YOUNG LATINO STUDENTS' LEARNING IN PROBLEM-BASED REFORM MATHEMATICS CLASSROOMS: DEVELOPING MATHEMATICAL THINKING AND COMMUNICATION (1)

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This study explores how Latino first grade students develop mathematical problem solving and communication in their native language. Problem types came from Cognitively Guided Instruction (Carpenter et al. 1999) and were embedded in students' cultural and linguistic experiences. Findings show students solved a wide range of CGI problems and developed confidence, flexibility, and sophistication in their strategies and explanations.

Problem solving and communication are at the center of reform mathematics education (National Council of Teachers of Mathematics, 2000). Word problems embedded in culturally and linguistically familiar situations allow young children to use what they know about the world to make sense of mathematics and learn with understanding (John-Steiner & Mahn, 1996; Carpenter, Ansell, Franke, Fennema, & Weisbeck, 1993; Hiebert & Carpenter, 1992). Students from diverse backgrounds, however, may not have equal access to reform mathematics curricula (Lubienski, 2000; Carey, Fennema, Carpenter, & Franke 1994). Latino immigrant children in U.S. schools deal with issues of culture, class, and language that affect their opportunities for full participation in problem solving activities (Trueba, 1999). This study explores what first grade, Spanish-speaking, Latino immigrant students can accomplish when they have repeated opportunities to solve problems and communicate their thinking in a native-language learning environment. Specifically, we show how children talk, draw, and write about word problems based in familiar contexts. Problem types used for the study were drawn from Cognitively Guided Instruction [CGI] (Carpenter, Fennema, Franke, Levi, & Empson, 1999).

Research Design and Methods

Researchers and teachers collaborated to design and implement problem solving lessons in two first-grade bilingual classrooms. For a period of one year we engaged in co-teaching mathematics lessons in Spanish with the purpose of developing students' problem solving strategies and their abilities to communicate their mathematical reasoning. In these lessons we worked with the teachers to contextualize word problems for young students (Carpenter et al., 1999).

Two bilingual first grade classes from an elementary school in a city in the Southwestern United States participated in the study. The school population is identified as Hispanic 86.3%, Native American 6.4%, Anglo 4.3%, African American 1.5%, Asian 0.8%, and other 0.9%. The majority of the students in this school speak Spanish, come from low socioeconomic backgrounds, are Mexican immigrants, and 99.1% of the students receive free or reduced price meals.

Data were collected on a purporsefully selected group of eight focal students, two boys and six girls. The criteria to select the students were: 1) they had participated in a CGI problem solving study the previous year (Turner, Celedón-Pattichis, Marshall & Tennison, in press), and 2) their first grade teachers agreed to receive classroom-based professional development on the CGI approach to teaching mathematics.

Lamberg, T., & Wiest, L. R. (Eds.). (2007). Proceedings of the 29th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Stateline (Lake Tahoe), NV: University of Nevada, Reno

Data collection focused on how first grade students learn to solve CGI word problems and communicate their mathematical thinking. This process involved pre and post student assessments in the form of individual video taped clinical interviews where students were asked to solve CGI word problems using manipulatives or paper and pencil and to explain their solutions. The problem types were similar to those used by Carpenter et al. (1993) and included Join, Separate, Compare, Multiply, Divide, and Multi-step problems. Focal students were also videotaped three times solving CGI problems in pairs and in groups of four to observe the effects of peer interactions on students' problem solving strategies and communication. Weekly field notes recorded focal students' words and actions during mathematics lessons and their drawings were collected from these sessions.

Data analysis involved open coding and axial coding (Creswell, 1998) of students' strategies, verbalizations and drawings. Codes were consolidated into categories and themes.

To ensure that teachers had support in problem-solving lesson development, researchers and teachers debriefed after each weekly lesson to discuss students' reactions to the day's problems, strategies students used to find solutions, the obstacles students encountered, how students communicated their thinking, and how student understanding could be assessed. Based on these conversations, the lesson for the next week was planned. These debriefing sessions were audio taped.

Preliminary Findings

The data from this study demonstrate that young Spanish-speaking immigrant students can successfully engage in key processes of reform mathematics when they have the opportunity to make sense of word problems by building on what they already know culturally and linguistically about the world. We found that:

- Students developed confidence and flexibility in problem solving and successfully solved a range of problem types not usually introduced in first grade including multiplication, division, compare and multi-step problems.
- Students developed increasingly sophisticated ways of talking about their mathematical understanding in their native language, Spanish, and for some, in their second language, English.
- Students' conceptual development went hand-in-hand with more flexible thinking and their ability to use more than one method to find a problem solution.
- Students demonstrated growing networks of mathematical understanding, but this growth was nonlinear with many concepts still partially or superficially developed and connections among concepts weak.
- Students' pictorial representations of problem solutions gave a valuable window into student thinking and showed both insights and gaps in student understanding.

Implications and Recommendations for Future Research

When students had repeated opportunities to solve problems and explain their thinking, they developed a flexible set of strategies and approaches that showed they were learning mathematics with understanding (Hiebert & Carpenter, 1992). This level of success would not have been possible without access to their native language and culture to make sense of the mathematics involved (Trueba, 1999). Although students were highly successful, the findings also show that all students, even the most advanced, need multiple exposures to concepts and repeated opportunities to practice with a variety of problem situations so that their growing knowledge base can become more secure. Along with multiple problem solving opportunities, teachers should give students multiple opportunities to demonstrate their thinking in order to truly uncover the depth of student understanding.

This study confirms the importance of exploring students' mathematical thinking and problem solving development. Specifically, the longitudinal data show the central role of non-linear concept formation among primary grade students and the importance of developing students' mathematical discourse to help them organize and consolidate their thinking (NCTM, 2000). Because representation gives valuable insight into student thinking, further research is needed to provide more evidence on how students represent increasingly complex problem types.

Endnote

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