Case 5

Facilitating the Participation of Latino English Language Learners—Learning from an Effective Teacher

by Kathryn Chval

Throughout my career, I have collaborated with dedicated and hard-working teachers who have opened their classrooms so that others could learn from them. Yet, one teacher, Sara, stood out from all the others. From the first time I visited Sara's classroom in 1992, I knew she was extraordinary—a teacher who could inspire a Hollywood production. Sara taught Latino English language learners (ELLs) in a low-income urban neighborhood in ways that I had not observed or read about in the literature. She did not reduce the curriculum's level of complexity, especially its language, even though the students were ELLs. Instead, Sara engineered a mathematics learning environment where students actively engaged in collaborative problem solving, oral and written communication and justification, and independent thinking. To give other practitioners insight into how Sara facilitated the participation of ELLs during mathematics, I share my experiences of researching Sara's fifth-grade classroom and provide images of her teaching.

Sara's Classroom

Sara is Latina, and at the time of the study she had been teaching for twenty-one years. To investigate Sara's teaching, I made audio recordings of 119 mathematics lessons over the course of one school year. I also observed 66 of those lessons and carefully documented what transpired with field notes and examples of student work.

Year after year, Sara's students consistently outperformed their peers on standardized assessments. For example, table 5.1 shows how the students in Sara's class compared with other fifth-grade classrooms at her school and throughout the district, as measured by the Iowa Test of Basic Skills for Mathematics during the year of the study. Although her students began the school year below the other two groups, they left Sara's classroom outperforming the other two groups as well as the national norm.

Table 5.1
Growth in one year, measured by median grade equivalent on Iowa Test of Basic Skills

Comparison groups	End of fourth grade mathematics total	End of fifth grade mathematics total	Gain
Sara's class (N = 22)	4.3	6.1	1.8
Other fifth graders in Sara's school (N = 56)	4.6	5.8	1.2
District (N = 23,479)	4.6	5.6	1.0
National norm	4.8	5.8	1.0

Sara's students also made significant improvement in their oral and written communication related to mathematics, as evidenced in the transcripts and examples of student work. For example, late in the school year, the students were given two problems, one of which was the following: "A three-quarter circle has an area of 100 square centimeters. Calculate the perimeter of the three-quarter circle." Students had already solved similar problems involving full circles; however, the three-quarter element was completely new. Violetta volunteered to present the solutions for both problems at the board to the class. She drew a sketch of a three-quarter circle on the board and then wrote the calculator keystrokes for her solution to the first problem (see fig. 5.3). As she wrote each keystroke, she explained the meaning behind it, as demonstrated in the transcript of Violetta's presentation. To find the perimeter of the three-quarter circle, Violetta calculated three-fourths of the circumference (she referred to this as "the curvy part") and then added the lengths of two radii (she referred to this length as "the diameter").

[100] [÷] [3] [=] [×] [4] [=] [÷] [π] [=]
[$\sqrt{x}$] [×] [2] [=] [STO] [×] [π] [÷] [4] [×]
[3] [=] [SUM] [EXC]

Fig. 5.3. Violetta's calculator keystrokes for first problem

Violetta: We are going to find the perimeter of the three-quarter circle. The area of the... 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. Divide by π to get the area of the square built on the radius. You take the square root to get the radius. And then you multiply by two to get the diameter. Then we store it [*a reference to the calculator*]. Then we multiply by π to get the circumference of the circle. Then we divide it by four to get the quarter circle. Then we multiply by three to get the curvy part of the three-quarter circle. Then we sum it—sum it to memory [*another reference to the calculator*]. So we can get the circumference, the perimeter, of the three-quarter circle.

Throughout Violetta's presentation, she used drawings of the problem, calculator keystrokes, gestures, and oral communication to explain how she solved the problem—all critical components of Sara's teaching that Violetta appropriated. Moreover, we see the mathematical challenge of the problem that was posed—atypical for fifth grade and for ELLs—demonstrating Sara's high expectations.

Establishing Expectations for ELLs' Participation

The transcripts of Sara's classroom at the beginning of the school year were quite different from Violetta's example. Students answered questions by using numbers or short phrases. They did not know how to work productively in groups. They did not exhibit the mathematical practices identified in the Common Core State Standards for Mathematics (CCSSI 2010, p. 10):

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Yet, by second semester, the CCSS mathematical practices were the norm in Sara's classroom. As I began to work with other teachers in professional development settings to help them learn about Sara's teaching, they commented on prevalent, unproductive interactions that hinder ELLs' participation, including encounters in which their native-English speaking peers disrespect them, ignore their questions or requests, do their work for them, or do not understand their mathematical misconceptions. Unfortunately, too often ELLs are left to work in isolation or to participate as spectators (Brenner 1998). Therefore, teachers need to be purposeful and act strategically to build a classroom community that values ELLs' contributions and enhances ELLs' participation in mathematical activities. This invites the question, What did Sara do to facilitate the participation of Latino ELLs in her mathematics classroom?

From the first day of school, Sara immersed ELLs in an environment filled with words, both written and spoken. She created an environment in which students experienced and used language in the context of collaborative activity and problem solving. She ensured that every student paid attention to spoken and written words and supported them as they began to use those words. Specifically, Sara—

1. spoke and wrote sophisticated words;
2. used these words frequently and in the context of solving problems; and
3. helped students build understanding of the meanings of these words.

During the whole-group discussions in the first twelve days of school, Sara prominently used words such as *tell, dictate, explain,* and *write.* Sara used these words 779 times, an average of 65 times per lesson. Such repetition is significant because it demonstrates that Sara expected her students to communicate while learning mathematics.

Sara developed an environment that was not only filled with communication, but also valued its often forgotten inverse—listening. Cazden (1988) argued that in a typical U.S. lesson, students look at the teacher, even when classmates speak. Sara, on the other hand, built an environment in which students were expected to look at their peers when they spoke. She explicitly discussed the value of listening and how it should take place. For example, on the first day of school, Sara taught a lesson comparing hearing and listening. Furthermore, to establish the importance of listening, Sara related her classroom to a family—a family that shares, cares, helps, and respects. Four examples from August 27 demonstrate this approach.

Example 1

Sara: You care about your family. Is there anyone here who does not care about their family? [*no response*] Ah, everybody cares about their family. Do you care about school?

Chorus: Yeah.

Sara: Do you? How do you show that you care about school? Violetta is annoyed. I can see it in her face. Hold on a second. Her face is all crunched up, and I know she wants to listen, and she's reacting to something that Matthew is doing. Is Matthew showing us that he cares?

Chorus: No.

Sara: Is Violetta hearing what all is going on?

Chorus: No.

Sara: No, she's busy taking care of a problem here. And Matthew is not listening very well. Matthew, we care about you, so what can we do to help you out? Because this is a family right here. We spend lots and lots of hours together, don't we?

Matthew: Yes.

Sara: So we are a family. When you do something, it affects all of us, doesn't it? All of us, right now, are paying attention to you, because you cannot pay attention. We have to pay attention because we care about you. Do you care about us?

Matthew: Yeah.

Sara: How are you going to show us that you care about us?

In example 1, Sara compared the class to a family. She also compared Matthew's behavior—his not listening—to not caring. During the first week of school, Sara began to establish the need for listening as she built the foundation for creating an environment where students cared about what was said.

Example 2

Sara: If I show you respect, I expect respect right in return. If I work very, very hard, I expect the same from you… that you work very, very hard. If I listen to you, then I want you to listen to me. I show you that I care by the work that I do. You show me that you care by the work that you do. That's how I want you to show me respect. How do you want me to show you that I care? Alejandro? Is there anything special that I should do, or am I already doing what you think I should do?

In example 2, Sara established important expectations, including respect, hard work, listening, and caring. In the following example, the students were working in pairs while Sara circulated and provided guidance. In this example, she emphasized that the students should ask for help when needed and that they should teach one another.

Example 3

Sara: There is a rule up there on the good rules. Which is the rule you should be looking at right now?

Students: Move quietly.

Sara: No, you're being very good about noise. Noise is wonderful.

Students: Be a good listener.

Sara: Be a good listener. Oh, something else I think.

Students: Move quietly.

Sara: Can we go down to the purple rule?

Students: Encourage participation.

Sara: Encourage participation. Are you allowed to move around the room quietly?

Students: Yes.

Sara: Yes. So Dalia was asking Alejandro, and Alejandro didn't know what to do. Alejandro wasn't participating because he never asked for help. So somebody over here. Anybody. You move around. I'm only one person. Move around quietly and ask each other. You can teach each other. Walk around. Help each other. I can't help all of you at the same time.

Example 4

Sara: We have to share things. That's how we learn. That's how we show people that we care for them.

The four examples above illustrate how Sara established a sense of family in her classroom—a family that shares, cares, helps, respects, and listens. Sara modeled effective listening, but also explicitly talked about how to do it. She made students responsible for articulating reasoning and for working hard to understand the reasoning of others—critical elements of the CCSS Standards for Mathematical Practice and the NCTM (2000) Process Standards. She emphasized looking at the speaker to demonstrate respect and good listening. She explained that good listening can lead to additional ideas, which in turn can increase the quality of the discussion. She also discussed the fact that good listening involves tone of voice, facial expressions, and gestures. From the first day of school, Sara discussed effective features of listening and the importance of listening. The following two excerpts provide examples:

Example 1: September 1

Sara: Which rule are we practicing right now?

Students: Good listeners.

Sara: We're going to be good listeners. What is a good listener? Someone who?

Students: Listens.

Sara: How do I know you're listening carefully? How does anyone know that you're listening carefully? What must you do when you are listening carefully?

Students: By looking at the person.

Sara: You look at the speaker and you focus your attention on the speaker completely. You're not playing with anything inside your desk. You're not looking through a folder. You're not chatting with a neighbor; you're listening.

Example 2: September 9

Sara: You're going to be a good listener. So you are going to look at whoever answers, or whoever completes an answer. Because sometimes people have part of the answer, and another person helps out and completes an answer.

At this early point in the year, Sara reminded the class to look at the speaker as he or she approached the chalkboard to present. (Early in the year, pairs of students would present solutions to the class, providing an opportunity for ELLs to communicate with a peer if they struggled during the presentation and to build their confidence with public speaking.) In the September 9 example, Sara emphasized looking not only at the first person who answers, but also at the next student, who may add to that answer. Later in the year, such reminders were nonexistent. Students followed the dialogue of the respective speakers with their ears and their eyes. Sara had developed an environment of talk and listening and had created a family that showed respect and caring by talking and listening. Sara had high expectations for her students—all of her students. Every student was expected to participate and contribute to the learning of everyone in the classroom—including the teacher. Sara established a collaborative environment—a family—rather than a competitive environment.

A teacher can establish disagreement or argumentation as a negative, confrontational classroom practice; however, Sara carefully created an environment whereby disagreement was cooperative, positive, and valued. In an interesting way, she used disagreement as a mechanism for developing cognitive processes such as reflection, analysis, reasoning, and justification. Thus, a family that shares, cares, helps, respects, and listens is in a position to "construct viable arguments and critique the reasoning of others" (CCSS Mathematical Practice 3).

At the beginning of the school year, the participation of Sara's students in these types of processes was restricted by their lack of experience. The following examples show Sara establishing the foundation for these processes—a critical element in the students' mathematical development. Sara used a simple teaching strategy to establish this practice in her classroom early on in the school year. For example, consider the progression of Sara's statements over the course of a few days, as shown in the following list:

September 1:	Are the [calculator] keystrokes correct?
September 2:	They don't agree with you.
September 3:	I disagree.
September 4:	Do you agree with that? Yes or no?

Sara began with a word familiar to her students—*correct*. In the second example, several students have stated that an answer is "not correct." Sara revoiced this response by saying, "They don't agree with you." In the third example, Sara modeled a desirable response for her students by saying, "I disagree," instead of saying, "You are wrong." Then Sara moved on to give the students a choice. At this point, the question is still phrased in a yes-or-no format. Not until September 16 does Sara go beyond that format (seven new students entered the classroom on September 10) as the following transcript demonstrates:

September 16

Marisa: We got our triangle, our right triangle in there, we got to multiply one leg times the other leg to find the area of one triangle.

Sara: Marisa, can you stop and say what you've done so far?

Marisa: Yes, we multiplied one leg times another leg on the triangle, and *N* equals twelve. And the area is the whole rectangle, and we don't want the whole rectangle. We want the triangle. So you have to divide by two—equals six. Six is the area. Centimeters. Is the area.

Sara: I disagree. Anybody else disagree?

Chorus: Yes.

Sara: You have to say that. When you see something you don't agree with, you say, "I disagree." If we don't disagree, then we don't have to discuss it.

Marisa: Square centimeters.

Sara: Yes. You corrected yourself. Good.

Here Sara established the importance of stating disagreement when it is observed. She also explicitly explained that disagreements warrant discussion. At this moment, Sara granted permission to her students not just to raise their hands when they saw a mistake, but to state it verbally. From this moment forward, students eagerly and consistently said, "I disagree." A few moments later, a student took the plunge and became the first to say the magic words. Sara did not praise the student for saying them, but challenged him to justify his response.

Sara: Really? How are you going to find the…

Student: I disagree.

Sara: You disagree with *what*?

A few moments later, the following dialogue ensued in the classroom:

1. *Sara:* Stop, stop, stop. Well, let's pretend that he said three times five. If he says three times five, Yomara, would you say you agree or disagree?

2. *Yomara:* Disagree.

3. *Sara:* *Why*?

4. *Yomara:* Why?

⋮

13. *Sara:* Well, Mark, he said three times five. And he meant this length times this length. *Why* do we disagree with that? One person. *Why* do we disagree with that, Yomara?

14. *Yomara:* Teacher?

15. *Sara:* Lucia, *why* do we disagree with that? Tell her the problem.

16. *Lucia:* Because she multiplied the hypotenuse.

17. *Chorus:* Yes.

18. *Sara:* Do we need the hypotenuse?

19. *Chorus:* No!

Not only did Sara's students have to say "I disagree," but they also had to describe what they disagreed with and present an argument for their position. In the preceding dialogue, Sara extended their talk, but more important, she involved students in discussions in which they justified solutions. This aspect of Sara's teaching was significant because students who justify solutions, especially while facing disagreement, will gain better mathematical understanding as they work to convince their peers about differing points of view (Hatano and Inagaki 1991; NCTM 2000). Sara recognized the importance of justifying and worked carefully to establish it as a classroom norm—a norm that appeared to be foreign to these students in the first few weeks of school.

During the first three weeks of the year, Sara stood near the chalkboard as students presented their ideas, and she circulated among the tables as her students worked together. During the second semester, she continued to circulate as her students worked, but as students presented, she withdrew to the side of the classroom, away from the chalkboard. She continued to guide the discussions; however, when disagreement or uncertainty arose, students stepped in and approached the board to help their peers instead. Sara's students took risks, made mistakes, and looked to one another for help.

Using Calculators to Facilitate ELLs' Participation

Sara introduced the term *keystrokes* in the context of a specific machine: the scientific calculator. In working with the calculator, Sara used this term in two distinct ways: (1) to denote the striking of calculator keys; and (2) to denote—in speaking or writing—the symbols representing the calculator keys. Sara required students to present keystrokes both orally and in writing to accustom them to communicating and discussing mathematical thinking.

In Sara's classroom, using keystrokes to discuss and negotiate meaning was more important than using the calculator to compute answers. The following excerpts from transcripts illustrate how Sara established these practices:

Sara: On your paper write the keystrokes that you would need to put into your calculator to find the area of that rectangle. Don't take the calculators out, I didn't say that. I asked you to write the keystrokes.

Sara: Your keystrokes are very important to me because they tell me what you are thinking. I cannot be inside your head. Oh, unless I open his head. [*class laughter*] I can't do it. But if I see your work, I know what you are thinking.

Figures 5.4 and 5.5 help establish the context for Sara's comments and demonstrate the typical use of calculator keystrokes during the second half of the year in her fifth-grade classroom. Figure 5.4 shows a sample problem. Sara drew the figure on the board, asked her students to work in groups to calculate its area, and then circulated to assess students' progress.

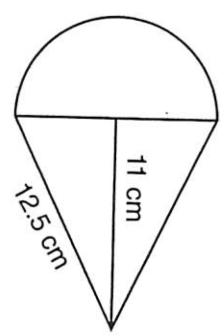

Fig. 5.4. Problem posed to Sara's students: What is the area?

After a short time, Sara asked for a volunteer to write the keystrokes on the chalkboard and explain his or her meaning for the first part of the problem. Marisa volunteered and came to the board to write the keystrokes to calculate the length of the radius of the semicircle (by treating the radius as one leg in a right triangle, with 11 cm as the length of the other leg and 12.5 cm as the length of the hypotenuse, and using the Pythagorean theorem), as shown in figure 5.5. Sara then asked for a second volunteer to continue where Marisa left off. Violetta volunteered to write and explain the second part of the solution, which involved calculating both the area of the semicircle and that of the isosceles triangle.

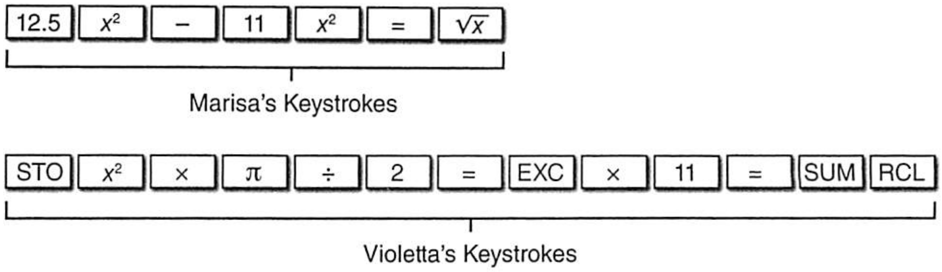

Fig. 5.5. Solution, as a series of calculator keystrokes, presented by two of Sara's students

Sara used calculator keystrokes as a common "language" that was central to the classroom discourse to mediate interactions in small-group and whole-class discussions. This common language was especially important to Sara's students who were learning English as a second language. Students presented keystrokes both verbally and in writing to communicate mathematical thinking, initiate conversations, pose questions to their peers and teacher, analyze their peers' solutions, and articulate corrections and modifications. The students used the keystrokes to plan and create strategies to solve mathematics problems and to create and articulate a process of reasoning to justify their solutions.

In fact, Sara's students became so proficient at thinking and problem solving with the keystrokes that they no longer needed the calculator itself. Sara's technique for using keystrokes in a typical mathematics problem is outlined in the chart in figure 5.6. Although Sara never explicitly articulated this technique herself, it was the process (with the exception of step 6) that she used in every observed lesson. (For further discussion of Sara's use of writing in the mathematics classroom, see Chval and Khisty [2009].)

Step 1	Students write a plan for solving the problem, using only keystrokes.
Step 2	Students use keystrokes to communicate plan.
Step 3	Students break down sequence of keystrokes into components and discuss the meaning of each component.
Step 4	Students listen to presentation of keystrokes, analyze keystrokes, and make a decision concerning agreement with that solution.
Step 5	Students suggest alternative keystroke sequences, including more efficient ones.
Step 6	Students write a narrative of how to solve the problem.

Fig. 5.6. Sara's process for her students for using calculator keystrokes

Through this process, Sara used keystrokes to facilitate her students' development of the functions of planning, problem solving, reflection, analysis, and writing. For example, Sara used calculator keystrokes to develop the students' planning function, or the ability to plan for the solution of a problem (step 1). Students were not only expected to write their keystrokes, but they were also expected to write them *before* they touched the calculators. In an important variation from common teaching practice, Sara did not have her students use keystrokes only to make a record of what they had already pressed. The keystrokes, as Sara used them in her classroom, served the students as a means of communicating and displaying their thinking and, more important, as a way to create a specific plan for solving a problem before they touched the calculators.

Once the students developed a plan for solving a problem, Sara used the keystrokes as referents for discussing mathematical ideas. As students presented sequences of keystrokes to the class, she challenged them to communicate their thinking by writing the keystrokes on the chalkboard and explaining their solutions verbally. Often, students presented part of the solution, like Marisa in the case above, and others, like Violetta in the same case, continued the solution. Sara used this public process to help students clarify their thinking and build meaning.

Once the keystrokes were on the chalkboard for all to see, every student had the responsibility to read them and analyze them. Even if students had written a different sequence on their own papers, they were responsible for understanding other solutions presented by peers. This responsibility included recognizing invalid methods, suggesting alternative methods, or determining more efficient methods. In this process, the students used the keystrokes as objects of reflection and analysis. Although some educators might think that Sara's emphasis on keystrokes would reinforce an algorithmic way of solving problems, analysis of student work indicated that students often generated anywhere from five to eight different solution strategies for many of the problems. This finding strongly suggests that students were not applying memorized procedures for solving problems.

Conclusion

Teachers need to consider how to support their students' development of proficiency with mathematics and language, enhance mathematical tasks, and at the same time establish, facilitate, and maintain productive classroom interactions specifically for ELLs if they want to achieve excellence and equity for these students in their classrooms. Sara provides a critical example of how to *support* ELLs as they simultaneously do advanced mathematical work and acquire a second language. She maximizes contextual supports, such as drawings, calculators, and other representations, which complement other supports, such as teaching for meaning and using students' thinking as learning resources.

Sara's teaching provides an example of how to use the potential of the calculator as a tool to enhance mathematical learning and understanding. She demonstrates how keystrokes can be used to promote and facilitate social activity among ELLs. She introduces the idea of using keystrokes as a common language to mediate interactions so that ELLs can negotiate mathematical meanings. Most important, Sara demonstrates the value of purposefully establishing a learning community where ELLs have the opportunity to participate in productive mathematical practices.

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