

Integration of English Language While Teaching Mathematics Podcast

Host:

Welcome to this podcast hosted by the U.S. Department of Education's Office of English Language Acquisition (OELA). We are here with Anthony Sepulveda, Education Program Specialist from OELA and Haiwen Chu, Senior Program Associate in Mathematics at WestEd. Today's discussion will focus on recommendations from the Institute of Education Sciences' Practice Guide for teaching English learners academic content and highlights some instructional practices that are relevant and important for mathematics teachers.

Today, we're going to explore three key themes: academic rigor for all students, quality interactions around math content, and purposeful language focus in a mathematics classroom.

With growing numbers of English learners in US schools, content educators are in need of practical and effective instructional approaches that can help them create access to their content areas for this population of students. It is our hope that this podcast can guide teachers as they design quality classroom instruction for English learners.

Let's get the conversation started....

Haiwen:

Academic rigor in mathematics means that English learners, alongside all their peers, need to develop more than just proficiency in procedures. English learners must also deepen their conceptual understanding and engage in mathematical practices that over time become increasingly sophisticated.

Anthony:

So, what does conceptual understanding mean, and how is it different from just knowing how to do the procedure?

Haiwen:

Well, let's use one well-known math concept as an example: the average, or arithmetic mean. There's a very well-known procedure here. You might hear students recite "Add up the numbers, then divide by the number of numbers". So that's the procedure, but what does it mean? Why is it important? Why does the formula work, conceptually speaking?

One way that a teacher might help students to think about average is as equal sharing—if everyone had the same amount. Let's say you have five books and I have one. The concept of equal sharing tells us how many books we'd have if we evenly distributed them. Because we have six books together, the average number of books is three. This idea will work for any number of people, or books. Now the standard procedure for average makes sense—because we are sharing equally, we need to add it all up and then divide.

Anthony:

That makes sense. So, Haiwen can you talk a little bit more about why this is important for English learners?

Haiwen:

It's important for English learners to deeply understand the concept of average—what it means and why it matters. Understanding the idea behind the procedure, offers English learners more insight so that they can make the concept their own and extend their understanding into new situations. For example, if I had three books instead of one, would our average be larger or smaller?

Anthony:

Larger.

Haiwen:

How do you know?

Anthony:

If you start out with more books, when we share, we'll each have more.

Haiwen:

Right, so we want to give English learners ample opportunities to engage in the same kind of reasoning. If they think about the idea of sharing, that enables English learners to explain *why* the result will be larger.

They will be able to extend their understanding to other real-world situations and problems. It's important for teachers to design instruction to support English learners in achieving this deeper learning or understanding. For English learners to reason about math concepts this way, they will need explicit modeling and support in terms of language. We will talk more about how to support English learners with language to make connections and articulate reasoning—like when you said that if I have more books, we'll each have more when we share. Later I'd like to talk more about how English learners will be able to describe making changes to the data using the language of cause and effect.

Anthony:

So, the importance of academic rigor makes sense. Now let's talk about what are quality interactions in the classroom and why they are important for English learners.

Haiwen:

Put simply, quality interactions are meaningful conversations that English learners have with their classmates and teachers about mathematics. These conversations are not just about showing what they know, but they are essential for English learners to develop an understanding of mathematical concepts and processes. These interactions take place within a language-rich classroom environment which will support English learners' simultaneous language development.

Anthony:

I see, so what should quality classroom interactions be like?

Haiwen:

There are three key characteristics of quality interactions.

First, talk must be sustained. English learners need opportunities to express complete ideas and make mathematical connections. This is different from the common pattern in which a teacher asks questions and students give one- or two-word answers. Sustained talk has the potential for developing and expressing deeper understanding.

Second, interactions should be reciprocal. These interactions are not scripted or dominated by one person. English learners need to have a genuine back-and-forth as they talk with their peers and their teachers. This give-and-take conversation includes agreeing and disagreeing. As students talk, they can build on or unpack ideas with each other.

Third, quality interactions must stay focused on mathematics. It's through talk with their peers that English learners can understand a mathematical concept or engage in a mathematical practice.

Anthony:

That's great! So how can teachers support English learners to have these quality interactions, when English learners may feel reluctant to speak up in class?

Haiwen:

At first, quality interactions will happen only by design. Teachers must draw on their existing skills to facilitate conversations and craft activities where all students have something to contribute.

One way is to have an engaging prompt about which all students will have something to say, with no "wrong" answers. For example, in a lesson about average, a prompt might be for students to talk about a time they had to share something with many people. This prompt draws upon students' prior knowledge and may be interesting for students to discuss with each other.

Talking about their own experiences may encourage English learners to speak more, to respond to each other, and to make connections to the mathematical goal. It all depends on the goal of the lesson. If the conceptual goal is to develop the idea of slope, a good prompt would be to ask students about a time when they had to climb something. This prompt will bring up many different experiences that the teacher can then connect to the idea of vertical and horizontal changes.

Anthony:

This is a great idea! What other activities will support English learners in engaging in quality interactions?

Haiwen:

A jigsaw project is an interactive classroom activity that offers many different opportunities for quality interactions. In a jigsaw project, a class explores different "pieces" of a mathematical puzzle. For example, the question might be what happens to the average when the set of data is changed. This question is very complex, and there are many different cases. Students start out together in base groups where they compute the average of a common set of data. Then, students

are assigned to different expert groups. Each expert group is responsible for a different kind of change to the data set, such as adding or deleting values, or changing values within the set. In their expert groups, students first investigate the effect. As experts, they reach a consensus on how to approach the problem and answer a few key focus questions. They have enough time in their expert groups to rehearse and develop what they will say. When these new experts return to their original base groups, they have plenty to relate. Because the expert groups are all different, there is also novelty as they share.

Anthony:

Great! I can see how the jigsaw structure would support English learners becoming experts and being able to talk about changing averages in sustained ways. Having that time in those small expert groups will help English learners to think strategically about what language they will choose to express their ideas. There's an opportunity for English learners to potentially learn from their peers' language choices and to appropriate some of that language when they report as experts to their base groups.

Haiwen:

That's a very good observation, Anthony.

Anthony:

Quality interactions with their peers are beneficial for English learners. Let's turn to the last theme, which seems especially critical for English learners. What does it mean to focus on language purposefully?

Haiwen:

Language is a tool for making complex connections and exploring ideas. To develop deep mathematical understanding, English learners will need complex language to make and express connections. This includes connecting real-world situations with procedures and representations, like graphs and equations.

For this reason, English learners need models of language that assist them in connecting multiple things. This goes beyond fill-in-the-blank language, such as "The mean is...".

For example, as students investigate how changing a set of data affects the mean, they'll need to use language such as "When I delete values that are smaller than the mean, the mean will increase." More generally, the formulaic expression is "When I make *such-and-such a change*, the mean will change in *such-and-such a way*"—students can insert their own specific ideas about what happens to fit their needs. The modeled formulaic expression enables them to connect a change with its effect.

Anthony:

That makes sense! English learners would be using this language to connect at least two ideas. I can also see English learners using that language in other situations.

But what about solving story problems? Don't English learners need support to understand what problems are about?

Haiwen:

Absolutely! English learners need support in making sense of what problems mean. To reach this goal, teachers need to create opportunities that build students' autonomy over time. What this means is that rather than providing students with fixed scripts, teachers need to signal the key strategic actions that students can undertake with any problem. In understanding a story problem, there are three things that teachers can help students do:

- 1) identify what the problem is asking;
- 2) identify given information and constraints;
- 3) draw a picture or model to represent the problem in a different way.

With each of these actions, there is language that can assist students. Rather than go in a predetermined order, English learners can use a clarifying bookmark to select different actions and language to talk about the problem with a partner. As partners notice different things, they have a conversation to make sense of the problem.

Let's try it with a story problem. Why don't you read it out loud, Anthony?

Anthony:

Okay. Three friends went to eat pizza together. Alicia ate 4 slices and Bobby ate 3 slices. The average number of slices they ate was 3. How many slices did Camilo eat?

Haiwen:

So, now you have a choice. What are you going to do, and what language are you going to use?

Anthony:

I choose to *identify what the problem is asking*. I guess I can say, "*The unknown in this problem is what Camilo ate.*"

Haiwen:

And I'm going to also talk about the unknown. "*Reasonable values for the unknown are between zero and four slices—I don't think Camilo could have eaten more than anyone else if the average is three slices.*"

So, let me choose the action "Draw a picture or model to represent the problem in a different way". "*I can represent this part of the problem by ... drawing a picture where three people each eat three slices.*" So, I draw this picture and I show you that three plus three plus three slices is nine slices total. That picture is showing the average, not the actual slices.

Anthony:

Okay, I think we are close to solving this problem now! So, what else can teachers do to help English learners as they solve story problems?

Haiwen:

Beyond getting the answer to this problem, what English learners need is generative language that enables them to understand the problem with the assistance of a partner. The power of modeling language is that it enables English learners to engage in the mathematical practice of making sense of problems and persevering in solving them. What's critical here is that it's not a

rigid script, it's the basis for a conversation with a peer as we are negotiating the meaning of the problem together.

Anthony:

So that makes sense for the practice of “make sense of problems and persevere in solving them”, but how can teachers support English learners with the other mathematical practices?

Haiwen:

For any mathematical practice, teachers can first identify strategic actions that are part of the broader practice. For example, for the practice “look for and make use of structure”, one strategic action might be “Put into groups or take groups apart”. That action will work in many different situations. Or they may want to “Look at what is the same or different.”

Teachers can then identify specific language that can assist students in those broader strategic actions. Connected with grouping slices together, some specific language that might help would be “*If I put together all the slices that the three people ate, I get a total of nine slices*”. In mathematics, English learners will have many opportunities where they can enact the strategic action of grouping or combining.

If teachers offer English learners with choices of strategic actions that are part of a mathematical practices and also specific language, all students can benefit from having peer conversations in which they are exploring patterns and other practices together. Over time, as English learners become more familiar with these actions and language, they will develop greater autonomy in making choices about what to do in new situations.

Anthony:

Thank you! The ideas that you shared will certainly help teachers support English learners during mathematics instruction.

Host:

Thank you for discussing these important topics with us today. You have given us many useful teaching tips and things to think about as we continue to serve English learners in classrooms across the country. As this podcast comes to a close, I encourage all of you to visit the NCELA website at www.ncela.ed.gov to download a many other resources available to teachers and administrators.