)

2. Planning

Make a plan by asking these questions (think, talk, write)

- What materials will I need?
- What procedures or steps will I take to collect information?
- How will I observe and record results?

3. Implementing



Gather the materials

- What materials do I need to implement my plan?

Follow the procedures

- What steps do I need to take to implement my plan?

Observe and record the results

- What happens after I implement my plan?
- What do I observe?
- How do I display my results? (graph, chart, table)

4. Concluding

Draw a conclusion

- What did I find out? Check the most correct statement based on your data.
- Was my hypothesis correct or incorrect? (explain your reasoning)

5. Reporting

Share your results (informal)

- What do you want to tell others about the activity?

Produce a report (formal)

- What is the answer to the problem?

Inquiry Matrix

Inquiry levels	Questioning	Planning	Implementing	Concluding	Reporting
0	Teacher	Teacher	Teacher	Teacher	Teacher
1	Teacher	Teacher	*Students*	Teacher	*Students*
2	Teacher	Teacher	*Students*	*Students/ Teacher*	*Students*
3	Teacher	*Students/ Teacher*	*Students*	*Students*	*Students*
4	*Students/ Teacher*	*Students*	*Students*	*Students*	*Students*
5	*Students*	*Students*	*Students*	*Students*	*Students*

English Language & Literacy

- Literacy strategies for all students
- ESOL strategies
- Linguistic scaffolding
- Home language
- Home culture

Literacy Strategies for All Students

Incorporate reading and writing strategies

- Activate prior knowledge
- Promote comprehension of expository science texts
- Promote scientific genres of writing
- Connect science process skills (e.g., describe, explain predict, conclude, report) to language functions (e.g., explain, compare, contrast)
- Use graphic organizers (e.g., concept map, word wall, Venn diagram, KWL)

ESOL Strategies

Use language support strategies

- Use a small number of key terms in multiple contexts
- Promote hands-on inquiry
- Use realia (real objects or events)
- Encourage multiple modes of representations (gestural, oral, pictorial, graphic, textual)
- Use graphic devices (graphs, charts, tables, drawings, pictures)
- Promote precision in observing and describing objects and events through attention to positional words (above/below, inside/outside), comparative terms (e.g., hot, hotter, hottest), and affixes (e.g., *in*crease or *de*crease)

Linguistic Scaffolding

Reduce language load while maintaining the rigor of science content and process

- Adjust language load for students at varying levels of English proficiency
- Use language that matches students' communicative competence in length, complexity, and abstraction
- Communicate at or slightly above students' level of communicative competence (i.e., comprehensible input)
- Build students' understanding and discourse skills (e.g., from "it is foggy" to "water vapor condenses into little water drops")

Home Language

Use home language support

- Present science terms in multiple languages in the beginning of each lesson
- Use cognates (and highlight false cognates) in home language
- Allow code-switching
- Allow ELLs to discuss the lesson in class using their home language
- Encourage bilingual students to assist less English proficient students in their home language
- Allow ELLs to write about activities in home language

Home Culture

Incorporate the ways students' cultural experiences influence science instruction

- Build on students' lived experiences at home and in the community (i.e., funds of knowledge)
- Explore culturally-based ways students communicate and interact in their home and community (i.e., cultural congruence)
- Use students' cultural artifacts, culturally relevant examples, and community resources
- Use texts with content that is familiar to ELLs

Mathematics

- Measurement and instruments
- Recording and display of data using graphs, charts, tables, and drawings
- Analysis and interpretation of data

Research Synthesis

Lee, O. (2005). Science education and English language learners: Synthesis and research agenda. *Review of Educational Research, 75*(4), 491-530.

Big Ideas

Based on your experience and expertise, think about effective science instruction for ELLs.

- What do ELLs bring to the science classroom?
- What are effective classroom practices in teaching science for ELLs?

What ELLs Bring to Science

- ELLs bring to the science classroom cultural and linguistic experiences that can be used as intellectual resources.

- At the same time, ELLs bring cultural norms and practices that are sometimes discontinuous or in conflict with norms and practices of science.

Effective Classroom Practices

- Articulate ELLs' linguistic and cultural experiences with science disciplines:

  - when continuous, capitalize on students' thinking and knowledge as points of contact

  - when discontinuous, make norms and practices of science explicit and visible

Effective Classroom Practices (continued)

- Provide all students with academically rigorous curriculum.
- Engage students in hands-on, inquiry-based instruction to promote scientific understanding, inquiry, and discourse.
- Be aware of ELLs' differing needs when deciding how much explicit instruction to provide and how to guide students for their own learning.

Equitable Learning Opportunities

1. Value and respect ELLs' experiences from home and community
2. Articulate ELLs' linguistic and cultural knowledge with science disciplines
3. Provide academically rigorous curriculum and instruction
4. Offer educational resources