SUPPORTING MATHEMATICAL LEARNING OF YOUNG DUAL LANGUAGE LEARNERS

By Sallee Beneke

In 2013, data revealed that children in Illinois were speaking 66 languages other than English at home, including but not limited to Spanish, German, Polish, Arabic, Urdu, Chinese (Mandarin or Cantonese), Korean, French, Hindi, and Tagalog (Illinois Early Childhood Asset Map, 2016). Dual language learners (DLLs) entering kindergarten who speak a primary language other than English are likely to perform more poorly in reading and math compared to their peers (Espinosa, 2015). In addition, young children who are DLLs are over-represented among children of poverty. This over-representation exists for a variety of reasons (Figueras-Daniel & Barnett, 2013: Hernandez, 2010), such as parents' formal education levels and ethnic/minority status. Unfortunately, a gap in student achievement is likely to persist over time between children who live in poverty and their peers from higher income homes, making academic success less likely (Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010).

The good news is that developing two languages during the early years can help children develop "enhanced executive function abilities, such as working memory, impulse control, attention to relevant versus irrelevant task cues, and mental or cognitive flexibility, as well as improved language skills" (Espinoza, 2013, p. 5); these skills help children learn. However, the time it takes to process input in two languages may cause some dual language learners to be a bit slower at word retrieval (Espinoza, 2013). Intentionally exposing children to English during the preschool years, while at the same time providing them with ongoing opportunities to learn important concepts in their home language, results in the highest achievement in both the home language and English (Collier & Thomas, 2009).

Increasing numbers of DLLs are now attending pre-school programs, and research has shown that attending a high quality preschool can help close the gaps in achievement. Changes in requirements for teacher preparation reflect the critical importance of learning to teach dual language learners effectively. For example, in Illinois all preschool teachers must meet licensure requirements for coursework related to the effective teaching of DLLs as of July 1, 2016 (Illinois State Board of Education, 2014), and Pre-K programs must provide instruction in the primary home language and English, if 20 or more English Language Learners (ELL) who speak the same language are enrolled (Barnett, Carolan, Squires, Clarke-Brown, & Horowitz, 2015).

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Knowledge about effective practices for supporting the math learning of young English language speakers can be combined with recommendations for teaching DLLs in order to differentiate their instruction. For example, research shows that explicit instruction in math is needed, and that math is not a universal language (Gottlieb, 2006). Effective teachers "intentionally activate knowledge and concepts in the home language and then explicitly help the child transfer this knowledge to the new language" (Espinosa, 2015, p. 80). The WIDA *Early Language Development Standards, Ages* 2.5 – 5.5 (WIDA, 2014) provide guidance for supporting dual language learners across 12 mathematical topics:

- Making comparisons
- Number sense
- Numeral recognition
- Computation
- Geometric shapes
- Patterns
- Classification/Sorting
- Graphic representations
- Measurement
- Spatial awareness
- Time awareness
- Data collection/Analysis

Within any group of young children, learners are on a continuum toward mastery of any skill. The WIDA standards emphasize the importance of scaffolding for young children who are DLLs across a continuum of English language levels (emerging, developing, bridging) for each of the 12 mathematical topics. In addition, the WIDA standards recognize that expressive (speaking) and receptive (listening) language skills differ, and that the receptive language skills of a DLL are often more advanced than their expressive language. Therefore, separate continua are provided for receptive and expressive language for each mathematical topic. Early educators can combine the insights offered by the WIDA standards with knowledge about developmental trajectories for children's mathematical thinking to provide effective math instruction for young learners (see Table 1).

Table 1. Using WIDA standards to support DLLs as they learn a mathematical concept (2-D shapes)*

Steps/ Ages	Skill	Related Competencies	DLL: Expressive	DLL: Receptive
STEP 1: Two & Three Year Olds	1.1 Think visually /holistically	Recognize and informally describe (including at least circles, squares, then triangles, rectangles).	Repeat names of geometric shapes with visual supports, following adult model Name geometric shapes with visual supports following adult prompt.	Follow one-step oral commands about shapes, follow models and use visual supports with an adult (e.g., "Find the circle").
	1.2 Think about parts	Identify shapes by number of sides, starting with restricted cases (e.g., prototypical equilateral triangle, square).	Repeat names and properties of geometric shapes following peer models in English and Home language.	Identify shapes from simple oral statements, following models and using visual supports with an adult.
STEP 2: Four Year Olds	2.1 Thinking visually /holistically	Recognize and informally describe at multiple orientations, sizes, and shapes (includes circles and half/quarter circles, squares and rectangles, triangles, and others [the pattern block rhombus, trapezoids, hexagons regular).	Describe geometric shapes with visual supports, following adult prompt. Name geometric shapes and their properties following peer models in English and Home language (e.g., "I see a circuló big").	Follow simple oral commands about shapes, following models and using visual supports with an adult (e.g., "This is a circle. Find a circle"). Identify geometric shapes and their position in space from oral statements using photos and pictures with an adult. Identify geometric shapes and their position in space from extended oral descriptions using photos and pictures with an adult.
	2.2 Thinking about parts	Describe and name shapes by number of sides (up to the number they can count). Describe and name shapes by number of corners (vertices).	Name geometric shapes with visual supports, following adult prompt.	
	2.3 Relating parts and wholes	Recognize sides of same/different length, including right vs. non-right angles		
STEP 3: Five Year Olds	3.1 Thinking visually /holistically	Recognize and informally describe, varying orientation, sizes, and shapes (includes all above, as well as octagons, parallelograms, convex/concave figures).	Describe geometric shapes with visual supports, following adult prompt. Describe geometric shapes their properties and their position in space following peer models in English and Home language (e.g., "I see a triangle *grande*. It is above the *cuadrado"*).	Identify shapes from oral comparisons following models and using visual supports with an adult. Distinguish between geometric shapes and the position in space based on oral statements and/or questions using photos and pictures with an adult.
	3.2 Thinking about parts	Recognize shapes by number of sides and corners (including new shapes).	Recount information related to geometric shapes and their properties using visual supports and adult prompts.	Follow oral commands about shapes using visual supports with an adult (e.g., "This is a circle. Help me find a big circle").
	3.3 Relating parts and wholes	Measure sides (simple units), gross comparison of angle sizes.		

Supporting the Mathematical Abilities of Dual Language Learners

Young DLLs need support to keep pace with their peers' acquisition of mathematical competencies, at the same time that they are learning to understand and speak English. Experts agree on several strategies that are helpful in supporting DLLs. Some strategies are general and support the overall learning of young DLLs, as they provide a context for success. Other strategies are specifically related to helping young children develop math competencies. These strategies are described in detail next.

Know the families of your students and their home context.

The families of young DLLs come from a variety of countries. Their expectations about early childhood education and about how their child will learn English are likely influenced by cultural experiences in their country of origin. In addition, just as no two English-speaking families are identical, families who are from the same country or speak the same language may have different strengths, expectations, and needs. It is important for teachers to get to know the families of their students, and develop relationships with them on an individual basis to build trust and understanding. Holding a meeting with families or conducting home visits at the beginning of the year are excellent contexts for sharing goals, expectations, questions, and concerns, including those related to math competencies. Families can be a wonderful resource, as they can help teachers get to know their children's interests and help in the development of culturally relevant preschool activities. By enlisting parents' assistance, teachers can help children generalize math concepts and skills learned in the classroom to home and community environments. Espinosa (2015) recommends that teachers administer a *Family Languages and Interests Interview* to gather relevant information about a child's early language learning environment and development, from the parents' point of view.

Teachers should not assume that family members understand the importance of parent involvement in their child's education. Family members from some cultures assume that education is the domain of the teacher and defer all major decisions to the teacher (Rodriguez-Brown, 2010). In addition, some family members may not know what math competencies are important for young children to learn or how they can support that learning. An interpreter or family member who speaks English can help teachers establish and maintain communication about these important topics with families of DLLs.

Develop positive relationships with each child.

Research demonstrates the critical relationship of children's social and emotional development to their academic success (Chien, et al., 2010; National Research Council and Institute of Medicine, 2000). The emotional well-being and social skills of young DLLs can positively or negatively affect their school success (Burchinal et al., 2012; Espinosa, 2010). Therefore for all children, including DLLs, it is important for teachers to create a socially and emotionally supportive classroom environment. One strategy to use is to intentionally develop positive relationships with each DLL by taking time to have friendly, one-on-one conversations that convey an interest in their ideas, experiences, and feelings. Given the fact that DLLs typically have slower word retrieval than English speakers, it is especially important to practice patience in waiting for them to respond to questions and comments.

Relate learning experiences to what children already know and can do.

Young DLL's math competencies should be assessed on an ongoing basis in both English and their home language (Solari, Landry, Zucker, & Crawford, 2011), as math skills may not be readily apparent if the child is only assessed in English. Assessment information should be used to plan instruction, with learning experiences targeted at what the child is beginning to understand. This will be more effective than instruction aimed at concepts or skills that a child has already mastered or those that are well beyond his ability. Knowledge about the child's skills and understanding can be used to arrange small group instruction with peers who share the same language level and need for similar math instruction.

Teach math vocabulary.

It is important to "mathematize" the early childhood environment for all young children, including DLLs. This can be done by taking advantage of opportunities to point out mathematical concepts and attributes that are part of the everyday environment and young children's daily experiences. Whenever possible, teachers should mathematize the environment for DLLs in their home language, so that the development of their mathematical competencies is supported (Espinosa, 2015). At the same time, the acquisition of English vocabulary is important for DLLs, as they work to bring their expressive vocabulary in line with their receptive vocabulary (August, Carlo, Dressler & Snow, 2005). Experts stress the importance of using strategies *intentionally* and *continuously* to support bilingualism (Prieto, 2009). Teachers can help DLLs acquire math vocabulary by using words in the home language that parallel the counterpart in English (e.g., "See this? In Spanish we say *circuló*, while in English we say *circle*."). This practice can be further strengthened by the use of pictorial cognate charts. Such a chart might show a picture of a circle along with the written words, "circle" and "circulo." Teachers can verbally label objects in both languages highlighting their mathematical characteristics (e.g., round bowl, square tray, two mittens, biggest star). It stands to reason that the more often mathematical characteristics are labeled in different situations and with different materials, the more likely children will generalize their understanding of English vocabulary. In addition, using a combination of facial expressions, gestures, real-life objects, and pictures will support children's understanding of new vocabulary (Figueras & Barnett, 2013). These visual props such as these are especially helpful when the names (e.g., number or shape names) are very different in the two languages.

Make informal math talk a part of your daily practice.

Informal teacher-child and child-child conversations are the primary ways in which children develop language at school (Dickinson & Porche, 2011). Informal conversations can take place just about anywhere and anytime in the preschool classroom (e.g., at the snack table, during interactions at choice time, on the playground). When early childhood teachers are mindful of the importance of helping DLLs develop math competencies, they can use these opportunities to intentionally emphasize math concepts across the everyday classroom environment. While preschoolers typically do not read, it can be helpful to label items (e.g., shapes, quantities, sizes) in two languages, as a way to remind yourself to use words in both languages.

Teach math concepts and skills in meaningful contexts.

Young children, including DLLs, are more motivated and engaged when learning is meaningful. Learning is more likely to be meaningful when children already know a little bit about the topic of study. Developing rich thematic units or projects around topics that are familiar and of high interest to DLLs can provide many opportunities for them to explore math concepts in a meaningful context. For example, a project on the pet store could provide opportunities to practice one-to-one correspondence (e.g., "Which mama animal does this photo of a baby animal go with?"), counting (e.g., "How many fish are in our tank? Let's count them."), measuring ("Our rabbit, Brownie is 1 foot tall. Which pets at the pet store are taller than Brownie?"), and recognizing shapes (e.g., "This side of the fish tank is a rectangle! What shape is this side?"). Whenever possible, adults can use children's home languages when referring to math concepts embedded in the unit or project topic. Additionally, adults can read topic-related children's books that contain math concepts and are available in various home languages (e.g., *Perro Grande…Perro Pequeño/Big Dog…Little Dog* by P.D. Eastman). Espinosa (2015) recommends that teachers select three to four picture books as anchor texts to use repetitively to foster development of a particular concept and related vocabulary. Related photographs, pictorial cognate charts, and word walls can be used to introduce new concepts and vocabulary as well as to deepen comprehension. By using the strategies described in this microteach, early childhood teachers can help young DLLS develop math competencies that are critical to their success.

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