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ABSTRACT

The new emphasis on communication of ideas and problem solving in mathematics teaching places an additional burden on limited English proficient (LEP) students with relatively poor language skills and their teachers. This research addresses the question of how students' language proficiency affects teachers' assessment of students' mathematical understanding. Participants were 20 intermediate grade teachers who taught both LEP and non-LEP students. Qualitative analysis of tutoring sessions between teachers and LEP and non-LEP students reveals that teachers teach differently with each group and know less about LEP students' mathematical understanding than non-LEP students' understanding. Quantitative analysis of teachers' predictions of students' success on a test of fractions indicates that teachers underestimate the success of LEP students more than they underestimate the success of non-LEP students. Staff development for teachers of LEP students should include their own examination of how they teach and their underlying assumptions about students' understanding. (Contains 5 figures and 35 references.) (SLD)

Mathematics Reform, Language Proficiency, and Teachers' Assessment of Students' Understanding

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Abstract

National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (1989) is currently inspiring curriculum that challenges students to develop conceptual understanding as well as basic skills within active learning environments. While this reform in education is much needed, implementation of its increased emphasis on communication of ideas and problem solving drives curriculum that is increasingly language based. This new dependence upon language places more burdens upon limited English speaking students and their teachers who already lack sufficient support. However, the mathematics community's important goals should not be decreased for LEP students to be successful. Instead, clear definition of the current environment for LEP students needs to be established so that sufficient support can be provided teachers so that they can be effective with *all* of their students. This research is one step in that direction. Through examination of teachers assessment of students' understanding and their interactions with both LEP and non-LEP students I find that there is sufficient reason to be concerned. Qualitative analysis of tutoring sessions between teachers and LEP and non-LEP students revealed that teachers teach differently with each group of students and know less about LEP students' mathematical understanding than non-LEP students' understanding. Quantitative analysis of teachers' prediction of students' success on a test of fractions indicates that teachers underestimate LEP students' success more than non-LEP students. Further research needs to continue to clarify the impact of mathematical reform on LEP students. Staff development for teachers of LEP students needs to include teachers' examination of how they teach and their underlying assumptions about students' understanding.

Mathematics reform inspired by Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) and other similar documents demand that 21st Century classrooms focus less upon computational skills and more upon students' ability to communicate their reasoning, write explanations of their process, and solve complex problems. Due to increased emphasis on communication of ideas and problem solving, new curriculum developed under Standards' guidelines *demands a much greater command of language skills* than previously required for success. The new dependence upon oral and written language places more burdens upon limited English proficient (LEP) students in mathematics classes. In spite of its important and inclusive goals, therefore, implementation of Standards may adversely affect immigrant populations. HOWEVER, emphasis on communication should NOT be decreased for LEP students to be successful. Implementation of mathematics reform is necessary to develop citizens of the 21st century and can benefit *all* students. Instead, communication should be encouraged and supported by, among other things, ensuring teachers' accurate assessment of LEP students' mathematical understandings. Ultimately, the important question is: how are the over 2.1 million limited English proficient students in today's schools impacted by these reform efforts?

Some believe in the premise that students' level of English language comprehension is not a significant factor for students who are learning mathematics (Kessler, Quinn, & Hayes, 1985; Kimball, 1990). Yet, much has been written about how mathematics is not a universal language (Ramirez Corpus Mather & Chiodo, 1994; Secada, 1983) and that there is a significant relationship between language skills and mathematics (Aiken, 1971; Cocking & Chipman, 1988; Cuevas, 1984; Dawe, 1983, DeAvila & Duncan, 1981; Garcia, 1991). Furthermore, Cornell (1995), points out that, particularly with budget reductions, LEP students are increasingly placed in mainstream classrooms rather than in English as a second language classrooms or

pull-out programs. Forty-two percent of all public school teachers have at least one LEP student in their classes. Yet, only thirty percent of those teachers has received training for teaching LEP students (Han, M.; Rodriguez, C.; & Quinn, P., 1997). Support for teachers is clearly needed.

While studies mentioned above have examined disparities in the standardized assessment of minority mathematics achievement due to language factors, no known studies have focused upon the impact that language may have upon teachers' assessment and knowledge of students' understanding in mathematics. Therefore, in an effort to begin to define the impact of mathematics reform upon teachers and their LEP students, this research addresses the question *"How does students' language proficiency affect teachers' assessment of students' mathematical understanding?"* Answers to this question may help educators effectively address the needs of LEP students in their classrooms as they engage in reforms called for by mathematics' Standards. The following rationale for the present study addresses the significant impact that language proficiency may have upon teachers who are trying to ensure success of all students in a mathematics reform environment and the importance of teachers' assessment within that environment.

The Importance of Language Proficiency

Since *Brown v. Board of Education* in 1954, research documenting the disparity in effectiveness of education in the United States for non-white students has grown tremendously. Nevertheless, the dropout rate among Hispanic students currently stands at 40-50 percent in comparison to 14 percent for whites and 25 percent for blacks (Garcia, 1991). Also, LEP students tend to receive lower grades, score below their classmates on standardized reading and mathematics tests, and are often judged by their teachers as academic "underachievers" (Moss and Puma, 1995)

Issues regarding LEP students are increasingly significant throughout the nation. The number of LEP students has nearly doubled in the past decade and the

growth is expected to continue. Forty-two percent of all public school teachers have at least one LEP student in their classes (Han, et al., 1997). While numerous studies identify the lower achievement in mathematics of language minority students (Cocking & Chipman, 1988; Secada, 1992), only recently has research concentrated on the effects of language proficiency on mathematics achievement. A number of studies have identified evidence for a significant, positive correlation between math achievement and verbal ability (Aiken, 1971; Cocking & Chipman, 1988). Also, DeAvila and Duncan (1981) and Fernandez and Nielsen (1986) found a significant relationship between Hispanics' English proficiency and their mathematics achievement. This research extends those efforts into the realm of teachers' assessment within the classroom.

Assessment is Integral to Instruction

While the numbers of limited English proficient students and their struggles for education increase, important mathematics reform is taking place. As a part of that effort, mathematics reform-minded documents such as Professional Standards for Teaching Mathematics (1991) and Assessment in the Mathematics Classroom (1993) prescribe that "Instructional activities should be based on information obtained from assessing students' mathematical understanding" (NCTM, 1991, p. 110). Also, teachers' accurate assessment of students' understanding is "a critical link in the educational process" and is essential to effective instruction (NCTM, 1993, p. 3). Knowing assessment's stated importance, if teachers inaccurately or incompletely assess students' understanding, then they will likely build incomplete models of students' understanding in their minds and base their instructional decisions upon faulty information, perhaps adversely affecting students' education.

The teacher effectiveness literature indicates that an important area of concern is instruction based on teachers' development of mental models. Studies describe effective teachers as consistently monitoring students' progress (Brophy and Good,

1986), understanding variations in ability and background of students (Shulman, 1987), and knowing whether their students could solve different problems (Carpenter, Fennema, Peterson, and Carey, 1988). Effective teachers use this knowledge to inform their instruction. Accordingly, the purpose of this comparative analysis of teachers' assessment of LEP students and non-LEP students is to help teachers learn about the complex dynamics involved when assessing and developing their mental models of LEP students' mathematical understanding so they can be more effective in their instruction in reform-minded classrooms.

Examining Teachers' Assessment of LEP Students' Mathematical Understanding

In order to study how language proficiency affects teachers' assessment of students' mathematical understanding, I studied twenty teachers who were enacting the NCTM Standards and reform-minded curriculum in their classrooms. Each teacher used the mathematics replacement unit Seeing Fractions, developed by Technical Educational Research Centers (TERC) and published by the California Department of Education. The teachers, who taught fourth, fifth, or sixth grade classes with a mixture of LEP and non-LEP students, had been trained in Specially Designed Academic Instruction in English (SDAIE) for limited English proficient students. Through three sets of data--videotape of students and teachers' interaction in a controlled tutoring situation; individual stimulated recall interviews with teachers; and teachers' prediction of students' success on a post-unit fractions test--I examined teachers' assessment of LEP students mathematical understanding.

Overall, results indicated that there is reason for concern regarding teachers' instructional practices with LEP students in mathematics reform-minded environments. Specifically, due to teachers' instructional practices, there are differences in the quantity and type of information available to teachers regarding LEP and non-LEP students' mathematical understanding. Each of the three sets of

data contribute to the picture that much more staff development needs to be done to ensure success for teachers and LEP students.

Tutoring Sessions

In the videotaped tutoring session, which was the heart of this research, ten of the twenty teachers were selected to tutor two students. One of the students was classified by the district as Limited English Proficient (LEP) and the other student was classified as fluent English speaking. Therefore, this procedure yielded 10 LEP student subjects and 10 non-LEP students for tutoring. A stimulated-recall interview followed the tutoring session to examine evidence teachers use for assessment. In analysis of each set of data, I explored possible differences in teachers' interaction and assessment of LEP and non-LEP students.

While teachers made sincere efforts to adhere to the ideals of the Standards agenda and engage students in problem solving during tutoring sessions, I observed very little mathematical conversation taking place and therefore hardly any information available for teachers regarding students' understanding. Of greatest concern are the inequitable patterns in teachers' questioning practices, LEP students' responses, and students' use of manipulatives that characterized the tutoring sessions.

Teachers' questioning practices during tutoring sessions.

The Professional Standards for Teaching Mathematics (1991) encourages teachers to "orchestrate discourse by posing questions and tasks that elicit, engage, and challenge each students' thinking (and) listening carefully to students' ideas" (p. 35). Teachers typically use questioning for assessment or extending students' thinking. Yet, further examination of teachers' interaction with students in tutoring revealed distressing patterns in teachers' questioning practices. Teachers ask more of what I describe as "unanswered questions" of LEP students than non-LEP students.[1] That is,

[1]see Rhine, 1995 for an example and a more detailed description

teachers ask LEP students more questions in chains than non-LEP students without expecting or waiting for answers (Figure 1). In this pattern of unanswered questions, teachers allow very little wait time (less than two seconds) before asking the next question; asking up to eight questions in succession before any verbal response from the student.

Each teacher in the study used this pattern of asking questions in a chain without wait time or response by the student, although more extreme in some cases. This result may seem intuitive, as LEP students might feel less confident in answering questions because of their limited English language skills. However, this explanation is not suitable in these tutoring interactions because unanswered questions were stated one after another, with less than two seconds of wait time, implying that teachers did not intend for the students to answer them. Therefore, teachers' questioning differed in terms of LEP students' opportunity to respond.

Insert Figure 1 about here

One goal of mathematics reform is that students are engaged in complex problem solving. It is clear from the interviews with teachers that this phenomenon was an attempt to implement strategies encouraged by the Standards--that is, facilitating students' thinking through questioning rather than simply providing them with the answer. However, a concern raised by this use of questioning is the reduction of cognitive demands on students. For example, in one interaction with a student, a teacher starts out with a complex mathematical question: "How would you divide it (the circle) into six?" This question is gradually reduced, in a succession of questions, without a contribution from the student, to "How do you cut a pizza?" The

teacher in this example may be attempting to facilitate LEP students' access to the problem by reducing the complexity of the language of the original question in order to scaffold the student's learning. Many of the questions that teachers ask in question chains are very similar to each other, varying only subtly in information, but significantly in wording. Yet, the LEP student may not understand the subtle differences in the questions and struggle with the overload of language rather than having the opportunity to struggle with the mathematical ideas.

These unanswered questions may have more impact upon LEP students than upon non-LEP students because many students who have English as a second language need to translate back and forth between languages in their mind--translating questions to their primary language, formulating answers, and then retranslating back into English. This translation is particularly problematic because, as Ron (1997) describes, there are certain content specific topics, such as mathematics, in which specialized vocabulary facilitates thought. Students typically learn the majority of their mathematics in one language and therefore lack the specialized vocabulary in their second language, making translation awkward at best.

While teachers may not expect students to process certain questions, LEP students may not be skilled in determining when they are expected to answer a question. Students may get lost in the translation and answer formulation while teachers are off in a new direction in their questioning. Further research should examine whether teachers have a tendency to reduce the cognitive complexity of questions more with LEP students than with non-LEP students and whether this is an effective strategy or decreasing appropriate challenges for LEP students.

If teachers are increasing their use of questions as a tool for developing students' conceptual understanding of mathematics, clearly they need professional development in the effective formulation and use of those questions. Dantonio (1990), for example, suggests a four-phase training cycle in which peer observers

and coaches are used to assure classroom transfer of the questioning processes. In addition, teachers need support in determining what to do with students' responses to questions, particularly in the case of LEP students who may have difficulty communicating the mathematics they understand or don't understand in English. For example, SDAIE strategies such as use of manipulatives, drawings, and less language dependent forms of communication may facilitate teachers' assessment and instruction with LEP students.

Students' response patterns during tutoring sessions.

In spite of math reform's goal of increasing students' communication of their ideas, analysis of the tutoring sessions revealed that teachers spoke almost four times as many words as students spoke, and asked ninety-six percent of the questions. Sixty percent of students' talk consisted of one to two word sentences, so there was very little verbal information for teachers to use for assessment purposes. Through more detailed analysis of students' response patterns I discovered that LEP students spoke significantly less sentences three words or over than non-LEP students (Figure 2). LEP students therefore gave less elaborated verbalizations during tutoring than non-LEP students. Overall, this indicates not only limited availability of a quantity of information about LEP students' understanding to the teacher, but also the type of

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Insert Figure 2 about here

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information available to the teacher for assessment. LEP students spoke less extended sentences, which implies that teachers focused primarily on brief or "correct answers" rather than on students' elaboration of their reasoning to inform their assessment of the student's understanding. This pattern of interaction is indicative

of mathematics instruction that is more traditional than reform minded, more fact focused than understanding focused.

Students' extended communication of their mathematical ideas not only facilitates teachers' assessment but forces students to clarify and organize their thinking. According to the Standards:

> Communication plays an important role in helping children construct links between their informal, intuitive notions and the abstract language and symbolism of mathematics; it also plays a key role in helping children make important connections among physical, pictorial, graphic, symbolic, verbal, and mental representations of mathematical ideas (NCTM, 1989, p.26).

As LEP students spoke less elaborated sentences, it implies that they have less opportunity than their non-LEP counterparts to construct the type of connections described in the Standards. These links lead to the deeper conceptual understanding that is the goal of mathematics reform. When teachers develop techniques such as posing probing questions and requiring students to explain their thinking they increase the communication and thoughtfulness of their students. Webb (1991) found that when students give content-related explanations, their achievement increases. In fact, she also discovered that students who were just told the correct answer to a problem decreased in their achievement. Professional development which aims to promote reform-minded skills, such as having students give explanations of their reasoning, should also help teachers become aware of possible language influenced discrepancies in their implementation of these techniques with LEP and non-LEP students, such as those observed in this research.

Manipulative use during tutoring sessions

Given the diminished amount of oral information about LEP students' mathematical understanding available to teachers, I also examined students' use of

manipulatives (i.e. unifix cubes, fraction circles, cuisennaire rods, etc.) as another source of information available to teachers during the tutoring. The NCTM Standards encourages manipulative use in elementary grades in order to help develop conceptual understanding and bridge the gap between concrete and abstract understanding of mathematics. Manipulative use is often touted by parents and teachers alike as evidence of progressive mathematics instruction. Further, manipulatives are typically advocated as mathematical tools and communication bridges during inservices with teachers of LEP students such as SDAIE.

However, contrary to what one might expect with these SDAIE trained teachers, I found that non-LEP students used manipulatives during tutoring significantly more than LEP students (Figure 3). Manipulatives can be used as a means for LEP students to communicate their ideas about mathematics in a way that is not as language dependent. In a survey following the study, teachers typically described how they tried to adapt to LEP students' language limitations by using manipulatives more to facilitate their communication and learning of mathematical ideas. Yet, in spite of teachers' beliefs about manipulative use, their instruction actually had the opposite impact--LEP students used manipulatives less than non-LEP students.

Insert Figure 3 about here

Manipulatives are often presented in mathematics inservices and workshops as ways of facilitating students' learning. However, Ball (1992) points out that teachers do not have "adequate opportunities for developing their thinking about them as one of several useful pedagogical alternatives" (p. 17). Teachers have very little training with or discussion about manipulatives and therefore little understanding about the appropriate use of different concrete materials under different

circumstances with different students. Adequate support and training of teachers on the use of manipulatives in reform-minded classrooms, particularly with LEP students, may facilitate communication between students and teachers about mathematical ideas and therefore alleviate the disparity found in this study. This phenomenon should be examined more closely in future research. Effective preparation of teachers with SDAIE must include efforts to more closely match teachers' beliefs and new understanding of strategies with their instructional practice.

Teacher and Student Interviews

The previous set of data regarding teachers' questioning practices, students' responses, and students' manipulative use implies that teachers in reform-minded classrooms often acquire less substantive information about their LEP students' thinking than about their non-LEP counterparts. For the second set of data I interviewed teachers in a stimulated recall process as they watched videotape of their tutoring session which provided the opportunity to elicit what teachers were thinking in regard to assessment of their students' understanding.

Forming general character descriptions of people seems to be human nature. Categorizations such as "Eva is smart" or "Michael is witty" are often part of everyday conversation. Interviews with teachers indicate that the same appears to be true in the classroom. Teachers not only form these general character descriptions, but use them as the basis for their assessments. Character assessment is apparent in this study as well.[2] Teachers use phrases such as "I know Gerry" and "He's a slow learner" as evidence for their opinions about students' understanding. These words imply that the teacher's assessment of Gerry's understanding of comparing fractions is based upon her previous experience with him and her general understanding of

[2]see Rhine, 1995 for detailed description of teachers' use of character assessment in the study

his character rather than observation of Gerry's actions or his explanations of his thinking during the tutoring. Teachers' integration of their prior experience with students into their current assessment is an important skill. However, not if the prior experience inhibits their current observations and assessment. In this study, teachers would typically not use their observations of students' current efforts to support their assessment. Rather, they would use their general character assessment as evidence instead.

Teachers' also use character assessment of their entire class or children in general as a foundation for their interpretation of an interaction with a student. All teachers in the study often used statements about students in general (i.e., "they") when responding to interview questions about individual student's mathematical understanding. However, teachers in this study used significantly more generalized pronouns (i.e., "they", "their", "them", and "kids") when talking about LEP students' understanding. The graph in Figure 4 portrays the teachers' striking pattern of using more generalizations when they discussed LEP students' mathematical understanding than when they discussed non-LEP students' understanding.

Insert Figure 4 about here

Teachers' tendency towards generalizations when discussing their LEP students' understanding likely reflects their greater lack of specific knowledge concerning their LEP students' mathematics. In contrast, Carpenter, Fennema, and Loef (1992) found that when teachers have specific knowledge about students' understanding, their instruction is impacted in ways that cause students' achievement to increase. An important finding from this research, therefore, is that teachers develop assessment of LEP students' mathematical understanding on the basis of

generalizations much more than they do with non-LEP students which may impact teachers' instruction in ways that limit LEP students' achievement..

Teachers' Prediction of Students' Performance

What are the ramifications of teachers' apparent lack of information about LEP students' understanding? To explore this question I asked teachers to predict how well their students would do on a test of fractions. For each problem on the fractions test, teachers predicted whether each student would get the problem right or wrong. My analysis of these predictions revealed that teachers significantly underestimated LEP students' performance more than non-LEP students' performance (Figure 5). In other words, teachers believed that LEP students would get problems wrong that they actually got right much more often than with non-LEP students. These results continue to indicate that teachers know less about LEP students' understanding than they do about non-LEP students' understanding. Furthermore, lacking information about students' understanding, teachers may assume that LEP students don't understand the mathematics.

Insert Figure 5 about here

One possible explanation for this phenomenon is that teachers consider LEP students' limited understanding of English language complexity synonymous with their understanding of mathematical complexity--if they don't understand the language, then they don't understand the mathematics. This erroneous assumption may lead to results such as those found in this study. In a mathematics reform environment in which language is increasingly used to communicate ideas and thinking, this is an area of significant concern. If teachers consciously or unconsciously equate students' language proficiency with their mathematical

proficiency and thereby underestimate LEP students' mathematical understanding, are LEP students being challenged to their full potential? Additional research can examine this question as well as other ramifications of teachers' limited understanding of LEP students' mathematics.

Discussion

Mathematics reform obliges teachers to engage their students in the ideas of mathematics rather than just formulas. Students' development and communication of their conceptual understanding necessitates the use of language in ways that have not necessarily been required of students in the past. Teachers of mainstreamed LEP students are placed in the tenuous position of teaching math in new ways that are increasingly dependent on language to students who are limited in their English language use. Moreover, teachers have typically experienced mathematics instruction in their K-16 education that is almost exclusively rule based rather than idea based. As a result, we are often asking them to teach in ways they have not been taught.

Not surprisingly, my research findings indicate that there is reason for concern regarding teachers' current management of the dynamics between reform-minded classrooms and the needs of LEP students. However, some of the results are not intuitive, such as LEP students using less manipulatives than non-LEP students. Generally, discourse patterns during tutoring and interviews revealed that teachers did not accommodate LEP students' needs by varying their interaction with them, which resulted in an insufficient quantity and quality of their knowledge of LEP students' mathematical understanding. Specifically, teachers had less access to LEP students' thoughtful reasoning and conceptual understanding because their instructional practices did not encourage students to elaborate upon their thinking. Instead, students' short answer responses such as "yes" and "okay" implied a focus upon more factual information. This is problematic as Graesser and Person (1994)

point out that students frequently answer "yes" to teachers' questions because they want to be polite, don't want to look ignorant, or don't realize their lack of understanding. As in Example 1, interviews with teachers as well as students in this study supported that interpretation here.

Example 1: Teacher's reflection on her instruction

T: "I'm not, as I look back, which is really good for me as a teacher too, I'm getting from him a nod, or I'm getting something and I'm not really checking to see if he really understands. What I'm basing my understanding, which is really kind of bad teaching, is on his nod, which, of course, he's probably going to say yes, so he doesn't embarrass himself."

This excerpt demonstrates a teachers' tendency to use limited (a nod) and possibly erroneous information about students' understanding to make instructional decisions. She went to great lengths to explain fraction concepts to this student, yet acknowledges that it probably went by in a blur for him. In contrast, when students are encouraged to elaborate their responses and take more control of the direction of the interaction, opportunities for teachers to assess students' understanding expand significantly through students' words and choices. Simultaneously, teachers' knowledge about students' understanding extends from factual to conceptual.

When students are provided mathematically challenging tasks that help them generate their own understanding rather than trying to appropriate the teacher's understanding, they are less dependent on the language of the teacher. This is particularly important in the case of LEP students. Teachers, consequently, are not as dependent upon LEP students' language for assessment because as the students have more control over the problem solving process, teachers can evaluate the direction and choices of problem solving strategies that LEP students make. Students' explanation of their reasoning, however, remains an essential piece of the

process--challenging students to organize their thinking into words as well as providing teachers with "material" to assess students' understanding.

When students have greater opportunities to contribute to and direct the interaction, teachers consequently have greater ability to distinguish between students' imitation of the teachers' actions and their understanding and appropriate use of mathematical concepts. Vygotsky (1978) describes this continuum from imitation to actual development as the zone of proximal development. Assessment plays a critical role within this zone, as teachers must determine where a student is in their understanding prior to deciding when to intervene and how to "scaffold" their learning. Without knowledge of the "teachable moments", teachers cannot be as effective with their instruction. Teachers in this study had limited knowledge of their students' understanding, particularly with LEP students, indicating their questionable ability to delineate between students' imitation and understanding and operate appropriately within students' zones of proximal development.

Another important lesson from this research is the value of reflective practice through the stimulated-recall interview as one means of improving teachers' practice. Teachers' responses indicate that watching videotape of their instruction may be an effective mechanism for addressing the anomalies in their assessment and instructional practice with LEP students identified above. When teachers had opportunity to reflect on their teaching through videotape analysis they readily identified areas of weakness in their instruction and assessment of students' mathematical understanding and spontaneously suggested ways to improve their instruction. For instance, in Example 1, as the teacher watched her tutoring of an LEP student, she conceded that she knew very little about the conceptual development of the student and acknowledged her need to check for his understanding. Another teacher, after viewing videotape in which her student struggled to fold paper into thirds, commented: "Now that I realize this I'm going to

be paying attention to see what he says. That is interesting." In each interview, teachers reflected upon their instruction with students and made verbal commitments to act upon those reflections.

Videotape of teachers' instruction has proven to be an effective tool to stimulate teachers' thoughtful reflection (Calderhead, 1981; Jensen, 1994; Storeygard & Fox, 1995). Solitary reflection with videotape can be effective, although a colleague's objective perspective can provide a different lens for the videotape. During the stimulated-recall interviews in this study, teachers often contributed judgments about their instruction unprompted. Yet, when I provided some thoughtful questions teachers often were able to reflect upon areas that they would not likely have considered. Hasseler and Collins (1993) suggest that structured collaborative reflection with videotape of teachers' instruction can increase the effectiveness of teacher improvement programs. Consequently, peer or university support may be helpful in constructively engaging teachers with videotape analysis that may confront teachers with the incongruities in their instruction with LEP students.

During informal discussions, teachers in the study generally expressed the desire to be more effective in their instruction and assessment with their LEP students and had confidence in their implementation of SDAIE strategies. As has been shown by an abundance of research, teachers' beliefs do not always translate into practice. Having teachers confront this reality through observation of videotape of their instruction is therefore a logical, critical piece in professional development that will help teachers eliminate practices, such as those found here, that are detrimental to their LEP students.

Particularly as teachers attempt to engage in math reform-minded instruction, they need opportunities to examine what actually takes place in their classroom. Through workshops and inservices the teachers in this study were continually developing their understanding of what math reform would look like in their

classroom. They were dedicated to increasing their students' thoughtful engagement with mathematics. Data from this study demonstrates that teachers need help with implementing that enthusiasm and vision so that they can achieve the goals of the reforms while meeting the needs of their LEP students. Very encouraging to me is that, given the opportunity, teachers were skilled at identifying problems with their instruction and forming strategies to improve upon that practice.

Conclusion

Given the significant role that assessment can play in teachers' decision making in the classroom, it is disheartening that teachers apparently have such little information about their LEP students' understanding of mathematics. The goals of mathematics reform and the goals of teachers of LEP students are complementary: each wants to increase students' ability to communicate. When teachers create classroom environments in which students increase their use of language in order to explain their thought processes, teachers can get much more information about their students' understanding.

Teachers need assistance in closing gaps between how they believe they teach and assess LEP students' understanding and the reality uncovered by this research. Teachers' reflection on videotape of their instruction shows promise as a way of overcoming teachers' inequitable instructional practices which result in them having particularly limited sources of information regarding LEP students' mathematical understanding. In particular, teachers may be able to overcome biases with LEP students and make more effective instructional decisions through collaborative reflection which can provide teachers with opportunity to rethink their instructional practice and strengthen their assessment and mental models of students' mathematical understanding.

The findings of this work have important implications not just for teachers of LEP students, but for all educators and students. For those supporting mathematics

reform efforts, increased use of language provides new opportunities for assessment. Teachers need to be prepared to effectively create these opportunities and capitalize upon the information that results. More generally, as teachers become more sensitive to language and cultural effects on mathematical communication and increase their awareness of students' understanding, their assessment and mental models of students' understanding can become more accurate and therefore, they would likely become more effective at addressing students' individual needs.

While the results of the study are of notable concern for educators of LEP students, this is not intended as a lack of endorsement of the NCTM Standards. On the contrary, it is my hope that this data serves as a "wake-up" call for those in positions of decision making. In order for these important goals to be met, there are numerous challenges to be faced. Not the least of these is serving the growing LEP population adequately by providing significant, effective training for teachers so they may in turn facilitate the success of *all* students in reform-minded classrooms.

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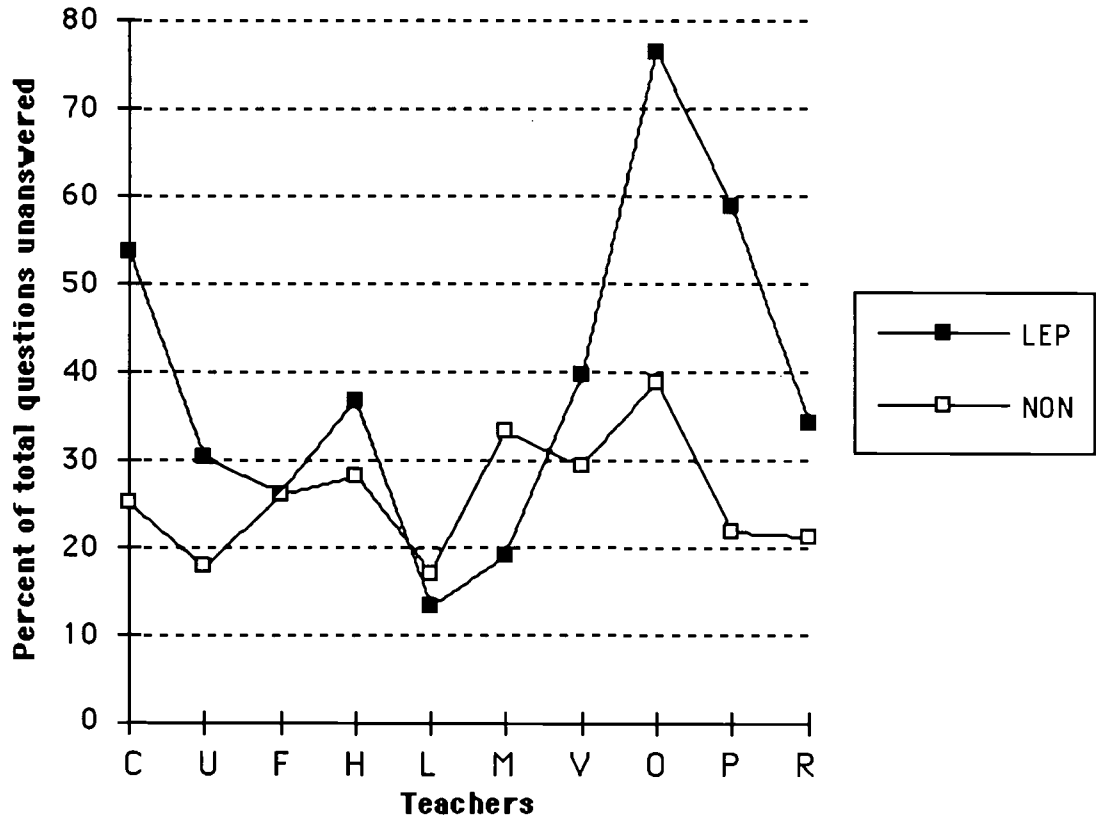
FIGURE 1

Unanswered Questions

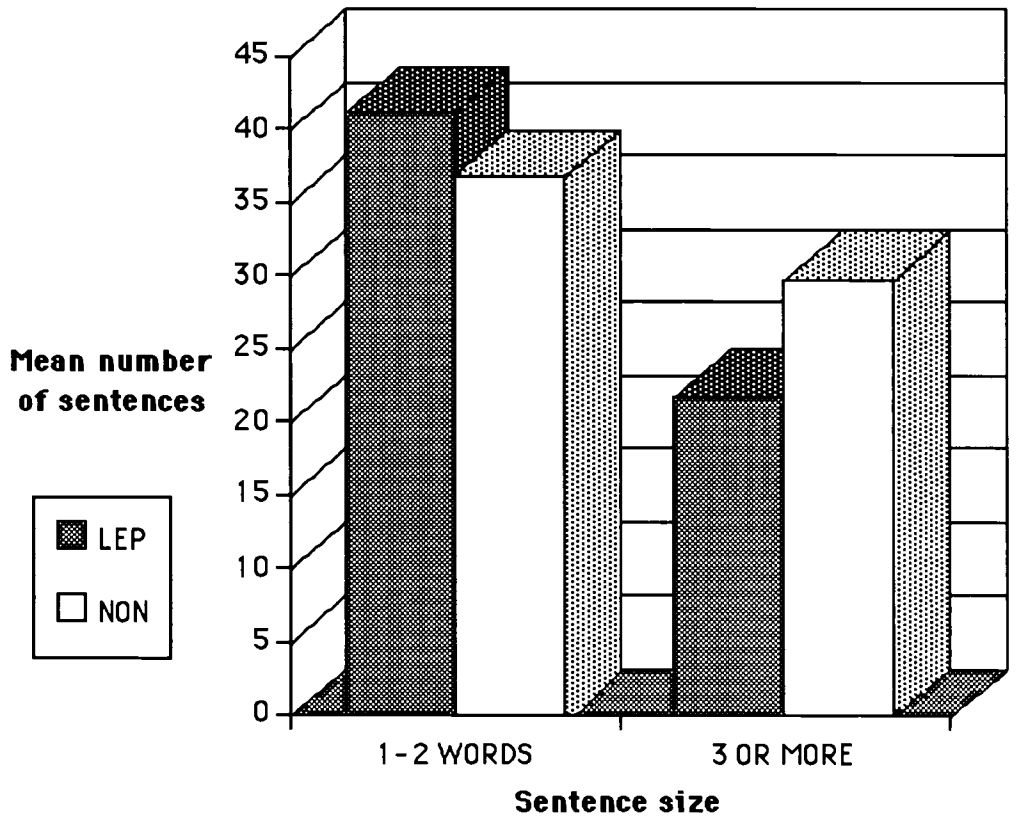


DATA:

TEACHERS	LEP	NON
C	53.79	25.27
U	30.36	18
F	26.39	26.03
H	36.67	28.08
L	13.33	17.02
M	19.23	33.33
V	39.86	29.27
O	76.47	38.89
P	58.97	21.74
R	34.25	21.11

FIGURE 2

Number of words spoken per sentence by students

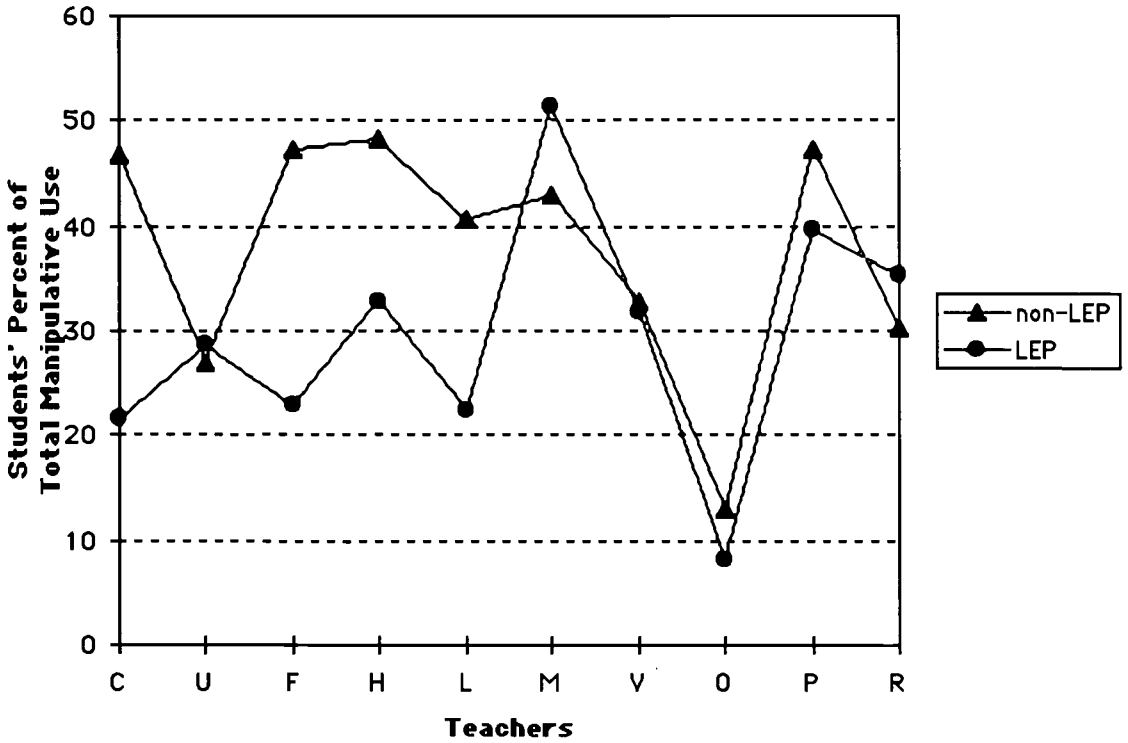


DATA:

	1-2 WORDS	3 OR MORE
LEP	41.1	21.7
NON	36.7	29.7

FIGURE 3

Manipulative Use During Tutoring

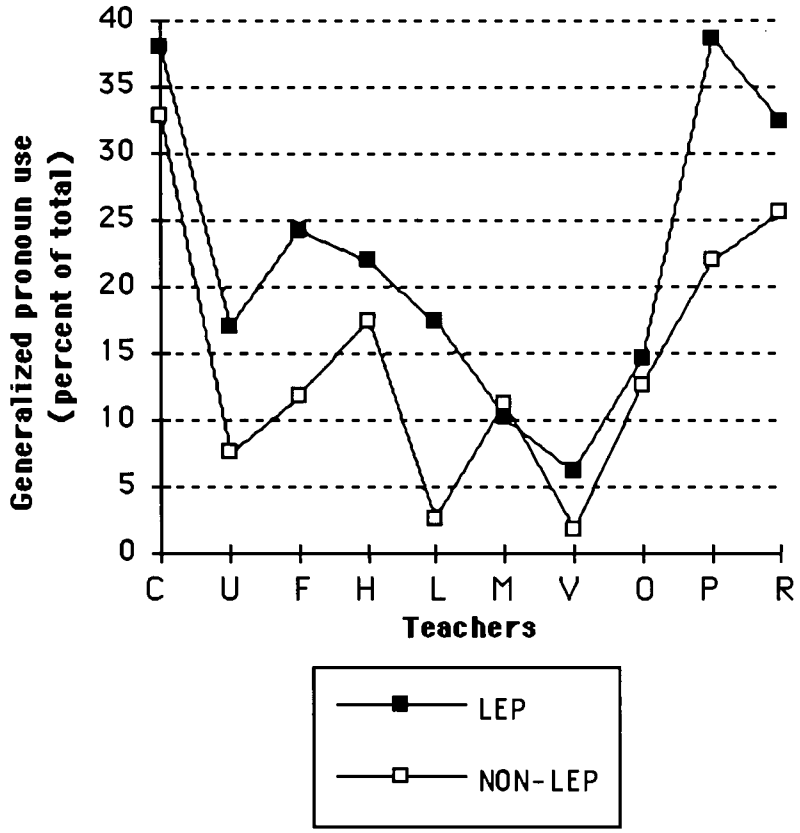


DATA:

TEACHERS	non-LEP	LEP
C	46.66	21.51
U	27	28.67
F	47.24	22.94
H	48.26	32.89
L	40.74	22.47
M	42.89	51.3
V	32.67	31.73
O	13.03	8.13
P	47.27	39.63
R	30.29	35.25

FIGURE 4

Pronoun use in teacher interviews

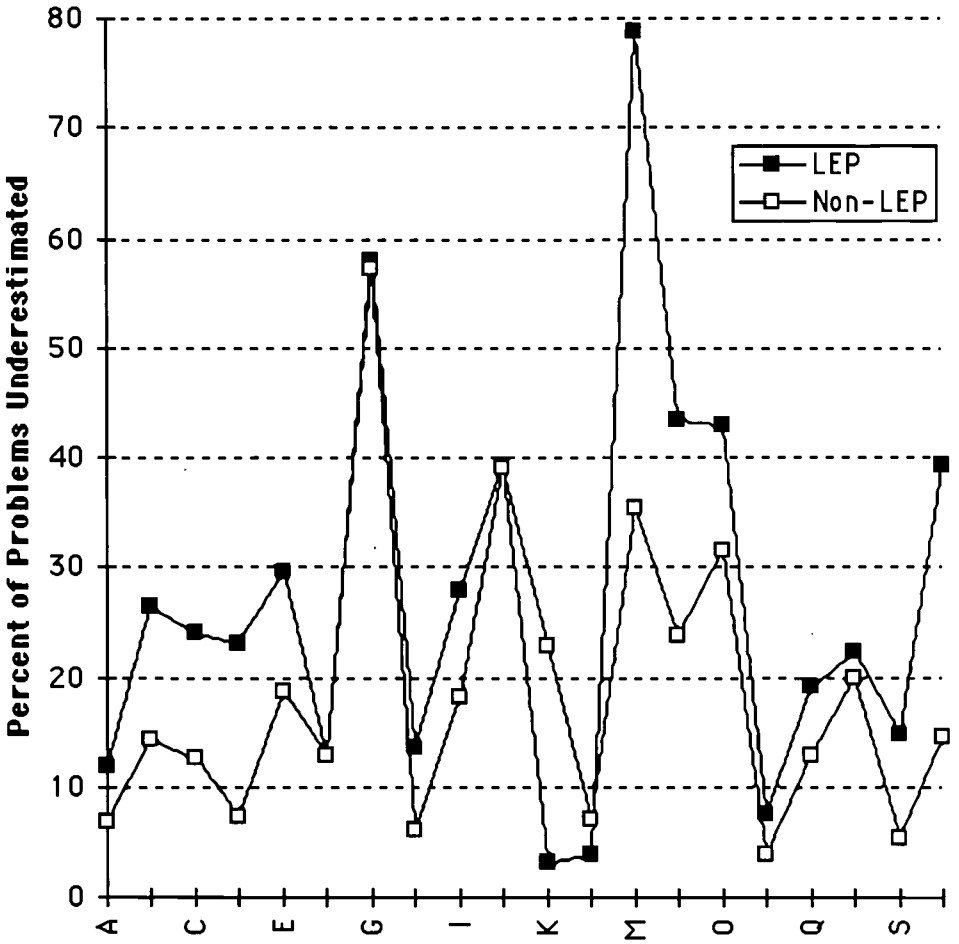


DATA:

TEACHER	LEP	NON-LEP
C	37.96	32.74
U	16.95	7.51
F	24.16	11.68
H	22.02	17.32
L	17.26	2.53
M	10.15	11.17
V	6.13	1.83
O	14.56	12.57
P	38.54	21.95
R	32.26	25.54

FIGURE 5

Teachers' Underestimation of Students' Success



Teachers	LEP	Non-LEP		Teachers	LEP	Non-LEP
A	11.96	6.9		K	3.13	22.7
B	26.36	14.29		L	3.87	7.03
C	23.91	12.71		M	78.79	35.43
D	23.08	7.23		N	43.3	23.8
E	29.6	18.6		O	42.86	31.4
F	12.74	12.86		P	7.4	3.9
G	57.89	57.21		Q	19.23	12.9
H	13.64	6.13		R	22.29	20
I	27.78	18.28		S	14.84	5.32
J	39.34	38.98		T	39.31	14.63

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