EFFECTIVE TEACHERS OF SECOND LANGUAGE LEARNERS IN MATHEMATICS

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This paper presents an overview of findings of an ongoing project to identify teachers who demonstrate effectiveness in teaching mathematics with minority second language learners. The objective of the study is to better understand the processes of instruction that contribute to positive student achievement in the subject. The study rests on the assumption that the teacher is a critical factor in student learning given the teacher's role as a more experienced other and as the engineer of learning environments. Data for the study include classroom-based observations and videotape analyses of teachers from two different geographical sites. This discussion will summarize the common characteristics among the teachers. Findings strongly suggest that key elements in teaching cannot be taken for granted.

In many classrooms, in primary through secondary level schools, in various parts of the world, there are a growing number of students whose home language and/or more proficient language is other than the dominant language of instruction. These students are second language learners (SLL); they enter school needing to develop or improve academic proficiency (Cummins, 1981) in the dominant language of institutions, government, and power. In many contexts, these same students are members of groups who have a history of underachievement and underrepresentation in educational areas that are particularly associated with basic social prosperity and advancement. In countries such as South Africa, the educational issues and success of the majority of second language learners are strongly connected to the country's overall political well-being. In the United States, the ethnic and linguistic demographics of classrooms have significantly changed over the last thirty years; so much so that a teacher can no longer assume that all students will speak English or will be sufficiently proficient in all modes of the language to participate fully and equally with other students who are native English speakers. This discussion will focus on the USA context; however, as just noted, the findings and implications of this work extend to other contexts and other SLL groups.

The work presented here is primarily concerned with issues related to the educational achievement of Latinos, and specifically students of Mexican descent. In the USA, this group is disproportionately low-income, has one of the highest rates of non-completion of high school and has had a long history of underachievement in mathematics. Consequently, the improved schooling of Latinos, particularly in mathematics is a major concerned for the educational community. In the recent decade, there has been much discussion about the relationship among Latinos' predominant characteristic as English language learners, communication processes in classrooms, and mathematics achievement (Secada, 1992; Khisty, 1999). Indeed, there are clear and obvious connections

between the clarity and comprehensibility of mathematical talk (both oral and written) in a second language and a student's ability to function with the talk to learn mathematics. In essence, a linguistically and culturally sensitive learning environment is highly relevant to second language learners' success in mathematics (Ortiz-Franco, Hernandez, & De La Cruz, 1999). We know generally what constitutes these effective learning environments. For example, connecting student experiences to mathematical problems makes them easier for second language learners to comprehend (Khisty, McLeod, & Bertilson, 199?). However, we still do not know enough about how teachers actually enact these supportive learning environments. A study was conducted to identify effective teachers of mathematics with second language learners, specifically Latinos, in order to better understand the classroom processes that seem to contribute to students' learning of the subject. This discussion draws upon part of the study and focuses on common characteristics found among a group of teachers. Two teachers who were found to be exceptional will be highlighted specifically by examples from their classrooms.

Theoretical Framework

The study is based on some key assumptions. First, that learning is a social activity; that higher psychological functions originate in human interactions and activity (Vygotsky, 1978). Second, these sociocultural activities are mediated through the use of cultural artifacts, tools, and symbolic systems, especially language, thereby implying a reciprocal relationship between the cultural and the intellectual. What is important here is that how and why these artifacts are used mediates how humans come to think with them (Moll, 2000). Third, sociocultural activity, or interaction, forms the context in which children participate and from which they appropriate tool use and cultural thinking. From this, we can assume that the "more experienced other" with whom children interact is highly relevant to their learning. The "more experienced other" is the person (be it parent, teacher, older sibling or peer) who initiates and assists the "less experienced" ones in learning; it is the "more experienced other" who provides the relationship between development and the cultural resources or tools that produce that development (Moll, 2000). However, this perspective does not suggest interaction or activity as an imitative set of dynamics. In former views of teaching, the teacher was seen as the subject and agent and the learner as the object and patient. On the contrary, if we observe normal human interactions, we can see that there is joint activity with teacher and students as co-constructors of the interaction. In summary, as Moll (2000) points out: "Social relationships are the key to the mental and personal development of individuals. The very mechanism underlying higher mental functions is a copy from social interactions" (p. 30).

Given the foregoing, the focus of the study was on the teacher, defined as the "more experienced other", and the primary person in the classroom from whom students would appropriate critical aspects of mathematics learning. It was further assumed that by observing effective teachers, it would be possible to

identify key aspects of their instruction as they enacted them. Teaching is such a complex activity that often teachers are not aware of all of what they do or say as they instruct. Furthermore, there are times when there is incongruence between what one says one believes about instruction and what one actually does. Ongoing observations of teachers during instruction would more accurately capture the relevant elements.

Methods and Data

This work began several years ago in one middle-size city in the west coast region of the USA and was continued in a large urban area of the Midwest. Both areas have large populations of Latino second language learners, and many schools (at all levels) could be found to have enrollments that were very near 100% Latino. In both areas, a search for effective teachers of mathematics with Latino second language learners began with identification of schools that had high standardized test scores in mathematics. Principals in these schools then were asked to recommend teachers who had demonstrated consistent ability to develop students to do well on the tests in this subject. Once a pool of teachers was identified, they were initially observed to determine if they fit a profile of effectiveness. Effective was determined on two levels. First, did the teacher have a history of significantly moving students ahead academically, i.e., having students who scored at or above grade norm ? Did students with this teacher demonstrate significant growth in mathematics as measured by standardized tests? Second, did the teacher model instruction that was consistent with general notions of best practices? Interestingly, there were not many schools in either area that both had high populations of Latino second language learners and high test scores in mathematics. Generally, most teachers who were initially identified produced occasionally only small gains or had students who usually fell just short of a standardized norm.

A pool of five teachers was finally selected for observation. All teachers had a history of their students gaining two to three grade levels during the year with them. In all cases, most of the teachers' students entered below grade level and left, a school year later, one to two grades above norm on a standardized test. One teacher was at second grade, two were at fifth grade, one was at sixth, and one was at eighth grade. Each teacher was observed using fieldnotes and was also videotaped for at least twenty hours of mathematics instruction. Some observations were conducted on consistent days to capture a fuller development of a mathematical concept and the rest were done intermittently to capture different parts of the school year's teaching and learning. While other types of data were collected as supporting or elaborating documents, the videotapes are the primary source of data. The videotapes were analyzed for relevant patterns in the teachers' instruction without any *a priori* determined set of elements. Teachers were informally interviewed about their instruction when additional clarification or elaboration was warranted. This discussion focuses on common characteristics or elements shared by all five of the teachers.

Shared Characteristics of Effective Teachers

The five teachers of this discussion shared some striking similarities in their instruction of mathematics with second language learners. The teachers did not teach in the same school or know each other. Two of them were fluent in Spanish but only one taught primarily in Spanish. The different use of Spanish was due to school program demands and not to the teachers' belief of the importance of the primary language in learning. The other teachers only spoke English but used various methods to incorporate Spanish in the classroom in order to facilitate students' learning. All of them had ten to fifteen years or more of experience teaching with second language learners. Only two of them had a concentration of college coursework in mathematics or mathematics teaching. In what follows, I will describe the aspects of their teaching of mathematics that seem particularly relevant to students' success. Examples from two teachers in particular, one second grade and the other fifth grade, will be used to highlight some of these characteristics.

Writing mathematics. First, at a time when reforms in mathematics have emphasized connections between this subject and other disciplines (NCTM, 2000), very little has changed in terms of using writing to develop mathematical concepts and understandings. Yet writing is clearly a process that can support and advance student thinking. It helps to bring order out of chaos in one's thinking (Halliday & Martin, 1993). In these classrooms, writing mathematics was a constant and natural part of the mathematics curriculum. In the second grade classroom, the teacher used writing addition and subtraction problems to teach not only mathematical literacy, concepts, and skills, but also general emerging literacy skills. Practice spelling lists included mathematical terms and students learned letters, sentence structures, and conventions such as punctuation in the context of reading and composing their own mathematical word problems and explanations. For example, when students completed composing their problems, they brought their work to the teacher who sat a group of students' desks. She would read aloud each piece of writing and comment on both the fluency of the writing and the mathematics in the problem. She also edited the writing with language corrections and send the student back to make the necessary revisions. All writing was kept in a student's own writing book, and often, a student's piece of work would be used to demonstrate to the whole class some particular aspect of writing and the structure of language they all needed to learn.

In a fifth grade class, after some work on developing understanding of a particular concept, for example, finding the missing leg of a right triangle, students had to write to a fictitious person telling them how to do a problem using the concept (Chval, 2000). This writing was revised at least five times with each draft having dialogue-type comments from the teacher. These comments were usually in the form of questions from the teacher asking for clarification on

specific aspects of the problem solving process. All comments from the teacher were detailed and clearly designed to guide the student's thinking and writing mathematically. It was not until the final draft that comments referred to issues of conventions of writing such as choice of words, spelling, and punctuation. Examination of samples of student writings over the several drafts strongly suggests how powerful writing and teacher's guidance through the process can be in learning mathematics (Chval, 2000).

Mutual support among students. Another characteristic among all the teachers was their development of mutual support among the students. All the teachers preferred to have students work with each other in pairs and encouraged the fluid movement of students such that, as needed, a student might move to join another pair to form a group of three or several students might form a larger group. Consistently, what determined the movement among students was the need to seek additional input on how to solve a problem or to get an additional check on the correctness of the answer. Sometimes a problem was so difficult that several students gathered to figure it out. Two things are particularly significant about this. First, the organization of students is different from what is often thought of or enacted for active learning and groupwork. Too often, teachers' understanding of groupwork means that students are organized into groups of three to five students who are to work together on a problem. The study's teachers felt that groups of three or more students hindered learning since mathematical problems were usually a task that could be accomplished individually thus not fitting the nature of groupwork. However, they did believe that good learning came from students talking together. Second, because of this belief, the teachers' focus became not the organization of students but rather students' sense of responsibility to help one another understand the mathematics. Therefore, a good deal of time was spent setting and reinforcing this culture. In the following example from the fifth grade teacher (Chval, 2000), we can get a glimpse of the development of this culture:

> Teacher: Alejandro wasn't participating because he never asked for help. So somebody over here. Anybody. You move around. I'm only one person. Move around quietly and ask each other. You can teach each other. Walk around. Help each other. I can't help all of you at the same time.

This kind of norm was not something taken lightly; in fact, establishing it was an integral part of the overall curriculum. All students were socially identified as having particular skills and expertise that could be tapped; at the same time, all students had to take initiative to help if someone else seemed to be having trouble. The organization of students into groups became secondary to the idea of mutual sharing of knowledge and willingness to help others learn.

High expectations. All the teachers also had high expectations for their students that were *actually* manifested in the curriculum. Much has been said over the last several years about the importance of high expectations for improving the learning of underachieving minority students (e.g. Dusek, 1985). However, too often this is a hollow belief with little evidence of it in teaching. This was not the case with these teachers. For example, the fifth grade teacher began the school

year with problems revolving around a right triangle such as finding a missing leg when other sides are known. The year was spent on other themes in geometry such as measuring circles and rectangles. This is extremely unusual work for fifth grade minority students who too often start the school year one to two grade levels below norm--as was the case with this particular class. Many years experience conducting staff development with practicing teachers has demonstrated to this author that teachers tend to misinterpret the educational dictum of "beginning with what the students know" to mean starting with mathematical basics. Too many teachers would have decided that geometry was too advanced for the students and would have taught a remedial program. This teacher like the others in the study defined her task as supporting and guiding her students in such a way that they would grasp whatever curriculum she gave them. That the students were below grade level norm did not deter her from teaching an "advanced" curriculum. Interestingly, like the other teachers' classes, outsiders assumed these students were part of a gifted class (Chval, 2000). While the idea of high expectations for students seems like an outdated one, these teachers demonstrate that it is still highly critical for the success of minority second language learners in mathematics.

Contextualization of mathematics. The teachers in this study were all very skillful at contextualizing mathematics. They saw contextual support as a critical tool for developing students' comprehension of mathematical ideas and practice, and accomplished it through a combination of all of the following: drawings, concrete objects, stories that came from students, students' experiences, and presenting everything said in written form so that students did not rely on listening for learning. Students in all the classes spent a good deal of time constructing models such as making three dimensional geometric shapes or cutting paper to show operations with fractions. In one example, in order to reinforce the ideas of perimeter and area, the fifth grade teacher had students stand next to some grouped tables in such a way that their bodies only touched the perimeter of the tables. Then the students were asked to sit on the tables so that they did not touch the perimeter and touched only the area. Such physical demonstrations were a frequent activity to ensure that students both would not forget the ideas being taught and would have a physical image to support the ideas. It is easy to assume that contextualizing mathematics is a good thing but not critical to mathematics learning. These teachers believed just the opposite. Contextualization in as many ways as possible was deemed to be the key to their students' comprehension, and therefore their learning. Creating a highly contextualized learning environment is also a key principle of effective instruction for second language learners in general (Cummins, 1986). Therefore these teachers were integrating what they knew about learning in second language with their mathematics teacning.

Pedagogic talk. While some of the teachers used only English for instruction and others used both Spanish and English, they were all highly mindful, but not necessarily conscious, of their pedagogic talk. They used their

talk such as probing questions and statements, both oral and written, as a tool for learning much like manipulatives. They all recognized that their students had thoughts about what they were learning but did not have words to describe those thoughts. Their task was to give the students the means to express their thoughts. However, the teachers believed this occurred by students appropriating what they frequently heard. Consequently, the teachers' talk was very deliberate but not unnatural; it also was very rich in terms of vocabulary, and students after a time could be heard using the same words and phrases appropriately. For example, the fifth grade teacher in one lesson used the word "congruent" over forty times but not in a repetitive manner. In the following excerpt, again, we can get a glimpse of how "congruent" is brought into students' environment and repertoire.

> Tch.: I have two congruent triangles here. Two equal parts, two exact triangles. I want only the area of my original triangle, ACB….[several teacher and student exchanges occur] Would you please read that, Julia?
> Julia: The triangle and its…
> Tch: Congruent
> Julia: Congruent [struggling]
> Tch: Look at that word everyone. Congruent. What does that mean? [students offer explanations which the teacher incorporates into her talk. Several exchanges later]
> Tch: They appear to be congruent to each other. I agree. They appear to be congruent. But this one and this are not congruent, are they?

All the teachers also were exceptionally skillful in guiding their students' thinking by the use of key questions, ones that would challenge and extend students' thinking. Overall, there were few lower level fact or knowledge questions. In this example, the class as a whole is reviewing how they solved finding the area of a rectangle. A student has offered only the correct numerical answer, and the teacher responds in a supportive manner: "I don't care what the number is. What does that number represent? What does it mean?" Such emphasis on asking for meanings punctuated all of the teachers' talk to an overwhelming degree. It should be noted that these types of questions served to both develop students' thinking

Conclusions

The purpose of this discussion was to highlight common characteristics of teachers of minority second language learners, teachers who had a clear record of being effective in significantly improving their students' learning of mathematics. The findings point to the importance of engineering supportive and linguistically sensitive learning environments, and that teachers' talk is critical to this process. However, it is not just any talk but talk that is carefully and meaningfully used as a teaching tool. It is talk that encourages students' positive appropriation of mathematics thinking and knowing. The teachers in this study also point to how important it is to integrate knowledge bases. In one way or another, they drew on principles of effective second language acquisition and literacy development, and incorporated these principles into their mathematics teaching. Observations of these teachers also suggest that it is important to ensure that teachers garner

accurate images of innovations. These teachers did not adopt the too common version of groupwork that is often found in classrooms whereby three to five students are physically gathered to work together. They, instead, recognized that the essence of groupwork centers around students talking with one another to share knowledge. This meant developing students to understand how important it is to support each other. Lastly, in essence, these teachers demonstrated that it is very viable to teach underachieving students as if they are gifted, that these students do not have to start at the very beginning because they did not learn the first time around. Ideas such as manifesting high expectations for students by teaching them advanced skills may be "old hat" in terms of research, but the effects of low expectations operate still in classrooms.

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