According to the National Center for Education Statistics (NCES), 47 million people living in the United States spoke a language other than English at home in 2000, representing approximately 18% of the total U.S. population (NCES, 2004). It is expected that these demographics will continue to change, and minorities will become the majority by 2030 (U.S. Census Bureau, 2009). Of special interest is the fact that the population of English language learners (ELLs), especially those who are learning English in K-12 school settings, will continue to grow (Chang, 2008). According to an “Issue Brief” by the American Youth Policy Forum (AYPF), about 20% of students were identified as an ELL in 2007, and a quarter of those students have difficulty with English (AYPF, 2009). A recent report from the Census Bureau (2009) suggests that one in every four children under the age of 5 in the United States is currently being raised in a home where a language other than English is being spoken.

The major concern of educators who work with ELLs is that these children face many difficulties when entering the U.S. public education system. More specifically, these children tend to fall behind their mainstream counterparts in science, reading, and mathematics (NCES, 2003; U.S. Department of Education, 2001). A vast amount of research conducted in the area identifies several factors associated with ELL underachievement (Capps et al., 2006; Chang, 2008). For instance, sociolinguists have confirmed that ELLs experience difficulties learning a new language and a new set of cultural norms, resulting in poor academic performance (Teranishi, 2004). Mathematics is one of the critical areas in which ELLs have
language-associated learning difficulties (Lee & Jung, 2004; Veel, 1999).

The National Council of Teachers of Mathematics (NCTM) strongly recommends that “students who speak a first language other than English or have related cultural differences must not face special barriers to learning mathematics” (NCTM, 2008, p. 1). Based on an NCES report (2002), more than 40% of teachers have had ELLs in their classrooms, but the majority reported that they were not prepared to teach ELLs due to lack of training (Byrnes, Kiger, & Manning, 1998). Another even more critical problem affects teaching ELLs mathematics: many educators believe, because mathematics is based on language of numbers and symbols (Janzen, 2008), that students do not need proficiency in English to perform mathematics well (Lee & Jung, 2004).

However, studies have shown a strong correlation between children’s English proficiency and mathematics performance (Ron, 1999; Schleppegrell, 2007). To help ELLs succeed in school mathematics, culturally and linguistically responsive instructional supports for English language learning are vital. Teachers of ELLs should be knowledgeable about non-English speaking children’s reactions to their teaching practices in mathematics and make use of effective research-based strategies when it comes to teaching mathematics to this group of students.

To make mathematics learning meaningful, Copley (2000) and the NCTM (2000) recommend that teachers connect mathematics concepts with children’s own experiences and cultures. The following episode, experienced by one of the authors of this article, reflects how children can become enthusiastic about math when they are able to make connections to their own culture.

Haeun, a 2nd-grade ELL, called me excitedly. “Aunt, I have to show you something.” I was wondering what she was going to tell me. From the expression on her face, it should be something big. I asked, “What is it?” Haeun started to unpack her backpack and tried to find something in her mathematics book. She was not supposed to bring the book home, but she had asked the teacher for special permission. Finally, she found the page and showed it to me. “Aunt, look at it, this is my favorite snack. See the Korean letters too?” The page Haeun was showing me featured a picture of a Korean snack with Korean letters on it. The picture was placed at the bottom of the page and could barely be seen since the size of the letters was too small to read. I was amazed that Haeun was able to see the letters and be excited about it.

This anecdote shows the significant impact on a child when she sees her own cultural heritage reflected in a school textbook. According to Janzen (2008), good teachers of ELLs are able to appropriately demonstrate to children that they value children’s first languages and cultures. This is critically important in teaching ELLs mathematics, since the majority of ELLs have shown poor performance in mathematics compared to their English-speaking counterparts (Zehr, 2010). The authors, in utilizing a cross-referencing method of examining existing literature associated with ELLs and learning mathematics, identified the following five components as critical elements that need to be considered when teaching mathematics to ELLs:

- Using children’s own stories in teaching mathematics
- Integrating conversational language and language that is familiar to students in teaching mathematics
- Promoting children’s native language
- Allowing students to think aloud as a strategy to promote understanding
- Integrating non-linguistic materials to facilitate math language.

Using Children’s Own Stories in Mathematics Teaching

The best practice for integrating ELLs’ cultural knowledge and experiences in teaching mathematics is to utilize their own stories to make mathematics problems (Lo Cicero, Fuson, & Allesxaht-Snider, 1999). ELLs often experience difficulties in understanding mathematics word problems. Robertson (2009) strongly recommends that teachers of ELLs integrate children’s real-life examples so that they can picture and understand mathematics problems better.

Children come to school with many stories acquired from their cultural contexts. For example, Yechan, a 2nd-grader, shared how he and his mom made kimchi, a traditional Korean dish. The teacher, Ms. Lee, paid close attention to his story and recognized that Yechan used fraction words in describing the process of cutting a cabbage into four equal pieces. Ms. Lee created a teachable moment using his story and made a fraction word problem to help Yechan reach a conceptual understanding of fractions.

Children often share in class stories from their home lives. Teachers of ELLs need to listen to children’s stories carefully and take advantage of them to teach mathematics in a meaningful man-
Robertson (2009) recommends that teachers of ELLs continuously look for familiar ideas or props that can be used to engage the children more actively, such as integrating family recipes or using personal stories. Furthermore, encouraging ELLs in the process of making their own mathematics word problems also benefits them, in that they can come up with the mathematics word problems that have familiar contexts and naturally reflect their lives as well as their own culture (Coggins, Kravin, Coates, & Carroll, 2007).

**Integrating Familiar Language**

ELLs come to school with various levels of English proficiency. Regardless of their proficiency level, it has been well proved that ELLs in school settings acquire conversational language skills much earlier than mathematics language or academic vocabulary related to mathematics (Coggins et al., 2007). According to Cummins (2005), ELLs need about two years to acquire conversational language, but far more time to master academic language. Usually, this academic language takes between five to seven years to develop and acquire. Teachers of ELLs should take this into consideration when teaching them mathematics. For example, a teacher may ask a child to solve the following division problem: “There are 5 children and 20 cookies. How can you divide 20 cookies among 5 children?” In the process of solving this problem, a child might use conversational language, such as “they share, everyone get the same” (Coggins et al., 2007, p. 10). Although the child did not use formal mathematics language, he or she did show a conceptual understanding of division using conversational language.

A teacher also needs to promote a child’s understanding of mathematics by presenting prompts using conversational language. In the following example, Daniela, a 3rd-grade ELL, is attempting to solve a story problem while a researcher (one of authors of this article) uses conversational language to help her understand the problem (Amaro-Jiménez, 2008). Mrs.
James, Daniela’s teacher, has asked her and her peers to compare the number of children in a given family to that in their own families and then find the difference. Mrs. James uses the word “difference,” which is a more familiar term for the child, instead of the word “subtraction.” The researcher stresses the word “difference” to prompt Daniela to solve the problem, and Daniela finally comes up with the word “subtraction.” As seen below, Daniela does not understand what subtraction means until she is given language that is familiar to her.

Daniela (D): Mrs. James says I have to find the number of children in my family, but I don’t know how.
Researcher (R): Okay, so do you know how many children there are in your family?
D: Yes, there are two.
R: Now what else do you need to do?
D: Compare the number of children in the big family with my family.

R then asked D if she knew what she had to do to find that number. She nodded and showed R her piece of paper. R then asked her if she could explain what she had done.

D: This is the number of children in my family (pointing to the number two). This is the number of children in the large family (pointed to the number 69). She then hesitated, paused). Wait . . . no, this is not the number. This is a lot of children in one family (laughed).

She then asked the girl sitting on her right if that was the number of children. The girl told her that that was the correct number.

D: The two numbers. Okay . . . what now?
R: Well (pause), if you need to find out the difference (emphasis) in the number of children, what do you need to do?
D: Oh (pause). Difference (pause). I need to do (pause), I need subtraction.
R: Yes, Daniela, you need to subtract.

The researcher used conversational language prompts that were more familiar to Daniela. Using conversational language helps ELLs gradually connect their everyday language with mathematics language (Irujo, 2007; Ron, 1999).

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Figure 2
Mathematics Word Bank in English and Spanish
Directly Integrating the Children’s Native Language Into Instruction

The biggest difficulty that ELLs encounter when they solve mathematics problems is understanding mathematics-related terms in English. Teachers of ELLs should allow them to make sense of these terms and concepts in their native language (Oliveras, 1996) and encourage them to use their primary language in learning mathematics if they are more proficient and comfortable doing so (Coggins et al., 2007).

Teaching mathematics terms/vocabulary is a critical part of helping ELLs to learn new mathematics skills and concepts. Teachers of ELLs should make an attempt to identify the terms they are using in their classroom that have cognates in the children’s native language (Slavit & Ernst-Slavit, 2007). The use of cognates effectively helps ELLs more easily understand mathematics terms in English by connecting with their native language (Hernandez, 1999). For instance, some of the shapes and colors that children need to learn early on have similar names in such languages as Spanish (e.g., circle – círculo, triangle – triángulo; see Figure 1).

Although teachers of ELLs may attempt to use cognates when teaching children mathematics terms, teachers should be aware that it is sometimes very difficult for ELLs to memorize these new math terms in English. Most mathematics terms are social knowledge, which means that children should learn them by means of a social agent in a given social and cultural context (Copley, 2000). As a result, ELLs should be exposed to mathematics terms in various ways on a daily basis.

One way to expose ELLs to math terms in English is through environmental math print. Giving ELLs access to mathematics terms on an everyday basis helps them become familiar with the terms in a written format. Specifically, displaying mathematics word bank charts (see Figure 2) that include terms in English and in the ELL’s native language can help him become familiar with English mathematics vocabulary, while preserving the mother tongue if the child is able to read and write in the native language. Likewise, creating a word bank chart that can be sent home can help solidify the home-school connection. Parents can be encouraged to use these word bank charts to help their children with homework and understand what their children are learning in the classroom. Displaying these charts in the classroom also will be a resource for native English-speaking children; they will become aware of language variety and learn to respect other people’s languages, and may begin to learn some of this academic mathematical vocabulary as well.

Encouraging ELLs To Use Self-Talk as a Strategy To Understand Mathematics Problems

Buck (2000) recommends that ELLs use “self-talk” or “think aloud” strategy, in either their native language or English, to help them clarify their understanding of math problems or their learning process while reducing their level of anxiety about the content they are learning in school. In the example that follows, Daniel, a 3rd-grader, is trying to solve a math story problem on a web-based software called Study Island (Amaro-Jiménez, 2008). For this test item, Daniel was asked to determine the missing number in a number line (i.e., find the pattern). The problem focused on a child who had to go through a certain number of steps on his way to school; Daniel needed to determine how many steps the child had walked after the third day of walking to the school. He was given the number of steps the child had walked on his first, second, and fourth days of school. As he read the problem, he began self-talking:

1. Different numbers (pause).
2. Mark couldn’t go by car (pause).
3. He had to walk up to go to his school.
4. He walked up the same number of steps each day (points to this sentence).
5. He walked up the same number of steps each day. He walked up the same steps each day (pause) each day (points to these two words and holds his index finger there).
6. It’s two hundred four, two hundred forty-four, three hundred twenty-four . . . (counts with fingers).
7. Oh, (pause) so he walked up the same number of steps each day.
8. Two hundred forty-four minus two (pause) hundred four.
9. Because it goes by fours (pause).
10. Hmm, by forties (pause).
11. Yeah, it’s 284.

In this case, Daniel re-read the passage more than once to determine exactly what he had to do. As noted in lines 4-5 and in line 7, Daniel’s self-talk indicates he read and re-read the part about the child having to walk the same number of steps each day multiple times. Self-talk
allowed him to think through the problem, as he was trying to make sense of the problem he had to solve. Moreover, Daniel was able to use self-talk as a strategy to interpret what he was being asked to do in the problem and to clarify problem-solving processes. As Irujo (2007) emphasizes, a self-talk strategy clearly helps ELLs interpret the language to understand what the problem is asking and increase the students’ own understanding of the task at hand.

**Providing Non-Linguistic Mathematics Materials To Facilitate Mathematics Language**

Teaching mathematics using only verbal communication frequently limits ELLs’ mathematics learning. Providing non-linguistic mathematics materials that have no or limited language complexity (e.g., manipulatives, pictures, diagrams, or graphic organizers) helps ELLs understand mathematics problems better and demonstrate what they know about concepts, skills, and processes (Lee & Jung, 2004; Robertson, 2009). However, Khisty (1995) claims that teachers of ELLs often present “decontextualized” mathematics materials that do not appropriately involve visuals and concrete materials. Asking ELLs to solve mathematics problems in English without providing appropriate visual or concrete materials would place ELLs in a quandary, because they cannot understand either the English mathematics terms or the mathematics concepts being taught.

Concrete materials often facilitate understanding of mathematics languages (Coggins et al., 2006). For example, concrete materials can help ELLs learn the meaning of such mathematics terms as “edge,” “corner,” “arc,” “rotate,” and so forth. Children can learn these terms by touching mathematics materials, such as attribute blocks or pattern blocks. According to Garrison and Mora (2005), the basic premise of teaching mathematics to ELLs is to relate new mathematics terms to tangible materials. These materials, while mathematically challenging, may require less-refined reading level or language skills (Teachers of English to Students of Other Languages, 2006). Teachers of ELLs should be cautious when integrating concrete materials to teach mathematics, however, because they do not always bring about positive learning outcomes (Clements, 1999; Clements & McMillen, 1996). When a teacher uses concrete materials in a prescribed, step-by-step manner, children tend to mimic the process that the teacher presents without gaining a conceptual understanding (Moyer, 2001). Concrete materials need to be used not as a goal, but rather as a vehicle to facilitate and develop ELLs’ understanding of math language and mathematics content.
ELLs need time to explore math materials, make mistakes, and make sense of math using the concrete materials. Before teachers provide verbal definitions of mathematics terms, they should ask ELLs to define the terms in their own words (Irujo, 2007; Robertson, 2009), encouraging them to use various representations (the child’s native language, drawings, manipulatives, etc.). For example, to help ELLs build a conceptual understanding of a “triangle,” instead of providing the definition of triangle, teachers need to provide materials that demonstrate the attributes of triangles and the time to explore them. A teacher may provide visual figures (see Figure 3) and have the students provide their perspectives. Finally, a teacher can introduce the term “triangle” and have ELLs define the term in their own words, in either their native language or in English. As the final step, a teacher may introduce the definition of triangle using mathematics language (or mathematics register).

Summary
There has been a misguided belief that ELLs should find mathematics to be less challenging, since it is mostly composed of symbols and numbers (Lee & Jung, 2004; Veel, 1999). However, a strong correlation exists between mathematics performance and language proficiency (Terasnishi, 2004). In learning mathematics, ELLs should understand not only mathematics problems from a textbook, but also oral language, because most mathematics content is delivered by a teacher in English (Janzen, 2008). Most critically, it is essential for ELLs to acquire mathematics language skills (Ron, 1999; Slavit & Ernst Slavit, 2007).

The primary job of teachers of ELLs is to help children bridge their conversational everyday language into mathematics language (see Ron, 1999, p. 25, for the pathway of acquisition of mathematics symbolic language). The good news is that there has been some recent improvement in ELLs’ performance in mathematics in the United States. Nevertheless, the gaps between ELLs and non-ELLs in both math and language remain statistically significant (Zehr, 2010). Without providing ELLs with careful and responsive support to understand mathematics language, this gap will continue and the majority of ELLs may fall behind in school mathematics. Therefore, it is critically important for teachers of ELLs to provide a culturally and linguistically supportive mathematics environment by taking into consideration ways to appreciate and use children’s native culture and language in their mathematics teaching as well as by adapting their teaching methods to ensure that they do not rely only on English words to communicate concepts.

References


