Creating Equitable Science Instruction for Multilingual Learners

May 8, 2021
David Crowther & Rita MacDonald
Who is here? Use the chat to tell us about yourself.

Here’s who we are.

David Crowther

Rita MacDonald
working together to interrogate and revise unintentionally exclusionary practices blocking ML access and engagement in science
“As a group, [English Learners] are underrepresented in STEM fields in college and in the workforce at a time when the demand for workers and professionals in STEM fields is unmet and increasing.”

NASEM, 2018, p.21
MSM Mission & Vision

We strive for equitable three-dimensional science instruction and learning where language is seamlessly contextualized and integrated for success for ALL students from all language backgrounds.

Four essential equity components:
1. Attention to *science identity*
2. Practices for *equitable engagement*
3. Practices for *integrated language* development
4. Formative assessment of language and science learning
Our shared commitments

1. Including multilingual learners in 3-D, inquiry-based science

2. Understanding multiple dimensions of equity for multilingual learners in science education (not just language)

3. Raising awareness of language for engagement in science learning
Session Goals

Learn about MSM’s Design Principles for Engaging Multilingual Learners in Three-Dimensional Science

Translate the Principles into equity-focused action in your classrooms
450 International Schools in 115 countries
MISSION
WIDA advances academic language development and **academic achievement** for children and youth who are culturally and linguistically diverse through **high quality standards, assessments, research and professional learning for educators**.

VALUES
**Innovation**: Drawing upon research and practice to create the best resources for children, youth, and educators

**Service**: Exceeding expectations with trusted and knowledgeable support of our clients and stakeholders

**Can Do Philosophy**: Recognizing and building upon the assets, contributions, and potential of culturally and linguistically diverse children and youth

**Collaboration**: Facilitating interaction among educators, state and local educational agencies, researchers, policy-makers, and experts worldwide

**Social Justice**: Challenging linguistic discrimination, cultural biases, and racism in education
Making Science Multilingual

Core Principle

The interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects.

Not walking separate paths—but forging a new path built upon the strengths of bringing science and language together for more equitable and engaging instruction for ALL students.
the legacy of disparities in science can be disrupted

students learn through expanding science & language repertoires

educators must leverage and sustain students’ cultural and linguistic assets

students have the right to learn science

phenomena

student ideas

science & engineering practices

positioning students with agency

Equity Practices

4 Pillars of Sense-making

Foundational Commitments

MSM Design Principles: Engaging Multilingual Learners in Three-Dimensional Science

https://go.wisc.edu/msmpaper
DP1: Students have the right to learn science.

DP2: The legacy of disparities in science can be disrupted.

Design Principles 1 and 2
Foundational Commitments
Because all students have the right to learn science, we must disrupt the legacy of disparities.

• **Principle 1: Students have the Right to Learn Science:**
  All students have the *right to learn science* to understand the world around them and the science that relates to issues in their lives and communities, so that they may act responsibly to serve their interests and the needs of their communities. Equitable science education supports engaged civic participation and provides students *access to further education and STEM careers.*

• **Principle 2: The Legacy of Disparities in Science can be Disrupted**
  Science education more equitably engages multilingual learners when educators view the teaching and learning of science from *multiple perspectives,* and attend to historical and contemporary disparities in power, authority, and status while working to disrupt those disparities and build a more just future with young people.
EVERY STUDENT

Legacy of disparities that must be disrupted (DP 2)

- Personal beliefs about self as belonging/not, science identity
- Teacher beliefs about MLs’ abilities to engage in science related to language & culture misperceptions
- School/district practices & policies about access to science courses
- Political beliefs about science, or who science is for & about

Right to learn science (DP 1)
- Community decision-making
- Social justice
- College access
- Career opportunities
What are some things we can do to overcome these obstacles?

Type some ideas into the chat window.
1. Connect to students’ lives, interests, and experiences.

2. Foster equitable community norms and peer collaboration.

3. Encourage the use of students’ home languages and multiple modalities.

4. Foster language growth and develop students’ awareness of how language works in context.

DESIGNING FOR EQUITABLE ENGAGEMENT
1. **Connect to students’ lives, interests, and experiences**

Opening up spaces for student agency and connecting learning to students’ lives are essential for making learning meaningful to students.

<table>
<thead>
<tr>
<th>Learn about and draw on students’ interests, experiences, and expertise about the topic of the lesson or unit.</th>
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<tbody>
<tr>
<td>Elicit authentic connections and examples from students and use these student contributions as a foundation for the learning that follows.</td>
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<td>Relate learning to local or global issues that impact students.</td>
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<td>Engage students in shared experiences related to the topic, so that students have a common foundation for reasoning and making connections.</td>
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<td>Engage students in reflection about their own participation and learning and set learning goals in collaboration with students.</td>
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<td>Give students opportunities to make choices about their learning.</td>
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<td>Make available to students' sources that reflect perspectives from various communities.</td>
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</table>
2. Foster equitable community norms and peer collaboration

Peer collaboration plays a central role in students’ disciplinary learning.

<table>
<thead>
<tr>
<th>Position all students as capable. Reinforce the idea that everyone’s contributions are important and valued</th>
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<tbody>
<tr>
<td>Develop a classroom community where <strong>multiple languages</strong> are recognized and overtly appreciated.</td>
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<tr>
<td>Discuss strategies that all students can use to foster effective <strong>communication</strong> among peers. Such strategies may include <strong>simplifying</strong> language (e.g., by rephrasing and slowing down), <strong>amplifying</strong> language (e.g., by providing multiple examples or reinforcing representations), checking for understanding, providing wait time, consulting a dictionary, and so on.</td>
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<tr>
<td>Encourage and model <strong>respect for difference</strong>.</td>
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<td>Engage students in reflection on how we use language to maintain <strong>effective group relationships</strong> (e.g., by opening up spaces for people and ideas, adjusting the intensity of statements, negotiating responsibilities...).</td>
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<tr>
<td>Model <strong>persistence and patience</strong> in working to understand all students’ ideas and language.</td>
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<td>Provide ample <strong>wait time</strong> after inviting students to share or revise ideas, and after students finish speaking.</td>
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<tr>
<td>Encourage self-reflection and provide detailed, <strong>constructive feedback on student participation</strong> in classroom activities.</td>
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</table>
3. Encourage the use of students’ home languages & multiple modalities. Students’ languages & language varieties are key to learning, and meaning is not made through language alone.

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<thead>
<tr>
<th>Recognize that students’ use of familiar language(s) and language practices (such as translanguaging) can help students: clarify ideas or instructions, build background knowledge, express and deepen ideas, and feel included and valued in the classroom community.</th>
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<tr>
<td><strong>Build students’ background knowledge</strong> using resources in their most familiar language(s) and multiple media.</td>
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<tr>
<td><strong>Support students in understanding how information is represented</strong> through different disciplinary tools (e.g., charts, maps, graphs).</td>
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<td><strong>Encourage students to express and explore ideas using multiple representations</strong> (e.g., drawings, models, concept maps, diagrams).</td>
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<td><strong>Supplement oral language</strong> (directions, discussions, insights) with visuals, gestures or actions, and/or written documentation of key ideas.</td>
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<td><strong>Frequently check student comprehension</strong> by asking questions in simple language, requesting a sketch or demonstration, or through other means appropriate for the student.</td>
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4. Foster language growth and develop students’ awareness of how language works in context. To develop language, students need carefully designed opportunities for language use. Language development entails not only learning more language structures (expressions and grammar rules) but also expanding students’ understanding of how they can use language to accomplish different goals in different contexts.

In any learning activity, make explicit the language expectations and reasons for them; elicit examples of the expected language and provide appropriate scaffolding.

Always focus on students’ meaning over linguistic correctness. Model alternate language choices and provide feedback on language when necessary, such as to avoid misunderstanding or help the student express an idea more effectively.

Give students multiple opportunities to discuss the same ideas over time, so they can deepen their understanding and refine their language.

Highlight context variables such as audience, purpose, and roles and relationships, and explore with students how they shape the language choices we make at the levels of the whole text, sections of the text, sentences, and words/phrases.
4. Foster language growth and develop students’ awareness of how language works in context.  
Continued....

<table>
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<th>Table Cells</th>
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<tbody>
<tr>
<td>When addressing language errors, focus on 1-2 errors over a period of time. Support students’ developing capacity to self-correct. Select errors that impact comprehensibility of students’ ideas or how effective students are at achieving their goals.</td>
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<td>Explore with students how they can integrate language with other modalities (such as visual representations, symbols, and models).</td>
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<td>Scaffold students’ transition from one language practice to another (for example, the transition from reading a text and taking notes to discussing these notes with peers and then writing a summary of the text).</td>
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<td>Document and highlight how different students express ideas, so that students’ own language can be a model for their peers.</td>
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<td>When providing language support, always offer students more than one way to express what they want.</td>
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Reflect on your classroom practices

- Is the phenomenon or topic interesting to students and relevant to their lives?
- Who is positioned as a contributor of ideas?
- Whose ideas are elicited and built upon?
- Do students have opportunities to draw on their languages, language varieties and other modalities for expressing ideas?
- Are language expectations made explicit and supported with appropriate scaffolding?
- Do students have multiple opportunities to practice using language in different ways?
Design Principles 3-6
SENSE-MAKING

DP3: Phenomena matter
DP4: Student contributions matter
DP5: Science and engineering practices matter
DP6: Positioning students with agency and authority matters.
Science as literacy: reading, worksheets, answering test questions

Science as engaging with phenomena, active sense-making, connecting to big ideas
Science as literacy: reading, worksheets, answering test questions

Science as engaging with phenomena, active sense-making, connecting to big ideas

The balance we strike between these approaches is highly consequential for MLs.
Four Pillars of Sense-Making
Phenomena, student contributions, science and engineering practices, positioning students with agency and authority all matter.

Principle 3: Phenomena Matter for Sense-Making
Learning science creates opportunity for active, meaningful, collaborative engagement with phenomena so that students work together to inquire into questions, figure out problems and design solutions, collect and make sense of evidence, build claims, and evaluate and communicate scientific information that matters to youth, their communities, and the world. When students have opportunities to engage with real-world events, new questions and problems arise, prompting students to pose and pursue additional questions using science and engineering practices. Creating opportunities for students to conduct qualitative or quantitative observations explicitly linked to phenomena or problems in order to generate evidence useful for building scientific explanations and arguments is essential for sense-making.

Principle 4: Student Contributions Matter for Sense-Making
Educator responsiveness to students’ ideas, language, and multiple ways of making sense is central to cultivating students’ interests and identities in science. Science is meaningful when students build and expand identities as capable learners, sense makers, users of science, and full participants in learning communities engaged in meaningful, consequential pursuits. Anchoring students’ contributions in an ongoing effort to build, test, revise, and justify scientific models created by students is an important way to keep students’ evolving meaning-making at the center of their scientific practice. Modeling, then, is a crucial component of students’ scientific work as they strive to develop and use models to explain, argue, or predict phenomena. When working within a community of learners, students develop models that can also serve as representations of thinking useful for communicating ideas with others.

Students build scientific understanding and language effectiveness simultaneously by engaging in communication-rich science and engineering practices, core ideas, and cross-cutting concepts. Engagement in science and engineering practices supports collective sense-making, both in the moment and across time, which supports gradual shifts in language use. Supporting students to gather evidence, coordinate that evidence with others’ ideas and evidence, and weigh strengths of evidence allows for shared sense-making about phenomena and makes space for students to critique different ideas and to build knowledge and language together.

Principle 6: Positioning Students with Agency and Authority Matters for Sense-Making
Students can express ideas that are complex, precise, and explicit with everyday language. Therefore, positioning students in ways that elicit their ideas is central to supporting their engagement as competent members of a learning community. Positioning students and teachers as co-inquirers whose interests, questions, and contributions are valuable for sense-making is essential for making science and language meaningful for learners. Creating opportunities for students to exercise agency as capable inquirers and problem-solvers fuels students’ efforts to build arguments from evidence as they become authors of scientific explanations, models, and designers of solutions to real-world problems.
Phenomena (DP3) act as engines that engage student ideas (DP4).

All students can speak with agency and authority (DP6) because they all experience the phenomenon.
The Science & Engineering Practices (DP5) strengthen student reasoning, agency, & authority by teaching how to work with ideas.
How MSM impacts sense-making in Science

Sense Making

How do students make sense of phenomena?

How do you know what they are thinking?

WIDA Language Practices
Express Co-Construct Interpret Present

Discourse Moves
Teacher to Student Student to Student

Equitable Science Instruction

Curriculum Science & STEM Kits
(Learning Cycle (5E), Phenomena or Story Lines)

Framework & NGSS DCI SEP CCC

Nature of Science

Ells in STEM Subjects (NASEM 2018)
1. To support sense-making, we need to know what students are thinking.

2. How can we find out what students are thinking in time to support change?

3. A focus on sense-making requires a shift in language focus.
WIDA LANGUAGE PRACTICES
for Engaging with Ideas in Science
Teaching **with a focus on sense-making** requires a shift in how we think about language.

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<th>Speaking</th>
<th>Listening</th>
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<td>Frontloading vocabulary</td>
<td>Prescriptive language tasks</td>
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4 language practices
language as a tool for sense-making

- **EXPRESS ideas**
- **CO-CONSTRUCT ideas**
- **INTERPRET ideas**
- **PRESENT ideas**
WIDA Language Practices: Language use during sense-making

**Get initial ideas out ‘on the table’ and clarify emerging ideas**
- Discussions and collaborative work in pairs or groups
- Highly interactive, unedited language, combined with gestures, actions, etc.

**Put ideas ‘in play’; analyze and critique ideas to construct new understandings**
- Discussions and collaborative work in pairs or groups
- Highly interactive, unedited language combined with gestures, actions, etc.

**Interpret and make sense of multiple forms of information**
- Reading texts, interpreting data displays or diagrams, watching videos, listening and taking notes on a lecture
- Mostly receptive written and spoken language combined with gestures, visuals, and other modalities

**Purpose: Present what’s learned for particular audiences and situations**
- Final written product or oral presentation
- Productive/expressive language that has been revised, edited, or scripted; follows specific criteria for effectiveness in terms of structure, format, content, word choice, stance, precision, detail, etc.
Examples of language practices in science

- Express ideas
  - Students interpret the meaning of diagrams or graphs of data

- Interpret ideas
  - Students share what they notice about a phenomenon with a group of peers

- Construct ideas
  - Students compare data collected by different groups to identify similarities and differences in their findings

- Present ideas
  - Students prepare a presentation explaining a phenomenon or system using a combination of oral and written text, diagrams, and/or tables
5E and 3D, inquiry-based science

Language for engaging with ideas

How do these connect?
## Integrating 5E Science Instruction and Language Practices

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### Integrating 5E Science Instruction and Language Practices

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- **ELABORATE**—2nd hands-on inquiry to help students tie in formal constructs to examine, change, or refine initial ideas
- **CLOSURE**—metacognitive checkpoint; students summarize what has been learned so far
- **EVALUATE (SUMMATIVE)**—end-of-unit test or a poster or presentation [Formative assessment is ongoing.]

*a LOT of talking about ideas!*
Sense-making discourse

Replace traditional Inquiry-Response-Evaluation interactions ...

• What is a habitat? Can anyone tell me the definition? ... Yes! That’s correct!

... with idea-focused conversations (discourse) among students. Probe for reasoning and evidence.

• Can anyone think of a situation where the opposite would occur? ...
• Do you agree with that group’s conclusion--why or why not?

See more at http://stem4els.wceruw.org/
TEACHER DISCOURSE MOVES

Help a student clarify

Help students apply their thinking to others' ideas

Make an idea public

Mark/emphasize a particular idea

Emphasize an idea

Help students deepen their reasoning

Help students listen carefully to and think about others' ideas

Help students deepen their reasoning

Help students apply their thinking to others' ideas; prompt peer-to-peer talk

STRENGTHEN REASONING: Teacher Discourse Moves

Help a student clarify his/her thinking

Wait time: 20-30 seconds after questions and after responses.

"Can you say some more about that?"
"Can you show us what you mean?"
"Can you draw that?"

Make ideas and thinking public and available for discussion

"Tell us more about what you're thinking."
Clarify/rephrase how idea is expressed, without overriding student's ownership.
"Did I say your idea correctly?"
Re-voice to connect everyday expression to more precise academic language. "So, you're saying..."

Mark/emphasize a particular idea

"Rebroadcast" an idea by re-voicing, or ask a student to re-voice or paraphrase to give an idea more exposure so everyone can hear it and think about it again.
"That's interesting. Can you say that again for us?"
"Will someone re-tell that idea for us?"

Help students listen carefully to and think about others' ideas

"Who can rephrase or repeat that idea for us?"
"How is that idea different from what we had said earlier?"
"Who wants to explain the evidence that Group A used?"
"Do you agree or disagree with that?"
"Whose idea/thinking is most different from your own?"

Help students deepen their reasoning

"Will you tell us more about your thinking on that? Why do you think that works?"
"Would that always be true?" "Is there a condition that would make that false?"
"How could you show that that is true?"
"How could we revise our model to account for this?"
"What new questions do you have now? What do we need to know more about now?"

Help students apply their thinking to others' ideas; prompt peer-to-peer talk

"Who will re-tell that idea for us? Please check back with X to see if you told it correctly."
"Who is ready to tell us the connections between those two ideas?"
"You look uncertain. What can you ask X to find out more?"
"How does that idea build on the last one? What's the connection?"
STUDENT DISCOURSE MOVES

Tell and explain

Tell or explain a new idea
“I think…”
“I know it will work because…”
“The best strategy would be…”

Clarify

Clarify someone’s idea
“Say again, please.”
“What did you mean when you said…?”
“Are you saying that…?”

Restate or summarize an idea
“He said…”
“In other words, …”
“The suggestion was made that…”

Compare ideas
“The same.”
“Our is better because…”
“The new strategy is more efficient because…”

Support an idea
“Good idea, because…”
“Remember, it said in our book that…”
“The advantage of that method is…”

Build on an idea
“Let’s try that.”
“We should change our model to show that.”
“That idea would help us figure out why…”

Question or challenge an idea
“Why?”
“But that doesn’t explain what we saw when…”
“Is there a more efficient way to …?”

Support

Question or challenge

Build on

Question or challenge an idea

Restate or summarize

Compare ideas
Do you use discourse supports to uncover and probe ideas in your classroom or remote settings? What kind? How is it working?

Add your ideas to the chat box
Language Use during 5E Instructional Sequence

- **engage**
- **explore**
- **explain**
- **elaborate**
- **closure**

evaluate (formative, stranded throughout)

**Everyday language**, with support as needed to clarify idea

**Introduce new language:**
1. when concept understood through activity
2. when it will increase a student’s effectiveness
What does it look like when students are engaging in all 4 language practices?

<table>
<thead>
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<th>Frequent interaction and dialogue</th>
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<tbody>
<tr>
<td>Students exchanging and building on one another’s ideas</td>
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<tr>
<td>Students moving beyond initial ideas and deepening or transforming their thinking</td>
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<tr>
<td>A variety of language uses – not all “academic language”</td>
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<tr>
<td>Wrestling with questions that don’t have simple answers, but require co-construction</td>
</tr>
<tr>
<td>Explicit transitions from interactive, unrehearsed talk to more formal or specialized written language</td>
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<tr>
<td>Continual interweaving of classroom talk with reading and writing</td>
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DP7: Educators must leverage and sustain students’ cultural and linguistic assets.

DP8: Students learn through expanding science and language repertoires.
**Principle 7: Educators must Leverage and Sustain Students’ Cultural and Linguistic Assets**

Equitable science education *leverages as assets* students’ experiences, ways of knowing, and cultural and linguistic resources. Learners’ life experiences, including family and community practices and pursuits, are essential for making sense of science and are worthy of being communicated, shared, and explored within a diverse learning community, ensuring that students develop science and language simultaneously in *culturally sustaining* ways.

**Principle 8: Students Learn Through Expanding Science and Language Repertoires**

Science is more culturally and linguistically responsive to multilingual learners when they have opportunities to explore ideas and questions, *beginning with their familiar language(s) and language practices*, and expanding science sense-making and developing language effectiveness gradually and over time through engagement in scientific discourse practices. Science teaching that leverages a broad range of language resources and multiple modalities (e.g., familiar and everyday language(s), translanguaging, gestures, and visual representations) *helps students expand their repertoires* of language use to enable expression of more complex ideas, explicitness, increased precision, and shifts in register.
Add more to this model.

PHENOMENON = powerful engine that drives science learning (DP 3)

Student ideas (DP 4)

I notice that... I think... I wonder if...

In my family/community/tribe, we know that...

No, what happened was...

Student agency & authority (DP 6)

SEPs (DP 5)

What do we know? How do we know what we know? What ways of knowing will we apply?

How do we think this through? How can we find out? What kinds of evidence do we need?

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Respect for diverse experiences, culture, & languages (DP7) and opportunities to broaden repertoires of science thinking and language use (DP8) permeate all of instruction.
How do we leverage assets and build linguistic and reasoning repertoires?

1. Connect to students’ lives, interests, and experiences.
2. Foster equitable community norms and peer collaboration.
3. Encourage the use of students’ home languages and multiple modalities.
4. Foster language growth and develop students’ awareness of how language works in context.

Try some actions from the presentation & watch for more from MSM!
What questions or ideas do you have?
Visit us at wida.wisc.edu and nsta.org
Thank you.
crowther@unr.edu
rkmacdonald@wisc.edu