

A photograph of a young boy with dark hair, wearing a light-colored t-shirt, hanging from monkey bars. He is looking upwards with a focused expression. The background is a soft, out-of-focus sky with light clouds. The entire image has a warm, slightly desaturated color palette.

Teaching Immigrant and Second-Language Students

Strategies for Success

Edited by Michael Sadowski

NO. 2 IN THE *HARVARD EDUCATION LETTER* SPOTLIGHT SERIES

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Teaching English-Language Learners "The Language Game of Math"

Insights for Teachers and Teacher Educators

*Meg Gebhard, Andrew Habana Hafner,
and Mary Wright*

In September 2003, nine-year-old Marisol Rivera hesitantly entered Mary Wright's third-grade classroom at Sullivan Elementary School in Holyoke, Massachusetts. Mary recalled her first impression of Marisol as a quiet, thoughtful girl who seemed tentative and unsure of herself, particularly when it came to math. Mary quickly noticed that during math, Marisol often hid behind other students and avoided eye contact, which made it hard to determine how much she understood. After checking school records and talking with Marisol's former teachers about her schooling experiences, Mary figured there probably were a number of reasons why Marisol was trying to make herself "invisible."

Since moving to Holyoke from Puerto Rico three years earlier, Marisol had attended content classes where she received

some support in her native Spanish, while also getting assistance in learning English as a second language. However, Mary recalled that Marisol's teachers grew concerned with the rate of her progress and decided that she should repeat second grade and receive assistance from the special education team for what they described as "processing problems in language arts and math."

With this background information, Mary reflected on Marisol's participation in her class during the first several months of school, but she still wasn't sure what the problem was: Was it English? Was it math? Was it something else? It was hard to say, but what Mary was certain about was the need to rethink the way she was teaching the English-language learners (ELLs) in her class, especially the way she was teaching math.

This need became even more evident in 2002 with two major shifts in education policy at the federal and state levels. In January, President Bush signed the federal No Child Left Behind Act, and the following November voters passed anti-bilingual education legislation in Massachusetts. With these changes, Mary and her students were being held accountable—sometimes publicly in local and major newspapers—for meeting new state and federal standards in a language that many children were still in the process of acquiring.

The challenges students and teachers like Marisol and Mary face in their day-to-day work are not uncommon. They are the same problems facing a growing number of linguistically and culturally diverse students and their teachers, particularly in communities across the United States with histories similar to Holyoke's. Holyoke is a midsize former industrial city that during most of the 1900s supported a predominantly white immigrant community by providing readily

available work in the city's paper mills. Over the last 30 years, nearly all of these mills have closed, but new businesses have not taken their place. Many of the skilled, better-paying jobs have also moved elsewhere, resulting in an unemployment rate that has doubled in the last three years from 4.2 percent to 8.4 percent. These trends have placed incredible stress on families and the available social service agencies in the community. Moreover, the families that rely on Holyoke's public schools to put their children on a path toward better-paying work are more linguistically, racially, and culturally diverse than three decades ago. The overall population of Holyoke in 2003 was described as 54 percent "non-Hispanic white," 41 percent "Latino" (mostly Puerto Rican), 4 percent "African American," and one percent "Asian." The school population, however, is 72 percent Latino.

The degree to which educators in many communities are ill equipped to address the complex challenges of supporting linguistically and culturally diverse students is illustrated in the 2003 math scores on the Massachusetts Comprehensive Assessment System (MCAS), the state's standardized testing program. These data show that 68 percent of all fourth graders scored in the "needs improvement" or "failing" category, and that failure rates are even higher at the upper grade levels. In 2003, almost no eighth-grade students in Holyoke (ELL or otherwise) scored "proficient" in math (37% scored in the "needs improvement" category, and 63% were considered "failing"). Clearly, this level of systemic failure is an enormous problem for educators, administrators, researchers, and policymakers who take the goal of social and economic equity through education seriously. It is also the problem that brought the authors of this chapter together.

THE ACCELA ALLIANCE

Meg Gebhard is an assistant professor at the University of Massachusetts and codirector of a school-based teacher education program called the ACCELA Alliance (Access to Critical Content and English Language Acquisition). The ACCELA Alliance is a federally funded partnership among the University of Massachusetts Amherst, three area school districts, and the diverse communities in Western Massachusetts. During the 2003–2004 academic year, Meg taught a two-semester course in second-language acquisition and academic literacy development. First, she assigned case studies written by leading education researchers who have studied the academic literacy development of linguistically and culturally diverse students in urban schools. She assigned these readings to give teachers an introduction to important debates in the teaching of reading and writing to English-language learners. Second, and more importantly, these readings provided teachers with detailed descriptions of classroom practices that either supported and/or constrained ELLs in learning to read and write in academic ways (e.g., drawing on prior knowledge and home-language abilities; providing an array of authentic purposes and real audiences for writing; providing models of good writing and analyzing its elements; creating opportunities for students to collaborate and receive feedback from peers and teachers). Meg hoped teachers would use these readings as models to develop their own research questions related to understanding more fully how their ELLs learned to read and write across the curriculum.

Mary Wright was a recipient of an ACCELA master's degree scholarship and a student in Meg's course. She grew up in Holyoke and had been working there for most of her 15-

year career as a classroom teacher. During the 2003–2004 school year, Mary taught a third-grade class with 25 students, two-thirds of whom were Latino and almost half of whom were in the process of learning English as a second language. Mary described teaching this class as one of the greatest challenges of her career because of her students' range of experiences and abilities. She had ELLs whose prior schooling experiences in Puerto Rico had equipped them to speed through skill-based worksheets quickly and accurately, but who had difficulty with the district's required math curriculum. This curriculum centered on teaching mathematical problem-solving rather than computational speed and accuracy. She had other students who were fluent English speakers. These students had experience with more process-oriented approaches to learning math, but really didn't have either the skill or conceptual base they needed to approach some of the tasks Mary was required to assign.

Mary describes the math hour as the time of the day when "it all came out." She says, "If someone is having a bad day, it'll show up in math. I know I'm going to get more bathroom requests, more fights, and more tears than any other time of the day." This level of anxiety was not limited to students, but extended to teachers and administrators because of an ongoing investigation by the state. (The state Department of Education was considering taking over the district in the wake of low test scores.)

Collectively, these classroom-, district-, and state-level pressures led Mary to focus her research questions on how to teach the language and content of this new math curriculum in the climate of high-stakes testing. In a journal assignment for Meg's class, Mary wrote:

I have begun to take advantage of students' normal curiosity about the MCAS test. . . . They know they have to take this test every year until 10th grade, and that their ability to graduate from high school depends on this test. . . . I keep telling them they are all very capable and they will pass the test . . . [but] I have to start teaching them about the types of open-ended word problems they are going to get—how to spot them and how to respond to them. We have started calling this a game, the language game of math. Third graders love games and can relate to the idea that if you know the rules, you can win.

To support Mary in exploring this central focus, Andrew Habana Hafner, a former classroom teacher and first-year doctoral student at the University of Massachusetts Amherst, visited Mary's class twice a month between September 2003 and May 2004. During these visits, he recorded digital video of students participating in math activities, collected samples of student work, provided transcripts of selected classroom interactions, and wrote detailed notes regarding how students' school days took shape. He also conducted informal interviews with students in Spanish and English.

Meg guided Drew and Mary as they collected data to inventory and analyze the kinds of reading and writing activities Marisol and other students had to accomplish in math. Next, she asked them to describe vocabulary, grammatical constructions, phrases, and organizational schemes that were particular to the third-grade math curriculum. In conducting an analysis of the language of math, Mary identified a task that she regularly assigned to students called "show your thinking." This was a multistep task that asked students to (a) read a mathematical word problem; (b) draw a picture represent-

ing the elements of the problem; (c) describe in narrative form how they would solve the problem; (d) write a corresponding mathematical formula; and (e) solve the equation correctly. The skills associated with this task were especially important for students to develop because Mary learned that almost all of the ELLs in her school had either skipped this open-ended section of the fourth-grade math MCAS or thought it was a multiple-choice question and responded accordingly.

USING LANGUAGE ARTS METHODS TO TEACH MATH

After reflecting on students' literacy inventories and aspects of her classroom practices, Mary realized that her students' math performance depended not just on their developing the kinds of skills traditionally associated with arithmetic, but on their language development as well. She began to apply language arts methods to teaching a content area that she previously associated only with numbers and symbols. Beginning in the fall of 2003, Mary instituted the following changes in her math program:

Grouping students by language and math ability. Mary grouped students heterogeneously by language and math ability so that they could share expertise and support each other in learning both mathematical concepts and the language of math. She continually tinkered with how she assigned students to groups to make sure they functioned optimally, given students' changing dispositions and abilities.

Attending to group dynamics. Mary provided plenty of "on the rug" time for the whole class to learn concretely how to support each other in groups. She taught students how to

give each other “wait time”; to make sure everyone had a fair number of chances to take the floor; to rephrase contributions to make sure they were understood by everyone; and to use certain phrases to express disagreement with one another respectfully (e.g., “I see what you mean, but here is another way to think about it” rather than “no, you’re wrong” or “that’s stupid”).

Using oral language to support reading and writing. Mary allowed students to “talk and draw” their way through complex math problems before they started to write their answers on paper. In doing so, she encouraged students to use their home language and artistic abilities as stepping stones on the way to understanding and using math vocabulary words, sentence structures, and organizational schemes.

Modeling and providing explicit instruction in language. Mary taught students how to dissect or “tag” the parts of the “show your thinking” word problems by modeling different ways of getting started and teaching students to recognize and use specific action words (e.g., “label,” “number,” “describe,” “explain,” “list,” “draw,” and “give evidence”).

Creating a math “word wall.” In the context of teaching students to “tag” word problems, she asked them to keep an inventory of important math words (e.g., “numerator,” “denominator,” “digit”) and words and phrases that signaled different kinds of mathematical operations (e.g., “sum,” “divided by,” and “divided into”). She created a math “word wall” using the language they identified as crucial to doing math. Students used this “word wall” as a resource when they were working independently.

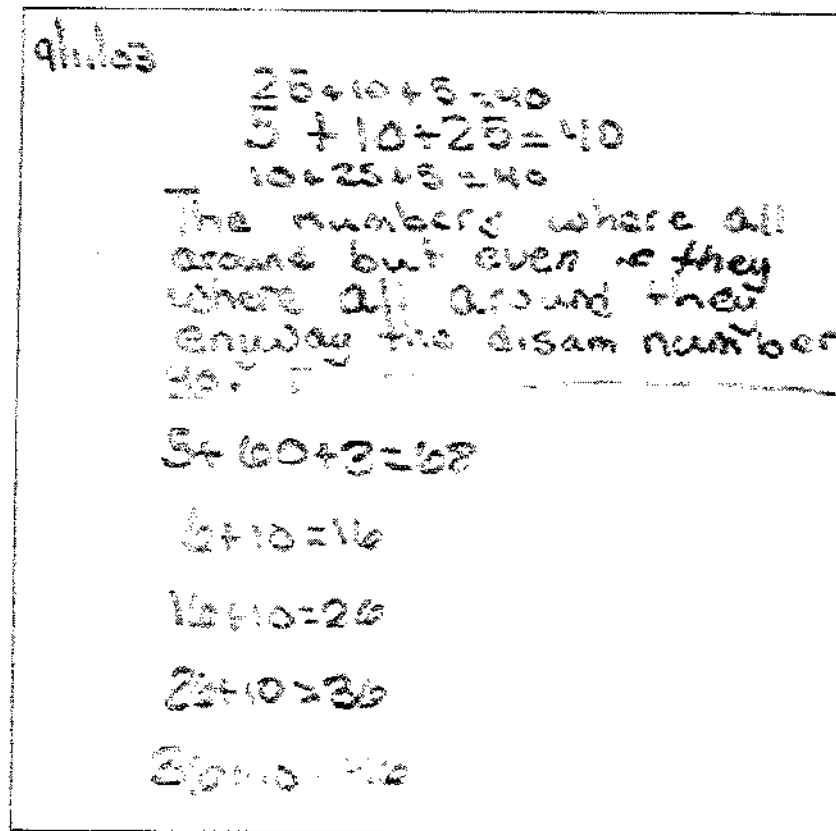


Figure 1. Sample of Marisol's work at the beginning of the school year

Using the writing process. She asked students to draft and revise their math work following the same processes they used in their language arts activities. Mary asked students to share drafts and respond to each others' ideas using guides, graphic organizers, and various worksheets. Next, she asked them to make revisions based on feedback they received from each other and from her in one-on-one conferences. Last, she asked them to proofread their work before turning in final copies.

MARISOL: A CASE STUDY IN THE RESULTS OF MARY'S NEW APPROACHES

To illustrate the changes we observed in Mary's class following the implementation of her language arts-based approaches, Figures 1 and 2 show representative samples of Marisol's "show your thinking" math work and Mary's analyses of these samples. (Mary and Drew focused on Marisol because they found her to be representative of the way many ELL students sometimes struggle with math.)

Marisol wrote the first sample in September (see Figure 1). For this assignment, she was asked to illustrate her understanding of the communicative property of addition (i.e., to explain why it didn't matter in what order she added the numbers in a list). In analyzing Marisol's work, Mary observed:



Marisol showed no strategies for how she combined the numbers. She copied the number strings and wrote the answers. She did not show or label which numbers she combined to tell how she found the totals. She did not use any of the math vocabulary we talked about. She did, however, make a good attempt to describe what she noticed. She used the words "all around" to explain that the numbers were in mixed-up order. She also tried to let me know that no matter what order the numbers were in, the sum would be the same ("they anyway the disam number 40").

In the next sample from the middle of the year (see Figure 2), Marisol was supposed to read a math problem involving butterflies, show how she solved the problem in graphic form, and explain her approach to the problem in a narrative. In response to Marisol's second sample, Mary noted:

Name: _____

At the Butterfly House there are 36 butterflies. The Butterfly House has 2 rooms. How many butterflies are in each room?

SHOW WORK

 <p style="font-size: 2em; margin-top: 20px;">18</p>	 <p style="font-size: 2em; margin-top: 20px;">18</p>
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Explain

First, I drew 18 butterflies on one side and 18 on the other side. Then I made sure there was 36 butterflies together.


Figure 2. Sample of Marisol's work at mid-year

Name: _____ Date: _____
 Student Sheet 4.3 (page 2 of 2)

_____ 's Story:

Gloria had (18) boxes of cran's.
There are three tables of kids'
How many boxes of cran's would
each table get?

My Solution:



Equation(s) $18 \div 3 = 6$

Figure 3. Sample of Marisol's work at the end of the school year

Marisol has begun to organize her thoughts in expected ways. Through her use of "first," "then," and "finally," she seems able to put her actions in order. . . . Her mathematical thinking is still floating at the surface, but she is finally beginning to write the numbers she is using. She can explain that she counted by 4's. I wish that she had explained to me how she knew to put 18 butterflies in each box. . . . Her progress is slow, but she is showing some of the features I had hoped for. One of the most positive outcomes I see is that Marisol is consistent. Once she begins to add these features, she owns them.

Last, in a sample collected at the end of the year, Mary asked students to make up their own word problems and solve them using the procedures and language practices they had been working on all year (see Figure 3). In response to Marisol's spring sample, Mary wrote:

What kind of an impact has all of this teaching had on Marisol, my self-proclaimed hater of math? Last week I gave out math papers for homework. I asked the students to make up their own division story problems, illustrate them, and write a math equation representing their word problem. . . . Marisol came up to my table at dismissal and asked for a bunch of extra papers so she could make-up *extra* math division stories for homework.

LOOKING AHEAD

Our analysis of Marisol's math work and Mary's research notes over the 2003–2004 academic year show how changes in instructional practices supported this student in "owning

the language of math" and in shifting from a "self-proclaimed hater of math" to being the kind of student who asks for extra math homework. We believe that Mary's ability to identify and teach the language of math in a meaningful and explicit way contributed to the gains Marisol made.

As the three of us continue to collaborate, we are interested in testing this hypothesis using both qualitative and quantitative measures. We are also interested in designing curriculum and instructional practices that not only apprentice students to the literacy skills they need to play (and win) high-stakes "math games," but also to explore and challenge many of the problems facing linguistically diverse schoolchildren, their families, and their teachers. Just as Mary's new language arts-based approaches represent an interdisciplinary approach to teaching math, why not break disciplinary barriers further and focus students' math work on important school and community issues, such as school funding, attendance figures, and graduation rates among ELL and other student groups? In this way, students can simultaneously learn and use the language of math *and* use their newfound knowledge to accomplish important, real-world work.