

# **Making the Language of Mathematics Comprehensible: Math Word Problems**

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Mary Esther Huerta, Ph.D.  
Texas State University-San Marcos  
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mh75@txstate.edu



# Rationale

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- 43% attrition rate cited for Hispanics in 2007 [see IDRA.org for other counties in Texas].
- There is a persistent academic lag in reading for L2 fourth grade readers.
- Long-term results have created an overrepresentation of ELLs in special education programs.



# Our Task

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Support second language acquisition and Teach Math concepts.

- ❖ How can we **differentiate** instruction for L2 readers?
- ❖ What approaches are successful in making math concepts comprehensible to students learning English?

# Meeting Academic Standards

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- ❖ Stage of second language acquisition always matters.
- ❖ Differentiated instruction meets competency variability across
  - ❖ Listening, speaking, reading, and writing
- ❖ ELLs must be able to independently manipulate the discourse, vocabulary, logic, propositions and arguments, the “linguistic code and cognition” grounded in “social practices,” and cultural norms linked to Math.

(Solórzano, 2008)

# Theoretical Foundation

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## **Metalinguistic Awareness**

- ❖ August, D., & Shanahan, T. (Eds.). (2006).
- ❖ Bialystok, E. (2007).
- ❖ Jiménez, R. T. (2000).
- ❖ Jiménez, R. T., García, G. E., & Pearson, P. D. (1996).
- ❖ Kuo, L., & Anderson, R. C. (2008).
- ❖ Langer, J. A., Bartolomé, L., Vásquez, O., & Lucas, T. (1990).
- ❖ Nagy, W. E., & Anderson, R. C. (1998).
- ❖ Proctor, C. P., Carlo, M., August, D., & Snow, C. (2005).

# Theoretical Foundation

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## **Variability in L2 reading:**

L2 readers are not a homogeneous group.

- ❖ Durgunoğlu, A. Y., & Verhoeven, L. (1998).
- ❖ Gutiérrez-Clellen, V., Calderón, J., & Weismer, E. (2004).
- ❖ Kintsch, W. (1998).
- ❖ Pérez, B. (2004).
- ❖ Verhoeven, (1994).



# Theoretical Foundation

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## **Assessing L2 Readers**

- ❖ Birch, B. M. (2002).
- ❖ Solano-Flores, G. (2008).
- ❖ Solórzano, R. (2008).
- ❖ Stanovich, K. E. (1980).
- ❖ Walpole, S., & McKenna, M. C. (2006)

# Metalinguistic Awareness

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## Cognition

- ❖ L2 readers process text through a bilingual, bicultural, and biliterate identity.
- ❖ Cognitive processes are influenced by a bilingual's ability to manipulate two language structures.
- ❖ Stage development influences attending to and manipulating structural and functional features of languages
  - ❖ Bilinguals' use of schemas differ





# Unitary Process of Reading

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- ❖ Biliteracy occurs through a unitary process, proceeding from first language and literacy development, and continuing to mastery of literacy in both languages.
- ❖ Biliteracy can also be descriptive of learning to read and write in two languages at any developmental period

# Variability in L2 reading

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- ❖ Even if ELLs speak the same language and/or dialect, they are a **heterogeneous** group:
  - ❖ Varying backgrounds, language, culture, and worldviews.
  - ❖ Differences in home stimulation, parental motivation for schooling, children's self-esteem, and the correlation between school and functional literacy.
  - ❖ Variability of instructional strategies, teachers, books, opportunities to learn, and the perceived distance between the L1 and L2.

# L2 Readers

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- ❖ May need extra time to make sense of unfamiliar concepts and texts.
- ❖ L2 Readers manipulate cognitive underlying processes that enable them to attend to, select, and control knowledge across the native language and English. (Bialystok, 2007).
- ❖ While native English speakers can devote their cognitive resources to comprehension using one language system, bilinguals use two. (García, 2000)



# Assessing L2 Reading

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- ❖ Language skills are always embedded in tests that employ language.
- ❖ The construct validity of a test is affected when ELLs are have limited English proficiency but are tested in English.



# Planning Instruction

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- ❖ What math concepts are embedded in the word problem?
- ❖ What knowledge of math concepts is required to solve the word problem?
- ❖ What is the application level of the concepts: Are they at a basic level or are they an iteration.



# What Do You Know?

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Teacher reads aloud:

Roxanne's book has 240 pages. If she reads 20 pages a day, how many days will it take her to read the entire book?

# Cognitive Process

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## Oral Language:

- ❖ Phonology: Teacher reads aloud
- ❖ Oral Language: Students employ listening and speaking (**Vocabulary of Mathematics**)
- ❖ Metalinguistic: Use of two language systems to express background knowledge

# Negotiating for Understanding

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Ask Students: **What questions do you have?**

Questions may target  
math concepts or language concepts

Roxanne's book has 240 pages. If she reads 20 pages a day, how many days will it take her to read the entire book?



# Understanding the Questions

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## **Students' questions are influenced by**

- ❖ Stage of second language development
  - ❖ listening, speaking, reading, and writing
- ❖ Gaps in background knowledge

Teachers use this information to design explicit instruction that scaffolds specific language acquisition and/or concepts needs.

# Simplifying Language

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Revise lexicon, syntax, grammar

**Without compromising the intent**

Roxanne reads a book. The book has 240 pages. Roxanne reads 20 pages each day. How many days will it take her to read all the book?

# Modifying Language Structures

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- ❖ Maintain the integrity of the question.
- ❖ Use the present tense.
- ❖ Use an active voice.
- ❖ Change clauses to short sentences.
  - ❖ Adverbial phrases
  - ❖ Verb phrases
  - ❖ Introductory clauses
  - ❖ Dependent and Independent clauses



# Teach Cognates

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Alexandra:

Cognates can help. Say you know a word in Spanish and you are reading in English. You read half of the word in English, and you don't know it. Once you get half of the word you think that it sounds like this other word in Spanish. When you reread you can get to the end of the word and get what it means.

# Discourse of Math

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- ❖ Teach key vocabulary
- ❖ Teach key math concepts

## **Long-term Learning Goal:**

ELLs must be able to independently manipulate the discourse, vocabulary, logic, propositions and arguments, the “linguistic code and cognition” grounded in “social practices,” and cultural norms linked to Math.

# Rationale for Simplifying Language

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- ❖ Differentiates instruction.
- ❖ Any readability level that exceeds current competency, provides insight about a student's progress in L2 reading development.
- ❖ **The certified teacher** can design small group instruction that provides **mini-lessons** targeting any gap in the development of a particular math concept.



# TASK

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- ❖ Identify the concept knowledge required to solve the problem.
- ❖ Modify the language.
- ❖ Predict what knowledge gaps may emerge
- ❖ List your approach to addressing knowledge gaps:
  - ❖ **Language**
  - ❖ **Concept**

# Learners of English

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## The Teacher must know:

- ❖ How many learners of English are in each class.
- ❖ What are the various L2 acquisition classifications represented?
- ❖ How variability in **literacy development, second language acquisition, and attainment of math concepts** is represented in each class?
- ❖ How does this impact your instructional approach to teaching Math?





# Rehearsal Time

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- ❖ Oral language
- ❖ Cognition
- ❖ Opportunity to express background knowledge in any language. A peer can always translate.
- ❖ The Teacher-Researcher gleans insight about
  - ❖ Abilities to manipulate math knowledge
  - ❖ Abilities to manipulate linguistic knowledge
  - ❖ Progress in learning academic English
  - ❖ How the use of L1 enriches comprehension, extending acquisition of English



# When Readability is Challenged

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Prior and Welling (2001) found:

- ❖ **Mumble reading** can help L2 readers focus attention, plan and apply comprehension strategies, monitor their comprehension, and to self-regulate.



# Frustration

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Less successful L2 readers may only depend on decoding skills when reading in English:

**Malena:** I imagine many things at the same time, and then I don't understand anything.

**Julia:** Sometimes I stop. I get bored because I don't understand, and I don't get any pictures in my mind.

# Making Sense of English-language Texts

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Depends on

- ❖ Strengthening L2 reader's self-efficacy;
- ❖ Providing differentiated Math instruction aligned with the stages of L2 acquisition across listening, speaking, reading, writing particular to each student;
- ❖ Creating explicit opportunities for ELLs to problem solve using their background knowledge embedded within two languages.



# Differentiated Math Instruction

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## **Accounts for Variability in**

- ❖ Cognitive Processes
- ❖ Spanish/English Linguistic Knowledge
- ❖ Background Knowledge: informal and formal knowledge
- ❖ The effectiveness of the methods used to teach Math concepts



# Ultimately

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Bilingualism only becomes a burden  
when contexts of learning do not  
accommodate for differentiated L2  
reading processes.

(Bialystok, 2007)