Practice Guide for Teachers of Multilingual Math Learners in Middle School Classrooms

This practice guide for teachers of multilingual math learners was developed as part of the multiyear, mixed-methods Analysis of Middle School Math Systems (AMS) study funded by the Bill & Melinda Gates Foundation. The study aimed to understand the extent to which teachers in four urban school districts plan and execute standards-based, rigorous, and culturally responsive mathematics lessons while using one of six different middle school mathematics curricula.

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Introduction

As international migration and transnationalism continue to rise, classrooms across the United States are becoming more linguistically diverse. Teachers may increasingly need to adapt their curriculum and instruction to support positive classroom experiences for multilingual learners (MLLs), who are learners developing proficiency in more than one language. Math teachers face the unique challenge of building their MLLs' English proficiency while simultaneously helping these learners develop math content knowledge and other math skills. Unfortunately, math curricula often provide inadequate guidance for teachers on how to implement activities for multilingual learners. Additionally, teachers report feeling inadequately prepared to best support MLLs (Hansen-Thomas et al., 2016), which may be linked to misconceptions that mathematics is easier to teach to English-learning populations than other topics (Hansen-Thomas & Cavagnetto, 2010). In reality, the language and culture of MLLs can serve as valuable resources for their own math learning and also support their classmates' learning (Ladson-Billings, 2014; National Academies of Sciences, Engineering, and Medicine, 2018; Orellana, 2016).

One way math teachers can position multilingual learners for success is to incorporate a **culturally responsive math teaching** approach in their classroom. But what does culturally responsive math teaching look like in practice? This guide shares actionable examples of how teachers can apply culturally responsive math teaching strategies to real middle school math lessons, such as those developed by Illustrative Math. The guide highlights five culturally responsive strategies that were observed in an eighth-grade teacher's classroom to support her MLLs' engagement with math. We hope readers of this guide will learn practical ways to use culturally responsive math teaching strategies to better support their MLLs.

Culturally responsive math teaching is an asset-based approach that incorporates students' identities and lived experiences into the classroom to make math more enjoyable, improve instructional effectiveness, and increase student learning.

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Who are the intended users of the guide?

This guide is intended to help anyone who works with MLLs in the middle school math classroom, including math teachers, math coaches, and instructional leaders who are responsible for planning lessons that support MLLs. Although this guide was developed using middle school math examples, the strategies are generally appropriate for elementary and high school math classrooms as well.

How to use this guide?

There are four main sections of this guide:

- **Section A** describes the *five strategies* that teachers can use to adapt lessons from any middle school math curriculum and make math more accessible for MLLs.
- **Section B** illustrates what these five strategies look like in practice when *implemented* in a real-world middle school math classroom.
- **Section C** presents *guiding questions* math teachers can ask themselves when planning their own lessons. These questions are designed to help teachers consider ways they can incorporate the five strategies that support MLLs in their math classroom.
- **Section D** presents a list of *additional resources* teachers can reference to make their math classrooms more inclusive for MLLs.

Contents

A. The Five Strategies

In this section, we describe five culturally responsive strategies that math teachers can implement to support their MLLs for success and position them as valuable resources for others. Teachers can but do not need to implement all five strategies in every lesson activity to support their MLLs. Some lesson activities will lend themselves better to a particular strategy than others, and we expect that teachers will mix and match strategies as they deem fit.

Strategy 1: Encourage MLLs to develop their mathematics skills while working in their home language.

One common misconception is that learners need to attain a specific level of English-language proficiency before they can engage in challenging mathematics. However, MLLs across the English-learning spectrum need meaningful opportunities to engage in mathematical reasoning, and they can do so by working in their home language as they build their English proficiency (Moschkovich, 2013). Consider the following ways teachers can create opportunities for MLLs to work in their home language while developing their math skills:

- Vocally support the frequent use of their preferred language and promote translanguaging in teacher–learner, small-group, and whole-class interactions. Translanguaging means using all your linguistic knowledge fluidly to create meaning and communicate with others (Aguirre & del Rosario Zavala, 2013; García, 2009). If you do not speak your learners' home language, you can still promote a translanguaging environment by encouraging learners to utilize multiple languages as they participate in your classroom.
- Encourage learners to write concepts in their notebooks using notations in their preferred language to help them cement their understanding.
- Celebrate times when MLLs use mathematical discourse to convey their thinking, in their home languages as well as English, and avoid correcting word pronunciation when they do speak in English.
- Add scaffolding into lessons to help build MLLs' confidence using mathematical discourse. For example, carve out time to rehearse with MLLs one-on-one so they feel prepared to share their thinking in small-group or whole-class settings.
- Incorporate sentence frames, which are partial sentences that learners can complete with their own words to explain their thinking. An example sentence frame might be "the strategy I used to solve this problem was [...] because [...]."

Strategy 2: Immerse MLLs in language-rich mathematics.

MLLs, like all students, are constantly building their academic language proficiency in English. A classroom that exposes MLLs to new (and accurate) math terminology helps them develop their math language and fluency, which opens pathways to learning the subject and engaging in classroom discussions (Chval et al., 2015). Teachers can help MLLs develop their math-focused academic language in the following ways:

- Use non-technical language that learners are more culturally familiar with as the starting point when developing their understanding of math terminology.
- Describe the meaning of math vocabulary using everyday language explanations to support learner understanding, such as by connecting with learners' life experiences to explore multiple meanings of the word.
- Make time in mathematics lessons to notice and discuss the difference and similarities between how everyday meanings of words compare to their specialized meanings in mathematical contexts. Giving this specific time and attention helps clarify important differences between everyday language and mathematics terminology.
- Write essential math concepts or ideas on the board or on a worksheet so that learners can refer to the language throughout the lesson. This approach enables learners to both see and hear the math terminology.
- Model how to use the academic language during whole-class instruction. Use the correct academic mathematical terms, rather than simplifying a word or phrase, to help build learners' math vocabulary.
- Provide learners many opportunities to use new vocabulary in context. For example, after introducing the meaning of new vocabulary, guide learners through an activity that uses that vocabulary.

Strategy 3: Encourage MLLs to use multiple forms of communication to show their thinking.

MLLs develop their English-language skills through various forms of nonverbal cues, written materials, and visual representations (Moschkovich, 2002; Chval et al., 2021). When setting up a lesson, consider offering multiple ways for learners to demonstrate their understanding of the material without relying solely on verbal communication. Consider the following methods of communication that can be used in the math classroom:

- Incorporate concrete objects, such as manipulatives, videos, and illustrations into class activities so learners can learn and demonstrate their understanding visually and physically.
- Encourage use of nonverbal communications (such as gestures), especially in cases where a learner seeks to illustrate their thinking but has not yet mastered the use of academic math language.
- Scaffold lessons using tables or graphic organizers to help learners connect math language with mathematical representations.

Strategy 4: Facilitate effective partnerships between peers.

MLLs' academic growth can be fostered through peer-to-peer interaction. There are opportunities to enhance all classroom settings with positive peer interactions, including partner work, group work, and whole-class discussions. Consider the following ways to create productive partnerships in the math classroom, from Chval et al. (2018):

- Establish participation norms with learners, such as not speaking over a peer.
- Provide resources, such as sample questions learners can ask each other during group work or a list of compliments they can offer to their peers.
- Provide ample opportunity for group work, which gives MLLs opportunities to listen to and contribute to mathematical discussions and ideas.
- Deliberately group MLLs with peers who speak the same languages, while also taking other learner characteristics into consideration when organizing groups to ensure the pairings are mutually beneficial. For example, a learner who is more proficient in English may help build the language proficiency of a partner who is less proficient in English. In exchange, the partner who is less proficient in English may introduce their peer to a new approach to mathematics they learned from a different cultural context.
- Model and then have learners practice giving each other compliments that foster mutual respect.
- Monitor how partners work by paying attention to interactions, such as what happens when a multilingual learner contributes to the conversation and consider changing groups if certain peer pairings are not productive.

Strategy 5: Build on learners' cultural and community funds of knowledge.

Cultural and community funds of knowledge are the everyday knowledge and activities in learners' homes and communities that they understand and relate to (Moll et al., 1992). Learners bring different ways of thinking about mathematics based on their backgrounds and experiences, in both formal and informal learning environments. Teachers can help MLLs leverage their cultural and community funds of knowledge in the following ways:

- Ask learners to reflect on times they might have seen a math concept in their own life, then encourage them to share their experience and adapt it into a problem for the class.
- Situate mathematics in stories that reference learners' community and home knowledge, culture, or experiences to make the math more relatable. Storytelling can help learners center themselves in the problem context and give access to the mathematics in a new way.
- Encourage the use of notation and algorithms that learners may have learned in other countries or from their family members. Because notations and algorithms vary across different countries' schooling systems, inviting the use of this particular fund of knowledge can also be a productive way for classmates to learn more about multilingual learners' prior experiences.
- Continuously learn about learners through surveys, conversations, and speaking with parents. The more a teacher knows about their learners' lived experiences, the more they will see connections between the mathematics they are teaching and the learners.

For additional information on incorporating learners' cultural and community funds of knowledge into the math classroom, please refer to the accompanying practice guide ("Culturally responsive mathematics teaching practice guide").

B. Implementing the Strategies

The AMS study team conducted classroom observations in four large U.S. urban districts. Using a culturally responsive math teaching rubric, the study team captured teaching practices including those related to supporting MLLs. Ms. Ureña, the teacher featured in this guide, was a standout teacher because of her high usage of multilingual learner strategies in the lessons we observed. Ms. Ureña is an 8th grade math teacher and coach at a Spanish-English dual language school. The school alternates between English and Spanish weeks, which determines the language used in instruction. The lesson discussed in this guide was taught by Ms. Ureña during a classroom observation held in an English week. Ms. Ureña adapted a grade 8 lesson from the Illustrative Math curriculum (see the Exhibit 1). In this section, we describe how Ms. Ureña used the five strategies described in Section A during three lesson activities. The descriptions are exemplars of Ms. Ureña's strategy use, rather than a comprehensive list of all the times she used strategies during the lesson.

Exhibit 1. Lesson overview

Illustrative Mathematics. Grade 8, Unit 4

Lesson 2: Keeping the equation balanced

Learning goals:

- Calculate the weight of an unknown object using a hanger diagram and explain (orally) the solution method.
- Comprehend that adding and removing equal items from each side of a hanger diagram or multiplying and dividing items on each side of the hanger by the same amount are moves that keep the hanger balanced.

Lesson 3: Balanced moves

Learning goals:

- Compare and contrast (orally and in writing) solution paths to solve an equation in one variable by performing the same operation on each side.
- Correlate (orally and in writing) changes on hanger diagrams with moves that create equivalent equations.

Activity 1 (Illustrative Mathematics, Lesson 2: Hanging socks)

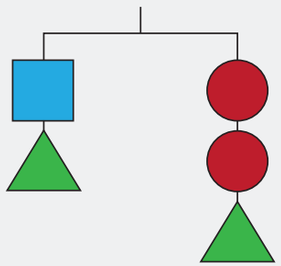
As the learners entered the class, Ms. Ureña handed them paper squares, triangles, and circles hung from a wire hanger (math manipulatives). Ms. Ureña then asked the learners to recall their conversation from the prior lesson about times they needed to balance different objects in their own lives. She asked them to review the picture of the two socks hanging from a hanger in their Illustrated Math textbook as a reminder of that conversation (see Exhibit 2).

After a brief conversation about the socks on a hanger, Ms. Ureña wrote the lesson objective on the whiteboard and displayed the practice problem on the smart board (see Exhibit 4). A chart with key vocabulary about parts of an equation was posted at the front of the room in both English and Spanish (see Exhibit 3). A chart with key vocabulary about parts of an equation was posted at the front of the room in both English and Spanish. The learners first solved the practice problem independently in their personal notebooks while Ms. Ureña circulated around the class, answering learners' questions in both English and Spanish. After several minutes of independent work time, Ms. Ureña brought the class back together into a whole-class discussion about which option(s) kept the hanger balanced. Ms. Ureña modeled options a through d using shapes on the hanger while asking the learners if each option would balance the hanger. For example, to demonstrate option a, Ms. Ureña replicated the words in the problem visually by adding two circles on the left and a square on the right of the hanger. After calling out whether each option would keep the hanger in balance, individual learners shared their reasoning for their answer with the rest of the class. Throughout the activity, Ms. Ureña wrote key concepts on the whiteboard as they arose in the whole-class discussion, such as, "If I am adding or subtracting the same value to each side of my hanger, it maintains the balance." Learners were encouraged to write these concepts in their notebook for later reference.

Exhibit 2. Socks on a hanger

Exhibit 3. Classroom vocabulary chart

Exhibit 4. Practice problem



Which changes would keep the hanger in balance? Select all that apply.

a. Adding two circles to the left and a square to the right

b. Adding 2 triangles to each side

c. Adding 2 circles on the right and one square on the left

d. Adding a circle on the left and a square on the right

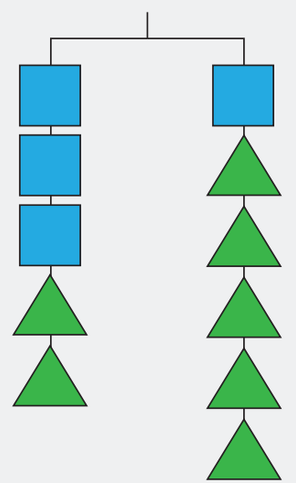
Strategies used	
Strategy 2 	Ms. Ureña used Strategy 2 in the following ways: • She **wrote essential math concepts and vocabulary on the board** in multiple languages and encouraged learners to write these concepts in their notebooks. Having key concepts in a visible location to reference throughout the lesson enabled the MLLs to see and hear the terminology at the same time, which builds English language proficiency. • After introducing the vocabulary, she immediately transitioned into the hanger activity so that the learners could **apply the new vocabulary**. This choice further cemented their understanding of how to use these terms in context. • Ms. Ureña explained that **graphic organizers** can be a useful tool for building math vocabulary as well, as they give MLLs a place to write down new words they do not understand during whole-class instruction. MLLs can then ask either her or a peer for help translating the meaning of that unfamiliar word so they can add a definition to the graphic organizer.
Strategy 3 	Ms. Ureña used Strategy 3 in the following ways: • She **incorporated several concrete objects into her lesson**, including math manipulatives, notebooks, and the whiteboard and smartboard. • The hanger was a particularly strong example of Strategy 3, as it provided the learners with a visual representation of the different parts of an equation. Ms. Ureña **used the hanger to visually show how the shapes were terms**, each side of the hanger was an expression, and the hanger itself served as an equal sign. • MLLs who were not comfortable verbally explaining their thinking in English could still **demonstrate their grasp of a math concept by physically moving the shapes** to balance the equation. Ms. Ureña could then check for understanding by watching what the learners were doing mathematically with the shapes.

Strategies used	
Strategy 5 	Ms. Ureña used Strategy 5 in the following ways: • She **grounded the lesson in her learners' real-world experiences** by reminding them of the sock picture and their prior discussion about balancing items of varying weights. Ms. Ureña explained that the sock picture resonated with her learners, as most of them hung clothing in their closets at home. • If she taught this lesson again, Ms. Ureña said she could elevate the use of Strategy 5 by **reflecting the real-world example of hanging clothing throughout the entire lesson.** For example, she could use shapes of the socks and other clothing items on the hangers, instead of the abstract geometric shapes of circles, squares, and triangles. • Another way she could have incorporated her learners' cultural funds of knowledge into the lesson was by **basing practice problems around a story a learner shared** about their personal experience balancing items. This approach would help ensure the real-world example is relevant to her learners' lives.

Activity 2 (Illustrative Mathematics, Lesson 2: Hanging blocks)

During this second activity, Ms. Ureña worked through the problem on the board while the learners worked in their notebooks. She reminded the learners that they had used the same hanger posted on the smart board in the previous day's lesson (see Exhibit 5). In that previous lesson, they compared the shapes using trial and error and figured out that for every one square, you need 1.5 triangles. In this lesson, they were revisiting the hanger to look at it as a metaphor for an equation. She asked the learners to work at their tables together to create an equation that represents the hanger. She encouraged the learners to use the manipulatives if helpful. During the activity, Ms. Ureña circulated the classroom providing individual support as needed, including rehearsing what some learners might share with the whole group.

Exhibit 5. Activity 2



This picture represents a hanger that is balanced because the weight on both sides is the same.

a. Elena takes two triangles off of the left side and three triangles off of the right side. Will the hanger still be in balance, or will it tip to one side? Which side? Explain how you know.

After giving the learners time to work through the problem in their small groups, Ms. Ureña brought the class back together. She asked them what elements are needed to build an equation. Learners offered responses such as "variable" and "equal sign." She also called on learners who had prepared and rehearsed responses. Ms. Ureña then led the whole class through how to write an equation that represents the hanger, calling on learners to offer their solutions and then engaging the full class by speaking from a "we" perspective. For example, she asked questions like "If this [hanger] were an equation, what would my left side be called?" A learner offered a response, and then Ms. Ureña asked the class, "Do we agree?" Next, Ms. Ureña led the class through solving the equation. Throughout the whole-class discussion, Ms. Ureña wrote on the whiteboard but encouraged the learners to write in their notebooks in whichever language they desired.

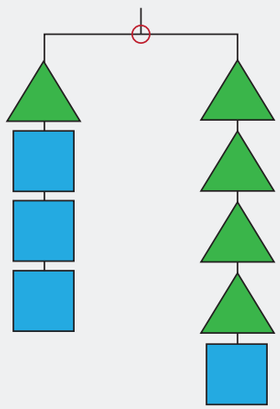
Strategies Used	
Strategy 1 	Ms. Ureña used Strategy 1 in the following ways: • She encouraged her learners to **add notations in their notebooks in whichever language they felt the most comfortable using.** She explained that notebooks should be a space where MLLs should feel free to write notes in their preferred language if it supports their understanding, because, as she explained, "the notebook serves as their own guide for their language journey in math." • She carved out time during the small-group breakout session to **work individually with MLLs so they felt prepared to participate during whole-class discussions**. Ms. Ureña explained that when her MLLs can rehearse their response with a teacher, they feel more confident when speaking in front of the class.
Strategy 3 	Ms. Ureña used Strategy 3 in the following ways: • She encouraged her learners to **write in their notebooks throughout the activity** because writing or drawing on paper is one additional way her MLLs can demonstrate their thinking. • Though she didn't use the "think, write, pair, share" framing for this lesson, she explained how that routine is often a helpful way she—and fellow teachers—can ensure their MLLs have time set aside to write (or draw) their thoughts. She can then **reference their notebooks to check for understanding** without putting pressure on her MLLs to speak to demonstrate they understood a concept.

Strategies Used	
Strategy 4 	Ms. Ureña used Strategy 4 in the following ways: • She intentionally assigned her learners to tables at the start of the class **using groupings she knew would lead to robust peer-to-peer interactions.** • She kept **several considerations in mind** when creating these groups, including her learners': – **Language skills:** In general, she likes to include a learner who is strong in both English and Spanish in each group and who can integrate everyone into the conversation. – **Math level:** Ms. Ureña considers the math level of the learners. For example, she had a MLL who arrived after the school year started and whose understanding of math was not at an 8th grade level, so she paired that learner with a MLL who had a higher level of math proficiency and could translate his thinking to the other learner. Although it is helpful to have a learner who is stronger academically support their classmate, Ms. Ureña is also careful to avoid creating a situation where the learner feels they need to explain everything to their peer all year long, or where the other learner starts to feel like they are not good enough to do the work alone. To avoid this, she changes groupings based on content mastery as shown by formative and summative data. – **Relationship dynamics:** Ms. Ureña also accounts for relationship dynamics and other social factors, such as what is going on outside the classroom, when pairing learners.

Activity 3 (Illustrative Mathematics, Lesson 3: Practice problem)

Ms. Ureña passed out a worksheet with a practice problem for learners to solve (see Exhibit 6). She asked learners to work in their groups to solve the equation together, using their hangers as needed to help visualize the problem. After learners solved the problem in their small groups, she brought the class back together to solve the problem as a whole class.

Exhibit 6. Worksheet activity



In this hanger, the weight of the triangle is x and the weight of the square is y.

a. Write an equation using x and y to represent your hanger.

b. If x is 6, what is y?

Strategies used	
Strategy 4 	Ms. Ureña used Strategy 4 in the following ways: • **She built a classroom culture at the start of the school year** that encouraged making mistakes and collaborating with others to solve problems through fun activities. Ms. Ureña highlighted that doing peer-based activities like the one in activity three (and throughout the rest of the lesson) was possible because of the groundwork she laid at the start of the school year. For example, within the first month of the school year, she engages her learners in a brain teaser[1] where they start with a football goal post made out of crayons, with a football (eraser) inside the goal post. Learners are asked to move two of the crayons to re-create the goal posts with the football on the outside. Learners had to work in teams to identify which crayons could be moved without changing the structure. Her goal for this activity was to teach learners that making mistakes in the math classroom is encouraged and that the math process is more important than the outcome. • **Ms. Ureña built a positive classroom culture by modeling constructive feedback.** After group activities, Ms. Ureña routinely provides each group with a "glow" (something the group did well) and a "grow" (something they could work on). She then encourages the learners to use this scaffold when working together in groups, especially when challenging a classmate on their answer. Instead of saying "That answer is wrong," learners could share what their peer did well before pointing out what they could work on to get the right answer.

C. Guiding Questions for Reflection and Planning

Strategy 1: Encourage MLLs to develop their mathematics skills while working in their home language.

- How do my classroom environment and instructional strategies invite learners to engage in mathematics using all their languages?
- What questions can I ask to affirm correct application of the math terminology?

Strategy 2: Immerse MLLs in language-rich mathematics.

- How do my lessons both encourage making sense of academic language and provide multiple opportunities to use it?

Strategy 3: Encourage MLLs to use multiple forms of communication to show their thinking.

- How do my lessons enable learners to choose how to communicate their thinking? For example, what nonverbal forms of communication can students use to show their math thinking?

Strategy 4: Facilitate effective partnerships between peers, including MLLs.

- How do my lessons provide the opportunity for MLLs to be active participants in small-group learning and be seen as resources to their peers?
- What student grouping strategies can I use? (Examples might include grouping based on language dominance, classroom behavior, or formative or summative assessments.)
- How do I foster peer-to-peer interactions?

Strategy 5: Build on learners' cultural and community funds of knowledge.

- How do my lessons draw on learners' cultural, community, and/or linguistic experiences in the mathematics we are learning?

D. Additional Resources

Books

- *Beyond Good Teaching: Advancing Mathematics Education for ELLs*
- *Teaching Mathematics to Multilingual Students, Grades K-8: Positioning English Learners for Success*
- *Cultivating Mathematical Hearts: Culturally Responsive Teaching in Elementary Classrooms*

TODOS: Mathematics for All!

The organization TODOS: Mathematics for All! offers many resources for working with MLLs, particularly the following:

- Its open access journal *Teaching for Excellence and Equity in Mathematics* had a special double issue on translanguaging and multilingual classroom practices.
- TODOS Live! webinars are delivered by experts sharing key ideas in equity around mathematics education. Recordings are housed on their Vimeo channel.

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Endnotes

[1] This is an example of the activity Ms. Ureña used. This is not a resource she mentioned using.