

Developing Mathematical Discourse Through CGI Problem Solving: Professional Partnerships in Primary Grade Bilingual Classrooms

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*CEMELA (Center for the Mathematics Education of



CEMELA: Center for the Mathematics Education of Latinos/as

⇒ Cross site, interdisciplinary

- Importance of language and culture in mathematics learning



⇒ National Science Foundation funding

⇒ Focus on: teaching, learning, parents, and policy

- University of New Mexico
- University of Arizona
- University of California at Santa Cruz
- University of Illinois at Chicago





Theory in Professional Development

- ➔ **Effective PD in bilingual mathematics** (Musanti, Celedon-Pattichis & Marshall, in press; Turner et al., 2008)
- ➔ **Situated professional development** (Cobb et al., 2003)
- ➔ **Complementarity in collaboration** (John-Steiner, 2000)
- ➔ **Professional development through participation** (Rogoff, 2003; Wenger, 1998)
- ➔ **Opportunities to learn in and from practice** (Ball & Cohen, 1999)



Cognitively Guided Instruction (CGI)

- ⇒ Framework for understanding children's mathematical thinking (Carpenter et al., 1999)
 - Student-centered learning based in context-rich word problems
 - Emphasis on students' strategies, explanations and justifications
 - Bridges students' experiential knowledge with formal school mathematics
- ⇒ Situating PD in relation to practice (Franke, Carpenter, Levi & Fennema, 2001)

CGI Problem Types

Join Result Unknown ($6 + 6 = \underline{\quad}$)

Separate Result Unknown ($13 - 5 = \underline{\quad}$)

Join Change Unknown ($7 + \underline{\quad} = 11$)


Compare & Part-Part Whole

Multiplication ($6 \times 3 = \underline{\quad}$)

Partitive Division ($15 \div 3 = \underline{\quad}$)

Measurement Division ($10 \div 2 = \underline{\quad}$)

Multi-Step (2×4) - $3 = \underline{\quad}$



Developing Mathematical Discourse in Spanish

- ➔ Teachers explicitly use mathematical language and expect that students will attempt to explain their thinking (Khisty & Chval, 2002).
- ➔ More sophisticated and efficient strategies are explicitly encouraged (McClain & Cobb, 2001).
- ➔ Native language is critically important in concept development (Collier & Thomas, 2004; Cummins, 1986).
- ➔ Students' explanations reflect their mathematical thinking (Sfard, 2001).



Situated Professional Development

- ➔ Long-term collaborative PD to develop CGI in bilingual classrooms--currently in our 4th year
- ➔ Goal to create professional partnerships
- ➔ Focus on integrating CGI into the curriculum
- ➔ Cooperative effort to design, support, and teach CGI problem solving
- ➔ Teacher support through workshops, summer institutes, weekly debriefing



La Joya Elementary School

- ➔ Bilingual urban elementary school
 - 86% Mexican descent population
 - 100% free or reduced meals
- ➔ Accelerated biliteracy program for ELLs
- ➔ Mathematics instruction in Spanish
- ➔ Two kinder classrooms
- ➔ One 1st grade classroom
- ➔ One 2nd grade classroom



Methods-Data Collection

⇒ Classroom

- Videotape of classroom mathematics lessons
- Students' work
- Fieldnotes of mathematics lessons
- Student demographics

⇒ Teachers

- Interviews in fall and spring
- Frequent (weekly) debriefings: Audiotaped

⇒ Students

- Individual CGI interviews
 - Pre-Post assessments: Videotaped
- Small group problem solving



CGI in Kindergarten

⇒ Rationale from teachers:

- Young students can successfully solve complex word problems *before* they master basic facts.
- Young students can explain in ways that make sense to them.
- Word problems help develop a sense of number.
- Word problems lay the foundation for formal mathematical concepts.



Multiplication Problem in Kindergarten

➔ Ms. Cruz: March, 2008

– Problem: I have 3 boxes. Each box has 5 lollipops. How many lollipops do I have total?

– Problema: Yo tengo 3 cajas. En cada caja hay 5 paletas. ¿Cuántas paletas tengo en total?



Multiplication Problem in Kindergarten

➔ Ms. Arenas: March 2006

- Problem: I bought 4 toy horses. I put them all in a bag. How many legs are there total?
- Problema: Compré 4 caballitos. Los puse en una bolsa. ¿Cuántas patas tengo en la bolsa en total?



CGI in 1st Grade

- ➔ Rationale from teacher: Supports local, state and national math standards:
 - Communication: Word problems develop the ability to retain and retell information, develop vocabulary, explanations and justifications.
 - 1st grade concepts: Skip counting by 2s, 5s, 10s and base 10 thinking.
 - Representation and connections: Bridging informal (picture) to formal (equation)



Multiplication Problems for 1st Grade

- ➔ Using problems to support base ten thinking.
 - There are some boxes of crayons. Each box has 10 crayons.
 - How many crayons in 3 boxes?
 - How many crayons in 3 boxes and 22 singles?
 - How many crayons in 5 boxes and 30 singles?



CGI in 2nd Grade

➔ Rationale from teacher:

- Students are encouraged to solve problems faster and more efficiently.
- Students apply concepts they are learning such as base 10 thinking, number decomposition, and number facts.
- Students develop, organize, and share their thinking through math discourse.



Partitive Division for 2nd Grade

➔ Ms. Sanchez: April 23, 2008

- Problem: Yisell had 45 cookies. She is going to share them among herself and 8 friends. How many cookies does each girl get?
- Problema: Yisell tenía 45 galletas. Ella va a compartirlas entre ella misma y 8 amigas. ¿Cuántas galletas recibe cada niña?



Implications for 2nd Grade Students

- ➔ Children respond to CGI problem solving with enthusiasm.
- ➔ Children want to share their solutions with the class and explain their thinking.
- ➔ Confidence and engagement increased throughout the year as did students' ability to explain their thinking.



Implications for Collaborative PD With CGI in Bilingual Classrooms

- ➔ Collaboration brings together theory and practice, draws on the strengths of all participants.
- ➔ Teachers develop their own rationale for CGI problem solving.
- ➔ Researchers have access to teachers' knowledge of student learning.
- ➔ Professional partnerships are a team effort to refine CGI problem solving in diverse classrooms.



¡Muchas Gracias!

- ➔ ...and thank you!
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