Teaching and Opportunities to Learn Mathematics in Bilingual Kindergarten and First Grade Classrooms

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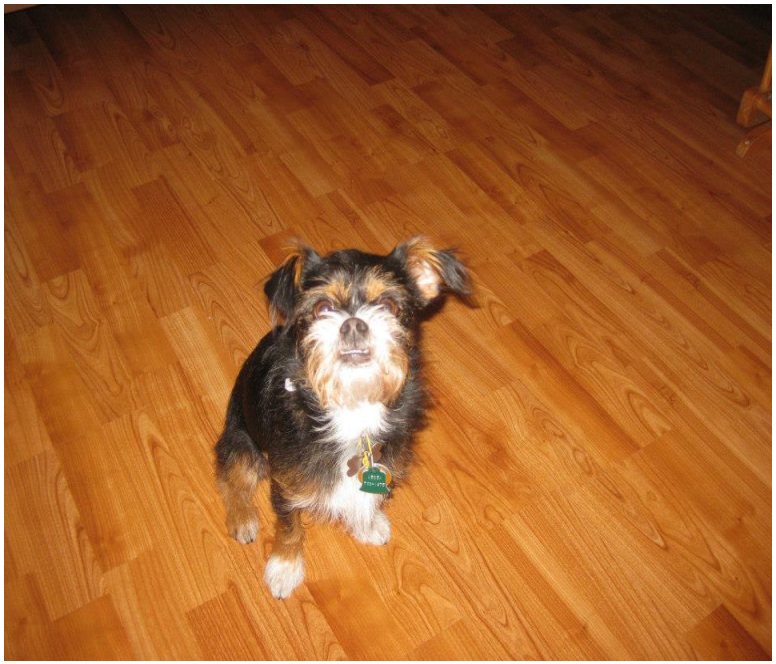

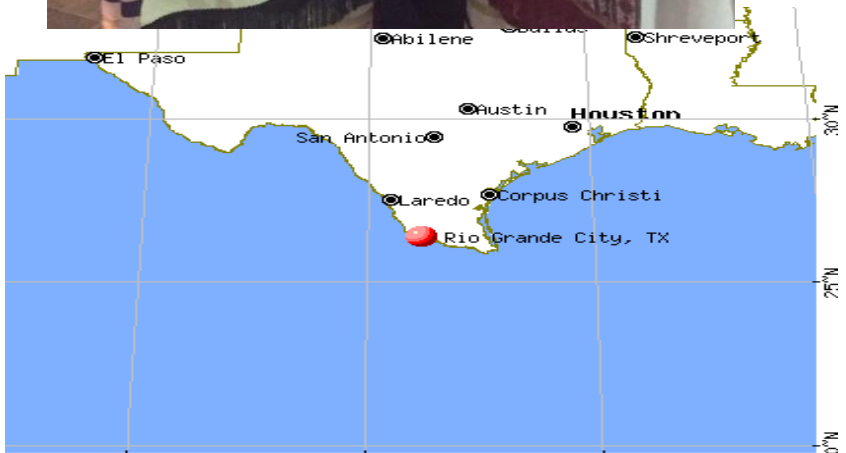
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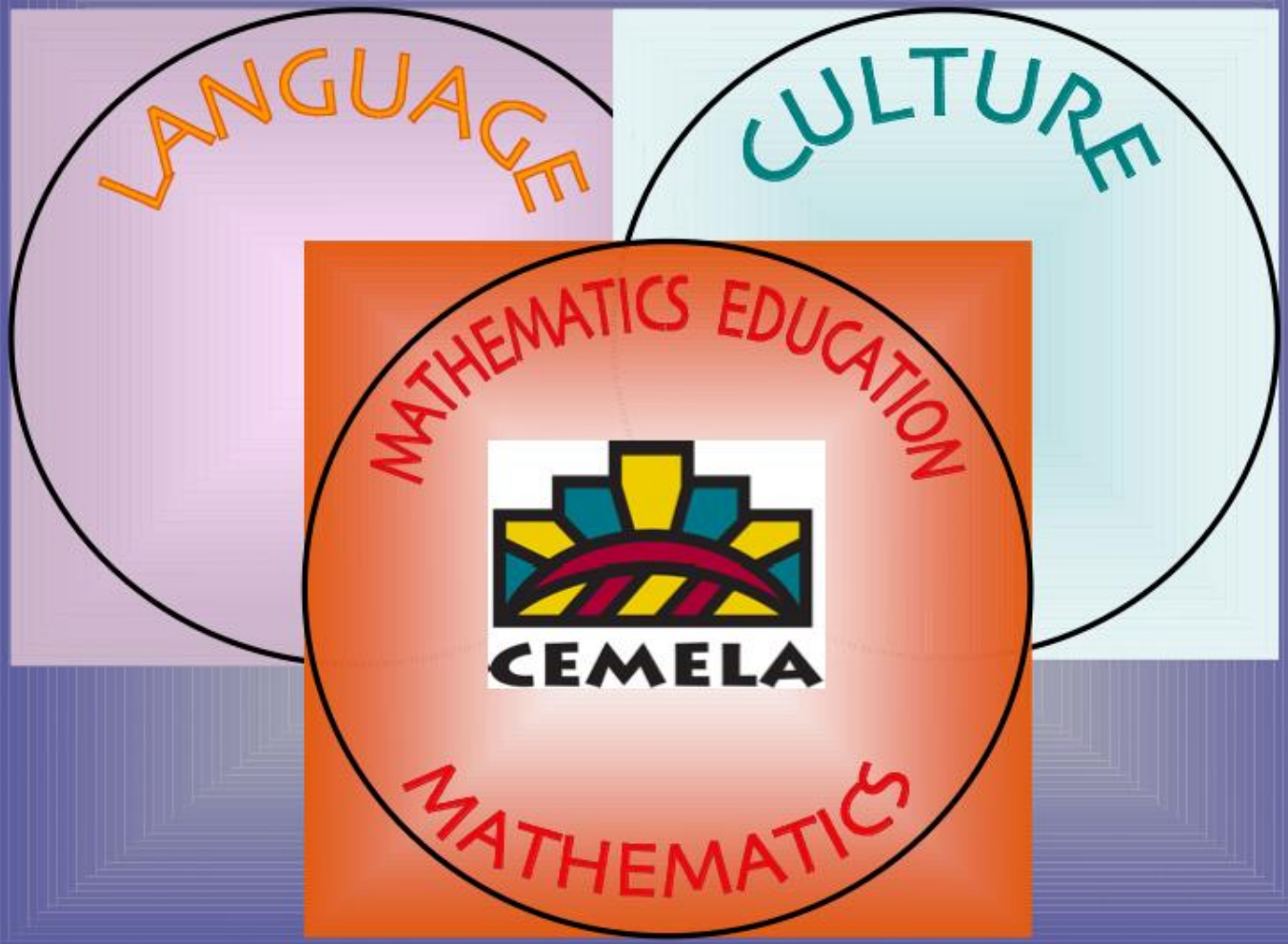
CEMELA'S INTEGRATED APPROACH



Guiding Principles

- Holding high expectations for students' academic growth and strengthening the native language--not only on transitioning them to English (García & Kleifgen, 2010)
- Understanding language and culture as intellectual resources rather than viewing these as deficits (Civil, 2007; Cummins, 2007; Moschkovich, 2007)
- Promoting Emergent Bilinguals' participation in mathematics conversations rather than focusing on decontextualized vocabulary (Celedón-Pattichis & Ramirez, 2012)

Young Children & Problem Solving

- Problem solving as integral to learning mathematics *(NCTM, 2000)*

- Often underestimated problem solving capacity of young children *(CGI Studies, Carpenter, Fennema et al., 1999, 2014)*

Young Latina/os & Problem Solving

- Latina/o students represent fastest growing group in public schools. Nearly half (45%) are Emergent Bilinguals (Kohler & Lazarín, 2007).

- Persistent gap in opportunities to learn between Latina/o students and white and Asian counterparts (Flores, 2007).

Young Latina/os & Problem Solving

- Unequal Access
  - Low income and minority students overrepresented in basic skills oriented classrooms (Oakes, 2005; Strutchens & Silver, 2000)
  - Trends apply to children as young as kindergarten, and young Latina/o and African American children in particular (Pianta et al., 2002; Stipek, 2004)

Young Latina/os & Problem Solving

- Given qualified teachers and access to problem solving instruction, low income students of color have demonstrated high levels of mathematical performance (Celedón-Pattichis & Turner, 2012; Kitchen, DePree, Celedón-Pattichis & Brinkerhoff, 2007; Parks, in press; Silver, Smith & Nelson, 1995; Turner & Celedón-Pattichis, 2011; Villaseñor & Kepner, 1993; Wager, in press).

Research Focus

- What instructional practices support young Latinas/os in mathematical problem solving?

- Given ongoing opportunities to solve problems, what is the nature of students' learning?

Theoretical Perspectives

- Opportunities to Learn *(Carroll, 1963; Tate, 2005)*

- Young children's Problem Solving
  - Cognitively Guided Instruction (CGI) *(Carpenter et al., 1999, 2014)*
  - Discourse and Learning Mathematics *(Moschkovich, 2010)*

- Cultural Knowledge and Practices and Learning Mathematics *(González, Moll et al., 2005)*

Setting

- 3 Kindergarten Classrooms, low SES schools with predominantly Latina/o student populations (73-87%)

Teacher	Students/Class	Lang. of Instruction
Ms. Arenas	All Latino, ELLs Dual Language Class	Spanish
Ms. Field	Native English and native Spanish speakers, ESL Class	English
Ms. Perales	Native English and Native Spanish speakers, Biling Class	Bilingual

Ms. López´s First Grade Classroom

- Dual language program
- Student population of Mexican descent
- Low income immigrant families
- All students spoke Spanish at home
- Integrated CGI into her curriculum

Methods

- Bi-weekly Classroom Observations
  - Video-taped, transcribed, coded (2 lessons in the fall and 3 in the spring from each classroom)

- Pre and Post Clinical Interview assessments
  - Conducted with 7 students from each classroom in Oct. and 15 from each classroom in May
  - Administered in student's dominant language
  - Coded for strategy use, correct/incorrect
  - Tasks based on Carpenter et al.'s (1993) study of kindergarteners' problem solving

Findings from Kindergarten Study

Opportunities to Learn:

1. Using storytelling to pose problems;
2. Integrating challenging mathematical tasks;
3. Positioning students as problem solvers and problem posers;
4. Integrating multimodal approaches to solve problems;
5. Implementing opportunities for listening, speaking, reading, and writing using the native language needed for transferring mathematical concepts from the native language to English

1. Introducing Problem Solving Through "Story-like" Conversations

- Problems that reflect *familiar contexts* invite students to draw upon lived experiences to make sense of mathematical ideas.
- The *narrative structure* of the problems scaffolds students' explanations.
- Problems in the form of stories help students learn to *represent mathematical ideas* and connect multiple representations. (e.g., drawings, symbols, objects).

2. Integrating Challenging Mathematical Problems

MULTIPLICATION, MEASUREMENT DIVISION, AND

PARTITIVE DIVISION PROBLEMS

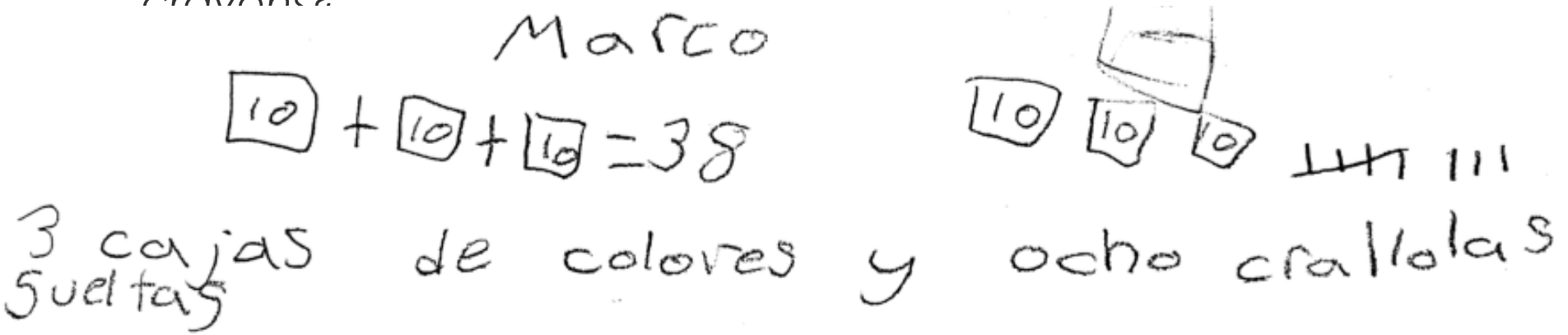
Multiplication	Megan has 5 bags of cookies. There are 3 cookies in each bag. How many cookies does Megan have altogether?
Measurement Division	Meagan has 15 cookies. She puts 3 cookies in each bag. How many bags can she fill?
Partitive Division	Megan has 5 bags of cookies. Altogether she has 15 cookies. There are the same number of cookies in each bag. How many cookies are in each bag?

Adapted from Cognitively Guided Instruction, University of Wisconsin-Madison, 1992.

Posing challenging and complex mathematical problems before or at the same time students master basic mathematics skills

Introducing More Challenging Problems in Terms of Content and Language

- As a challenge, Mrs. López decided to introduce students to multiplication and division problems where collections of tens can be grouped or partitioned into equivalent groups (Carpenter et al., 1999, p. 33).
- Multiplication: "*Zirce has 3 boxes of crayons and 8 single crayons. How many crayons does she have in all?*"
- Measurement Division: "*Now let's think of a similar story. Okay. Now think. How many boxes do you think we will fill with 24 crayons?*"



Opportunities to Learn: The Case of Ms. Arenas

- Ms. Arenas students had *more opportunities* to solve a *broader* range of problems.
  - More time spent on problem solving
  - Equitable distribution between basic and challenging problems
- All of Ms. Arenas' students were taught mathematics in Spanish.
- Twice as often Ms. Arenas used an informal, storytelling manner to present word problems.

Content Analysis of Selected Lessons from Three Kindergarten Classrooms

Teacher	Problem Type									Mean number of problems per lesson	Mean lesson length	Number range
	JRU	SRU	JCU	MULT	PD	MD	CDU	MS	Other			
Arenas	5	6	2	6	5	0	2	1	0	5.4	25.2 min	1-20
Perales	5	7	0	0	2	1	0	0	4	3.8	17.8 min	1-15
Field	8	2	0	5	0	0	0	0	1	3.2	17 min	1-12

Ms. Arenas' Post Assessment Results (n=15)

Problem Type	% Correct	% Correct (Carpenter)
Join Result Unk (6+6)	87	NA
Separate Result Unk (13-5)	93	73
Join Change Unk (7+__=11)	73	74
Multiplication (6x3)	80	71
Partitive Division (15÷3)	73	70
Measurement Division (10÷2)	73	71
Multi-Step (2x4) - 3	60	64

Video Case

- Ms. Arenas' Class, March

- Multiplication Problem:
  - "I bought 4 toy horses at the store. I put them all in a bag to take home. How many feet were there in the bag?"

- Whole Group Problem Solving Session

- We contend that Ms. Arenas' students may have benefited from frequent opportunities to solve linguistically and contextually-rich problems which have the potential to draw upon home and community-based knowledge and experiences as resources to support understanding (Civil, 2007; Turner, Varley Gutiérrez, Simic-Muller & Díez-Palomar, 2009).

Caveats

- Ms. Arenas' students were more successful on some problem types; however, students across *all* 3 classrooms showed remarkable growth compared to what other studies might predict.

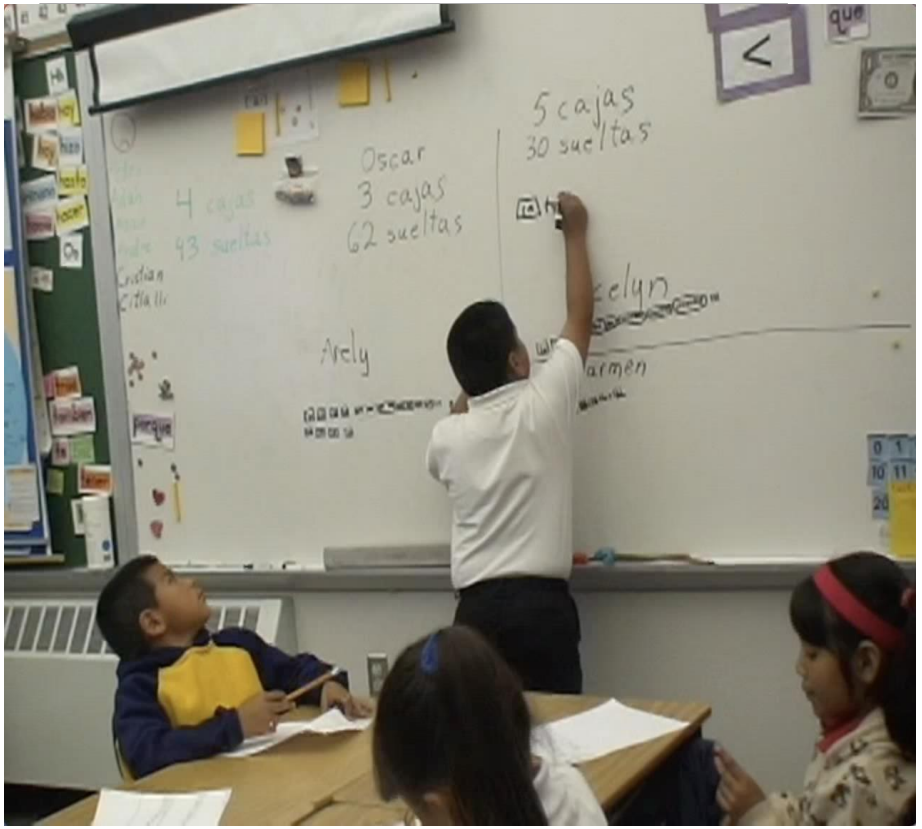
- We highlight differences only to describe how *expanded opportunities* may have resulted in even greater achievement gains.

3. Positioning Students as Problem Solvers and Problem Posers

- Students develop and use their *own strategies* to solve problems:
  - **Direct modeling** (using concrete objects or manipulatives)
  - **Counting strategies** (counting up or down, counting on from, etc.)
- Students construct their own "story" problem becoming "problem creators."
- Students develop ownership and confidence as mathematics learners.

First Graders as Problem Posers (VIDEO)

- Fosters academic language development by scaffolding students in the process of thinking and communicating a mathematics problem.
- *Collective construction of meaning.*



Math Journals: Students as Problem Posers

Students create their own problems and learn to pose problems in writing representing the solution pictorially and symbolically.

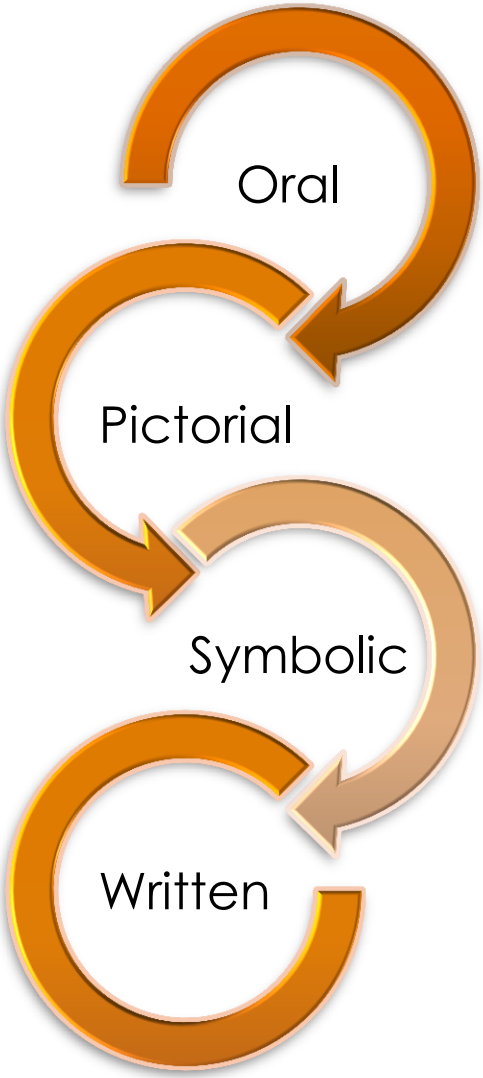
- Thinking: Requires in depth understanding of the structure of a problem
- Drawing: Representing the problem and solution
- Writing: Providing the story line for their own number stories

Language Demands: Scaffolding Reading and Writing

Lee:	¿Cómo lo sabes? Escríbelo con palabras y números.
Tú tienes 8 cajas de crayolas y 3 crayolas sueltas. ¿Cuántas crayolas tienes en total? 83	Porque yo conte de 10en 10 y si hay de 8 cajas y de crayolas y 3 sueltas en total son 83. 10+10+10+10+10+10+10+10+3=83

Multimodal Representation

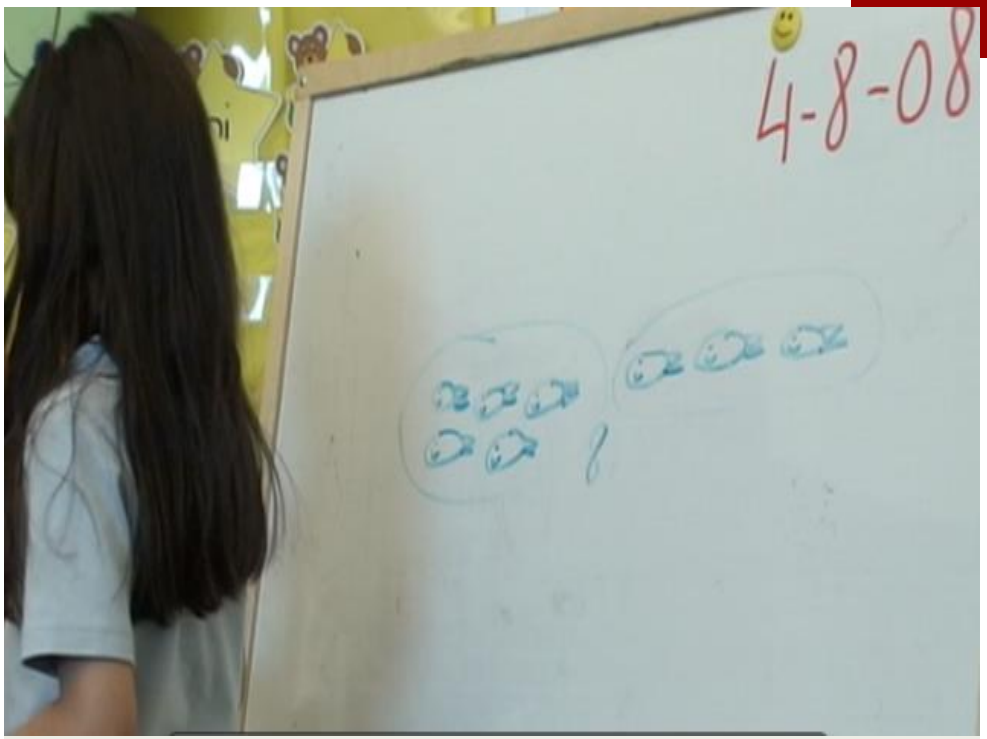
Supporting students to make the transition from concrete to abstract



Emphasizing the need to make connections among these representations

5. Building on Native Language (Spanish) for Mathematics Teaching and Learning

- Avoiding a strict separation of languages.
- Building on students' academic vocabulary by appealing to their first language and making an explicit connection to the use of cognates.



In my fish tank I put 5 fish.

Mrs. Craw gave me 3 more.

How many do I have now?

Recommendations

- Include a wide variety of challenging mathematics problems.
- Use storytelling to vary the context of the word problems by using your own students' names, friends' names, or relatives' names. Use objects or places that are familiar in students' communities.
- Use journals to encourage students to pose problems in writing and represent the solution pictorially, symbolically, and written. They can pose these problems to their friends or take them home to pose to their families.
- Use the students' native language to persevere in solving word problems.

Research Directions and Projects

- *Center for the Mathematics Education of Latinos/as (CEMELA), Diversity in Mathematics Education (DiME), others.*
- *Equity Within Mathematics Education Research as a Political Act: Moving From Choice to Intentional Collective Professional Responsibility* (Aguirre et al., 2017)
- *Access and Equity: Promoting High Quality Mathematics in Grades PreK-2, 3-5, 6-8, and 9–12* (NCTM—Marta Civil as Book Series Editor)
- Teachers Empowered to Advance Change in Mathematics (Drake et al., Multi-site project integrating funds of knowledge with children's mathematical thinking in teacher preparation).
- Mathematics and Language, Literacy Integration (MALLI) in Dual Language Settings (multi-site project—Bravo et al.)

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THANK YOU!

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