Linguistic Environments and Mathematics Development:

Perspectives on Increasing Instructional Effectiveness with Latinas/os

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Purpose

- To direct our attention to key assumptions that should guide mathematics instruction for bilingual learners, or language minority students, especially Latinas/os;
- To offer examples of effective instruction based on these assumption;
- To challenge conventional wisdom about Lationas/os' learning mathematics

Who I am: Background to my comments

- A Chicana whose home language was Spanish but whose schooling was in English;
- A mathematics major who taught high school Algebra and Geometry, and who developed same courses for Spanish-speakers;
- A teacher educator and researcher concerned about improving Latinas/os' education;
- A researcher whose work is based in classrooms and in collaborating with teachers doing action research

Some quick notes:

- While the focus of my talk is on Latinas/os, the content equally applies to all other linguistic minority groups.
- I deliberately use the terms linguistic minority, bilingual learner, and language minority student interchangeably;
- ELL obscures social/political realities and misdirects our thinking about students' learning

Background to my discussion

- The issues of Latinas/os' mathematics learning are not served by a focus on strategies; when strategies fail, the blame falls on students.
- Reductionism in instruction maximizes misinterpretations, misapplication, and just plain "missing the boat"; for example, academic language is more than vocabulary; discourse is more than contextualized vs. decontextualized (Gee, 1998)
- The issues of Latinas/os' learning content are too complex to be served by a strategy fetish

What I will discuss

- I focus on key concepts or assumptions that we should adopt, and that critically impact & direct instructional decisions
- First assumption: Strong and lasting development comes from meaning-making (Khisty, 1995; 1999); not from engaging students in looking for right answers, limiting talk, focusing on the textbook, or having a narrow range of content.

Going beyond just "meanings":

"…Through the language used by teachers and students to talk [mathematics], particular models and definitions of [mathematics] are being constructed. Regardless of whether there is a language of a discipline used…a situated language of a discipline is being constructed—one that defines what it means to be a mathematician….the words selected, the patterns of interaction experienced, and the range of events constructed by members define what counts as mathematics, mathematical actions, and being mathematicians (Brillant-Mills, 1994, pg.302)."

Second assumption: Situated practice is critical to development of not only content but academic language

"All language is meaningful only in and through the contexts in which it is used. All language is meaningful only on the basis of shared experiences and shared information. All language is "inexplicit" until listeners and readers fill it out, based on the experiences they have had and the information they have gained in prior socioculturally significant interactions with others (Gee, 1998, pg. ix)."

Third assumption: Instruction involving linguistically diverse students must be based in second language acquisition principles.

- Development of language involves a constant and continuous process of appropriation. This points to the critical role of the teacher or peer as a model.
- Language development is best as functional production. Language should be used naturally to accomplish some communicative task (Mohan & Slater, 2002).
- The target language needs to be explicitly and overtly taught.
- Students should have access to multiple modes of communicating their knowledge.
- Home language can not be ignored, denied, or denigrated

A real classroom example:

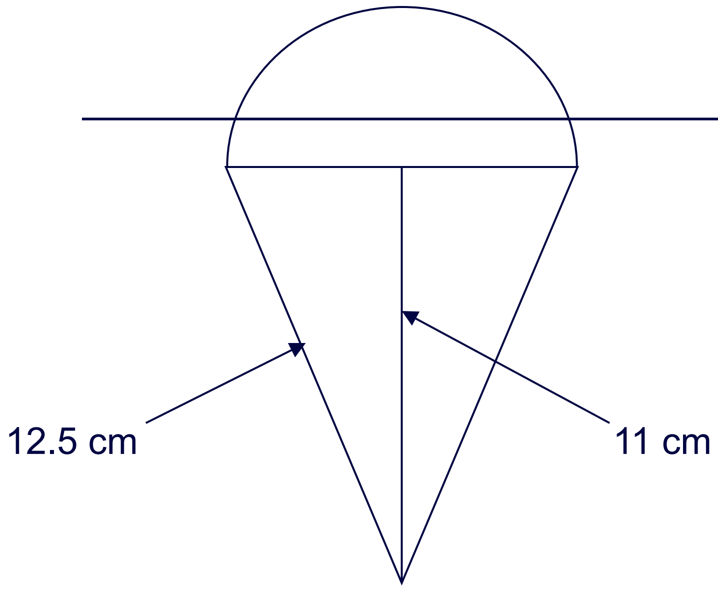
- A fifth grade classroom in a working class neighborhood school.
- Students are all Latina/o with wide range of L1 and L2 language proficiencies; some are Special Ed.
- Students enter below grade level, but all leave 5^{th} grade at or above grade level; some even gain 3 grade levels in 1 year.
- Math is taught in English but Spanish is used freely.
- Geometry is studied all year (thematic approach); students do better on all parts of standardized tests than other 5^{th} grades.

Toward the end of the school year, students are given the problem: Find the area and perimeter of the two dimensional ice cream cone.

Here are the dimensions of the cone that are used, and the keystrokes the students place on the board.

Area of the Cone

12.5	x^2	-	11	x^2	=	$\sqrt{2}$



sto	x^2	x	π	÷	2	a x c

x	11	Σ	Rel	=	121

Perimeter of the Cone

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=	x	π	=	÷	2	=	sto	12.5

Σ	Σ	Rel


PLAY

Some striking features of this instruction:

- Students & teacher interact around concepts; no numbers are mentioned until the very end;
- Teacher asks questions to engage students in extended talk; no simple one-word answers are accepted;
- Use of calculators as regular tools and writing of keystrokes; these facilitate quick assessment of student work and promote symbolic reasoning (algebra);
- There is a climate of social/community responsibility; "We help each other." "We are here to work and work is learning.

Most striking #1: Teacher's talk as model of language

- At beginning of school year, teacher does most of talking: asking questions, introducing concepts.
- In first 12 lessons of the year, she speaks

"area"	699 times
"rectangle"	395 times
"leg"	442 times

(Chval & Khisty, 2009)

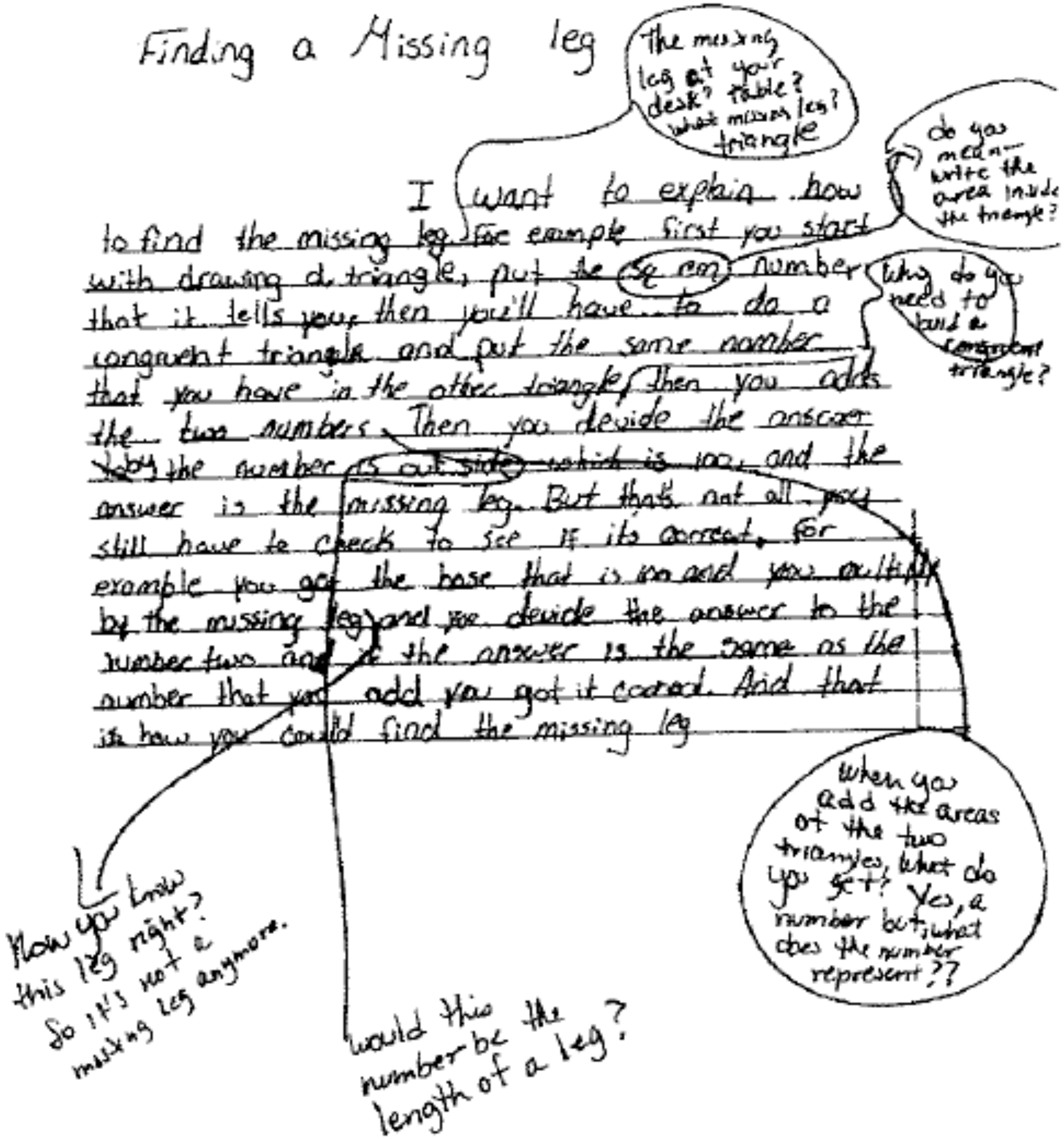
Example of Sara's (teacher's) talk

1.	Sara:	What do I need to do to the 24, to get the area of that right triangle?
2.	S:	Divide by two.
3.	Sara:	Why do I divide it by two?
4.	S:	You have two triangles.
5.	Sara:	I have two congruent triangles here. Two equal parts, two exact triangles. I want only the area of my original triangle, ACB. Then I'm going to divide this by two. And what will my answer be?
•••		
9.	Sara:	Number three. Would you please read that, Julia?
10.	Julia:	The triangle and its…
11.	Sara:	Congruent.
12.	Julia:	Congruent [struggling]…
13.	Sara:	Look at that word everyone. Congruent. What does that mean?
14.	Javier:	Like another copy.
15.	Sara:	An exact copy. Because here, look here is the circle. Is this circle congruent to that circle?

Most striking, #2: Writing

- Students write mathematically from the first day of the school year, complete multiple drafts, publicly share drafts
- Writing serves a communication purpose.

  Example: Sara: How do you explain to someone how to find the missing leg of a right triangle, when you know the area and the other leg? Explain how you did all that. I want to take this home and I want to show it to one of my friends who doesn't know how to find the area of a right triangle let alone a missing leg. … But I want her to know how to do it and I want her to read your papers and *if she understands what you wrote, then you've done a good job explaining* (italics denotes emphasis in her voice). [Day 9]


Finding a Missing leg

I want to explain how to find the missing leg. For example first you start with drawing a triangle, put the sq cm number that it tells you, then you'll have to do a congruent triangle and put the same number that you have in the other triangle, then you adds the two numbers. Then you devide the answer by the number is out side which is 100, and the answer is the missing leg. But that's not all you still have to check to see if its correct. for example you got the base that is 100 and you multiply by the missing leg and you devide the answer to the number two and if the answer is the same as the number that you add you got it correct. And that its how you could find the missing leg

The missing leg at your desk? table? what missing leg? triangle

do you mean— write the area inside the triangle?

Why do you need to build a congruent triangle?

When you add the areas of the two triangles, what do you get? Yes, a number but, what does the number represent??

How you know this leg right? So it's not a missing leg anymore.

would this number be the length of a leg?

Figure 9.4 Javier's second draft

Teaching of writing is explicit

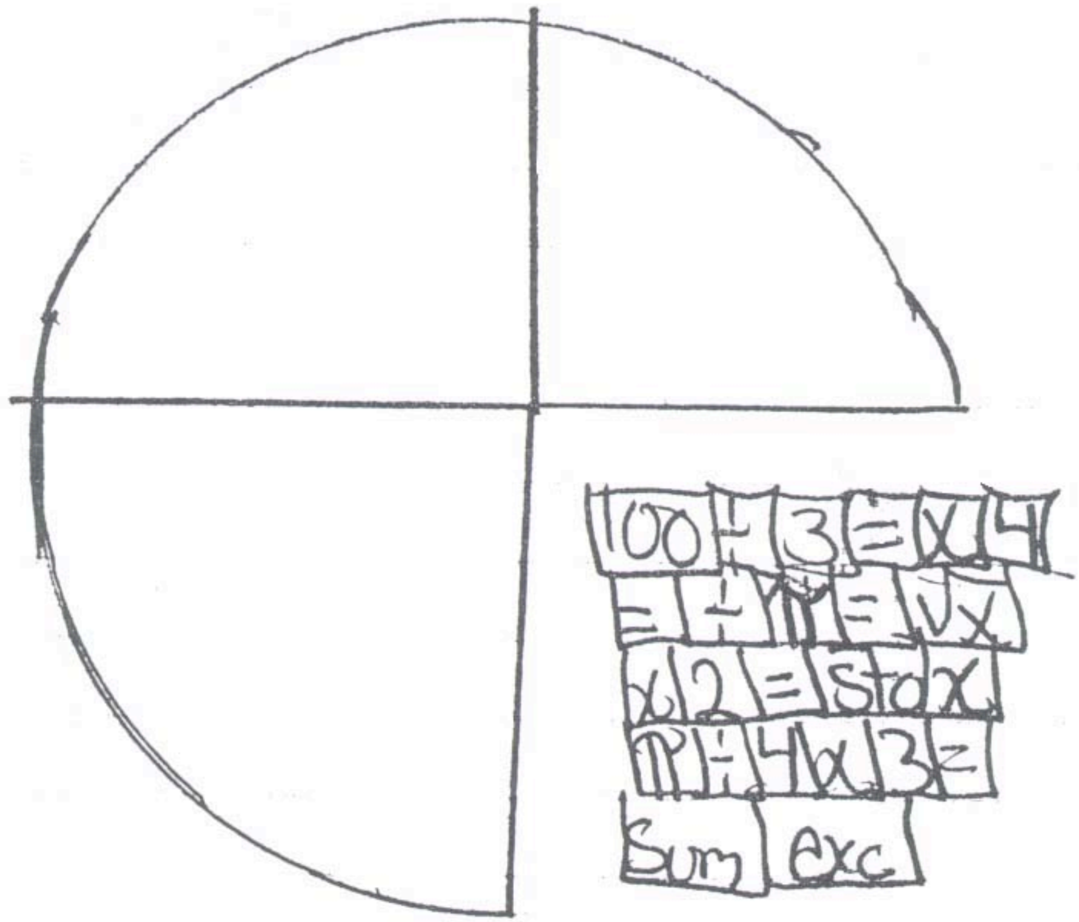
- 3rd draft will be better—right? Right.
- The missing leg at your desk? Table? What missing leg?
- Do you mean—write the area inside the triangle?
- Why do you need to build a congruent triangle?
- Would this number be the length of a leg?
- When you add the areas of the two triangles, what do you get? Yes, a number but, what does the number represent?
- Now you know this leg right? So it's not a missing leg anymore.

#1 Not clear because many details are missing.
#2 You did not include any examples so I cannot see what you mean.

You would have a better explanation if you:

1) reread your work; 2) add details; 3) draw a sketch; 4) write key-strokes[2]; (5) think a little more.

I did a challeng ploblem and I got it. I went in front of the class to excplain it. This is how I solved it. I am going to excplain how to find the perimeter of three quare circles. First I took [100÷3] to find the area of a quarer circle. Next I multiplied by [4] to get the area of a whole circle. Afther this I divided by [π] to get area of a square build on the radius. Then I took the [$\sqrt{x}$] to get the radius or side length of the sq. built on the radius. Next, I multiplied by [2] to get the diameter. Then I [STO] because that is the two straight lines. After this I multiplied by [π] to get the circumference of a circle. I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<table>
<tr><td>Violetta’s Talk on her presentation to the class</td><td>“The area of the three quarter circle are 100 square centimeters. Now we are going to go backward from the area to the perimeter. One hundred divided by three equals the area of one quarter-circle. Multiply by four to get the area of the whole circle.”</td></tr>
<tr><td>Keystrokes</td><td><table><tr><td>100</td><td>÷</td><td>3</td><td>=</td><td>X</td><td>4</td><td>=</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Geometric Figures</td><td></td></tr>
<tr><td>Juan’s Writing</td><td>I am going to explain how Violetta went from the area of the three quarter circle to the perimeter. Violetta took the area of the three quarter circle and (symbol for divide) by three to get the area of the quarter circle. Then she multiplied the area of one quarter circle by 4 to get the area of the whole circle.</td></tr>
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Concluding remarks

- I have shared with you a classroom environment that is a tightly woven web of linguistic experiences and conceptual meaning-making events;
- Because the "web" is so tight and broad, the environment is able to support and advance all students within it, who otherwise traditionally fail;
- The instruction in this classroom can not be reduced to mere strategies; it requires a whole new way of thinking;
- If this can be done in this classroom, why can't it be done in more classrooms with Latinas/os?

Gracias
Thank you

Some references:

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