A Longitudinal Study of Integrating Literacy and Science for Fifth Grade Hispanic Current and Former English Language Learners: From \textit{Learning to Read} to \textit{Reading to Learn}.

Cindy Guerrero, M. Ed.
Fuhui Tong, Ph.D
Beverly J. Irby, Ed.D
Rafael Lara-Alecio, Ph.D

TABE 41th Annual Conference
Houston, TX
Oct. 11, 2013
Background

* Fast growing English language learners (ELLs)
  * 4.7 to 11.2 million between 1980 and 2009 (National Center for Education Statistics [NCES], 2011)

* Under-achievement of ELLs
  * 8th grade reading: 26% achieving at or above basic level, compared to 78% of non-ELLs
  * 8th grade science: 14% ELLs and 66% non-ELLs achieving at or above basic level (NCES, 2009, 2010)

* Challenge in reducing achievement gap and limited research on integration of science with reading for ELLs (Stoddart, Pinal, Latzke, & Canaday, 2002)
Huntley (1998), McCombs and Wang (1998): infusion of two content domains (i.e., math and science) at middle school mainstream classrooms.

In an *interdisciplinary* curriculum, there is one discipline that is of primary focus, with one or more other discipline that is of secondary focus to establish context so as to support the learning in the primary domain.

We purport that for ELLs, the integration between English language and reading literacy and science should be interdisciplinary at different grade levels.
Application of the Theory

* **Elementary Level**: English language/reading literacy as the primary focus; science embedded to support ELLs’ acquisition of reading skills—*learning to read*

  * ELLs learn complex language forms and functions through the access to science texts, engage in contextualized use of language in science inquiry, and enhance their conceptual capacity of the content topic of science (Pearson, Moje, & Greenleaf, 2010; Santu, Maerten-Rivera, & Huggins, 2011).

* **Secondary Level**: focus shift to science inclusive of English reading literacy strategies—*reading to learn*

  * Such a focus requires the accurate use of academic language so that students can conduct scientific inquiries, construct theoretical explanations of the natural phenomenon, and communicate scientific principles and procedures (Fang & Wei, 2010).
Integration at Elementary Grades

- Cummins (1981, 1984) BICS, CALP
- Krashen’s (1985) comprehensible input hypothesis and acquisition learning hypothesis
- *Academic language*: related to the content area of science, including (a) making inferences from incomplete evidence, (b) clarifying ambiguities, (c) making and recording predictions and observations, (d) designing experiments, (e) creating perspective-based writing/post-cards/newspaper articles/journals/reports, (f) reflecting on science concepts, and (g) synthesizing information.
Integration at Elementary Grades

• Limitation in teaching ELLs

Separation of language skills from content area academic language (Greenleaf & Hinchman, 2009; Snow, Met, & Genesee, 1989) preventing ELLs’ access to rigorous subject matter instruction and specialized academic language (Lee, Lewis, Adamson, Maerten-Rivera, & Secada, 2008), perpetuates little growth (Lee & Spratley, 2010), and deprive students’ opportunities to learn in other academic subjects, particularly, in science (McMurrer, 2007).

• Recommended practice

• effective literacy practice for ELLs should begin in early elementary grades for the development of specific skills in learning to read

• reading interventions for ELLs should be systematic, structured, intensive, content-oriented, and interactive (Linan-Thompson & Hickman-Davis, 2002, Tong et al., 2008)
Integration at Intermediate Grades

• Bybee (1996): scientific literacy

• Ruiz-Primo, Shavelson, Hamilton, and Klein (2002): science achievement

• We propose that achievement in science is related to the educational experience in language learning classrooms such as bilingual/English as second language; therefore, both instruction and curriculum matter.

• We also suggest that for ELLs that science achievement is grounded on the student’s understanding and acquisition of vocabulary and scientific language and the student’s ability to transpose that understanding and apply it in a meaningful manner.
Integration at Intermediate Grades

- Limitation in teaching ELLs

Vocabulary instruction with a science focus typically has received minimal instructional attention in kindergarten through twelfth grade classrooms across the nation (Scott, Jamieson-Noel, & Asselin, 2004; Watts, 1995). Widespread reduction of language-based learning activities due to teachers’ limited knowledge on how to integrate literacy instruction into hands-on scientific exploration (Greenleaf et al., 2011; Rivard, 2004).
Interdisciplinary Science-embedded English Language /Reading Intervention

- Concept-Oriented Reading Instruction (CORI, Guthrie et al., 2004)

  Explicit instruction in reading strategies; hands-on and inquiry-based learning, establishing collaborative working environment for students, and engaging them in writing, drawing, and presenting findings ➔ advancing students’ science concept learning, comprehension skills and motivation

- Reading Apprenticeship model (Greenleaf et al., 2001)

  research-based instructional approaches; closely aligned with science learning goals, and the science was integrated ➔ improved English proficiency, reading comprehension, and academic engagement in science
Interdisciplinary Literacy-embedded Science Intervention

- Inquiry-based science plus reading (ISR, Fang & Wei, 2010) infusion with explicit reading instruction and a weekly-based home science reading program ➔ more effective inquiry-based science than the science-only curriculum

- 5-E (Bybee, 1997): Engage, Explore, Explain, Elaborate, and Evaluate
  low science and literacy skills at the beginning could make comparable gains in content learning
Purpose

- Investigate the joint impact of two interdisciplinary interventions:

  a) *Interdisciplinary science-embedded English language and literacy* (English Language and Literacy Acquisition, K-3, Institute for Education Sciences [IES])

  b) *Interdisciplinary English literacy-embedded science* (Middle School Science for English Language Learners, 5th-6th, National Science Foundation [NSF])

To compare students’ science and English literacy achievement between those who participated in these two interventions and those students who did not receive such interventions.
Aldine ISD is a Learning First Alliance District and a Two-time Broad Finalist.
Aldine ISD Demographics

- 62.28% Hispanic
- 31.38% African American
- 1.98% Asian
- 4.26% White
- 0.09% Native American
- 82.03% Economically Disadvantaged
- 26.83% ELL
- 23.82% Mobility Rate
Design and Participants

- 56 Spanish-speaking ELLs as determined by the district identification criteria upon school entry in Kindergarten.

- In both interventions, schools were randomly assigned to treatment/control condition.

- 11.55 years ($SD = .52$) in treatment, 11.44 years ($SD = .42$) in control by the end of fifth grade.
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Note. E= Experimental/Treatment, C = Control.
Two Level Intervention

Interdisciplinary Science-embedded English Language / Reading Intervention (K-3)

Level I
Teacher Professional Development

Level II
Student Instructional Intervention

Interdisciplinary English literacy-embedded science intervention (5th grade)
Level I: Teacher Professional Development

- Systematic and structured training, monitoring, mentoring, feedback, and self-assessment through reflection via professional portfolio
- Teachers attend bimonthly training sessions on:
  program intervention components,
  selected ESL strategies,
  second language acquisition theory,
  portfolio development, and
  student assessments
- Bilingual paraprofessionals attend monthly training sessions on:
  Selected ESL strategies,
  Small group instruction,
  Interpersonal skills, and
  Testing and data collection
Academic Oral Language (K-3)

- Targets academic vocabulary
- Provides sentence using words in context
- Asks a daily question using the target word
- Presents visual aids for comprehension
- In first grade, this component became Academic Oral Language in Science [AOLS], integrating science vocabulary
- In second grade, this component became Academic Oral and Written Language in Science [AOWLS], integrating writing
- In third grade AOWLS was integrated into the science curriculum
How would you move a large mass of dirt?

wagon  bucket  box
**Life in a Tree**

Instructions: Write about each creature on the blanks beside the picture.

**Caterpillar**
- They turn into butterflies.
- They hatched near leaves.
- They have a lifecycle.

**Bird**
- They make their nest in the tree branches. The branches are high off the ground and that makes them safe.
- They make noise hoo hoo. They have close to grab mice. They sleep in the day and come out in the night.

**Owl**

**Squirrel**
- They live in the trunk of the tree. They climb trees by the trunk.
A raccoon lives in the tree. They make noise.

They hunt there for food. They live over a tree.

Writing Assignment:
If you could be an animal that lives in a tree, what animal would you be? Why? What would your life be like?

Write your answer in your notebook. Use your notes to help you remember how the different animals live.
**Life in a Tree**

Instructions: Write about each creature on the blanks beside the picture.

- **Caterpillar**
  - They eat leaves.

- **Bird**

- **Owl**
  - Owls use their claws to hold on to tree branches. They...

- **Squirrel**
  - Squirrels run fast. They like to eat nuts and acorns.
The Raccoon lives inside of the trunk. The trunk cannot flag the Raccoon.

A fox digs a hole under the tree. Foxes like to eat small animals.

Writing Assignment:
If you could be an animal that lives in a tree, what animal would you be? Why? What would your life be like?

Write your answer in your notebook. Use your notes to help you remember how the different animals live.
Storytelling and Retelling for English Language and Literacy Acquisition

STELLA (K-3)

- Uses authentic children’s literature
- Utilizes Bloom’s Taxonomy for questioning
- Integrates science concepts & vocabulary
- L1 clarifications (paraprofessional)
- 5-Day scripted lesson (1 book/week)
Snakes

Description:
The snake is yellow and poisonous. The snake is an invertebrate because the snake doesn’t have a backbone. And they are reptiles.

Habitat:
The snakes live kind of everywhere and

Usefulness:

Name: Esmeralda Rangel
Teacher: Mr. Cruz
Date: 10/28/07
School: Odum Elem.

Project ELLA 2007-2008
Content Reading in Science for English Language and Literacy Acquisition
CRISELLA (3)

- Full science curriculum, Scott Foresman ©2006 series:
  - Interesting pictures and visuals
  - Vocabulary introduction, cards, and extensions
  - How to Read Science
  - ELL support
  - Checkpoint questions
  - Differentiated instruction
  - Scaffolded inquiry activities
How to Read Science

- Teach target reading skill
- Practice skill with science article
- Apply skill using graphic organizer
- Practice skill four times in each chapter
condensation

the changing of a gas into a liquid
CRISSELLA: Chapter 13 Energy

Reading Objectives:
- The student understands explicit ideas and information in third-grade or higher texts (for example, main idea, implied message, relevant supporting details and facts, chronological order of events).
- The student uses simple strategies to determine meaning and increase vocabulary for reading, including the use of prefixes, suffixes, root words, multiple meanings, antonyms, synonyms, and word relationships.
- The student reads and organizes information (for example, in story maps, graphs, charts) for different purposes (for example, being informed, following directions, making a report, conducting interviews, taking a test, performing a task).


Target Reading Skill: Main Idea and Details

Science Objectives:
- The student recognizes various forms of energy (e.g., heat, light, and electricity).
- The student knows that most things that emit light also emit heat.
- The student knows the many ways in which energy can be transformed from one type to another.
- The student knows that various forms of energy (e.g., mechanical, chemical, electrical, magnetic, nuclear, and radiant) can be measured in ways that make it possible to determine the amount of energy transformed.
- The student knows ways that heat can move from one object to another.

NS: A, Science as Inquiry
B, Physical Science

TEKS:
Science: 3.1A 3.2A-E 3.7A

Target Vocabulary: electric charge, electric current, electric circuit, thermal energy, refract, absorb, potential energy, kinetic energy, reflect

Materials: Everyday have Pronunciation Guide and Error Correction Techniques

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<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
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<td>Ch 13 KWL (placed in each student's science journals), ELMO display copy, student editions, Ch 13 vocabulary cards, &quot;Using Synonyms&quot; activity sheet ELMO copy.</td>
<td>Ch 13 Lesson 1 Sound Preview and Word Knowledge, student editions, Ch 13 Lesson 1 Lesson summary individ student copies, teacher copy, and Ch 13 Lesson 1 Sound Preview and Word Knowledge sheets p. 1-3</td>
<td>Ch 13 Lesson 2 &quot;Energy Changes Form&quot; flowchart ELMO display copy, student editions, Ch 13 Lesson 2 Vocabulary Extension sheets p. 1-3 (thermal energy), student editions, Ch 13 Lesson 3 Vocabulary Extension sheets p. 1-3</td>
<td>Ch 13 Lesson 3 Vocabulary Extension sheets p. 1-3 (thermal energy), student editions, Ch 13 Lesson 3 Vocabulary Extension sheets p. 1-3</td>
<td>Sound Preview and Word Knowledge Ch 13 Lesson 4 ELMO display copy, teacher will need to prepare a flashcard, mirror, two balloons, and a piece of paper.</td>
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Day 1: Introduce Ch 13
Modified KWL (12 minutes)

What I Already Know (activating prior knowledge)
Individual copies of Ch. 13 KWL chart should be trimmed and placed in each student’s science journal. Make sure students are grouped into pairs. SEs should be open to p. 353, and say: “In Chapter 13 we learn about energy. Energy is the ability to do work or to cause change. En capítulo 13 aprendemos de la energía. Energía es la capacidad de hacer trabajo o hacemos cambios. Let’s read the title together.” (Tap to signal class to read in unison). Chapter 13, Energy.”

- “Today we will work together to complete our KWL charts.” Display the Ch.13 KWL chart on ELOMO. Point to the ‘K’ portion of the chart and say “We will begin our KWL chart by finding out what you already know about energy.”
- Say: “OK, now I will set the timer for 1 minute while you discuss energy with your partner.”
- After the timer goes off, say, “Now I want you to write some things you already know about energy on the ‘K’ part of your KWL chart.” Give students 2 minutes to write on the ‘K’ section their individual KWL charts
- Call on a few students to share what they already know about energy, “What do you already know, or think you know about how energy?”

What I Want to Know (setting purpose for reading)

- “Now let’s work on the next part of our KWL chart. The ‘W’ stands for what we Want to learn. But it can also mean what we predict we will learn. Take a few minutes to look through Chapter 13. Look at the headings, pictures, and charts and predict what you think we might learn about energy.” Set the timer for 2 minutes as the students ‘walk’ through the pages of Chapter 13 and get an idea of what they might learn. The teacher should be modeling looking through the chapter and noticing the headings, pictures, and captions.
- After the timer goes off, say “Now I want you to write some things you predict you will learn about how matter changes.” Give the students 2 minutes to write on the ‘W’ section of their individual KWL charts.
- What are some things you predict you will learn in this chapter?” Select a few students to predict what they think they will learn.

What I Learned
Point to the the ‘L’ part of the KWL chart say, “After you finish reading the chapter, you will come back and complete the ‘L’ part and record what you actually learned.”
Sound Preview and Word Knowledge
Chapter 7, Lesson 1

hy dro sphere

“All the waters of Earth make up the hydrosphere. The surface waters of the earth and water vapor in the atmosphere make up the hydrosphere.”

dis solve

“Dissolve means to mix thoroughly with a liquid. For example, salt dissolves in water.”

sa lin i ty

“Salinity is the measure of how salty water is. Ocean water is more salty in some places than in other places. Places where rivers pour fresh water into the ocean have low salinity.”
"In science the word *crest* means the top part of something. The top part of a mountain is called a crest. The top part of an ocean wave is also called a crest."
Vocabulary Extension: Multiple Meanings

“Many words have more than one meaning. If you look up the word solution in a dictionary you might find many different definitions, like this:”

**solution** noun 1. A special kind of mixture formed by dissolving a substance in a liquid: I gargled with a solution of salt in water. 2. The act or process of solving a problem: Use your books to help find the solution for the hard questions. 3. The answer to a problem: Help me, but don’t tell me the solution. **so-lu-tion**

“When you read a word, and you are not sure which definition to use, look at the surrounding words and sentences to help you decide which meaning is being used. Let’s read the sentence below together:”

**When one or more substances dissolve in another, a solution forms.**

“When meaning of solution is used in the sentence? It is ‘an answer to a problem’ or ‘a special kind of mixture’?”

Allow student response and give feedback.
Vocabulary Extension: Synonyms/Antonyms

Vocabulary Strategy: Using Synonyms

“Remember that a synonym is a word that means about the same thing as another word. When you read an unfamiliar word, you may sometimes find a synonym nearby. See if you can find a synonym for the word refract in this sentence:”

The droplets **refract**, or bend, the light.

“What is a synonym for refract?” Allow student response and give feedback. “Yes, the word bend means the same thing as refract. Finding a synonym can help you better understand the meaning of a word. What is a synonym for the word absorb in this sentence?”

When light hits objects, they **absorb**, or take in, some of the light.

“Yes, to take in means the same thing as absorb. What is a synonym for the word vibration in this sentence?”

A back-and-forth movement, or shaking, is called a **vibration**.

Allow student response and give feedback. “Yes, the word shaking means the same thing as vibration. Remember that when you read an unfamiliar word, you may sometimes find a synonym nearby.”
Fidelity

• Inter-rater reliability .95

• quantitative check based on a 4-point Likert rating scale with a total possible score of 96. The mean scores were over 4 years were 86.6

(a) knowledge of the content and script, (b) material usage and student involvement, (c) teacher talk versus student talk, (d) leveled questions, and (e) classroom management,
The Control/Typical Practice of English Language Instruction

- 45-60 minutes daily
- taught by certified bilingual/ESL teachers
- aligned with district benchmarks and state standards
- less intensive with great variation in vocabulary instruction across classrooms.
- interrupted at times by restroom breaks.
- other subjects were infused into the ESL block
Two Level Intervention

Interdisciplinary Science-embedded English Language / Reading Intervention (K-3)

Interdisciplinary English literacy-embedded science intervention (5th grade)

Level I
Teacher Professional Development

Level II
Student Instructional Intervention
Level I: Teacher Professional Development

• Systematic and structured training, monitoring, mentoring, feedback, and self-assessment through reflection via professional portfolio
• Bi-weekly staff development sessions:
  – English science vocabulary building and fluency
  – Oral and written academic science language development
  – Integrated science content reading comprehension
  – Imbedded ESL strategies in science
  – Enhanced instruction for science teaching
    • 5E Instructional Model
    • Questioning strategies
• Monthly staff development for paraprofessionals
Level II: Student Instructional Intervention

- Academic in-class science intervention (85 minutes daily) using 5E Model of instruction:
  - **Engage**: make connections between past and present learning, focus students’ thinking
  - **Explore**: provides students with common base of experience through manipulating materials or exploring environment
  - **Explain**: students verbalize understandings, teachers introduce formal definitions, explanations for concepts
  - **Elaborate**: students develop deeper and broader understandings by practicing skills or learning more information
  - **Evaluate**: students and teachers evaluate understandings of concepts
Supporting science and reading skills with expository (informative) text:

- Vocabulary development and extensions
- Word reading instruction
- Partner reading
- Using text from Scott Foresman ©2010 series and ScienceSaurus that directly align to 5th grade science TEKS (Texas Essential Knowledge and Skills, state guidelines)
WAVES
Written and Academic oral language
Vocabulary development in English in Science

- Individual science notebooks to help students process science content by:
  - Predicting
  - Recording
  - Organizing
  - Drawing
  - Questioning
  - Reflecting
Weekly Lesson Plan
Earth's Changing Surface (Rapid)

**Science Objectives:**
- Day 1 (Monday) – The student will describe how an earthquake can change the surface of Earth using a foldable.
- Day 2 (Tuesday) – The student will identify and describe how forces can change the surface of Earth using a news report.
- Day 3 (Wednesday) – The student will describe how forces can change the surface of Earth using a foldable.
- Day 4 (Thursday) – The student will interpret how land forms are the result of constructive forces using a foldable.
- Day 5 (Friday) – The student will interpret how land forms are the result of destructive forces using a foldable.

**Reading Objectives:**
- The student understands explicit ideas and information in fifth-grade or higher texts (for example, main idea, implied message, relevant supporting details and facts, chronological order of events).
- The student uses simple strategies to determine meaning and increase vocabulary for reading, including the use of prefixes, suffixes, root words, multiple meanings, antonyms, synonyms, and word relationships.

**ESL Strategies:** Academic Language Scaffolding, Cooperative Learning, Leveled Questions, Modeled Talk, Think Aloud, Visual Scaffolding

**TEKS:**
**Science:** 3.6B, 5.12A, Process Skills
**Language Arts:** 5.4A, 5.5F, 5.6A, 5.7A, 5.8B, 5.9B, 5.9E, 5.10A, 5.10G, 5.10L, 5.11B, 5.13B, 5.15A

**ELPS:** 1A, 1E, 2C, 3D, 4A, 4J, 5B

**Target Vocabulary:**
Verbs: identify, interpret
Content: force, constructive force, destructive force, earthquake, volcano, tsunami, landslide, flood, glacier, weathering erosion, deposition of sediment

**Materials:**
- **Day 1**
  - Warm Up: Forces that change the Earth's surface ½ sheet, pocket folders
  - Engage: W20D1.ppt
  - Explore: fault boxes for demonstration
  - Explain: EduSmart 3.6B #1 & 2, Week 20 Vocabulary.ppt, SF Textbook p. 268-269, Partner Reading Discussion Card W20D1
  - Evaluate: Earthquake foldable template, journal
  - Copy of Week 20 homework
Daily Activities

Day 1: 83 minutes

DOWLS: Forces that change the surface of Earth [Pocket Folders] (7 – 10 minutes)

Each student receives a half sheet for warm-up.
Display warm-up on ELMO.
Read prompt with the students. Students explain how they decided which forces change the surface of Earth quickly. Let students discuss their answers with their group. Call on students randomly to share their answers.

*Have students change and add answers as you review the warm-up with the class.

Engage: Power point – Earthquake (5 minutes)

Have students observe the slides. Discuss with students that earthquakes not only damage and destroy buildings, but they also change the surface of Earth.

Questions:

- Describe the damage to buildings by the force of the earthquake.
- Describe the damage to the surface of the Earth by the force of the earthquake.
- Draw a conclusion about the force of earthquakes.

Call on students to share their responses.

Refer to the objective for the day,

- Identify the cognitive verb for today.
- What does it mean to describe?

Explore: Fault boxes - model (15 minutes)

Have students observe the fault boxes when they are together. Shift the boxes.
Have students observe power point slides. Discuss slides with the students.
Questions: Describe how the earthquake changed the surface of Earth. Explain how this model is different than a real earthquake. Explain why we use models.

Explain: EduSmart 3.6.B #1 & #2 and Textbook 268-269

**EduSmart** – Glaciers (15 minutes)
Students will view this section of EduSmart. At each section break, ask the appropriate questions using the questioning strategies.

**CRISELLA**
**Vocabulary Preview** [Power Point] (4 minutes)
Show students Week 20 Vocabulary powerpoint slides 1-5, stop where designated

**Textbook p. 268-269 – Earthquakes (6 minutes)**
Set timer for 4 minutes as students partner-read the selection.
Partners will read the discussion questions on the Partner Reading Discussion Card and then re-read the selection a second time, looking for the answers.
After re-reading, partners will discuss answers.
- Define earthquake.
- Define fault.
- Identify the cause of earthquakes.
- Describe the effects of earthquakes.

**Evaluate / Product:** Notebook Foldable – Earthquake [Journal] (20 minutes)

Foldable – Students will identify earthquakes as a force that can change the surface of Earth. Students will describe how an earthquake can change the surface of Earth.

Explain to the students they are creating a foldable to show their knowledge of the forces of earthquakes. This is the assessment for today. Students need to work on foldable individually.

Review power point with students before they begin to work on the product.

**Closure:** (3 minutes)
- Identify the force that can cause land to rise or fall down.
- Identify the cause of earthquakes.
- Identify the effects of earthquakes.
- Explain why we do not have earthquakes in Texas.

**Homework:** (5 minutes) Briefly preview weekly homework.
Fidelity

- Inter-rater reliability .86
- Quantitative check based on a 4-point Likert rating scale based on each of the 5-E, with a total possible score of 124, mean = 107.17

(a) Material usage and material preparation (b) Student involvement, (c) Academic language scaffolding, (d) Affective and cognitive feedback, (e) Writing feedback, and (f) Pacing
The Control/Typical Practice of Science Instruction

- 80-90 minutes daily
- taught by certified or permitted bilingual/ESL education and science education teachers.
- a locally-developed science curriculum aligned to the state standards.
- 5-E model once per week
- varied ESL strategies and teachers’ questions strategies
- limited use of science journals.
Measures

- District benchmark tests in science—6th test, cumulative of physics, chemistry, space, earth and life science, with process skills integrated ($\alpha = .68$)

- State standardized test: Texas assessment of knowledge and skills (TAKS)

- Dynamic Indicators of Basic Literacy Skills (DIBELS)—Oral Reading Fluency

- Woodcock Language Proficiency Battery-Revised (WLPB-R)—Verbal Analogies ($\alpha = .83$), Oral Vocabulary ($\alpha = .78$), Passage Comprehension ($\alpha = .83$)
District Benchmark Science Test

• 2 x 2 chi-square test of independence on science intervention
  Passing: $E>T$, $\chi^2 = 3.877$, $p = .049$, Cramer’s V = .372
  Commended performance: $E>T$, $\chi^2 = 3.232$, $p = .072$, Cramer’s V = .360
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TAKS

• Science
  No difference between treatment and control
  In language control group, male science-E > female science-E

• Reading
  Commended performance: E>T, $\chi^2 = 3.062$, $p = 0.08$, Cramer’s V = .337
### DIBELS

Statistically Significant Interaction Effects Generated by Repeated Measure ANOVA in Oral Reading Fluency

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<td>69.100</td>
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</table>
WLPBR

• students in the treatment condition (in either intervention) achieving higher gains from pre-test to post-test.
Passage Comprehension

![Bar Chart]

- **Language-E**: Pre-test: 85, Post-test: 95
- **Language-C**: Pre-test: 85, Post-test: 90
Oral Vocabulary

![Graph showing oral vocabulary scores for Science-E and Science-C, comparing pre-test and post-test results.](graph_image)
Discussion and Implications

- Students receiving literacy-embedded science intervention in fifth grade outperformed those who did not in English oral reading fluency, knowledge of word meanings, and mastery of science concepts comparable to grade level, and high academic science and reading achievements that are considerably above the state standards.

- Students who received the K-3 English intervention continued to develop faster than those who did not in English reading fluency and comprehension skills.

- Students benefited the most from participation in both interventions.

- Students with neither of the interventions displayed a disadvantage in oral reading fluency, science learning, and reading achievement.
Implications for Science Intervention among ELLs

• The importance of early intervention with interdisciplinary science-embedded reading curriculum; and instruction for ELLs in elementary grades should emphasize *learning to read* in content areas such as science.

• Intensive, longitudinal instruction better prepared ELLs in learning to read by intentionally and strategically infusing a variety of topics in science into the language instruction in each grade level as early as kindergarten.
Implications for Science Intervention among ELLs

• “science learning entails and benefits from embedded literacy activities and that literacy learning entails and benefits from being embedded within science inquiry” (Pearson, Moje, & Greenleaf, 2010, p. 462)

• Instruction for ELLs in middle grades should emphasize reading to learn, with continued support in English language and reading literacy to ensure current and former ELLs’ success in science.
Conclusion and Recommendation

• Integration between science and English language and reading literacy should be *interdisciplinary* with a primary focus on learning to read in K-3 considering the importance of English language and reading skills as the foundation for academic learning in science; and with a primary focus at the lower middle grades on science when students develop their knowledge in the content area of science and continue with English language and reading literacy acquisition.

• Future studies to test the effect of such an integrated curriculum of science and English language and reading literacy at higher grade levels among low-SES ELLs and former-ELLs.
Thank you!

- For a full detail of this study, please see:
  - Language Diversity Network  ldn.tamu.edu