Diane Torres-Velasquez with Gilberto Lobo

Culturally Responsive Mathematics Teaching and English Language Learners

Culturally responsive teaching is a dynamic form of teaching that builds on and supports students' home culture. The strategies that we recommend in this article for English Language Learners (ELL) are based on research or classroom experience. We provide real-life examples of how the second author, Gilberto Lobo, implements these ideas in the context of data analysis.

Lobo was a veterinarian and a university professor in Mexico. Now, as a dual language teacher of fifth graders, he surrounds his students with all kinds of animals and plant life. Students witness the life cycle and the food chain. They learn mathematics and science in Spanish using hands-on experiences. More important, Lobo uses language and culture to capture the students' attention in novel ways. He guides student learning in ways that make the skills and knowledge their own. He is part of a three-way teaching team that includes Mrs. Duran, who teaches reading and language arts in English, and Mr. Garcia, who teaches social studies in English. The team collaboratively plans and evaluates student learning each day. Lobo uses the following strategies for increasing the success of his ELL students:

- Relating mathematics to real-life experiences
- Using mathematics as a tool for developing the learning community
- Using questions to help students develop the language and concepts of mathematics
- Explicitly teaching the vocabulary of mathematics using questions to help students develop the language and concepts of mathematics

Relating Mathematics to Real-Life Experiences with the Consensogram

Nieto (1999) reminds us that learning emerges from and builds on prior experience. It begins with the assumption that everyone brings important experiences, attitudes, and behaviors to the process of education (p. 6). Lobo uses the students' real lives for connections to the mathematics curriculum. For example, the students begin the school year by learning about the class community with graphs. Rather than teach a unit on graphing by using a set of data from a mathematics text, the team has students collect data about themselves and their real lives. Although students are learning about data and its graphic representation, the primary purpose of this activity is for students to learn about themselves and about one another. The students begin the development of their learning community through data collection, using a teaching tool called the Consensogram (Langford

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1999), a statistical survey tool that measures a group's perceptions, views, and opinions. The Consensogram can also be used to provide information about students, or whoever is being sampled in the data collection.

Students begin their data collection by answering survey questions about their background. They write their response to each question anonymously on a sticky note (all notes are the same size and one note is used for each question). Notes are collected in a basket, read aloud, and grouped by the class into categories of response. The teacher then uses the notes to make a bar graph of the responses to each question by physically aligning similar responses to display the data. The class discusses the results of the survey, as represented on the graphs. After constructing a bar graph with the sticky notes, Lobo has students develop a data table with sections to include the question, and the number of responses by fraction and then by percentage (see **fig. 1**). Students enter data on the computer and make computer-generated graphs (see **figs. 2** and **3**).

One question on the Consensogram asks the students to think about why they are at school. Students have the following three options for a response:

1. Education is important.
2. Education is important for my family, but not for me.
3. We don't care, but there is no other place to go.

The majority of students tell the truth. The teachers never get mad about the students' opinions and certainly never use the information against them in any way. Lobo explains:

> If they do not feel that school is important, I tell them that I don't take it personally. I respect their opinion and invite them for a conversation with me at any time about reasons that education could be important in their lives. I don't try to find out who says what. The reason for asking these questions is to find out about the group, not to punish anyone for how they think.

In the survey questions, the teachers want to demonstrate the nature of data collection and its representation. By tapping into questions that tell the students about who they are, the class is turning thoughts, beliefs, and values into concrete mathematical data of great significance. That is when teachers can turn information into representations such as graphs, fractions, or decimals that have mathematical meaning. Lobo explains, "You are using numbers for meaning without the pressure, because many of the kids are scared of 'mathematics.' " Lobo and his team understand that learning is socially mediated and develops within a culture and community. By collecting data about themselves, students are quickly able to identify themselves on the graph and begin to think about what this data means in terms of describing the class as a group.

Mathematics as a Tool for Developing a Community of Learners

Lobo describes the classroom community as something teachers are creating *with* students. The classroom is part of the community. In this community, the teachers connect mathematics to things students know, then use those skills to teach them more about themselves and their culture. The teacher's role in creating a community of learners is essential. Teachers' expectations, beliefs, and values are constantly being conveyed through their actions and through their language, even when interpreting graphs. Respect, or disrespect, for community members and their values is conveyed through the lessons teachers create.

Culturally responsive teachers recognize the influence of culture and community in teaching (Gay 2000). They are aware that teaching is a political act (Nieto 1999). What teachers deem as important or unimportant, wondrous or boring, worthy of pride or shameful, is communicated to their students one way or another, through their language and through their curriculum. Teachers communicate these ideas both through the things they say or do and through the things they do not say or do. In other words, teaching—even the teaching of mathematics—is a political activity. The way in which mathematics is taught, the purpose for which it is used, the models that teachers choose to accept, and the information that teachers value tell students what is important in their classroom and in their school.

Nieto (1999) stresses that the role of the teacher as cultural accommodator and mediator is fundamental to the promotion of student learning. Teaching is about relationships (Nieto 1999). When students can identify with the school and with the teachers, they are more likely to feel that they have a place in the classroom as learners. The teachers on Lobo's team relate to their students by telling them about who they are. Lobo talks about his own move from Mexico, where he was a highly respected veterinarian and where he taught at the university. He talks to the students candidly about the types of jobs he held when he first arrived, and about the hard work it took to become their teacher. By discussing how his household would respond to the same questions as those used in this article, he is using the data represented on the graphs as a starting point for important conversations. How does this relate to teaching mathematics?

In Lobo's class, learning mathematics is clearly a community activity. Students are taught to depend on one another, to support one another, and to value diversity. They are taught to use the community and the world around them. They are explicitly told that speaking two languages and valuing mathematics are assets, and that learning mathematics is a way to a better future. Lobo uses the graph as a starting point for discussions on the importance of students' bilingualism. He knows that the students will learn English, but he stresses to them that continuing to learn their home language is important. Is this mathematical? Yes. Without the graphic data as statistical evidence, the students and team teachers would not realize the extent of the use of non-English languages in their community and around the world.

Lobo believes that the teachers need to know as much as possible about the parents so that they do not frustrate them: "We know that each family is different. Some of the parents haven't had many years of schooling and others have college degrees. Most of the students come from homes where Spanish is spoken. We encourage them to continue using Spanish at home." He sees getting to know the students and their parents as a teacher's responsibility. The teachers firmly believe that all the parents want a better life for their children and encourage the students to make the choice of working hard and getting a good education. Lobo provides strong examples of the significance of the knowledge and skills under study to the lives of his students. He uses what he knows about his students—for example, many of the families come from Spanish-speaking countries and many of his students are first-generation American citizens—to connect mathematics education to their lives. Then he uses the mathematics (the data that arise about students and their families) to learn more about his students to further inform his teaching.

The Language of Mathematics and the Language of Graphs

Skilled teachers recognize the importance of language as a tool for teaching mathematics (Whitin and Whitin 2003). They are able to shape and guide conversations using language to help students further their development of mathematical concepts. Lobo recognizes that learning to use the language of mathematics goes beyond having the skills to retell a story or have a conversation with a friend. He engages students in a higher level of academic discourse or mathematical conversation. For example, instead of simply describing what they see on a graph, students use simulations to take on roles of professionals who would need to know the skills of data collection

Figure 1

Raw data from Consensogram by number and percentage

CONSENSOGRAM: Where Students' Parents Were Born

State/Country	Number	Percentage
1. CIUDAD DE MEXICO (D.F)	2	4.88%
2. CHIHUAHUA, MEX.	30	73.17%
3. GUERRERO, MEX.	2	4.88%
4. JALISCO, MEX.	1	2.44%
5. NUEVO MEXICO, U.S.A.	5	12.20%

Born in Mexico 85%
Born in U.S.A. 15%

CONSENSOGRAM: Where Students Were Born

State/Country	Number	Percentage
1. CHIHUAHUA, MEX.	8	38.10%
2. GUERRERO, MEX.	1	4.76%
3. NUEVO MEXICO, U.S.A.	6	28.57%
4. TEXAS, U.S.A.	3	14.29%
5. CALIFORNIA, U.S.A.	2	9.52%
6. UTAH, U.S.A.	1	4.76%
TOTAL =	21	100.00%

Born in Mexico 43%
Born in U.S.A. 57%

CONSENSOGRAM: Prominent Language in the Home

Question	Number	Percentage
1. Spanish is the most prominent language spoken in the home.	17	80.95%
2. My parents speak in Spanish and we answer in English.	2	9.52%
3. English is the most prominent language spoken in the home.	2	9.52%
TOTAL =	21	100.00%

and analysis. He has students demonstrate their "expertise" about the community using the data on the graphs, and the teacher as the client.

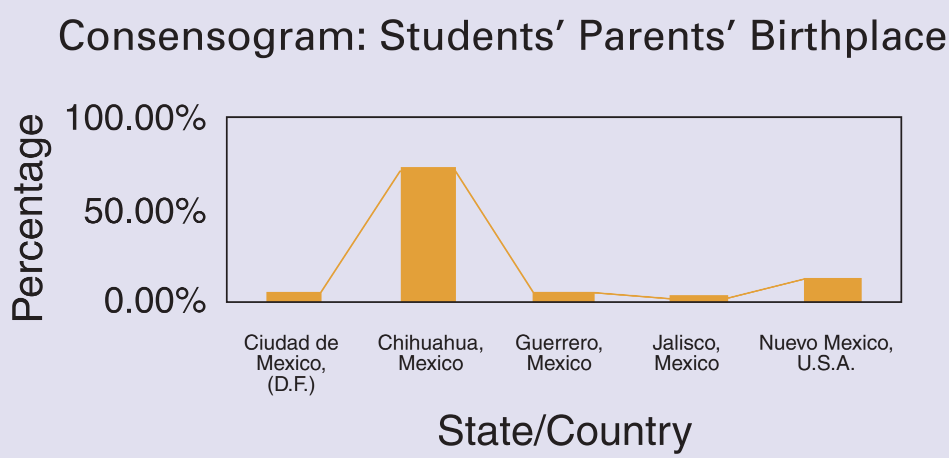
Statistics and data analysis carry their own vocabulary and mathematical language. Friel, Curcio, and Bright (2001) closely examined what is known about developing skills in the comprehension and use of graphs. They define *graph comprehension* as "graph readers' abilities to derive meaning from graphs created by others or by themselves" (p. 132). Teachers of mathematics recognize that the development of number sense involves a lot of experiences working with numbers and numerical concepts, bridging concrete objects to abstract representations. In the same way, students need a lot of experiences working with, thinking about, and talking about real data and their representation in order to develop their *graph sense.* Whitin and Whitin (2003) examined how teachers guide conversation and discussions in mathematics to help students make conjectures and justify their thinking when reading and talking about graphs. Following up a student's observation with a question such as "How can you tell that the green column is bigger?" gives the student the opportunity to explain his or her thinking.

Friel, Curcio, and Bright (2001) developed a framework for asking questions in guiding graph comprehension. The elementary level requires students to extract information from the data. This involves locating the data on the graph and translating the graphic representation into real information. Lobo guides the students through questions and discussions about the data and about what is represented on the graph. He might ask, "What do you see on this graph?" The intermediate level requires graph readers to find relationships in the data, integrating and interpreting the information in the graph. Here, Lobo asks, "What would it mean if, for example, 95 percent of the parents in this class came from a Latin American country? What language would probably be spoken at home?" The most advanced level requires graph readers to analyze the relationships that are implicit in the graph—in other words, to read beyond the data. The researchers stress that especially at this third level, students need prior knowledge about the topic. These findings support what we know about culturally responsive teaching and the need to connect learning mathematics to what the students already know.

In discussing the results of the Consensogram, Lobo uses the types of open-ended questions described above to guide student observations

Figure 2

Bar graph of where students' parents were born by percentage



about data, about themselves, and about their community. At the most advanced level, Lobo uses the Consensogram to prompt the students to think ahead about their future in comparison to the present, as represented in the graphs. He inspires the class to "read beyond the data." He asks students to compare the first two graphs (see **figs. 2** and **3**) about the birthplaces of students and their parents. After interpreting and analyzing the data on these graphs, he takes students a level further by asking them to predict data from the third graph (see **fig. 4**). Lobo relates to his students in ways that could affect their future selves and their self-esteem. In the following example, Lobo uses the question of where students are from, uses the graphs, and turns the question into one of patterns of migration. After the students have mathematically analyzed the data collected on parents' and students' birthplace, Lobo asks the following:

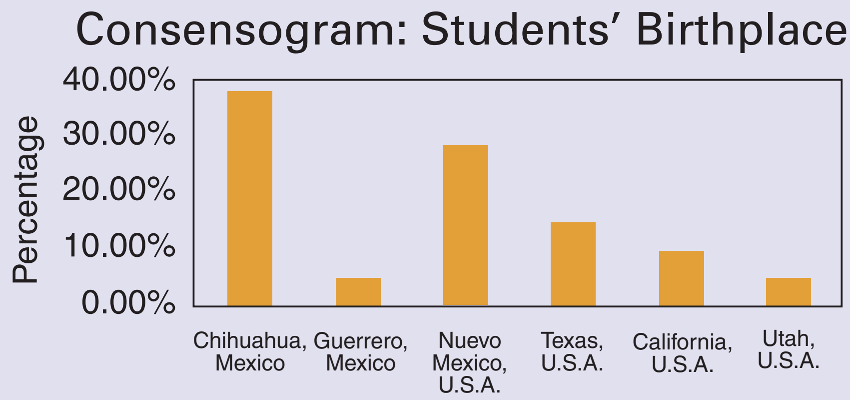
> Look at graphs 1 and 2. Do you see how it [the data] is changing? *(This question refers to the birthplaces graphed for parents [see **fig. 2**] as compared with the birthplaces graphed for students [see **fig. 3**].)* How could this graph help us predict patterns of migration?
>
> Compare this with how animals migrate. Why do they migrate? *(Students provide answers such as the effects of extreme weather conditions, the lack of food, and so on. With the animals in the classroom, they have already had this discussion.)* OK, so why do *humans* migrate?
>
> Now look at this third graph [see **fig. 4**]. These are the students in this class. What do you think will happen to the children of *these* kids? They probably will be born in the United States. How will life be different for them? Do you think that they will grow up speaking Spanish at home? If you don't speak to your children in Spanish, will they be able to speak it?
>
> Do you see how it [the data] is changing? *(This involves a future projection for which data cannot yet be collected.)*

Teaching Vocabulary Explicitly

Teachers should teach both mathematics and English vocabulary explicitly and in ways that the students will not forget. Lobo uses multi-modal activities, analogies, and even props to introduce, practice, and enhance storage and retrieval of core vocabulary. When teaching vocabulary, Lobo gives students a lot of opportunities to hear him use the vocabulary in context. One way he does this involves finding graphs using student interests, such as sports, local elections, and so on. Using real graphs from newspapers, magazines, and the Internet, he teaches the vocabulary directly. He gives the students the key words of the topic and makes sure that they have a precise written definition from which to study. He discusses the data from real graphs with students and involves the students in conversations about the

Figure 3

Bar graph of where students were born by percentage



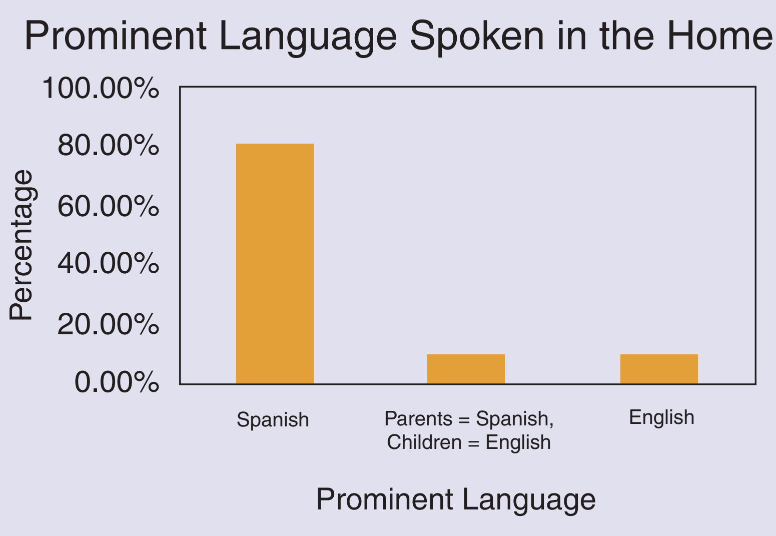
topics of the graph (such as data on sports heroes and television show preferences). He allows many opportunities for the students to practice using the language. For instance, he has the students compete in friendly academic games. He also gives the students a study guide. Students work together to fill in blanks in the study guide, then take the completed guide home to practice with their parents. In one game, students form teams, and each team member learns to support and depend on the other. These games drill vocabulary in fun ways as students compete to show what they know about new terms, their meanings, and how to use vocabulary in context.

Students play a variation of "Spin the Bottle" by groups. In this case, students would have heard, learned about, and studied words such as *horizontal, vertical, perpendicular, statistics, data, table, axis, percentage,* and *fraction.* (*Table* is a word with multiple meanings and can be confusing for ELL students if it is not explained carefully.) When the bottle points to one group after the first spin, that group asks the vocabulary question. The second spin is the group that provides the definition and uses the word correctly. If the definition and use are correct, that group has a chance to ask the first group a question in return. If both groups answer correctly on both rounds, they both win a prize. Otherwise, no one wins and both groups dedicate themselves to learning the words better.

The excitement of the review before the competition is contagious! During the actual rounds of competition, students hold their breath. They understand that they are accountable for knowing the vocabulary and are eager to show what they know. How does Lobo make this common game exciting? He has high expectations for his students. As students succeed, he instills a sense of pride in their accomplishments: "Ah! Maestro Rodriguez, you really know your field! Where did you study?" (In a Latin American country, being called a "maestro" is the highest compliment. The term is reserved for the most esteemed university professor or highest authority on a subject.) Typically, the

Figure 4

Bar graph of prominent language spoken in the home by percentage



student beams and exclaims proudly that she studied at Truman, their current school.

Conclusion

This article has discussed and illustrated some strategies for teaching culturally responsive mathematics to ELL students. Learning to use any language is a complex activity, even when it is your native language. Many of the strategies that Lobo uses in his mathematics classroom are not limited to the teaching of mathematics, nor are they limited to the teaching of language. They can be used in other subject areas and by native speakers of English. These strategies help students perceive and describe their world, their community, and themselves using mathematics and language, and they help students connect to their world, their peers, and their teachers. The strategies presented here did not exclusively teach mathematics, nor did they exclusively teach language. For example, the development of the learning community is an activity more related to culture and relationships than to any particular mathematical concept or language skill. Yet Lobo uses these strategies to support the teaching of mathematics in ways that are meaningful for his ELL students. Cultural relevance, language development, and development of graph sense can help connect mathematics to students' lives and teach them to think critically about their future.

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