Bridging Language and Content Learning

Are Math Language Routines and Design Principles Worth the Trouble?

Students develop and demonstrate their understanding of math concepts through speaking and writing, helping them organize ideas, process procedures, and clarify their reasoning. Language is essential for both developing and expressing their mathematical understanding. **In other words, students use language to "figure stuff out" and to "show what they know."**

THE VISION

A healthy, safe, productive, generative, joyful learning culture in which all students, including multilingual learners (MLLs)...

Experience teachers' interest in their ideas

Are curious about each other's ideas

Are motivated and supported to share both finished and unfinished thinking, without anxiety / fear of judgement

Help each other explore ideas, refine thinking and language by giving feedback, communicating to be understood, and listening to understand

Math Language Routines (MLRs) are useful tools for establishing a healthy, interactive learning culture in all classrooms.

There are **4 Design Principles** that integrate mathematical language development into curriculum and instruction, helping teachers emphasize the language skills essential for exploring and communicating central mathematical ideas.

The **4 Design Principles** are:

- **PRINCIPLE 1 — Support sense-making**
- **PRINCIPLE 2 — Optimize output**
- **PRINCIPLE 3 — Cultivate conversation**
- **PRINCIPLE 4 — Maximize linguistic and cognitive meta-awareness**

We'll dig more into these Principles on the next pages.

Click here to read more on the *Principles for the Design of Mathematics Curricula* research.

Acknowledgment

This product was developed by CREATEd Fellows, Sheila Howard and Jen Loescher who worked with Vinci Daro, Renae Skarin, and Jack Dieckmann, researchers; Joyce Mullally, Instructional Coach, Clark County School District; and Vicky Tong, graphic designer at Sociable Consulting. It is informed by Principles for the Design of Mathematics Curricula: Promoting Language and Content Development (Zweirs et al., 2017) and support was provided through the CREATEd initiative of the Center for Research Use in Education, University of Delaware. For more on the co-design process used by the team, please visit CREATEd's Co-Design Toolkit.

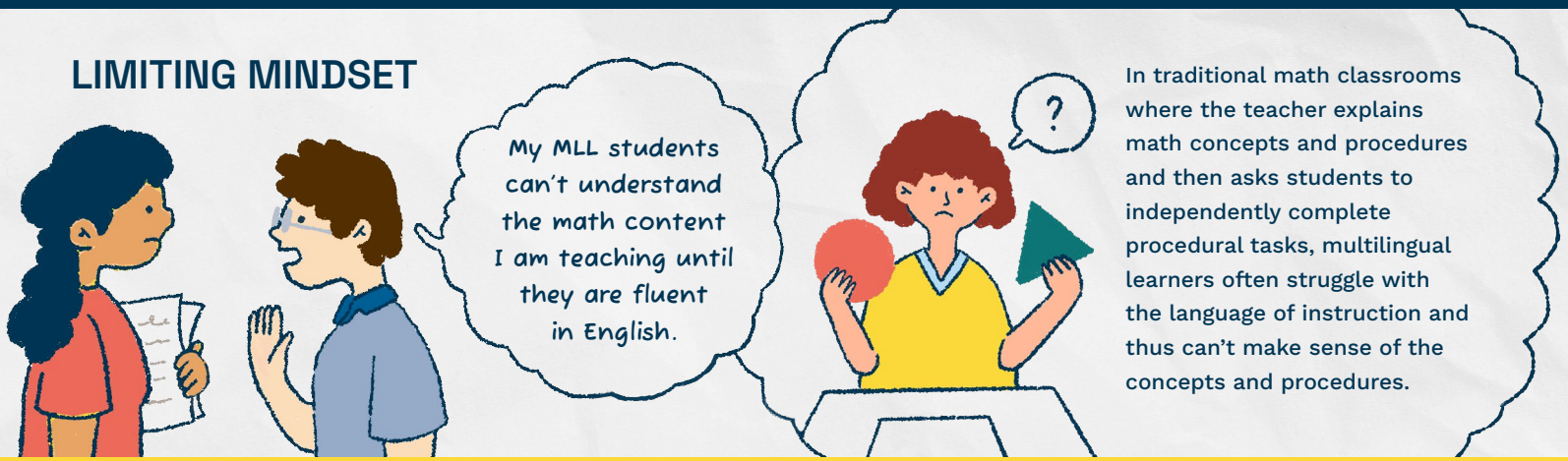
Zwiers, J., Dieckmann, J., Rutherford-Quach, S., Daro, V., Skarin, R., Weiss, S., & Malamut, J. (2017). *Principles for the Design of Mathematics Curricula: Promoting Language and Content Development*. Retrieved from Stanford University, UL/SCALE website: http://ell.stanford.edu/content/mathematics-resources-additional-resources

PRINCIPLE 1

Support Sense-Making

To support sense-making, teachers amplify (rather than simplify) math language, and provide enough time, scaffolding, and repeated opportunities for students to make sense of concepts and engage in math practices.

LIMITING MINDSET



In traditional math classrooms where the teacher explains math concepts and procedures and then asks students to independently complete procedural tasks, multilingual learners often struggle with the language of instruction and thus can't make sense of the concepts and procedures.

Current research in content area learning (see resources below) demonstrates that if we intentionally include instructional practices such as the MLRs, we can provide MLL students with opportunities to make sense of and meaningfully participate in grade-level math learning.

The MLRs, if implemented strategically, can support more effective sense-making in mathematics than traditional methods of instruction.

Click **here** or scan the QR code for the resources on the MLRs.

MLR2 — Collect and Display → Page 11
MLR6 — Three Reads → Page 15
MLR8 — Discussion Supports → Page 17

STUDENTS

MLL students are just as able as their peers to make sense of math if language is made more comprehensible to them through various strategies that amplify concepts and language.

TEACHERS

To support MLL students, instruction must provide multiple opportunities to practice language for mathematical purposes, ensuring comprehensible input and productive struggle, and fostering learner autonomy, motivation, and a deeper understanding of content and language.

PRO TIPS!

TEACHERS CAN

- Organize and chunk information
- Provide visuals or manipulatives to enhance math communication
- Facilitate multiple opportunities for students to express using home language, gestures, and visuals
- Crowdsource language and ideas to provide entry points and reasoning tools for language-rich problems

Review the related MLRs.

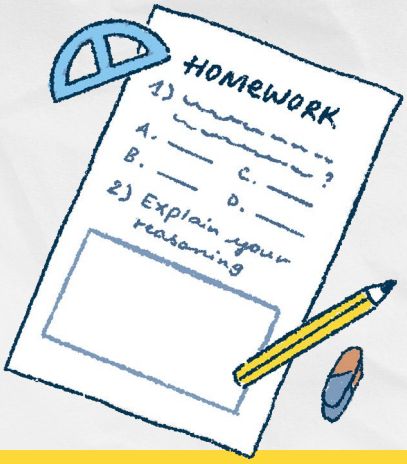
PRINCIPLE 2

Optimize Output

When students produce their own math explanations through speaking and writing, they engage a deeper level of thinking and language skills, promoting precision, detail, and deeper math learning.

LIMITING MINDSET

I don't expect my MLLs to speak much in class discussions, or write much when asked to explain their reasoning. They are afraid to speak or maybe shy so I let them off the hook.



When students explain math through speaking or writing, they must be given multiple opportunities to refine their language and add details (dimension) to their thinking before their language can be precise. This process helps them summarize, synthesize, and connect ideas, promoting deeper math learning evident in their presentations and posters.

The MLRs, when implemented strategically, optimize student output by encouraging speaking and writing, which deepens mathematical thinking, enhances precision and language skills, and strengthens their ability to articulate and refine their reasoning.

Click **here** or scan the QR code for the resources on the MLRs.

MLR1 — Stronger and Clearer → Page 9
MLR3 — Critique, Correct, and Clarify → Page 12
MLR4 — Info Gap → Page 13
MLR5 — Co-craft Questions and Problems → Page 14
MLR7 — Compare and Connect → Page 16

STUDENTS

Learning a new language involves running mini-experiments: listening, imitating, trying out new language, and adjusting based on feedback. Encouraging MLLs to speak and write in math provides opportunities to:

- Express ideas and justify conjectures
- Critique others' reasoning
- Create and evaluate models

TEACHERS

Frequent speaking and writing by MLLs allows formative assessment of their math knowledge, expression, and areas needing support. Teachers can assist by:

- Asking strategic questions
- Revoicing
- Analyzing language models (e.g., MLR3)
- Offering linguistic support for full participation

PRO TIPS!

TEACHERS CAN

- Decide when to ask for output and provide appropriate support (linguistic or conceptual)
- Choose the amount and format of output to request
- Identify which math concepts are worth asking students to generate output
- Highlight key language to help students refine their understanding

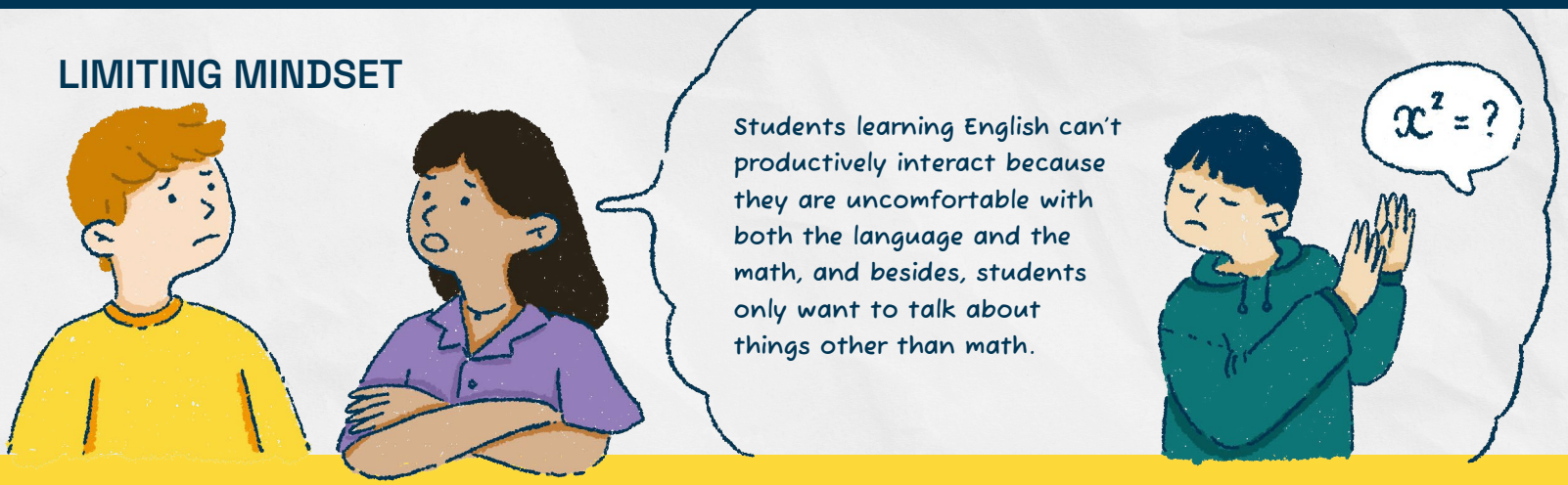
Review the related MLRs.

PRINCIPLE 3

Cultivate Conversation

A math conversation builds shared understanding through listening, responding, and initiating ideas, with teachers modeling curiosity and setting expectations for asking questions to understand and communicating clearly to be understood.

LIMITING MINDSET



With practice and support, math conversations help students deepen understanding, improve practices, and use more precise language. Effective conversations require a clear purpose, challenging tasks, and simple interaction structures to guide collaborative exploration of ideas.

Well-designed structures for peer interactions, like the MLRs, will help students to see peers and resources for their learning and vice versa, and support students to engage equitably.

Click **here** or scan the QR code for the resources on the MLRs.

MLR1 — Stronger and Clearer → Page 9
MLR3 — Critique, Correct, and Clarify → Page 12
MLR4 — Info Gap → Page 13
MLR5 — Co-craft Questions and Problems → Page 14
MLR8 — Discussion Supports → Page 17

STUDENTS

Ideas and language are crowdsourced, built up, developed, revised, and refined, in a safe way at the pace of individual students' learning.

TEACHERS

Students learn from each other, not just the teacher, by building on each other's ideas and language. Student conversations provide an opportunity for teachers to formatively assess students' competencies, and inform next steps in instruction.

PRO TIPS!

TEACHERS CAN

- Provide appropriate structure and time for conversations, guided by formative assessment
- Identify clear mathematical focus and purpose for conversations
- Build a collaborative culture by modeling curiosity and asking clarifying questions
- Formatively assess student conversations to inform instructional next steps

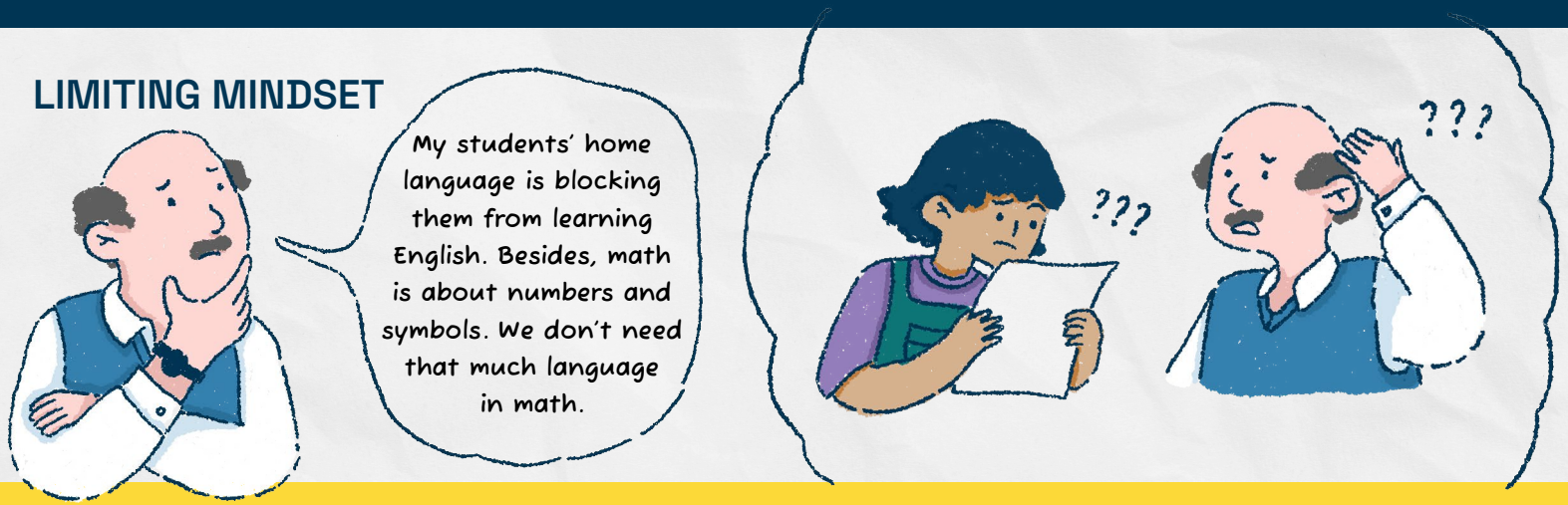
Review the related MLRs.

PRINCIPLE 4

Maximize Linguistic and Cognitive Meta-Awareness

Maximizing meta-awareness empowers students to consciously reflect on their mathematical reasoning and language use, enhancing both their understanding and communication skills.

LIMITING MINDSET



Metacognition helps students monitor their learning, identify confusion, and seek clarity, while metalinguistic awareness develops as they compare their language to others, revealing subtle differences in how mathematical ideas are organized and communicated.

Many MLRs can be used to develop and formatively assess students' meta-cognitive and meta-linguistic awareness.

Click **here** or scan the QR code for the resources on the MLRs.

MLR2 — Collect and Display → Page 11
MLR3 — Critique, Correct, and Clarify → Page 12
MLR5 — Co-craft Questions and Problems → Page 14
MLR7 — Compare and Connect → Page 16

STUDENTS

As students notice language patterns, codes, and ways to communicate in math, they connect every day, home (cross-language comparisons), and academic language, enhancing participation in mathematical practices and fostering deeper engagement as mathematical thinkers.

TEACHERS

Teachers can help students develop metalinguistic awareness in math by providing language models of explanations that students can analyze and revise (MLR3), pointing out the way we formulate, revise, and defend strong arguments and justifications in math.

PRO TIPS!

TEACHERS CAN

- Emphasize and amplify the language forms used to make conjectures, explanations, arguments, justifications and generalizations
- Provide language models, including 'first draft' work for students to critique and improve
- Normalize revising ideas and writing to enhance understanding

Review the related MLRs.